

# Lapp Cable Guide



**LAPP GROUP**



**U.I. Lapp GmbH**

Schulze-Delitzsch-Straße 25  
70565 Stuttgart, Germany

Tel. +49(0)711/78 38-01

Fax +49(0)711/78 38-26 40

[www.lappgroup.com](http://www.lappgroup.com)

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## 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.

nated 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.

Our range includes cables, accessories, cable handling systems and pre-assembled cables. Based on our coordi-

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.



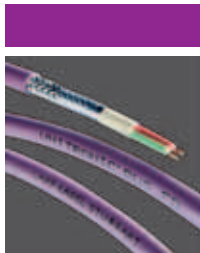
### UNITRONIC®

#### 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.



### 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.



### 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.



### 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

17 SERVO harnessings  
for drives

18 LCK Wrapping Label +  
FLEXIMARK® Stainless  
steel marking

19 Frontplug SIMATIC  
S7-300 with UL/CSA

14 UNITRONIC® BUS L2/FIP +  
M 12-PROFIBUS cable

15 HITRONIC® program  
for optical fibres

16 HOT-MELT

4 EPIC®

5 Cable systems and  
cable harnessing

6 Power chain systems

7 ÖLFLEX® FD

8 Woven cables

9 ÖLFLEX® ROBOT

10 SKINTOP®

11 SILVYN® RILL/  
SILVYN® FPAS

12 ÖLFLEX® Spiral cables

13 ETHERLINE®  
Fieldbus Systems

## 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](http://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](http://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](http://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
- Spiralsised 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®

Power- and control cables



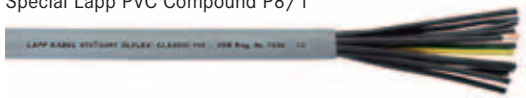
## ÖLFLEX® CLASSIC 100/110



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® 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



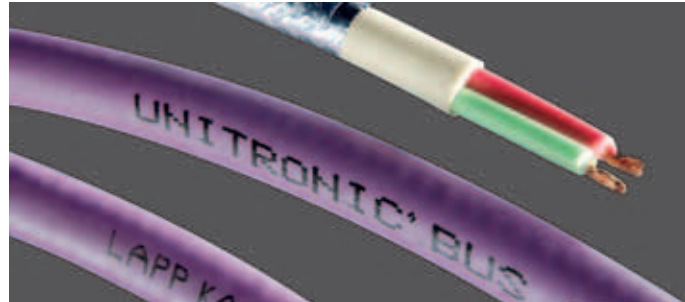
## Cable for sensor/ actuator components

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



## UNITRONIC®

Data communication systems



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## 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

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

## 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® 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

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## UNITRONIC® BUS ASI



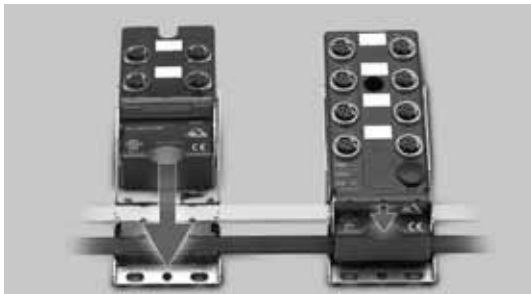
### Application range

- 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.

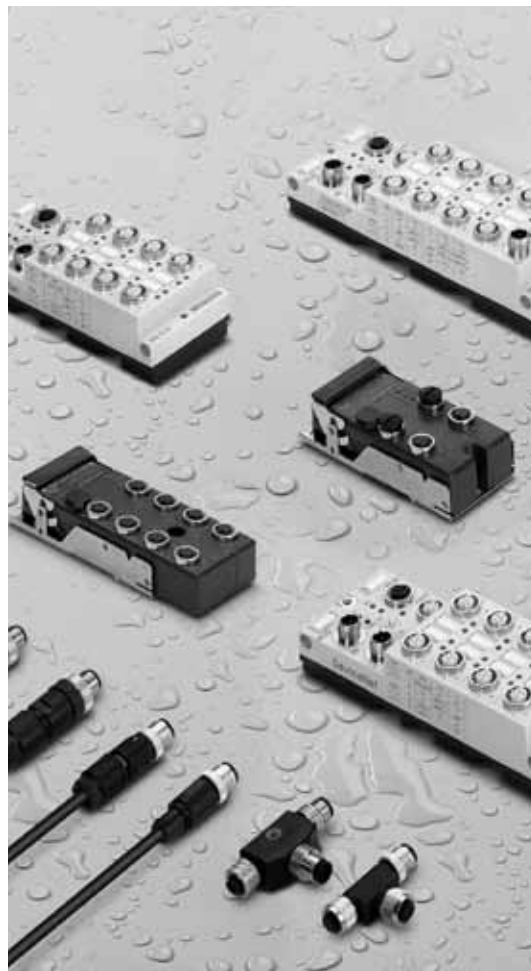
### Product features

- 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® BUS PB



UNITRONIC®

### 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, PROFIBUS-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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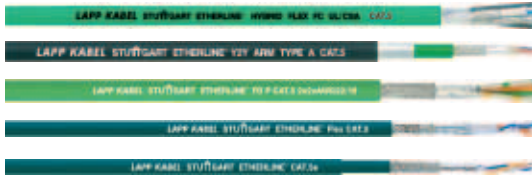
## ETHERLINE®

Data communication systems for ETHERNET-Technology





## ETHERLINE® 2-pairs CAT.5/5e



### Benefits

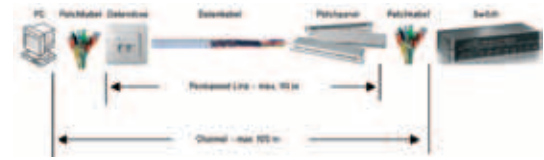
- ETHERNET with the globally accepted TCP/IP protocol will most probably either provide a connection to the established “Fieldbus World” or the Sensor-Actuator level. Either via a gateway to the “Fieldbus World” or straight through downwards to the lowest communication level. The transmission rates are presently either 10 Mbit/s (ETHERNET) or at least 100 Mbit/s = LAN CAT.5 requirements (Fast Ethernet = 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.

## 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 Fa	CAT.7a	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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## 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 62.5 µm, 50 µm Multimode LWL HDX	412 m 2,000 m
Gigabit ETHERNET	1000 Base-CX	Twinax STP (150 Ohm)	25 m
	1000 Base-T	Twisted Pair	100 m
	1000 Base-SX	62.5 µm Multimode LWL	275 m
	850 nm	50 µm Multimode LWL	550 m
	1000 Base-LX	62.5 µm Multimode LWL	550 m
	1300 nm	50 µm Multimode LWL Singlemode LWL	550 m 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	62.5 µm Multimode LWL	26 m
	850 nm	50 µm Multimode LWL	84 m
	10G Base-LR/LW	Singlemode LWL	10,000 m
	850 nm	Singlemode LWL	40,000 m

**HITRONIC®**  
Optical transmission systems



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 be carried out without consideration of possibly occurring sources of electromagnetic 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 automation
- 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



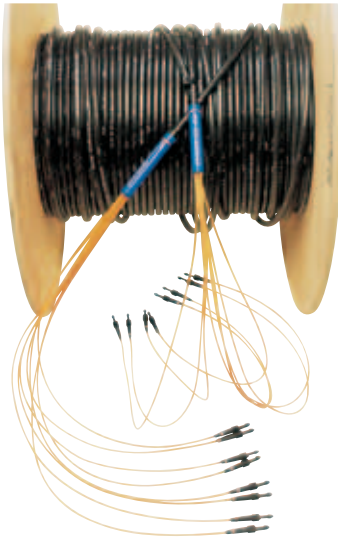
## Optical transmission systems



**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.



## Fibre Optical cables F.O.

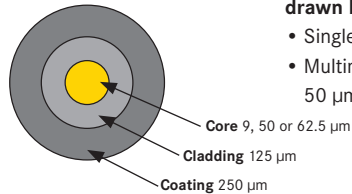
### Advantages of Fibre Optical Cables

- 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:

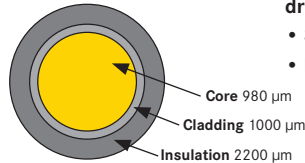
- Singlemode Fibre SM 9  $\mu\text{m}$
- Multimode Fibre MM 50  $\mu\text{m}$  or 62.5  $\mu\text{m}$



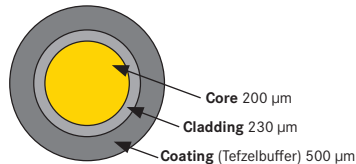
### POF – Polymer Optical Fibre

A distinction is drawn between GOF:

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



### PCF – Plastic Cladded Fibre



### 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

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

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 1 Gbit/s: 550	100 Mbit/s: 2.000 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 1 Gbit/s: 275	100 Mbit/s: 2000 1 Gbit/s: 550	
GOF SM			1 Gbit/s: 5.000	1 Gbit/s: 80.000 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-friendly termination.

## EPIC® Rectangular Connectors

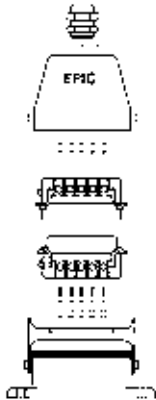
Quality, functionality and safety.

Three attributes, one brand name: EPIC® rectangular industrial connectors are renowned 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.



### Technical Data

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

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



## Technical Data

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

## EPIC® Circular connectors



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

### 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)

## 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.



**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

**Electrical data 5 + PE**

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

**Electrical data 3 + PE + 4**

Rated current	1 mm contacts: 7 A at 1.0 mm <sup>2</sup>
Rated current	2 mm contacts: 22 A at 2.5 mm <sup>2</sup>
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)
Overtoltage category	3
Termination size/type	1 mm contact: 0.14 – 1.0 mm <sup>2</sup> crimp AWG 18 – 24 crimp
Termination size/type	2 mm contact: 0.5 – 2.5 mm <sup>2</sup> crimp 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 Mechanically resistant

## 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

## 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

### Product features

- 4 mm connector system with double hook
- Pre-assembled with 100% automatic control
- Wide range of wire sizes from 1.5 mm<sup>2</sup> up to 6 mm<sup>2</sup>
- TÜV Rheinland certified
- UL in preparation

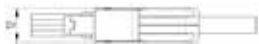
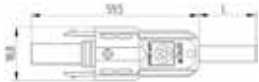
### Application range

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

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## 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

## SKINTOP®

Cable glands



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## 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



## 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.

## 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.

## 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

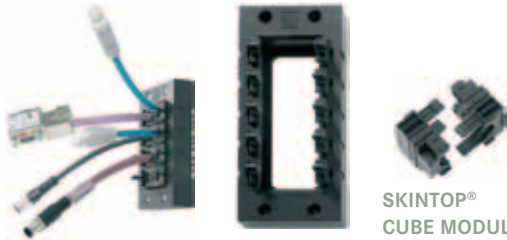


### Application range

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

**SKINTOP® CUBE**

SKINTOP® Cable Bushing System



SKINTOP® CUBE

SKINTOP® CUBE FRAME

SKINTOP®  
CUBE MODULE**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



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

## 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.

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## 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 sinusoidal 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.

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## 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.

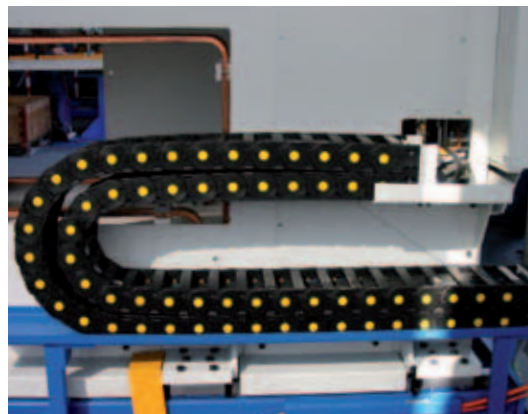


### SILVYN® HTDL

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 height 18 – 76 mm
- 12 types, many widths

### Application areas

- Automation
- Handling equipment
- CNC machines
- Medium sliding applications

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## 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)

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## 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

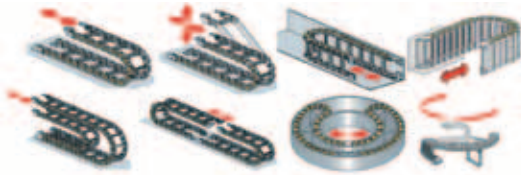
### Application areas

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

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## SILVYN® CHAIN Installation types

### Horizontal

























### Vertical

































**FLEXIMARK®**  
Cable marking products



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

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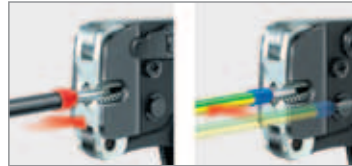
How?	DATA MARKING		
What?	 Laser office printer	 Flexisoft with ePLAN® and WS-CAD interface	 Thermal transfer printers
CABLE	Outdoor & Indoor	  COLLARS FOR CABLE TIES LFL 4.2      FLEXILABEL LFL & HOLDERS PTET/LAB	  FLEXILABEL TFL & HOLDERS PTEF/LAB      COLLARS FOR CABLE TIES & MARKING TAGS TMB
	Indoor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

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# Cable Accessories

## PEW 8.87

Front crimp pliers with a large range of diameters from 0.08 to 10 mm<sup>2</sup>



## EASY STRIP 2

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

X cassette: 0.02-10 mm<sup>2</sup>

XL cassette: 0.1-4 mm<sup>2</sup>

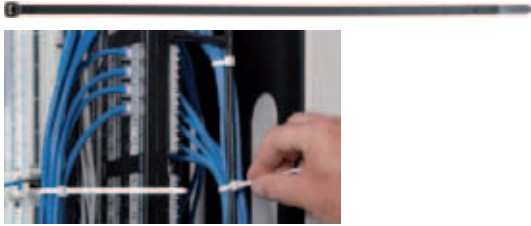
Please see our Main Catalogue for further details.



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Current information [www.lappgroup.com/products](http://www.lappgroup.com/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.

## 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

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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 over-

voltage, 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 between 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).

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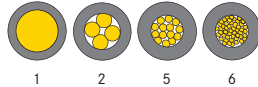
Classification according to design:

- Compact core: of a single wire (up to 16 mm<sup>2</sup>) 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 mm<sup>2</sup> 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

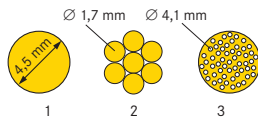


Example of a conductor with nominal cross-sectional area of 16 mm<sup>2</sup>

$$A = \pi r^2 \text{ or } A = \pi d^2 / 4$$

A = geometric cross-sectional area  
 r = radius  
 d = diameter

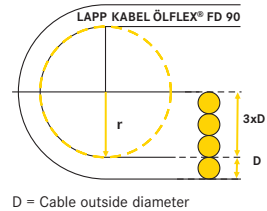
- 1: solid wire (1 x 4.5 mm)
- 2: multiple wires (7 x 1.7 mm)
- 3: fine wires (122 x 0.41 mm)



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### 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.



### 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.

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C, H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>, 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





## 2.4 Identification of wires (wire identification code)

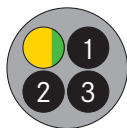
To be able to connect the wires correctly, they must be uniquely identified.

### 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

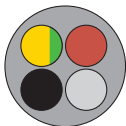


### Colour code

- 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



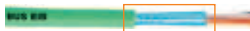
- Electromagnetic protection (EMC) by braiding made of tinned copper „C“ wires, e.g. ÖLFLEX® CLASSIC 110 CY black 0.6/1 kV



- 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.

Protection from emissions



Protection from emissions



## 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

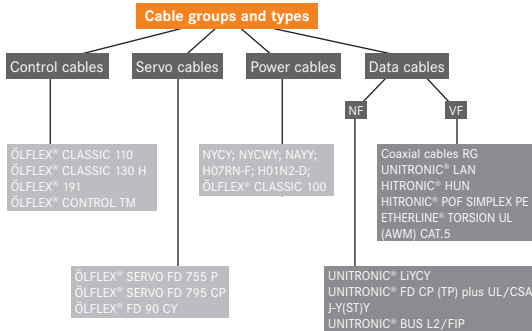
The mostly used sheath materials are as follows: PVC, PUR, SR, GR.

### 3. Labelling products of the Lapp Group programme

#### ÖLFLEX® CLASSIC 110 4 G 1.5 mm<sup>2</sup>



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? 2. What nominal voltage is required?

1. What is the purpose of use?  
Description of application
- $U_o/U$   
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...)
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

- 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. Standards, approvals, 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).

5. What requirements for norms should be fulfilled?  
National norms, e.g. VDE, HAR, UL, CSA, NOM...

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	
	<b>Application</b>														
	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			●							●			●		
<b>Standards</b>															
Based on VDE/HAR/DIN	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
As per Standard with VDE certification															
with VDE registration						●	●		●	●					
with HAR certification (HAR)															
with UL certification															
with CSA certification															
<b>Temperature range</b>															
+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® 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	
	<b>Laying</b>														
	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	●	●	○		●	●	●	●	●	○	○	●	●	●
	<b>Bending radius, low flexing</b>														
	5 x D														
	10 x D														
12.5 x D															
15 x D	●	●			●	●	●	●	●			●	●		
20 x D					●	●					●	●	●	●	
<b>Nominal voltage</b>															
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	
	<b>Make-up</b>														
	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 form 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		
	<b>Application</b>														
	Excepted circuits remain energized acc. IEE 60204-1 § 5.3.5														
	For intrinsically safe circuits in hazardous locations to VDE 0165	●	●												
	Hand tools and lamps on worksites														
	Oil resistant to UL + CSA specification					●	●	●	●	●	●	●	●	●	●
	Oil resistant to VDE			●	●	●	●	●	●	●	●	●	●	●	●
	Bio oil resistant														
	Cables resistant to chemicals														
	Cables resistant to ultra-violet light														
	Cold-flexible cables									○	○	●	●	●	
Servomotors/ Motive pow. engineering				●			●		●		●	●	●		
<b>Standards</b>															
Based on VDE/HAR/DIN	●	●						●	●						
As per Standard															
with VDE certification			●	●	●	●								●	
with VDE registration															
with HAR certification (HAR)			●	●	●	●	●	●	●	●	●	●	●	●	
with UL certification					●	●	●	●	●	●	●	●	●	●	
with CSA certification					●	●	●	●	●	●	●	●	●	●	
<b>Temperature range</b>															
+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	
	<b>Laying</b>													
	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	●	●	●	●	●	●	●	○	○	○	○	○	●
	<b>Bending radius, low flexing</b>													
	5 x D													●
	10 x D													●
12,5 x D			●		●									
15 x D	●	●			●		●	●						
20 x D			●		●		●	●		●				
<b>Nominal voltage</b>														
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	
	<b>Make-up</b>													
	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 form 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

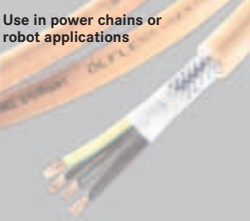
■ = Temperature range for flexible laying

▣ = Temperature range for static and flexible laying

□ = Temperature range for static laying

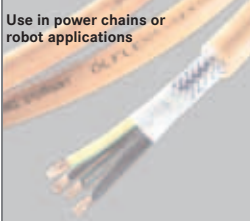
Selection Tables

A2: Highly Flexible FD® Cables – for use in power chains or robot applications

Application Criteria	Cable and Lead Designation											
 <p>Use in power chains or robot applications</p>	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
	<b>Application</b>											
	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												
<b>Temperature range</b>												
+105 °C												
+90 °C		□	□						□	□		
+80 °C		■	■	□	□	□	□	□	■	■	■	
+70 °C	■			■	■	■	■	■			■	
+60 °C												
+5 °C												
-5 °C						■						
-10 °C		■								■		
-20 °C												
-30 °C	□						■	■				
-40 °C		■	■	■	■	■	■	■	■	■	■	
-50 °C		□	□	□	□	□	□	□	□	□	□	

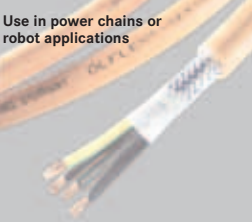
Selection Tables

A2: Highly Flexible FD® Cables – for use in power chains or robot applications

Application Criteria	Cable and Lead Designation											
 <p>Use in power chains or robot applications</p>	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
	<b>Minimum bending radius factor for continuous flexing</b>											
	5 x D		●						●			●
	6.5 x D											
	7.5 x D			●			●	●				
	10 x D											
	12.5 x D	●			●	●					●	
	15 x D											
	20 x D											
	<b>Laying</b>											
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	○	●	●	●	●	●	●	●	●	○	●	
<b>Nominal voltage</b>												
350 Vss				●	●							
30/300 V AC												
300/500 V AC												
600/1000 V AC	●	●	●			●	●	●	●	●	●	
600 V acc. to UL/CSA										●	●	

**Selection Tables**

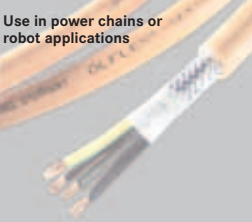
A2: Highly Flexible FD® Cables – for use in power chains or robot applications

Application Criteria	Cable and Lead Designation											
 <p>Use in power chains or robot applications</p>	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
	<b>Make-up</b>											
	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

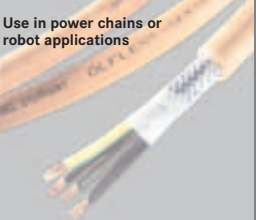
**Selection Tables**

A2: Highly Flexible FD® Cables – for use in power chains or robot applications

Application Criteria	Cable and Lead Designation										
 <p>Use in power chains or robot applications</p>	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	
	<b>Application</b>										
	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									●	●	
<b>Temperature range</b>											
+105 °C									▣	▣	
+90 °C											
+80 °C	▣	□	□	□	□	□	▣	▣			
+70 °C											
+60 °C		■	■	■	■	■					
+5 °C				■	■						
-5 °C					■						
-10 °C											
-20 °C							■	■			
-30 °C		■									
-40 °C	■		□	□	□	□	□	□	■	■	
-50 °C	□	□							□	□	

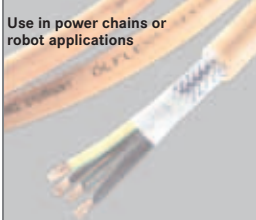
## Selection Tables

A2: Highly Flexible FD® Cables – for use in power chains or robot applications

Application Criteria	Cable and Lead Designation										
 <p>Use in power chains or robot applications</p>	ÖFLEX® SERVO FD 795 CP	SERVO-cable, acc. Indramat Standard INK	ÖFLEX® FD CLASSIC 810	ÖFLEX® FD CLASSIC 810 CY	ÖFLEX® FD CLASSIC 810 P	ÖFLEX® FD CLASSIC 810 CP	ÖFLEX® FD 820 H	ÖFLEX® FD 820 CH	ÖFLEX® FD ROBUST	ÖFLEX® FD ROBUST C	
	<b>Minimum bending radius factor for continuous flexing</b>										
	5 x D										
	6.5 x D										
	7.5 x D	●		●	●	●	●	●	●	●	●
	10 x D		●								
	12.5 x D										
	15 x D										
20 x D											
<b>Laying</b>											
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/s <sup>2</sup>	●	●	●	●	●	●	●	●	●	●	
For very high acceleration up to 50 m/s <sup>2</sup>											
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	●	●	○	○	○	○	○	○	○	●	
<b>Nominal voltage</b>											
350 Vss		●									
30/300 V AC											
300/500 V AC			●	●	●	●	●	●	●	●	
600/1000 V AC	●	●									
600 V acc. to UL/CSA	●	●									

## Selection Tables

A2: Highly Flexible FD® Cables – for use in power chains or robot applications

Application Criteria	Cable and Lead Designation										
 <p>Use in power chains or robot applications</p>	ÖFLEX® SERVO FD 795 CP	SERVO-cable, acc. Indramat Standard INK	ÖFLEX® FD CLASSIC 810	ÖFLEX® FD CLASSIC 810 CY	ÖFLEX® FD CLASSIC 810 P	ÖFLEX® FD CLASSIC 810 CP	ÖFLEX® FD 820 H	ÖFLEX® FD 820 CH	ÖFLEX® FD ROBUST	ÖFLEX® FD ROBUST C	
	<b>Make-up</b>										
	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



## Selection Tables

A2: Highly Flexible FD® Cables – for use in power chains or robot applications

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 (TP) plus	UNITRONIC® FD CP (TP) plus	UNITRONIC® BUS PB FD P
<b>Application</b>											
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											
<b>Temperature range</b>											
+105 °C											
+90 °C			■								
+80 °C	■	■								■	■
+70 °C					■	■	■	■	■	■	■
+60 °C											
+5 °C											
-5 °C				■	■	■	■				
-10 °C											
-20 °C											
-30 °C											■
-40 °C	■	■	■	■			■	■	■	■	■
-50 °C	■	■									■

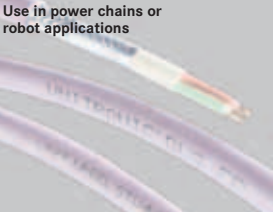
## Selection Tables

A2: Highly Flexible FD® Cables – for use in power chains or robot applications

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 (TP) plus	UNITRONIC® FD CP (TP) plus	UNITRONIC® BUS PB FD P
<b>Minimum bending radius factor for continuous flexing</b>											
5 x D		●						●			
6.5 x D											
7.5 x D			●	●	●		●		●	●	●
10 x D											●
12.5 x D											
15 x D											●
20 x D											
<b>Laying</b>											
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/s <sup>2</sup>	●	●	●	●	●	●	●	●	●	●	●
For very high acceleration up to 50 m/s <sup>2</sup>											
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		●	○	○	●	●	●	●	●	●	●
<b>Nominal voltage</b>											
350 Vss							●	●	●	●	●
30/300 V AC											●
300/500 V AC		●	●								
600/1000 V AC				●	●						
600 V acc. to UL/CSA				●	●						

## Selection Tables

A2: Highly Flexible FD® Cables – for use in power chains or robot applications

Application Criteria	Cable and Lead Designation											
 <p>Use in power chains or robot applications</p>	ÖFLEX® FD 855 P	ÖFLEX® FD 855 CP	ÖFLEX® FD 90	ÖFLEX® 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	
	<b>Make-up</b>											
	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












## Selection Tables

A3: Conveyor Cables

Application Criteria	Cable and Lead Designation											
	ÖFLEX® CRANE	ÖFLEX® LIFT F	ÖFLEX® CRANE F	ÖFLEX® CRANE OF	ÖFLEX® LIFT	ÖFLEX® LIFT	ÖFLEX® LIFT S	ÖFLEX® CRANE ZS	ÖFLEX® CRANE NSHTÖU	ÖFLEX® CRANE VS (NSHTÖU)	ÖFLEX® CRANE PUR	
	<b>Temperature range</b>											
	+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	□	□							□	□	▣	
<b>Standards</b>												
Based on VDE/HAR/DIN	●	●	●	●				●	●	●	●	
With VDE approval												
With VDE-Registrierung												
With HAR-Approval						●	●			●		
Flame retardant acc. to IEC 60332.1-2	●	●	●	●	●	●	●	●	●	●	●	
<b>Application</b>												
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 OF	ÖLFLEX® LIFT	ÖLFLEX® LIFT S	ÖLFLEX® CRANE ZS	ÖLFLEX® CRANE NSHTÖU	ÖLFLEX® CRANE VS (N)SHTÖU
<b>Bending radius</b>									
5 x D								●	
6.5 x D								○	
7.5 x D									●
10 x D		●		●					
12.5 x D	●								
15 x D									
20 x D					●	●	●	●	
<b>Nominal voltage</b>									
300/500 V	●	●	●	●	●	●	●		
450/750 V		●							
600/1000 V								●	●
<b>Make-up</b>									
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	●		●	●				●	●

- = 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 NSHTÖU	ÖLFLEX® CRANE VS (N)SHTÖU	ÖLFLEX® CRANE PUR	ÖLFLEX® CRANE	ÖLFLEX® CRANE OF	ÖLFLEX® CRANE ZS	ÖLFLEX® LIFT	ÖLFLEX® LIFT S	ÖLFLEX® CRANE F	ÖLFLEX® LIFT F
<b>Festoons</b>							●	●		
<b>Cable winding reels</b> light stress level (Monospiral installation – stacked)			●	○	●					
<b>Cable winding reels</b> medium stress level (Multispiral installation – single-layer)			●	○	●					
<b>Cable winding reels</b> high stress level (Multispiral installation – multi-layer)			●	●						
<b>Cable winding reels</b> vertical laying			●	●						
<b>Cable tender systems</b> (horizontal)			●	●						
<b>Cable tender systems</b> (vertical)				●						
<b>Guide pulley systems</b>			●	●						
<b>Push buttons</b>			●	●		●				
<b>Power chains</b>			○	○	○				○	○
<b>Elevator/Lift</b>							●	●	●	●

● = Main application ○ = Suitable application

## Selection Tables

A5: Data transmission cables for low-frequency analog/digital transmissions

Application Criteria	Cable and Lead Designation														
	UNITRONIC® LVY	UNITRONIC® LVY	UNITRONIC® LVY (TP)	UNITRONIC® LVY (TP)	UNITRONIC® LVY (TP)	UNITRONIC® PUR CP	UNITRONIC® PUR CP (TP)	UNITRONIC® LIHH	UNITRONIC® LIHH (TP)	UNITRONIC® 100	UNITRONIC® 100 CY	UNITRONIC® LVY-CY	UNITRONIC® LFYCY (TP)	UNITRONIC® CY/PDY (TP)	UNITRONIC® LYD11Y
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 mm <sup>2</sup> /AWG 22)	●	●		●	●	●	●	●	●	●	●				
Temperature range															
+80 °C	□	□		□	□	□	□	□	□	□	□	□	□	□	□
+70 °C	■	■	□	□	■	■	□	□	■	■	□	□	■	■	■
+60 °C															
-5 °C	■	■		■	■				■	■					■
-20 °C															
-30 °C	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
-40 °C															

Further halogen free cables and leads on request.  
 ● = 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


## Selection Tables

A5: Data transmission cables for low-frequency analog/digital transmissions

Application Criteria	Cable and Lead Designation														
	UNITRONIC® LVY	UNITRONIC® LVY	UNITRONIC® LVY (TP)	UNITRONIC® LVY (TP)	UNITRONIC® LVY (TP)	UNITRONIC® PUR CP	UNITRONIC® PUR CP (TP)	UNITRONIC® LIHH	UNITRONIC® LIHH (TP)	UNITRONIC® 100	UNITRONIC® 100 CY	UNITRONIC® LVY-CY	UNITRONIC® LFYCY (TP)	UNITRONIC® CY/PDY (TP)	UNITRONIC® LYD11Y
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)															

Selection Tables


A5: Data transmission cables for low-frequency analog/digital transmissions

Application Criteria	Cable and Lead Designation													
	UNITRONIC® ST	UNITRONIC® FD	UNITRONIC® FD CY	UNITRONIC® FD P plus	UNITRONIC® FD CP plus	UNITRONIC® FD CP (TP) plus	UNITRONIC® Li2YCY (TP)-Li2YCV (TP)	UNITRONIC® Li2YCY PIMF	JE-Y(STY)	JE-LiYCY (TP)	Telephone indoor cable J-Y(STY)	Fire alarm cable J-Y(STY) red	UNITRONIC® J-2Y(STY)	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 mm <sup>2</sup> /AWG 22)	●	●				●	○	●	●	●	●	●	●	
Temperature range														
+80 °C	□	□	□	□	□	□	□	□	□	□	□	□	□	
+70 °C	■	■	■	■	■	□	□	□	□	□	□	□	□	
+60 °C												□	□	
-5 °C		■	■										□	
-20 °C													□	
-30 °C	□	□	□				□	□	□	□	□	□	□	
-40 °C			■	■	■									

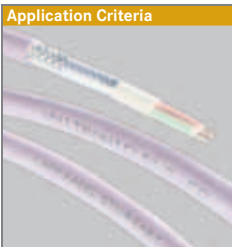
● = Principal application  
 ○ = Application not customary, but possible, or alternative design available in the range  
 ■ = Temperature range for flexible laying  
 □ = Temperature range for static and flexible laying  
 □ = Temperature range for static laying  
 Further halogen free cables and leads on request.

Selection Tables

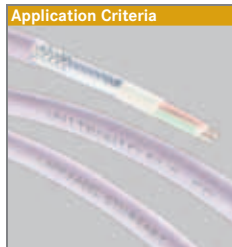
A5: Data transmission cables for low-frequency analog/digital transmissions

Application Criteria	Cable and Lead Designation													
	UNITRONIC® ST	UNITRONIC® FD	UNITRONIC® FD CY	UNITRONIC® FD P plus	UNITRONIC® FD CP plus	UNITRONIC® FD CP (TP) plus	UNITRONIC® Li2YCY (TP)-Li2YCV (TP)	UNITRONIC® Li2YCY PIMF	JE-Y(STY)	JE-LiYCY (TP)	Telephone indoor cable J-Y(STY)	Fire alarm cable J-Y(STY) red	UNITRONIC® J-2Y(STY)	Telephone outdoor cable
Application														
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)														●

Selection Tables  
A6: UNITRONIC®-COAX-/BUS-/LAN-Cables – Interfaces COAX-/BUS-/LAN-Cables

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
<b>Application</b>													
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)							●	●					
<b>Standards</b>													
PROFIBUS									●	●	●	●	●
INTERBUS (Phoenix Contact)	●	●	●	●	●								
BITBUS (Intel)						●	●						
For LAN installations (IBM, Ethernet etc.)													
With IBM reference approval													
Acc. to DEC specification													
<b>Temperature range</b>													
+205 °C													
+90 °C													
+80 °C				□		□							
+70 °C	□	■	□	■		□	□	□	□	□	□	□	□
+60 °C													
-5 °C													
-20 °C		■		■		■		■					

A6: UNITRONIC®-COAX-/BUS-/LAN-Cables – Interfaces COAX-/BUS-/LAN-Cables

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
<b>Temperature range</b>													
-30 °C	□		□		□		□		□		■	□	■
-40 °C										□			
-50 °C													
-190 °C													
<b>Characteristic impedance</b>													
≥ 150 Ohm										●	●	●	●
≥ 120 Ohm													
≥ 100 Ohm	●	●	●	●	●	●	●	●					
≥ 93 Ohm													
≥ 75 Ohm													
≥ 60 Ohm													
≥ 50 Ohm													
<b>Capacity category</b>													
CAT.5 ≤ 100 MHz													
CAT.6 ≤ 250 MHz													
CAT.7 ≤ 600 MHz													
<b>Make-up</b>													
PVC sheath		●		●	●	●	●	●	●	●	●	●	●
Halogen free sheath													
PE sheath													
PUR sheath, wear resistant; cutting resistant	●	●		●	●			●		●			
Flourpolymer outer sheath													
<b>Laying</b>													
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
- (with diagonal line) = Temperature range for static and flexible laying
- = Temperature range for static laying

## Selection Tables

A7: UNITRONIC® BUS and ETHERLINE®

## 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	=	Profi Bus
PE	=	Polyethylene outer sheath
PROFIBUS-DP	=	Decentralized Periphery
PROFIBUS-FMS	=	Fieldbus Message Specification
PROFIBUS-PA	=	Process Automation
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](http://www.lappgroup.com).



## Selection Tables

A8: Screw Type Cable Glands – At a glance

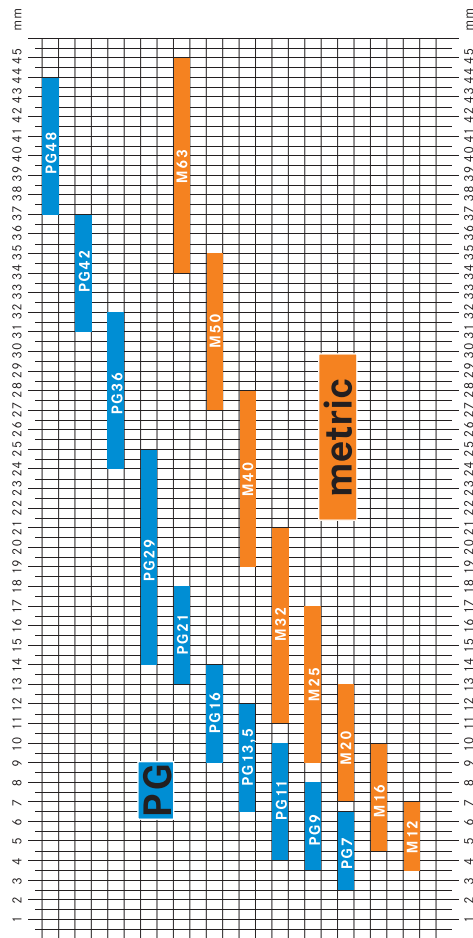
	Characteristics								
	Protection class IP / NEMA	Connection thread metric	Connection thread PG	Connection thread NPT for round cables	for flt at cables	Metal	Plastic	Angle	Strain relief
<b>Cable glands</b>									
SKINTOP® ST-M/STR-M/ST(R) M ISO	68/69K	●		●		●		●	●
SKINTOP® CLICK/CLICK-R	68			●		●		●	●
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	●		●		●		●	●

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

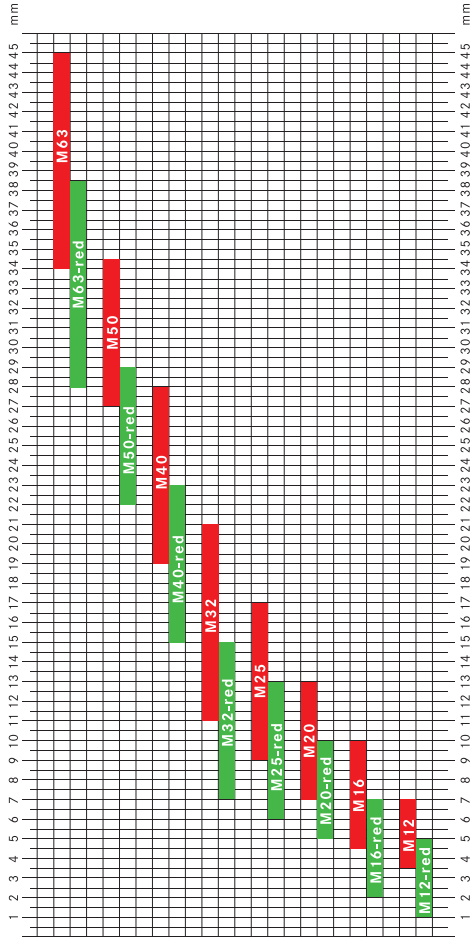
VITON® is a registered trademark of DuPont de Nemour

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

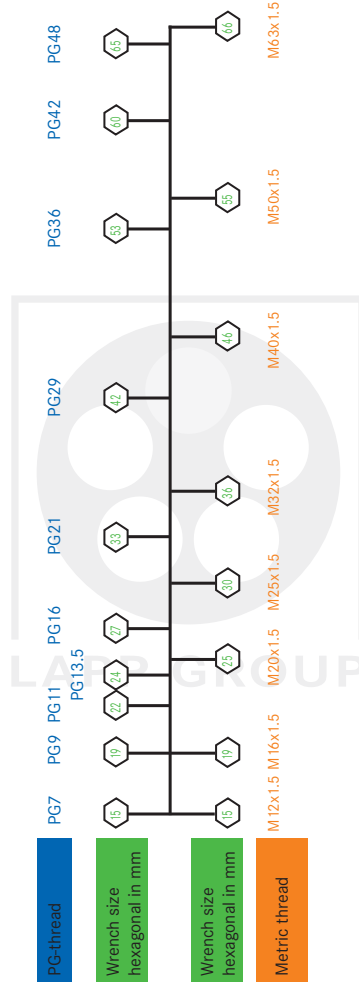




Clamping ranges SKINTOP® metric  
**SKINTOP® ST-M** and **SKINTOP® STR-M**



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



## Selection Tables

A11: Applications of HITRONIC® fibre optic components – At a glance

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
<b>Lapp Kabel HITRONIC® fibre optic (POF) program – fibre type, part number</b>												
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 <b>DESINA®</b> 4x1.5 + 2xPOF 980/1000, Part No. 2186 001			●		●	●			●			

## Selection Tables

A11: Applications of HITRONIC® fibre optic components – At a glance

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
<b>Lapp Kabel HITRONIC® fibre optic (PCF) program</b>												
HITRONIC® BUS PCF DUPLEX indoor, Part No. 2185 311									●	●	●	
HITRONIC® BUS PCF DUPLEX outdoor, Part No. 2185 302									●	●	●	
<b>Lapp Kabel HITRONIC® fibre optic (GOF) program</b>												
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)	●											

Selection Tables

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

Cable type	Type of service	Power Drive Systems														
		Line	Motor	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

Siemens part designations (6FX5002/5008, 6FX7002/7008, 6FX8002/8008) are registered trademarks of Siemens AG and for comparing purpose only. Indramat part designations (IKG, IKS, INK, INS, RKL und RKG) are registered trademarks of Bosch Rexroth AG and for comparing purpose only. Lenze® part designations (EWLM\_, EWLR\_, EWLE\_, EWLL\_, EYL und EYP) are registered trademarks of Lenze® AG used for comparing purposes only. SEW and SEW Eurodrive are registered trademark of SEW Eurodrive GmbH & Co KG, Ernst-Blickle Str. 42, D-76646 Bruchsal. Heidenhain, Elau, KEB, Controles Techniques, Berger Lahr, B & R, Fanuc and others are registered trademarks of its Owner, printed for comparing purpose only.

For more assemblies, refer to Main Catalogue. For detailed product information, please consult our current Main Catalogue or our homepage [www.lappgroup.com](http://www.lappgroup.com).

Selection Tables

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	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
<b>Nominal voltage</b>																
300/500 V	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
450/750 V			○	○												
600/1000 V																
10 kV																
600 V according UL/CSA					●	●										
<b>Standards</b>																
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	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
<b>Make-up</b>																
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	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
<b>Individual colours</b>																
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				
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.		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® 140, 140 CY, 150, 150 QUATRO, -191, -191 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				
All values are for +20 °C						
Inorganic chemicals	Conc.					
Alums	cs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Aluminium salts	a.c.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ammonia, aq.	10 %	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ammonium acetate, aq.	a.c.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ammonium carbonate, aq.	a.c.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ammonium chloride, aq.	a.c.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Barium salts	a.c.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Boric acid, aq.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Calcium chloride, aq.	cs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Calcium nitrate, aq.	cs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chromium salts, aq.	cs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Potassium carbonate, aq. (potash)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Potassium chlorate, aq.	cs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Potassium chloride, aq.	cs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Potassium dichromate, aq.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Potassium iodide, aq.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Potassium nitrate, aq.	cs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Potassium permanganate, aq.		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Potassium sulfate, aq.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Copper salts, aq.	cs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Magnesium salts, aq.	cs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sodium bicarbonate, aq. (soda)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Sodium bisulphite, aq.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Sodium chloride, aq. (cooking salt)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sodium thiosulphate, aq. (fixing salt)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nickel salts, aq.	cs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Phosphoric acid	50 %	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Mercury	100 %	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

= no to slight reaction  
 = slight to average reaction  
 = average to strong reaction  
 = good resistant  
 = moderate resistant  
 = less/not resistant  
 aq. = in aqueous solution  
 a.c. = any concentration  
 cs. = cold saturated

		Cable and Lead Designation				
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.		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® 140, 140 CY, 150, 150 QUATRO, -191, -191 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				
All values are for +20 °C						
Inorganic chemicals	Conc.					
Mercury salts, aq.	cs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nitric acid	30 %	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Hydrochloric acid	conc.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Sulphur	100 %	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sulphur dioxide, gaseous		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Carbon disulphide		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Hydrogen sulphide		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sea water		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Silver salts, aq.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hydrogene peroxide	3 %	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Zinc salts, aq.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Stannous chloride		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Organic chemicals						
Ethyl alcohol	100 %	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Formic acid	30 %	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Gasoline		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Succinic acid, aq.	cs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Acetic acid	20 %	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Hydraulic oil		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Isopropyl alcohol	100 %	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Machine oil		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Methyl alcohol	100 %	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Oxalic acid, aq.	cs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cutting oil		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Vegetable oil and fats		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Tartaric acid, aq.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Citric acid		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

		Cable and Lead Designation			
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.		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, UNITRONIC® LYD11Y, 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 LIF Y Halogen-free cables and leads UNITRONIC® H-(STH, 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			
All values are for +20 °C					
Inorganic chemicals	Conc.	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, UNITRONIC® LYD11Y, 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 LIF Y	Halogen-free cables and leads UNITRONIC® H-(STH, 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
Alums	cs.				
Aluminium salts	a.c.				■
Ammonia, aq.	10 %	□	□	□	■
Ammonium acetate, aq.	a.c.	□	□	□	■
Ammonium carbonate, aq.	a.c.	■	□	□	□
Ammonium chloride, aq.	a.c.	■	□	□	□
Barium salts	a.c.				■
Boric acid, aq.		■	□	□	■
Calcium chloride, aq.	cs.	■	□	□	■
Calcium nitrate, aq.	cs.				■
Chromium salts, aq.	cs.	□	□	□	■
Potassium carbonate, aq. (potash)			■	□	□
Potassium chlorate, aq.	cs.		□	□	□
Potassium chloride, aq.	cs.	■	□	□	■
Potassium dichromate, aq.		■	□	□	□
Potassium iodide, aq.			□	□	■
Potassium nitrate, aq.	cs.		□	□	■
Potassium permanganate, aq.		■	□	■	□
Potassium sulfate, aq.			□	□	■
Copper salts, aq.	cs.	□	□	□	□
Magnesium salts, aq.	cs.	□	□	□	■
Sodium bicarbonate, aq. (soda)		■	□	□	□
Sodium bisulphite, aq.		□	■	□	□
Sodium chloride, aq. (cooking salt)		□	□	□	■
Sodium thiosulphate, aq. (fixing salt)		■	□	□	□
Nickel salts, aq.	cs.	□	□	□	■
Phosphoric 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

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

		Cable and Lead Designation			
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.		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, UNITRONIC® LYD11Y, 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 LIF Y Halogen-free cables and leads UNITRONIC® H-(STH, 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			
All values are for +20 °C					
Inorganic chemicals	Conc.	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, UNITRONIC® LYD11Y, 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 LIF Y	Halogen-free cables and leads UNITRONIC® H-(STH, 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
Mercury salts, aq.	cs.	□	□	□	■
Nitric acid	30 %	□	□	□	■
Hydrochloric acid	conc.	■	□	□	■
Sulphur	100 %	□	□	□	□
Sulphur dioxide, gaseous		■	□	□	□
Carbon disulphide		■	□	□	□
Hydrogen sulphide		□	□	□	□
Sea water		□	□	□	■
Silver salts, aq.		□	□	□	□
Hydrogene peroxide	3 %	□	□	□	□
Zinc salts, aq.		■	□	□	■
Stannous chloride		□	□	□	□
Organic chemicals					
Ethyl alcohol	100 %	■	□	□	■
Formic acid	30 %	■	□	□	■
Gasoline		□	■	□	■
Succinic acid, aq.	cs.	□	□	□	■
Acetic acid	20 %	□	□	□	■
Hydraulic oil		■	□	□	■
Isopropyl alcohol	100 %	□	□	□	■
Machine oil		■	□	□	■
Methyl alcohol	100 %	□	□	□	■
Oxalic acid, aq.	cs.	■	□	□	■
Cutting oil		■	□	□	■
Vegetable oil and fats		□	□	□	■
Tartaric acid, aq.		□	□	□	■
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.

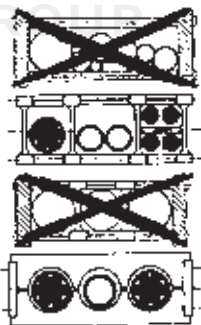
2. The minimum permissible bending radii of the cables must be strictly adhered to (please, find further appropriate information in the Technical Data of our Catalogue under bending radius for flexible use).
3. The cables must be laid out without twisting into the power chain system. Therefore, please, 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.



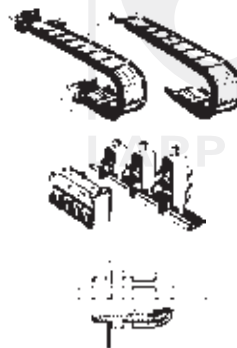
4. The cables must lie loosely next to each other in the chain stays. As far as possible they should be arranged individually, disjoined via separators and placed within individual holders in the neutral zone of the chain. The free space for the cables in the chain stay should be at least 10 per cent 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).
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.

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

September 2009

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

- 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 unreeel the cable with the aid of idler pulleys by using a drag rope and a cable holding sleeve.
- During unreeeling 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 cable temperature may not be below +5 °C during this procedure (normative reference to VDE 0298).
- 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 be avoided.



incorrect



incorrect

- 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:

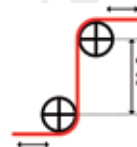


- If the infeed point is passed over during operation it will be necessary to use a compensating pulley of appropriate diameter carrying 1 – 2 cable windings. If the infeed is underground below the surface it will be necessary to provide a diverting funnel above the compensating pulley.
- It is essential to use sufficiently proportioned clamps or cable holding sleeves (length  $\geq 4 \times D$ ) 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  $40 \times D$  but it is advisable to use also here a compensating pulley.
- 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.
- For ÖLFLEX® CRANE NSHTÖU cables with an outside diameter of up to 21.5 mm the inner bending diameter should not be less than 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.

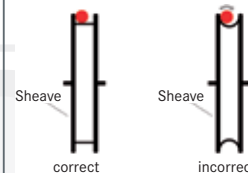
- S-bends in the cable must be avoided. However if this proves impossible in the case of cables with an outside diameter of up to 21.5 mm the center spacing of the two idlers must be at least 20 times and for those above 21.5 mm at least 25 times the cable diameter.



- The permissible reeling speed may be up to  $v = 2 \text{ m/sec}$  at an acceleration of up to  $a = 0.4 \text{ m/sec}^2$ .
- The static continuous tension load should not exceed  $15 \text{ N/mm}^2$  of the total copper cross-section and the dynamic peak tensile force may not exceed  $25 \text{ N/mm}^2$ . 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 permanent 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.



- The actual current rating (I) in continuous operation depends on
  - the conductor cross-section ( $I_{\text{max}}$ )
  - 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:

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

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

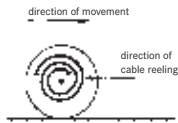


### ■ Lift Control Cables Type ÖLFLEX® LIFT, ÖLFLEX® LIFT T, ÖLFLEX® LIFT S

#### 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 than 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.

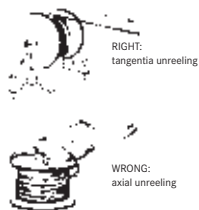
Fig. 1



#### 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

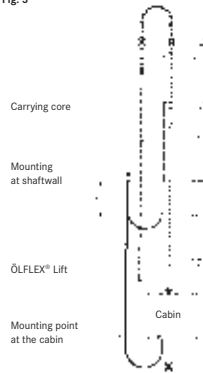


### ■ Lift Control Cables Type ÖLFLEX® LIFT, ÖLFLEX® LIFT T, ÖLFLEX® LIFT S

#### 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 cable  
GL Glass filament  
Li Stranded core to VDE 0812  
LiF Stranded core to VDE 0812, superfine wire

## 4. Special features

T Support wire  
Ü 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 mm<sup>2</sup>

## 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 mm<sup>2</sup>

## Example: NSHTÖU 24G 1.5

ÖLFLEX® CRANE NSHTÖU – VDE approved, 24-core with protective conductor, cross-section 1.5mm<sup>2</sup>

## Example: H05 VV-F 3G 1.5

medium PVC sheathed cable 3-core with protective conductor, cross-section 1.5 mm<sup>2</sup>

## 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)
- StII 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

## 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

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

### 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	

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

EXT = Extension Cables

COM = Compensating Cables

### ■ 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 conductors	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 conductors	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 conductors	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

T9: Core Ident Code according to VDE Colour Code

### ■ 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.

T9: Core Ident Code according to DIN Colour Code

### ■ 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   
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:**



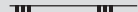






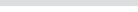







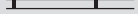


The cores of these pairs are marked  
by the basic colours of the insulating  
sheath, which are repeated in the  
same sequence in each unit:

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 in-  
sulation 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.



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

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

Conductor Resistances: for annealed- | core cables  $\geq 0.5 \text{ mm}^2$  acc. to DIN EN  
copper-conductors in single- and multi- | 60228 (VDE 0295).

Nominal cross-section in $\text{mm}^2$	Conductor resistance for 20 °C for 1 km in $\Omega$ (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 mm <sup>2</sup>	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 mm <sup>2</sup>	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			
Method of installation	A Single core cable • rubber insulated • PVC insulated • TPE insulated • heat resistant	B Multi core cables and cords for home- and portable apparatus • rubber insulated • PVC insulated • TPE insulated	
Number of current carrying conductors	1 <sup>3)</sup>	2	3
Nominal cross section in mm <sup>2</sup>	Current rating in A	Current rating in A	
0.08 <sup>1)</sup>	1,5	-	-
0.14 <sup>1)</sup>	3	-	-
0.25 <sup>1)</sup>	5	-	-
0.34 <sup>1)</sup>	8	-	-
0.5	12 <sup>2)</sup>	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			
Method of installation	C Multicore cables + cords, excl. home- + portable apparatus • rubber insulated • PVC insulated • TPE-insulated • heat resistant	D Multicore heavy duty rubber cables ≤ 0.6/1kV Single core special rubber cables 0.6/1kV or 1.8/3kV	
Number of current carrying conductors	2 or 3	3	1 <sup>3)</sup>
Nominal cross section in mm <sup>2</sup>	Current rating in A	Current rating in A	
0.08 <sup>1)</sup>	1	-	-
0.14 <sup>1)</sup>	2	-	-
0.25 <sup>1)</sup>	4	-	-
0.34 <sup>1)</sup>	6	-	-
0.5	9 <sup>2)</sup>	-	-
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 than 3 current carrying cores of multiconductor cables up to 10 mm<sup>2</sup>: Table 12-3
- Ambient temperatures > 50 °C of heat resistant wire & cables: Table 12-4
- for winded, spooled cables: Table 12-5
- Grouping of single 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: Single 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, NHX-MH, NY, NYC, NYCWY, NHXHX see VDE 0298-4, 2003-08, Table 3 & 4.

Cables & wires in machines: see DIN EN 60204-1/VDE 0113-1 Cables & wires in machines for USA: see National Electrical Code & NFPA 79, Table 13

<sup>1)</sup> VDE 0891-1 -borrowed current ratings for conductor sizes < 0.5mm<sup>2</sup> (0.08 - 0.34 mm<sup>2</sup>)

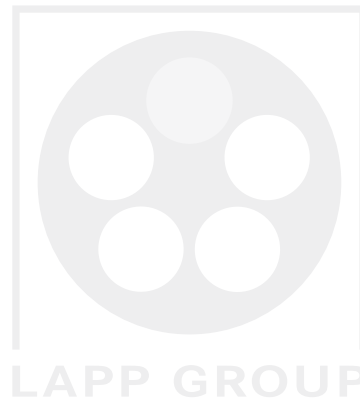
<sup>2)</sup> In terms of VDE 0298-4, 2003-08, Table 11 column 2 extended range for size 0.5 mm<sup>2</sup>.

<sup>3)</sup> 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 be applied before 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 conductor size up to 10 mm<sup>2</sup> (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 accordance to DIN VDE 0298-4, 2003-08, conduits or closed wire ways (in accordance to Table 21).

Number of current-carrying multicore cables or number of groups of 2- or 3-phase A.C. circuits single core cables								
Type of installation (method)	1	2	3	4	5	6	7	8
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, directly 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, directly 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, directly attached to ceilings.	0.95	0.81	0.72	0.68	0.66	0.64	0.63	0.62
With clearance of "d" between each other, directly attached to ceilings 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							
Type of installation (method)	9	10	12	14	16	18	20
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, directly 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, directly 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, directly attached to ceilings.	0.61	0.61	0.61	0.61	0.61	0.61	0.61
With clearance of "d" between each other, directly attached to ceilings 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).

dance 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	
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
		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 method) 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			Applicable as a multiplier of the rated values of:	
		1	2	3		
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	
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	
Cable tray, punched (ventilated)	in touch	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	
Cable tray, ladder type	in touch	1	1.00	0.91	0.89	three cables, vertical array, delta-configuration
		2	1.00	0.90	0.86	
Cable tray, ladder type	in touch	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 method) 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			
	30 °C			
Ambient-temperature				
Installation-methode				
Free in air				
Number of current carrying conductors	2	3	2	2
Conductors nominal cross-section in mm <sup>2</sup>	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		
	30 °C		
Ambient-temperature			
Installation-methode			
Free in air			
Number of current carrying conductors	3	3	3
Conductors nominal cross-section in mm <sup>2</sup>	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		Continuous		Interrupt				
Operating periode		5 min						
Operating factor OF		100 %	85 %	80 %	60 %	35 %	20 %	8 %
Nom. cross section copper conductor mm <sup>2</sup>		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		Continuous		Interrupt				
Operating periode		10 min						
Operating factor OF		100 %	85 %	80 %	60 %	35 %	20 %	8 %
Nom. cross section copper conductor mm <sup>2</sup>		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 °F 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.

Conductor size AWG or kcmil (MCM)	Temperature Rating of Conductor			Conductor size AWG or kcmil (MCM)	Temperature Rating of Conductor		
	60 °C (140 °F)	75 °C (167 °F)	90 °C (194 °F)		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 marked 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 conductors 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 <sup>-3</sup> )
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 terephthalate	PBTP	–	-60 +110	3.0 – 4.0
Polytetrafluorethylene	PTFE	5Y	-190 +260	2.1
Tetrafluorethylene Hexafluorpropylene Copolymer	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

Material	Parameter				
	Abbreviation	volume resistivity ( $\Omega \times \text{cm}$ )	tensile strength $\text{N}/\text{mm}^2$ MPa	Elongation %	Water absorption ( $20^\circ \text{C}$ ) %
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 terephthalate	PBTP	$10^{16}$	50 – 100	50 – 300	0.5
Polytetrafluorethylene	PTFE	$10^{18}$	14 – 40	240 – 400	0.01
Tetrafluorethylene Hexafluorpropylene Copolymer	FEP	$10^{18}$	20 – 25	250 – 350	0.01
Ethylene-tetrafluorethylene	ETFE	$10^{16}$	40 – 50	100 – 300	0.01
Perfluoroalkoxy-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	EPDM	$10^{14}$	5 – 25	200 – 450	0.02
Thermoplastic polyolefin elastomer	TPE-O	$5 \times 10^{14}$	$\geq 6$	$\geq 400$	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

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 terephthalate	good	good	good	flammable
Polytetrafluorethylene	very good	very good	very good	non-flammable
Tetrafluorethylene Hexafluorpropylene Copolymer	very good	very good	very good	non-flammable
Ethylene-tetrafluorethylene	very good	very good	very good	non-flammable
Perfluoroalkoxy-polymer	very good	very good	good	non-flammable
Chloropren rubber	very good	poor	good	self-extinguishing less
Silicone rubber	very good	poor	moderate	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 to 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 mm<sup>2</sup> as well as the requirements of the AWG system, in the following these systems are compared on the basis of their nominal sizes.

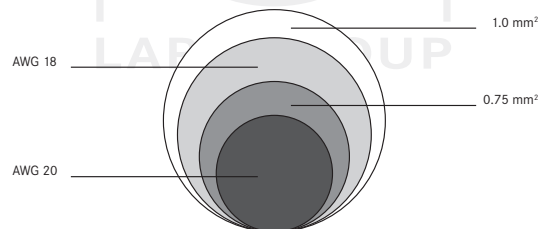
**Please consider that there are no definite equivalents**, because the requirements of both systems regarding cross section and conductor resistance differ to each other. The following Table should help to find the right nominal cross section. The respective standards for the project planning, e.g. UL 1581 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				column			
1a	1b	2	3	4	5a	5b	
Required North-american dimension		Geo-metrical conversion	Metrical nominal cross section, which fulfils the electrical requirements	Required metrical cross section	Northamerican dimension, which fulfils the electrical requirements		
AWG	kcmil	mm <sup>2</sup>	mm <sup>2</sup>	mm <sup>2</sup>	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			column			
1a	1b	2	3	4	5a	5b
Required North-american dimension		Geo-metrical conversion	Metrical nominal cross section, which fulfils the electrical requirements	Required metrical cross section	Northamerican dimension, which fulfils the electrical requirements	
AWG	kcmil	mm <sup>2</sup>	mm <sup>2</sup>	mm <sup>2</sup>	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.

#### Example for how to calculate the copper price supplement for cables:

Flexible cable ÖLFLEX® CLASSIC 100, 3G1.5 mm<sup>2</sup>, Copper index per Catalogue: 43 kg/km. Therefore the calculated copper weight is 43 kg per 1 km.

Copper index (kg/km)	x	(DEL + 1 % procurement surcharge) - copper price basis	=	copper supplement cost in Euro/100 m
		1000		

ÖLFLEX® CLASSIC 110, 3G1.5 mm<sup>2</sup>.

DEL: 247.75 Euro/100 kg. Cu base 150.- Euro/100 kg.

Cu index: 43 kg/km

43 kg/km	x	(247.75+2.48) - 150.00	=	4.31 Euro/100 m
		1000		

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 mm<sup>2</sup>.

#### 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".

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(S)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.

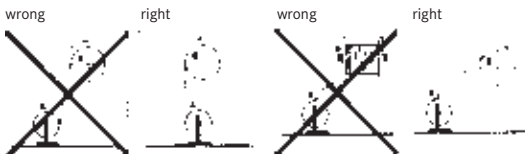
#### The copper index

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

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 applicable.

<p>UNDERWRITERS LABORATORIES INC.</p>	<p>LISTED COMPONENT MARK FOR CANADA AND UNITED STATES</p>	<p>ISTITUTO ITALIANO DEL MARCHIO DI QUALITÀ</p>
<p>LLOYD'S REGISTER OF SHIPPING</p>	<p>CANADIAN STANDARDS ASSOCIATION</p>	<p>PHYSIKALISCH-TECHNISCHE BUNDESANSTALT</p>
<p>ZERTIFIKAT GERMANISCHER LLOYD</p>	<p>VERBAND DEUTSCHER ELEKTROTECHNIKER</p>	<p>eingetragen im Musterregister beim Amtsgericht Stuttgart</p>
<p>SCHWEIZERISCHER ELEKTROTECHNISCHER VEREIN</p>	<p>GGVS Gefahr-Gut-Verordnung-Straße EN 220500 ff.</p>	<p>„Gost R“ Certification for Russia</p>



Unreeeling 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 NSS-HÖU 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

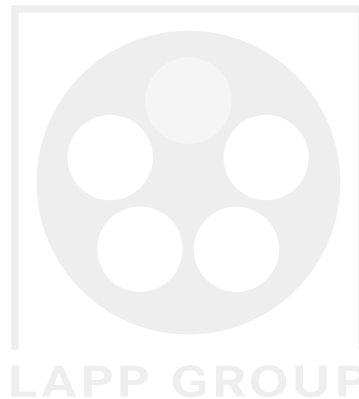
The tensile stress imposed on the conductor should be as low as possible. The following tensile stresses for the conductor must not be exceeded in the case of cables:

- Flexible cables 15 N/mm<sup>2</sup> 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 radii 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 mm<sup>2</sup> 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 $\varnothing$	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 $\varnothing$	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 $\varnothing$	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 $\varnothing$	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.

Cable and lead designation						
Reagens	concentration	at temp +°C	Polyamide PA 6	Polyamide PA 6.6	Polyamide PA 12	Thermoplastic Polyurethane PU
			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.			
Exhaust gases, containing carbon dioxide	any	60				
Waste gas, containing SO <sub>2</sub>	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	20	pure ■	pure ■	pure ■	
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

Cable and lead designation						
Reagens	concentration	at temp +°C	Polyamide PA 6	Polyamide PA 6.6	Polyamide PA 12	Thermoplastic Polyurethane PU
			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.			
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% ■	



		Cable and lead designation				
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.		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

		Cable and lead designation					
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.			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 <sub>2</sub>	low			■	■		
Acetaldehyde	40%		■				20 °C
Acetone	100%		■	▣	▣		□
Acrylic acid	100%						20 °C
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%		■	■	■	■	▣

	Cable and lead designation					
		Polypropylene PP	Polyethylene HD-PE	Polyethylene LD-PE	Polystyrene PS	Nitrile Butadiene rubber: NBR
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.						
Reagens	concentration					
Ethanoic acid	10%	■	■	■	▣	
Ethyl alcohol, hydrous	10%				■	
Ethyl dichloride	100%	▣	□	□		□
Ethylenoxid	100%	▣				
Ethyl 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

	Cable and lead designation					
		Polypropylene PP	Polyethylene HD-PE	Polyethylene LD-PE	Polystyrene PS	Nitrile Butadiene rubber: NBR
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.						
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%	20 °C ■	20 °C ■	20 °C ■	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% ■	□
Hydrochloric 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** Technical Tables

T24: Chemical resistance of plastic materials

		Cable and lead designation					
		Polypropylene PP	Polyethylene HD-PE	Polyethylene LD-PE	Polystyrole PS	Nitrile Butadiene rubber NBR	
Reagents	concentration						
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.							
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

LAPP GROUP

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<b>Absorption</b>	Cause for attenuation of a fibre optic cable.
<b>ACR</b>	Abbreviation for Attenuation to Crosstalk Ratio. The ACR value indicates the relationship between the near-end crosstalk and the attenuation at a certain frequency.
<b>Address bus</b>	System of associated cables, to which address bits can be transferred.
<b>Adhesion</b>	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.
<b>Aging</b>	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.

<b>Aging resistance</b>	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.
<b>Alternating current</b>	The alternating current is produced by linking three alternating currents with identical oscillation values and frequencies. Also known as multi-phase alternating current.
<b>Aluminium sheath</b>	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.
<b>American wire gauge</b>	Cables or cores according to American cross-sections/ dimensions. High AWG number → small cross-section, low AWG number → large cross-section (see Table T16).

<b>Ampacity</b>	Maximum permitted current that can be transmitted under defined conditions. VDE0298, Part 4.
<b>Ampere</b>	The strength of an electric current that flows through a conductor. Unit of measurement for the electric current (A).
<b>Analog signal transmission</b>	Transmission of continuously variable signals with which the light output is modulated.
<b>Angle of beam spread</b>	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.
<b>ANSI</b>	Abbreviation for the American National Standards Institute. An American committee which, similar to the German DIN, develops and publishes standards.
<b>Antenna cable</b>	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.



<b>BASEC</b>	Abbreviation for the British Approvals Service for Cables. Certification body – Great Britain and Northern Ireland.
<b>Basic raw materials</b>	In addition to the basic raw material, synthetic materials contain a range of other components such as stabilisers, softeners, filler and colour.
<b>Batteries Act</b>	The Battery Act came into force in 2009 and also covers the registration and return of batteries.
<b>Battery cables</b>	Link between battery and generator in the engine. They are developed, manufactured and delivered in accordance with customer requirements/product specifications.
<b>Baud</b>	Unit for a modulation rate in the transmission of communications. One step per second. 1 bit/s = baud, 1Mbit/s = 1 Mbaud → see Bit
<b>Bel</b>	1 Bel = 10 decibels. In high-frequency technology, the common unit of measurement for

	attenuation and, like decibel, a dimensionless ratio.
<b>Bending capacity</b>	The bending capacity indicates how far a product can bend without forfeiting function.
<b>Bending cycle</b>	Number of bends repeated in the drag chain (How often was a cable actively stressed during testing or during application?)
<b>Bending radii</b>	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 $15 \times D$ and $30 \times D$ , depending on construction type and regulation. D is the outer diameter of the cable. (At Lapp: ÖLFLEX® FD with $5 \times D$ or $7.5 \times D$ ).

<b>Bending test at low temperature</b>	Cold flexibility test for cables. A cold cable is wrapped around a pin and no cracks may occur in the insulation.
<b>Binary</b>	Property restricted to just two values.
<b>Bit</b>	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.
<b>Bit error rate, BER</b>	Ratio of error bits to the overall number of bits received during a specific period.
<b>Blue cable</b>	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).
<b>Braid angle</b>	Variation in degrees between the longitudinal axis and the wire routing within the braid.

<b>Braiding</b>	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.
<b>Breakdown</b>	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.
<b>Breaking load, ultimate load</b>	The product of nominal cross-section and tensile strength is the breaking load.
<b>British Standard Wire Gauge</b>	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.

<b>Cables for hand-held machinery</b>	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).
<b>Caloric load values</b>	Caloric load is the energy that is released when cables and other building materials are burned.
<b>Campus</b>	The campus or primary wiring establishes the connection between the various buildings within a structured wiring system.
<b>CAN</b>	Controller Area Network. Result-controlled communication system. As a generator of information, this reports to all connected nodes.
<b>Canadian Electrical Code</b>	See → CEC
<b>Capacity</b>	Electrical unit of measure, measured in Farad, or electrical unit of measure $V \times A = \text{Watts}$ .

<b>Carrier frequency</b>	The frequency of the oscillation whose amplitude, phase or frequency is influenced by a signal.
<b>Carrier frequency, hook-up wire</b>	In carrier frequency systems, they are used to transmit signals. Up to 120 carrier frequency channels can be simultaneously transmitted in a cable.
<b>CCC</b>	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.
<b>CE</b>	Abbreviation for Communauté Européenne (European Community).
<b>CE marking</b>	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 Electrique 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.

<b>Clamping range</b>	Cable diameter range for which the assured properties of a cable gland apply.
<b>CNOMO</b>	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.
<b>Coating</b>	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.
<b>Coaxial cable</b>	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 construc-

tion, 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.

<b>Copolymer</b>	Mixture which polymerises from two or three monomers to form a chain.
<b>Copper</b>	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.
<b>Copper base</b>	The monetary value used to value the copper contained in cables in the price.
<b>Copper weight</b>	It expresses the mass of the copper contained in the cables.
<b>Copper-clad aluminium wire</b>	This wire is made up of an aluminium core and a copper sheath.
<b>Core</b>	The optical core in glass fibre cable technology.
<b>Core check, response at increased temperature</b>	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-

imum resistance is assigned to the nominal cross-section, within which the conductor structure is specified. The cross-section is normally specified in  $\text{mm}^2$ . 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.  $\text{Current} = \text{Voltage} / \text{Resistance}$ .

**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 ratio 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 **ST**andardised **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<sup>2</sup>.

**DIN**

Abbreviation for Deutsches Institut 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 vari-

ous 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.

<b>Duroplastic</b>	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.
<b>Earth connection</b>	Earthing of a point of the circuit, such as the neutral point, neutral conductor, midpoint or outer conductor.
<b>Earth electrocode, ground system</b>	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.
<b>Earthing</b>	Earthing guarantees a clear reference potential for screening the active and passive components of a network.
<b>ECAD</b>	The ECAD component standard is a manufacturer-independent standard for describing item and engineering data in electrical engineering, specifically for machine and equipment manufacture.

<b>EIA</b>	Abbreviation for Electronic Industries Associations.
<b>Elastomere</b>	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.
<b>Electric circuits</b>	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.
<b>Electric diameter of conductors</b>	Determined on cables by electrical resistance measurements.
<b>Electric Field</b>	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](http://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.



<b>Foil</b>	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.
<b>Frequency</b>	Number of changes of polarity in an alternating current per second; the unit of measure is Hertz (Hz).
<b>FTP</b>	Abbreviation for Foil Shielded Twisted Pairs; in these cables the twisted pairs of cores are screened by a common plastic clad aluminium foil.
<b>Full duplex</b>	Full duplex transmission allows simultaneous transmission and reception of signals.
<b>GAEB</b>	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 <a href="http://www.lappkabel.de">www.lappkabel.de</a> .
<b>General cable tie</b>	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.
<b>Glass fibre cable</b>	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.
<b>GOST</b>	Standards institute in Russia (comparable with the VDE in Germany, British Standards in the UK, IMQ in Italy and UTE in France)

<b>Gradient fibre</b>	Light waveguide with a gradient profile, i. e. with a $\rightarrow$ 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.
<b>Grid</b>	The exact spacing between the conductors in a ribbon cable.
<b>Gusset</b>	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.
<b>Halogen free</b>	Refers to materials that do not contain any halogens such as chlorine (Cl), bromine (Br), iodine (I) or fluorine (F).
<b>HAR</b>	Quality mark for a harmonised cable complying with CENELEC HD standards, issued only by HAR testing bodies, e. g. VDE, USE, BASEC, USE, SEV.

<b>Hardness</b>	See $\rightarrow$ Shore
<b>Harmonizing key</b>	$\rightarrow$ See Table T6.
<b>HD</b>	Abbreviation for harmonisation document. In the EU, HDs have the status of a harmonised European standard (like ENs).
<b>Heat of combustion</b>	The temperature or heat released when a cable is burned (see $\rightarrow$ Thermal load).
<b>Hertz</b>	Unit of measure for the frequency of an alternating current (in Germany 50 Hz for mains cables).
<b>Hood</b>	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.
<b>Hood termination</b>	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 sub-committee 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](http://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/otpc/nrtl/](http://www.osha.gov/dts/otpc/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.

<b>Insulation</b>	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).
<b>Insulation resistance</b>	The electrical resistance of a non-metallic material between two electrodes, measured using a DC voltage.
<b>Intensity</b>	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 <sup>2</sup> ).
<b>Interactive</b>	Property of two systems to influence one another in order to exchange messages.

<b>Interbus</b>	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.
<b>Interface</b>	Connecting point in a technical system that has particular properties enabling connection to another technical system.

<b>Internet</b>	Worldwide virtual data network.
<b>Intrinsically safe</b>	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).
<b>IP Code</b>	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).
<b>ISDN</b>	Abbreviation for Integrated Services Digital Network. Integrated service digital telecommunication network. Suitable for transmission of voice, text, images and data.

<b>ISO</b>	Abbreviation for International Organisation for Standardisation. Committee that develops internationally recognised standards.
<b>Joint</b>	Interconnection point between (data) transmission paths.
<b>Kink</b>	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.
<b>kV</b>	Abbreviation for Kilovolts. 1 kilovolt equals 1,000 Volts.
<b>LAN</b>	Abbreviation for Local Area Network. Physically limited network used for communication within a building or company.
<b>Laser-printer, ink-jet printer</b>	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.

<b>Lever series</b>	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.
<b>Li2YCY</b>	Polyethylene screened individual cores.
<b>Li5YCY</b>	TEFLON® PTFE screened individual cores. TEFLON® is a brand name of the company DuPont de Nemours.
<b>Lift cable</b>	Lift cables are control cables with strain relief used for lifts, gantry cranes, teach pads, etc. (e. g. ÖLFLEX® LIFT, ÖLFLEX® CRANE at Lapp).
<b>Link</b>	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.

<b>LiY</b>	Individual cores (strand) predominantly 0.14 and 0.25 mm <sup>2</sup> LiYv: Tin plated individual cores (strand).
<b>LiYCY</b>	Individual cores with copper screening (C stands for copper).
<b>LiYY</b>	Multi-core stranded cable (ÖLFLEX®, UNITRONIC®).
<b>Longitudinal water tightness</b>	Achieved by filling the gaps between the core arrangements with various kinds of filler (e. g. petroleum jelly filling).
<b>Loss factor</b>	The loss factor depends on frequency, temperature and capacitance. This factor is the ratio of effective power to idle power with a sinusoid voltage.
<b>Machine set-up for core insulation – Extrusion</b>	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, eccentric

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.



<b>Modulation</b>	A network signal to be transmitted is modified by a carrier signal.
<b>Monomode fibre</b>	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.
<b>Motor cable</b>	Motor cables are supply cables for electric motors (e. g. ÖLFLEX® SERVO FD at Lapp).
<b>Multimode fibre</b>	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.

<b>Mutual capacity, operating capacity</b>	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.
<b>Nanosecond</b>	Billionth of a second. Time unit for the internal switching speed of computers.
<b>Near-end crosstalk, far end crosstalk</b>	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).
<b>NEC</b>	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 IEC 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](http://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  $U_0/U$  in V :  $U_0$  = 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  $R_0'$ . 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.

<b>Operating voltage</b>	The actual voltage in a grid. This can fluctuate by up to 5%, caused by the alternating use of consumers.
<b>Opposite direction of lay</b>	See → Stranding
<b>Order length</b>	The length of cable ordered by the customer.
<b>OTDR</b>	Measuring method for testing glass fibres for faults or transmission quality. OTDR stands for Optical Time Domain Reflectometer.
<b>Outdoor cable</b>	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.
<b>Outer conductor</b>	Conductors that connect current sources with consumables. For example, C1, C2 or C3 in

	a three-phase system but not conductors come from the mid-point or neutral point. The conductor is arranged concentrically around the inner conductor of a coaxial pair.
<b>Outer diameter</b>	Diameter of the smallest circle that will enclose the surface of the sheath.
<b>Outer sheath</b>	Enclosed cover for protection of the elements underneath.
<b>Outer sheath</b>	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.
<b>Overcurrent</b>	If the permitted ampacity is exceeded, this is referred to as overcurrent.
<b>Overcurrent protection devices</b>	Overcurrent protection devices break the current supply in case of overcurrent. They include overcurrent protective switches and safety fuses.

<b>Oxygen index</b>	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.
<b>Pad</b>	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.
<b>Pair</b>	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).
<b>Panel mount base</b>	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.

<b>Patch cable</b>	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.
<b>Patch field</b>	A patch field is the switching device that is used to set up, establish and route connections.
<b>PE</b>	Abbreviation for polyethylene.
<b>Photodiode</b>	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.
<b>Photovoltaic</b>	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.

<b>Pigtail</b>	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.
<b>PiMF</b>	Abbreviation for pairs in metal foil.
<b>Pollution level</b>	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.
<b>Polyamide</b>	Polyamide is a polymer. Polyamide is cold resistant with impact loads, impact resistant and abrasion resistant.
<b>Polycarbonate</b>	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.

<b>Polychloroprene-rubber</b>	Synthetic rubber is resistant to solvents, has very good strength properties and is flame resistant, however very expensive (high-quality rubber cables, Pat-tex glue).
<b>Polyethylene</b>	Polyethylene is a halogen-free plastic, but is highly flammable. By adding additional materials, PE can be made flame retardant and smokeless.
<b>Polyuretane</b>	Extremely impact resistant, difficult to strip, strong reset forces. (PUR, 11Y, Q ).
<b>Polyvinylchloride</b>	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.

<b>Power dissipation factor</b>	Power that is converted into heat or other energy losses.
<b>Preform</b>	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.
<b>Print wheel</b>	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.
<b>Profibus</b>	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.

<b>Protective conductor</b>	(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.
<b>PTFE</b>	Abbreviation for polytetrafluoroethylene, TEFLON® plastic (PTFE); a trade name of the company Du Pont de Nemours.
<b>PUR</b>	Abbreviation for polyurethane; a ductile, abrasion resistant thermoplastic alternative to rubber, e. g. in ÖLFLEX® 400P, ÖLFLEX® 540P.
<b>PVC</b>	Abbreviation for polyvinylchloride.
<b>PVC-powder additive</b>	Additives are added to PVC mixtures as matting agents, lubricants, colour pigments, wax for smooth surfaces.
<b>Quad</b>	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 through 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.

<b>Reeling</b>	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.
<b>Reference earth</b>	Part of earth considered as conductive that lies outside the zone of influence of any earthing arrangement.
<b>Reflexion</b>	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.

<b>Refractive index</b>	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.
<b>Refractive index distribution, index profile</b>	Progression of the refractive index $n$ across the cross-sectional area of a fibre optic cable.
<b>Resistance</b>	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.
<b>Resistant</b>	The cable has a resistance to certain substances, i. e. they do not destroy it.
<b>Retention of cable glands</b>	The ability of a cable gland to limit the movement of a secured cable under static load.

<b>RFID</b>	RFID stands for Radio Frequency Identification and means that data can be transmitted with no contact or line of sight.
<b>RJ45</b>	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.
<b>RoHS</b>	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 ).
<b>Route warning tape</b>	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 atten-

<b>Rubber insulated cable</b>	Cable with rubber sheathing. For example, H05 RR/RN, H07 RR/RN at Lapp (previously: NMHöu/NSHöu).
<b>S-FTP</b>	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.
<b>Same direction of lay</b>	See → Stranding
<b>Sample test, screening</b>	Testing of production lengths or production parts in relation to production quantity.
<b>Screened cable</b>	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.

<b>Self-extinguishing</b>	Property of a (synthetic) material to extinguish itself when a flame is removed from the material.
<b>SEMCO</b>	Swedish testing body, similar to the VDE.
<b>Semi-conductor</b>	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.
<b>Semiconductor bandgap</b>	Energetic distance between the valence band and the conduction band of a semiconductor.
<b>Separating layer</b>	Foils positioned between the individual layers on the cable core to prevent harmful influences.
<b>Separator</b>	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.
<b>SEV</b>	Abbreviation for Schweizerischer Elektrotechnischer Verein [Swiss Electrical Engineering Association], testing body similar to the VDE.
<b>Sheath print</b>	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.
<b>Sheathed cable</b>	Designation for NYM and other sheathed cables.
<b>Shielding</b>	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.

<b>Single-wired conductor</b>	A single-wire conductor consists of just one wire.
<b>Skin effect</b>	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.
<b>Slave</b>	Subscriber in a network that can only communicate in data exchange when addressed by the master (see → ASI).
<b>SNA</b>	Abbreviation for System Network Architecture. Network architecture concept that enables data to be transmitted between different types of computer.
<b>Specific volume resistance</b>	The specific volume resistance [Ohm m] results from the measured volume resistance [Ohm]

<b>Speed of signal propagation</b>	multiplied by the measuring area [m <sup>2</sup> ] divided by the sample length [m]. VDE 0207, Part 4 and VDE 0303, Part 30.  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.
<b>Spiral cable</b>	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.
<b>Splice</b>	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.



<b>Supporting cable</b>	Because of their small dimensions, they are used for installation in small and miniature equipment.
<b>Supporting core</b>	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.
<b>Surface mount base</b>	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.
<b>Synthetic india rubber</b>	Butyl synthetic rubber has a high resistance to ageing and lower gas permeability. It is highly resistant to chemicals.

<b>T-Coupler</b>	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.
<b>Take-up system</b>	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.
<b>Talcum</b>	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.

<b>Tensile load</b>	The maximum force with which a cable can be loaded under defined conditions.
<b>Test voltage</b>	The voltage applied to a test specimen to demonstrate a particular electrical strength.
<b>Tex</b>	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.
<b>Thermal splice</b>	A thermal splice is a connection between light waveguides created by fusing the ends of the conductors.
<b>Thermoplastics, thermoplastic materials</b>	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.

<b>Thomson measuring bridge for resistance measurement</b>	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).
<b>Tight buffer tube</b>	Fibre type used in light waveguides, with a solid plastic layer attached directly to the outer glass.
<b>Tin</b>	Tin is used for tin plating copper wires.
<b>Torsion</b>	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.

<b>TTP</b>	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).
<b>Tube cable</b>	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.
<b>Twist protection</b>	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.
<b>Type test</b>	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

<b>UL</b>	made or the material, technology or design has been changed. The frequency of type tests is set out in legislation, contracts or operationally.
<b>UL</b>	Abbreviation for Underwriters Laboratories. American testing body, similar to the VDE in Germany.
<b>UL Approval for cable glands</b>	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).
<b>UL listing mark for listed cables &amp; wires</b>	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).

<b>UTE</b>	Abbreviation for Union Technique de l'Electricité (France).
<b>Vagrancy currents</b>	Currents that do not flow through the electrical mains (L1, L2, L3, N) are referred to as vagrancy currents.
<b>VDE</b>	Abbreviation for Verband Deutscher Elektrotechniker e.V., [German Electrical Engineering Federation], VDE testing and certification institute – VDE testing body.
<b>VDE Approbation for cable glands</b>	Approval is granted after a test complying with DIN/EN 50262 and is confirmed by an approval certificate,
<b>VDEW</b>	Abbreviation for Vereinigung Deutscher Elektrizitätswerke [Association of German Electricity Plants].
<b>Velocity of propagation</b>	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.

<b>Vibrator, chopper</b>	A pole reversal of medium power for generation of an AC voltage from a DC voltage.
<b>Volt</b>	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
<b>Volt meter</b>	Instrument for measuring voltage.
<b>Voltage-level classes</b>	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.
<b>Voltage, tension</b>	Electrical unit of measure, measured in Volts, i. e. Voltage = Resistance x Current.



<b>VSWR (Voltage Standing Wave Ratio)</b>	Ratio of the transmitted signal voltage to the reflecting signal voltage measured along the transmission path.
<b>Vulcanising</b>	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).
<b>Wall thickness</b>	The thickness of the insulation or sheath.
<b>WAN</b>	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.

<b>Watt</b>	Electrical unit of measure for power $V \times A = \text{Watts (VA)}$ .
<b>Wave lengths</b>	Length of a full wave oscillation (period). In optical signal technology, three wavelength ranges are normally used – 850 nm, 1300 nm and 1550 nm.
<b>Waveguide dispersion</b>	The dispersion that occurs with non-monochromatic light sources because of 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.
<b>Wear resistance</b>	The characteristic of a cable, wire or material to withstand surface wear.
<b>WEEE directive</b>	Under electrical and electronic equipment legislation (ElektroG in Germany), the WEEE directive governs the withdrawal of electrical and electronic products.

<b>Wire drawing</b>	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.
<b>Wire termination technique</b>	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.
<b>Wire-wrap connection</b>	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).

<b>Wiring cable</b>	Cable for wiring equipment, control cabinets etc.
<b>Wiring system</b>	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.).
<b>Working current, service current</b>	The maximum permissible current that may be transmitted.
<b>Woven cable</b>	Several conductors running parallel which are held together using a thin sheath. See also → Flat cable.
<b>Zinc</b>	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
Automotive cable	Fahrzeugleitungen
AWM	See Glossary
Backbone	See Glossary

**Key words**

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

**Key words**

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

**Key words**

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
Copolymer	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

**Key words**

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	Datenübertragungsrage
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

**Key words**

Dispersion	See Glossary
DKE	See Glossary
Drag chain cables	Schleppkettenleitungen
Drain wire	Beidraht
Ductility	Biegsamkeit
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

**Key words**

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, Biegsamkeit
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 – Kabelmängel und Leitungen – Laser- und Tintenstrahldrucker

**Key words**

Insertion attenuation	Einfügdungsdämpfung
Insertion loss	Einfügdungsdämpfung
Insulated wire	Ader
Insulation	Isolation
Insulation resistance	Isolationswiderstand
Intensity	Intensität
Interactive	Interaktiv
Interface	Schnittstelle
Intrinsically safe	Eigensicher
Joint	Knoten
Kink	Knick
Laser-printer	Bedruckung – Kabelmantel und Leitungen – Laser- und Tintenstrahldrucker
Laying temperature	Verlegetemperaturen
Leading protective ground	Schutzkontakt, voreilend
Leakage current	Ableitstrom
Length of lay	Schlaglange
Length of twist	Schlaglange
Lever series	Bugelarten
Lift cable	Hangekabel
Longitudinal water tightness	Langswasserdichtigkeit
Loss factor	Verlustfaktor
Machine set-up for conductor insulation – Extrusion	Anlagenaufbau fur Isolierhullen – Extrusion
Master-Slave principle	Master-Slave-Prinzip
Material dispersion	Materialdispersion
Mica powder	Glimmer
Microbending	Mikrokrummungen
Mode	Moden
Mode dispersion	Modendispersion
Monomode fibre	Monomodefaser
Motor cable	Motorenkabel
Multimode fibre	Multimodefaser
Mutual capacity	Betriebskapazitat

**Key words**

Nanosecond	Nanosekunde
Near-end crosstalk, far end crosstalk	Next, Fext (Nebensprechdampfung)
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	Betriebskapazitat
Operating supplies	Betriebsmittel
Operating temperature range	Betriebstemperatur
Operating voltage	Betriebsspannung
Opposite direction of lay	Gegenschlag
Order length	Bestelllange
Outdoor cable	Auenkabel
Outer conductor	Auenleiter
Outer diameter	Manteldurchmesser
Outer sheath	Auenmantel, Mantel
Overcurrent	berstrom
Overcurrent protection devices	berstromschutzorgane
Oxidation inhibitor	Alterungsschutzmittel
Oxygen index	Sauerstoffindex
Pad	Fuller
Pair	Paar
Panel mount base	Anbaugehause
Patch cable	Patchkabel
Patch field	Patchfeld
Photovoltaic	Photovoltaik
Pigtail	Anschlussfaser
Pollution level	Verschmutzungsgrad
Polyamide	Polyamid

**Key words**

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

**Key words**

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	Einmodenfasern
Single-wired conductor	Leiter, eindrähtig
Skin effect	Skin-Effekt
Specific volume resistance	Spezifischer Durchgangswiderstand
Speed of signal propagation	Signalausbreitungsgeschwindigkeit (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



**Key words**

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	Thermospieß
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	UL Listing Mark
for listed cables & wires	für „listed cables & wires“
UL recognition mark	UL Recognition Mark
for AWM cables and wires	für „AWM cables and wires“

**Key words**

UL-Approval	UL-Zulassung
for cable glands	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 Approval 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

## Safety instructions

### 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 corro-

sive 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  $\text{mm}^2$  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  $\text{mm}^2$  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  $-25^\circ\text{C}$  to  $+55^\circ\text{C}$  (max.  $+70^\circ\text{C}$  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.





## **Imprint**

### **U.I. Lapp GmbH**

Schulze-Delitzsch-Straße 25

70565 Stuttgart, Germany

Tel. +49(0)711/78 38-01

Fax +49(0)711/78 38-26 40

[www.lappgroup.com](http://www.lappgroup.com)

[info@lappkabel.de](mailto:info@lappkabel.de)

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