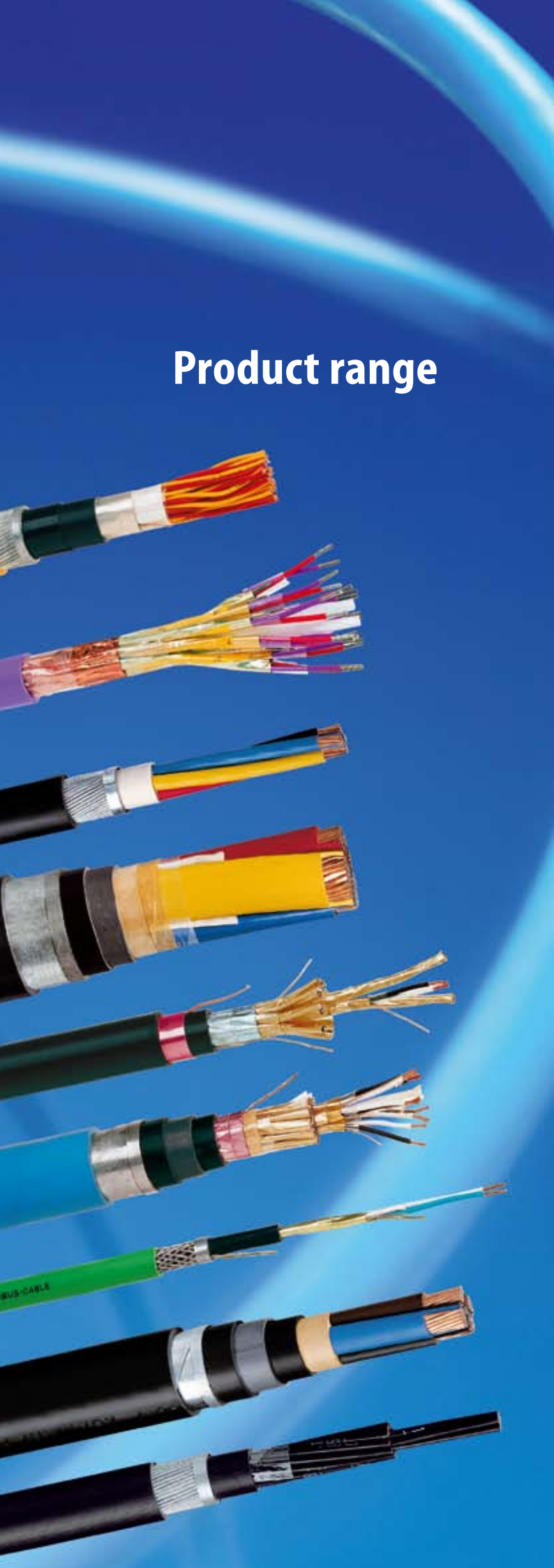


Cables for Data Transmission in Industrial Automation



The Quality Connection

LEONI
KERPEN



Product range

- **Instrumentation-
and control cables**
- **Thermocouple extension
and compensating cables**
- **Power cables
(low and medium voltage)**
- **Data- and Bus cables
(copper and fiber optic)**
- **Telecommunication cables**
- **Mining cables**
- **Cables for special applications**

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Fieldbus technology

Application

Fieldbus systems are used in digital networks which control machines and devices within a production plant with the help of actuators and sensors.

The IEC standard 61158-2 defines the profile of so-called H1 buses. The bus systems Profibus and FOUNDATION Fieldbus now predominant in process automation, follow this communication protocol.

Fieldbuses shall meet the following requirements:

- Use in hazardous and no-hazardous areas
- High transmission speeds
- Large amounts of data
- Real-time capabilities
- Deterministic
- Energy supply via bus



Levels of the Hierarchy

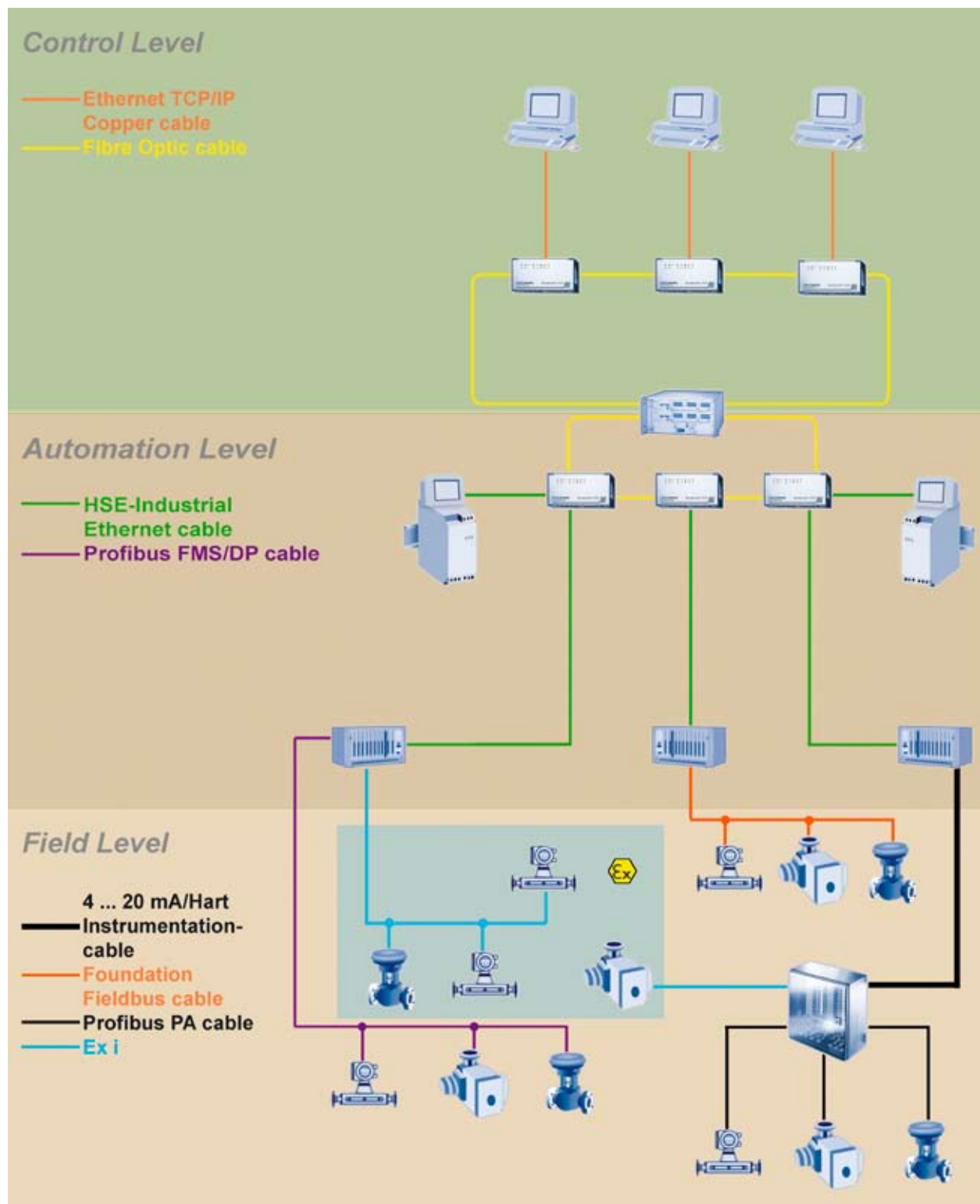
Digital communication and data transfer within a production structure takes place horizontally, i.e. between devices on one level, and vertically, to the systems on the other levels of the hierarchy.

The following levels are usually distinguished in automation systems :

- The Control level controls and monitors higher functions with bus cycle times of <1000 ms.
- The Automation level controls the actual processes and control loops with bus cycle times of <100 ms.
- The Field level transfers data of the actuators and sensors; this requires a bus cycle time of <10 ms.



Hierarchical Model with Industrial data transmission cable types



Demands made on Fieldbuses / Fieldbus systems

In the automation engineering, a wide range of factors determine which Fieldbus system to use, i.e. the technical characteristics of each bus system make it suitable for the sector and the application for which it is intended.

Process Automation

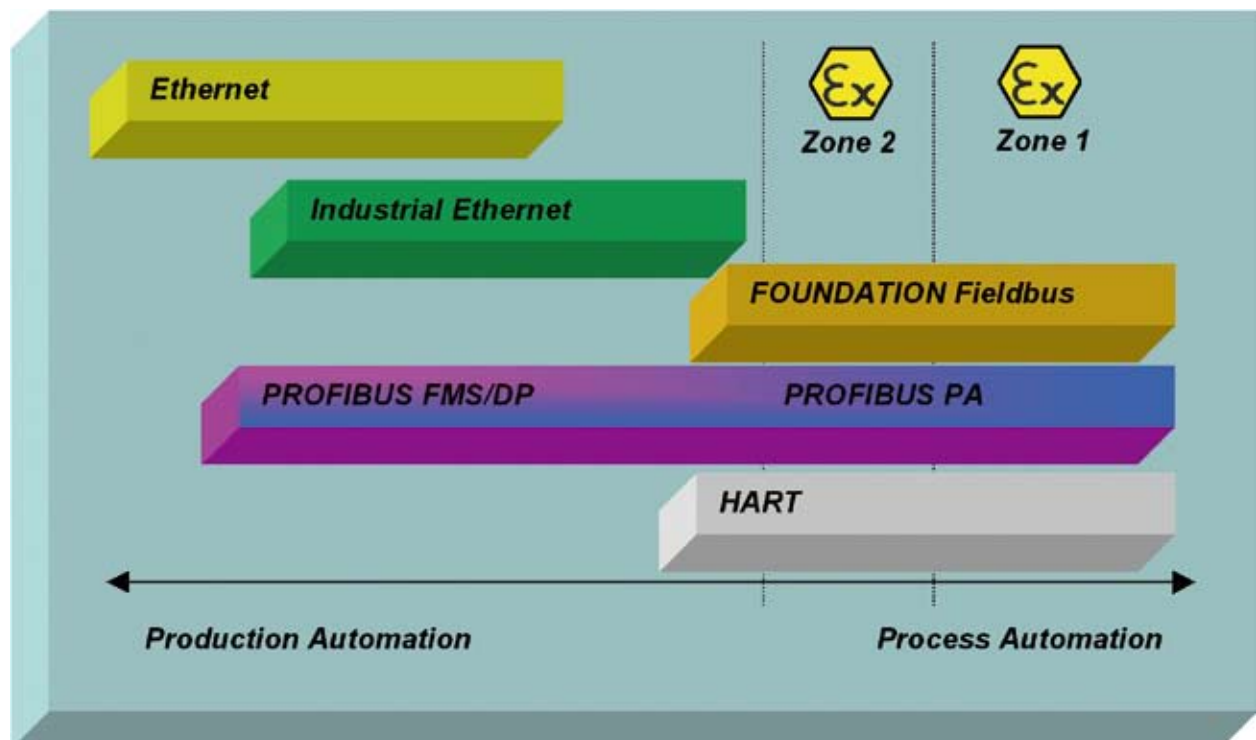
In process automation, we speak of the continuous or batch processing of goods in plants of the chemical, food or steel industries, power stations etc. Typically, the systems used for the process industry are strongly decentralized, complex plants which can be very extensive. The demands made on response times are usually less critical: these can be in the range of several seconds.

However, 'always up' systems are important for process automation as plants cannot be switched off due to the continuous processes running there.

Production Automation

Production automation mainly deals with the processing of goods in phases which are often independent of one another, for example in the automobile or electronics industry.

In these fields, high demands are made on the reaction times, i.e. hard real-time requirements in the millisecond range.



FISCO-Model

Especially in the use of bus systems in explosion-hazard areas, the so-called FISCO (**F**ieldbus **I**ntrinsically **S**afe **C**oncept) facilitates the planning, installation and extension of networks.

The FISCO model was developed in Germany by the Physikalisch Technische Bundesanstalt (PTB) and has now been standardised according to the international standard IEC 60079-27.

The requirements for use of the FISCO model are as follows:

- All participants in the bus (devices) must be "FISCO"-approved.
- Every field device takes up a constant basic current of at least 10 mA.
- Only one supply source per Fieldbus segment.
- With ignition protection type **ia** (Zone 0), the cable must not be longer than **1000 m** and with ignition protection **ib** (Zone 1 and Zone 2) **1900 m**.
- Maximum length of each spur cable: 60 m for device group IIC and IIB.
- Maximum length of each trunk cable, including all spur cables: **1000 m** for device group IIC and **5000 m** for device group IIB.

According to IEC 60079-27, the parameters for the bus cables are as follows:

- Loop resistance $R = 15 \dots 150 \, \Omega/\text{km}$
- Loop inductance $L = 0.4 \dots 1 \, \text{mH}/\text{km}$
- Mutual capacitance $C = 45 \dots 200 \, \text{nF}/\text{km}$

When lines and cables matching the above requirements are used, it is no longer necessary to take other cable parameters into account.

The Fieldbus Standard IEC 61158-2

1. Bus-Types for 31.25 kbit/s – 100 Ω (e.g. PROFIBUS PA, FOUNDATION Fieldbus)

IEC 61158-2 defines following categories for cable types for the data transfer range of 31.25 kbit/s

Parameter	Type A	Type B	Type C	Type D
Impedance at f = 31.25 kHz	100 $\pm$ 20 Ω	100 $\pm$ 30 Ω	not specified	not specified
Max. conductor resistance	24 Ω /km	56 Ω /km	132 Ω /km	20 Ω /km
Max. attenuation at f = 39 kHz	3.0 dB/km	5.0 dB/km	8.0 dB/km	8.0 dB/km
Max. capacitance unbalance to shield	2 nF/km	not specified	not specified	not specified
Max. capacitance unbalance	not specified	6 nF/km length $\geq$ 30 m	not specified	not specified
Nom. conductor cross-section	0.8 mm ²	0.32 mm ²	0.13 mm ²	1.25 mm ²
Max. propagation delay change	1.7 μ s/km	not specified	not specified	not specified
Minimum shield coverage	90 %	not specified	not specified	not specified
Maximum usable length including all spur cables	1.900 m	1.200 m	400 m	200 m

Type A is the preferred bus type nowadays.

Type A is a 1-pair cable with an overall shield and is tailor-made to meet the high demand of automation engineering.

Type B is an alternative type also used.

Type B is a version consisting of several pairs and an overall shield. Please note the restricted characteristics which can have a detrimental effect in case of future extensions of the plant.

Types C and D are of little importance and have been included here for the sake of completeness only.

2. Bus-Types for the characteristic Impedance Range – 100 Ω up to 220 Ω (e. g. PROFIBUS DP)

For bus use in the characteristic impedance range between 100 Ω and 220 Ω , IEC 61158-2 defines cable types A and B with the following characteristics:

Parameter	Type A	Type B
Characteristic impedance	135 – 165 Ω at $f = 3$ up to 20 MHz	100 – 130 Ω at $f > 100$ kHz
Conductor resistance (loop)	110 Ω /km	not specified
Minimum conductor cross-section	0.34 mm ²	0.22 mm ²

The cable consists of one pair and an overall shield and the preferred type is type A.

Optical Fibre Cables

In addition to copper cables, fibre optic cables consisting of the following fibre types defined according to IEC 61158-2 are used:

Multi mode fibre	62.5/125 μ m
Single-mode fibre	9...10/125 μ m as well as
Plastic fibre	980/1000 μ m



1. PROFIBUS (PROcessFieldbus)

1.1 PROFIBUS DP (Decentralized Periphery)

PROFIBUS DP was specially designed for rapid cyclical data transmission.

PROFIBUS DP uses RS-485 as a transmission technology for high data rates. Depending on the data rate, the maximum segment lengths for cable type A are as follows:

	Unit	Values								
Data rate	kbit/s	9.6	19.2	93.75	187.5	500	1500	3000	6000	12000
Segment length	m	1200	1200	1200	1000	400	200	100	100	100

1.2 PROFIBUS PA (Process Automation)

The PROFIBUS PA is used in the field of process automation and its special characteristics are power supply over bus and intrinsic safety.

The transmission technology used MBP (Manchester Coded Bus Powered). MBP is synchronous transmission with a fixed transmission rate of 31.25 kbit/s and Manchester-II coding. The intrinsically safe PROFIBUS PA is connected to the PROFIBUS DP via segments couplers or links.



1.3 Synopsis of Transmission Media PROFIBUS

	MBP	RS485	RS485-IS	Optical Fibre
Data transmission	digital, Manchester Coding	digital, NRZ*) coding, RS485	digital, NRZ*) coding, RS485	optical, NRZ*) coding
Transmission rate	31.25 kbit/s	9.6 – 12000 kbit/s	9.6 – 1500 kbit/s	9.6 – 12000 kbit/s
Cable	1-pair cable, twisted and shielded Type A	1 -pair cable, twisted and shielded Type A	1 -pair cable, twisted and shielded Type A	multi- & singlemode-fibre with glass, plastic fibre (POF)
Power supply	via bus line	optionally via additional cores	optionally via additional cores	optionally via additional cores
Ignition protection type	EEx ia/ib	no	EEx ia/ib	no
Network topology	Line and tree structure	Line structure	Line structure	Line-, star- and ring structure
Number of participants	max. 32 per segment, max. 126 per network	max. 32 per segment, max. 126 per network	max. 32 per segment, max. 126 per network	max. 126 per network
Repeater	max. 32 per segment, max. 126 per network	max. 9 with signal refresh	max. 9 with signal refresh	unlimited, with signal refresh (depending on the time delay of signal)

*) Non-Return-to-Zero



Transmission systems



2. FOUNDATION Fieldbus

Like the PROFIBUS PA, the FOUNDATION Fieldbus is a bus system designed for process automation.

Like the PROFIBUS PA, the FOUNDATION Fieldbus is standardised via IEC 61158-2 and works with the same transmission media (see page B9).

The difference to PROFIBUS PA is that the FOUNDATION Fieldbus does not require Fieldbus masters and the field devices can correspond with each other.

With the FOUNDATION Fieldbus, the “host device” only monitors the procedures. Within process automation, the FF forms a so-called LAN (Local Area Network) and the FF devices are connected to H1 links. Several H1 links are connected to the high-performance network HSE High-Speed-Ethernet via linking devices. Individual devices can also be directly connected to the HSE network.

As with the PROFIBUS PA, the FISCO model applies for the FOUNDATION Fieldbus, thus allowing intrinsically safe use of the FF in explosion-hazard areas of the plant.

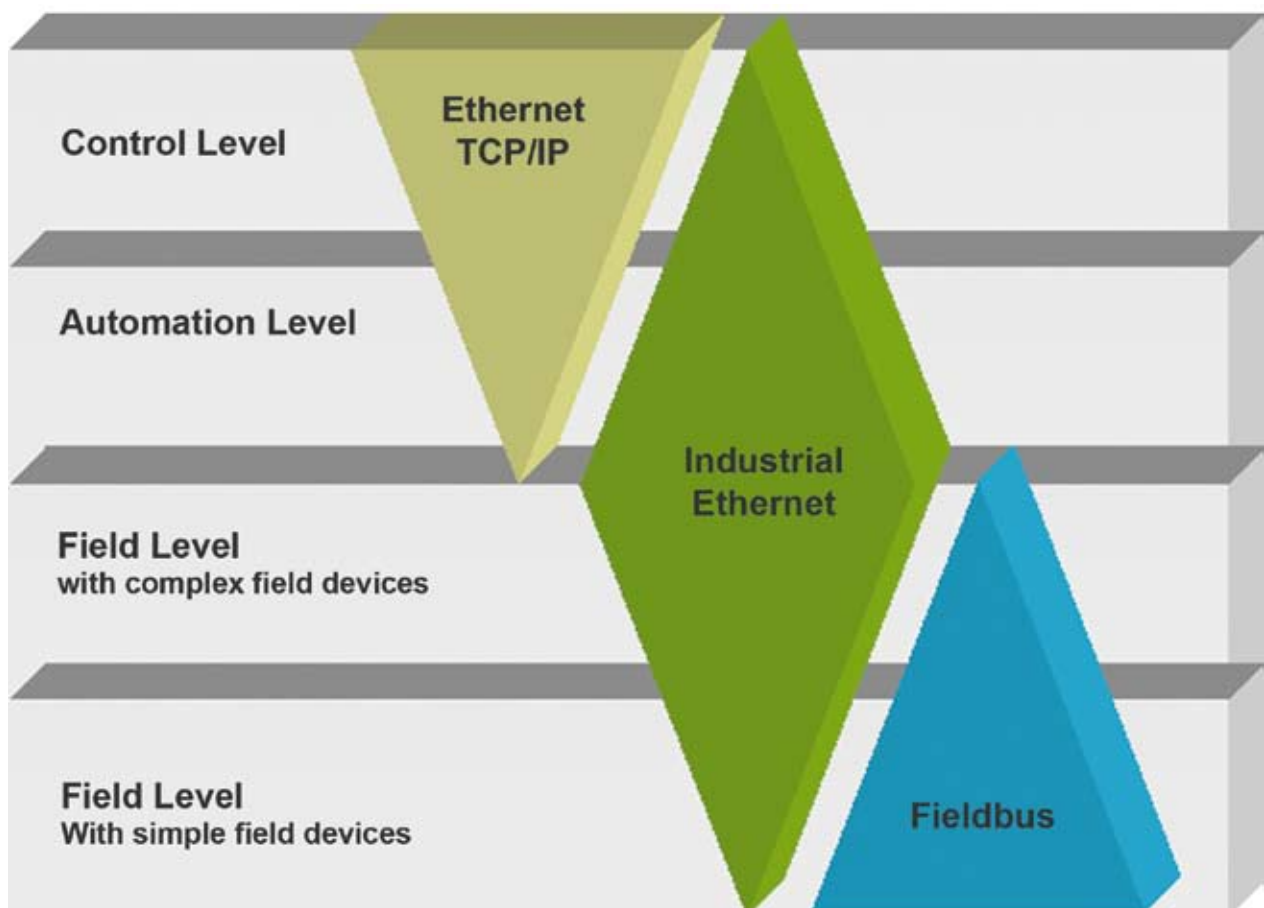
Industrial Ethernet

Ethernet is an established standard in office communication.

As a result of the increased demands made on transmission speeds and data rates, the Ethernet protocol is also found besides bus technology in the world of automation, including field device controls.

New technologies (such as switching etc.) also make Ethernet suitable for real-time applications, allowing it to be used in the field of automation parallel to the Fieldbus.

The level structure is then as follows:

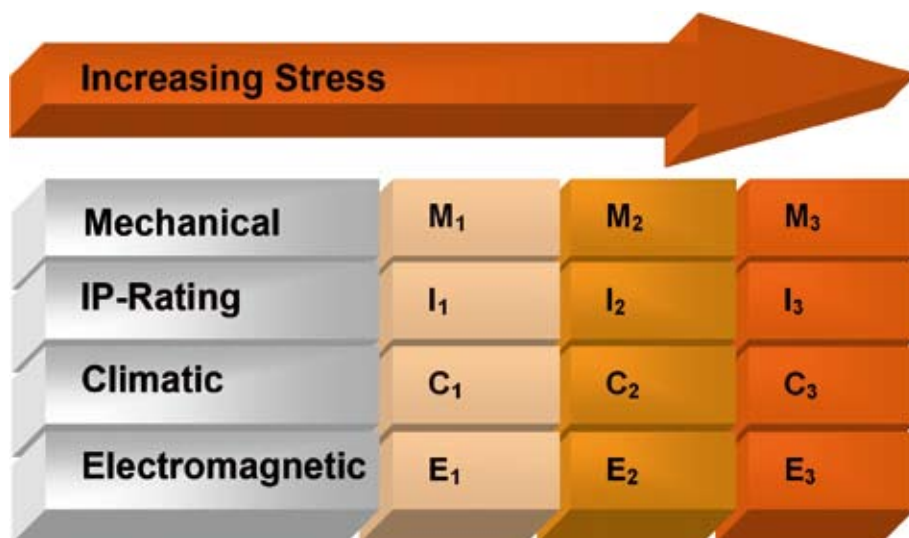


The M I C E - concept

The wide range of environmental conditions prevailing with industrial applications mean that the demands made on lines and systems can vary. The draft standard ISO/IEC 24702 / EN 50173-3 classifies environmental conditions via the so-called MICE matrix.

This distinguishes between the following

- Mechanical environmental influences "M"
This category defines shock, impact and vibratory stress
- Housing protection "I"
This category defines the particle size and the quantity of liquid etc.
- Climatic and chemical environmental influence "C"
This category defines the environmental temperature, the humidity, the concentration of various gases etc.
- Electromagnetic stress "E"
This category defines electrostatic discharges and magnetic field strengths etc.



A wide range of environmental profiles can be defined according to the MICE table.

Examples:

M ₁ I ₁ C ₁ E ₁ :	Office area (worst case)
M ₂ I ₂ C ₂ E ₂ :	Factory buildings (worst case, light duty)
M ₃ I ₃ C ₃ E ₃ :	Field area (worst case, heavy duty)
M ₃ I ₁ C ₂ E ₂ :	Combination



Industrial Ethernet

The Product Range

In contrast to the office environment, the industrial environment is quite different and often presents harsh conditions, such as:

- High dust load
- High humidity
- Mechanical stress due to vibrations or impact
- High temperatures and temperature fluctuations
- Corrosive or contaminating media such as acids, alkalis and oils

For cables in “harsh environments”, IEC 62012 offers design elements and materials adapted to industrial environmental conditions.

For example:

- 2-pair designs support Ethernet (10 Mbit/s) and Fast Ethernet (100 Mbit/s).
- 4-pair designs support all current and future protocols, i.e.: Ethernet (10 Mbit/s), Fast Ethernet (100 Mbit/s) and GigaBit Ethernet (1000 Mbit/s)
- S/FTP cables have one dual screen consisting of an individual and an overall screen. They have excellent EMC characteristics and superior electrical performance and are designed for industrial use.

They also support the transmission of several services under one sheath (cable sharing)

- Flame retardant
- Zero-halogen
- Oil-resistant
- Radiation-proof
- Perspiration-proof
- Abrasion-proof
- Suitable for drag chains
- Heat-resistant

Industrial Ethernet	INDUSTRIAL ETHERNET	PROFINET TYPE A CATEGORY 5	PROFINET TYPE B CATEGORY 5	PROFINET TYPE C CATEGORY 5
	MegaLine[®]	 2 x 2 x AWG 22/1 (Quad)	 2 x 2 x AWG 22/7 (Quad)	 2 x 2 x AWG 22/19 (Quad)
Application				
		Industrial secondary and tertiary cabling acc. to EN 50173-3 and ISO/IEC 24702 for indoor application. (fixed installation)	Industrial secondary and tertiary cabling acc. to EN 50173-3 and ISO/IEC 24702 for indoor application. (flexible installation)	Industrial secondary and tertiary cabling acc. to EN 50173-3 and ISO/IEC 24702 for indoor application. (for drag chains)
Electrical Properties				
Conductor resistance		max. 57.1 Ω/km	max. 57.6 Ω/km	max. 57.8 Ω/km
Impedance (f = 100 MHz)		100 Ω ± 5 Ω		
Bandwidth		200 MHz		
NEXT@Bandwidth frequency		nominal 33 dB		
Attenuation@Bandwidth frequency		nominal 24 dB/100 m		
Interference power suppression up to f = 1 GHz		nominal 90 dB		
Construction				
Conductor		plain annealed copper, AWG 22/1	plain annealed copper, AWG 22/7	plain annealed copper, AWG 22/19
Insulation		polyethylene PE		
Colour code		pair 1: blue/white – pair 2: orange/yellow		
Laying up		cores twisted to quad		
Inner sheath		extruded thermoplastic material		
Screen		plastic coated aluminium tape in contact with tinned copper wire braid, optical coverage approx. 85 %		
Outer sheath		polyvinylchloride PVC green, Ø approx. 6.6 mm	polyvinylchloride PVC green Ø approx. 6.7 mm	polyurethane PUR green Ø approx. 6.8 mm
Weight		approx. 60 kg/km		
Minimum bending radius		8 x cable diameter		
Temperature Range				
During operation		- 20 °C up to + 70 °C		
During installation		- 5 °C up to + 50 °C		
Other Properties				
Flame retardant		acc. to IEC 60332-3-24 (cat. C)		acc. to IEC 60332-1
Connectors/Glands				
		please see our catalogue Solutions@Kerpen or visit our homepage www.leoni-kerpen.com		
		Further cable variations and part numbers on page C5		

INDUSTRIAL ETHERNET	MegaLine® D1-20 SF/U HV CATEGORY 5 HEAVY DUTY	MegaLine® F6-70 S/F HV flex CATEGORY 7 HEAVY DUTY	MegaLine® E5-70 S/F 11Y flex CATEGORY 6 _A HEAVY DUTY	Industrial Ethernet
MegaLine®	 4 x 2 x AWG 24/1	 4 x 2 x AWG 24/7 PiMF	 4 x 2 x AWG 27/7 PiMF	
Application				
	Industrial secondary and tertiary cabling acc. to EN 50173-3 and ISO/IEC 24702 for indoor application. (fixed installation)	Industrial secondary and tertiary cabling acc. to EN 50173-3 and ISO/IEC 24702 for indoor application. (fixed installation)	Industrial workplace, work area and patch panel acc. to EN 50173-3 and ISO/IEC 24702 for indoor application. (flexible installation)	
Electrical Properties				
Conductor resistance	max. 95 Ω/km	max. 84 Ω/km	max. 170 Ω/km	
Impedance (f = 100 MHz)	100 Ω ± 5 Ω			
Bandwidth	200 MHz	700 MHz	700 MHz	
NEXT@Bandwidth frequency	nominal 40 dB	nominal 65 dB	nominal 70 dB	
Attenuation@Bandwidth frequency	nominal 26.5 dB/100 m	nominal 5.65 dB/10 m	nominal 8.15 dB/10 m	
Interference power suppression up to f = 1 GHz	nominal 90 dB			
Construction				
Conductor	plain annealed copper, max. AWG 24/1	plain annealed copper, max. AWG 24/7	plain annealed copper, max. AWG 27/7	
Insulation	foamed polyethylene with skin layer			
Colour code	white/blue, white/orange, white/green, white/brown			
Individual screen	--	plastic coated aluminium tape		
Laying up	cores to pairs, pairs to cable core			
Screen	plastic coated aluminium tape in contact with tinned copper wire braid, optical coverage approx. 65 %	tinned copper wire braid, optical coverage approx. 65 %		
Outer sheath	zero halogen compound FRNC yellow Ø approx. 6.6 mm	zero halogen compound FRNC yellow Ø approx. 8.8 mm	Polyurethane PUR yellow Ø approx. 5.9 mm	
Weight	approx. 51 kg/km	approx. 78 kg/km	approx. 34 kg/km	
Minimum bending radius	8 x cable diameter	5 x cable diameter	5 x cable diameter	
Temperature Range				
During operation	- 20 °C up to + 60 °C		- 40 °C up to + 70 °C	
During installation	0 °C up to + 50 °C		0 °C up to + 50 °C	
Other Properties				
Flame retardant	acc. to IEC 60332-3-24 (cat. C)		acc. to IEC 60332-2-2	
Connectors/Glands				
	see our catalogue Solutions@Kerpen or visit our homepage www.leoni-kerpen.com			
	Further cable variations and part numbers on page C5			

Industrial Ethernet	INDUSTRIAL ETHERNET	MegaLine® D1-20 SF/U 11Y flex CATEGORY 5 HEAVY DUTY	MegaLine® D1-20 S/U 11Y superflex CATEGORY 5 HEAVY DUTY	MegaLine® F10-130 S/F (L)2Y CATEGORY 7 _A HEAVY DUTY
	MegaLine®	 4 x 2 x AWG 26/7	 4 x 2 x AWG 26/19 4 x 2 x AWG 24/19	 4 x 2 x AWG 22/1 PiMF
Application				
		Industrial workplace, work area and patch panel acc. to EN 50173-3 and ISO/IEC 24702 for indoor application. (flexible installation)	Industrial cabling acc. to EN 50173-3 and ISO/IEC 24702 for indoor application. (for drag chains)	Industrial cabling acc. to EN 50173-3 and ISO/IEC 24702 for outdoor application. (fixed installation)
Electrical Properties				
Conductor resistance		max. 145 Ω/km	max. 130 Ω/km (AWG 26) max. 95 Ω/km (AWG 24)	max. 57.1 Ω/km
Impedance (f = 100 MHz)		100 Ω ± 5 Ω		
Bandwidth		200 MHz	100 MHz	1300 MHz
NEXT@Bandwidth frequency		nominal 42 dB	nominal 45 dB	nominal 80 dB
Attenuation@bandwidth frequency		nominal 3.86 dB/10 m	nominal 3.95 dB/10 m (AWG 26) nominal 3.15 dB/10 m (AWG 24)	61.4 dB/100 m
Interference power suppression up to f = 1 GHz		nominal 55 dB	nominal 55 dB	nominal 70 dB
Construction				
Conductor		plain annealed copper, AWG 26/7	plain annealed copper, AWG 26/19 plain annealed copper, AWG 24/19	plain annealed copper, AWG 22/1
Insulation		foamed polyethylene with skin layer	FEP	foamed polyethylene with skin layer
Colour code		white/blue, white/orange, white/green, white/brown		
Individual screen		--	--	plastic coated aluminium tape
Laying up		cores to pairs, pairs to cable core		
Screen		plastic coated aluminium tape in contact with tinned copper wire braid, optical coverage approx. 65 %	tinned copper wire braid, optical coverage approx. 65 %	plastic coated aluminium tape in contact with tinned copper wire braid, optical coverage approx. 65 %
Inner sheath		--	elastomer	zero halogen compound
Outer sheath		Polyurethane PUR yellow Ø approx. 6 mm	Polyurethane PUR yellow Ø approx. 6.8 mm –AWG 26/19 Ø approx. 8.3 mm –AWG 24/19	Polyethylene PE above aluminium tape Ø approx. 12 mm
Weight		approx. 37 kg/km	approx. 58 kg/km (AWG 26/19) approx. 84 kg/km (AWG 24/19)	approx. 150 kg/km
Minimum bending radius		8 x cable diameter	5 x cable diameter	8 x cable diameter
Temperature Range				
During operation		- 40 °C up to + 70 °C	- 40 °C up to + 85 °C	- 25 °C up to + 70 °C
During installation		-10 °C up to + 50 °C	0 °C up to + 50 °C	- 10 °C up to + 50 °C
Other Properties				
Flame retardant		acc. to IEC 60332-1-2		acc. to IEC 60332-3-24 (cat. C) (without outer sheath)
Connectors/Glands				
see our catalogue Solutions@Kerpen or visit our homepage www.leoni-kerpen.com				
Further cable variations and part numbers on page C5				

Industrial Ethernet





PROFIBUS DP 150 Ω

The product range

For PROFIBUS DP LEONI Kerpen offers products, which are optimized for the miscellaneous applications in automation technology. The cable versions fulfil basically type A according to IEC 61158-2, i.e. the laying-up of cables are pairs with screen.

Following cable versions are available:

- **BASIC**

Standard version for fixed installation.

- **FAST ASSEMBLY FA**

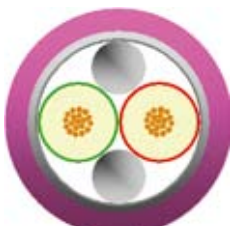
Such as standard version BASIC, but suitable for fast assembly with special tool (see chapter “assembly” on page H4).

- **FLEX**

Such as standard version BASIC, but with 19-strands conductor for flexible installation.

Profibus DP 150 Ω	PROFIBUS DP	BASIC	FAST ASSEMBLY	FLEX
		 1 x 2 x AWG 22/1	 1 x 2 x AWG 22/1	 1 x 2 x AWG 22/19
Application				
		Spur and trunk cable for fixed installation indoor and outdoor, on racks, in conduits.	Spur and trunk cable for fixed installation indoor and outdoor, on racks, in conduits. Suitable for fast assembly.	Spur and trunk cable for flexible installation indoor and outdoor, on racks, in conduits.
Electrical Properties				
Loop resistance	max. 110 Ω/km			
Screen resistance	nominal 12 Ω/km			
Impedance (f ≥ 3 MHz)	150 Ω ± 15 Ω			
Mutual capacitance	nominal 30 nF/km			
Capacitance unbalance to earth	max. 1.5 nF/km			
Attenuation @ f = MHz 0.25/0.625/1.25/3.125/16	nominal 6 / 9 / 12 / 18 / 40 dB/km		nominal 6 / 9 / 14 / 23 / 47 dB/km	
Inductance	nominal 0.90 mH/km			
Construction				
Conductor	plain annealed copper, solid, 0.64 mm Ø			plain annealed copper, 19 strands, AWG 22
Insulation	foamed polyethylene with skin layer			
Colour code	a-core: green - b-core: red			
Screen	plastic coated aluminium tape in contact with drain wire and tinned copper wire braid	plastic coated aluminium tape in contact with tinned copper wire braid	plastic coated aluminium tape in contact with drain wire and tinned copper wire braid	
Inner sheath	--	extruded copolymer	--	
Outer sheath	polyvinylchloride PVC Ø 8.0 ± 0.4 mm			polyvinylchloride PVC Ø approx. 8.9 mm
Weight	approx. 78 kg/km	approx. 78 kg/km	approx. 82 kg/km	
Minimum bending radius	5 x cable diameter	5 x cable diameter		
Single bending			5 x cable diameter	
Repeated bending			10 x cable diameter	
Temperature Range				
During operation	- 40 °C up to + 70 °C ¹⁾			
During installation	- 5 °C up to + 50 °C			
Other Properties				
Flame retardant	acc. to IEC 60332-3-24 (cat. C) and UL 13 (vertical tray)			
Oil resistant UV-resistant	acc. to ICEA S-73-532 acc. to UL 1581 article 1200			
Connectors/Glands				
	M16 / M 12 ; D-9-pin D-sub			--
Further cable variations and part numbers on page D5				

¹⁾ + 75 °C with UL-approval

PROFIBUS DP	FLEX-PUR	FAST ASSEMBLY FA SWA ARMoured	BASIC WITH PE SHEATH	Profibus DP 150 Ω
	 1 x 2 x AWG 22/19	 1 x 2 x AWG 22/1	 1 x 2 x AWG 22/1	
Application				
	Spur and trunk cable for flexible installation indoor and outdoor.	Spur and trunk cable for fixed installation indoor and outdoor, on racks, in conduits. Suitable for direct burial.	Spur and trunk cable for fixed installation indoor and outdoor, on racks, in conduits. Suitable for direct burial.	
Electrical Properties				
Loop resistance	max. 110 Ω/km			
Screen resistance	nominal 12 Ω/km			
Impedance (f ≥ 3 MHz)	150 Ω ± 15 Ω			
Mutual capacitance	nominal 30 nF/km			
Capacitance unbalance to earth	max. 1.5 nF/km			
Attenuation @ f = MHz 0.25/0.625/1.25/3.125/16	nominal 6 / 9 / 14 / 23 / 47 dB/km	nominal 6 / 9 / 12 / 18 / 40 dB/km		
Inductance	nominal 0.90 mH/km			
Construction				
Conductor	plain annealed copper, 19 strands, AWG 22	plain annealed copper, solid, 0.64 mm Ø		
Insulation	foamed polyethylene with skin layer			
Colour code	a-core: green - b-core: red			
Screen	plastic coated aluminium tape in contact with tinned copper wire braid		plastic coated aluminium tape in contact with drain wire and tinned copper wire braid	
Inner sheath	--	extruded copolymer	extruded copolymer	
Armour	--	galvanised round steel wires SWA	--	
Outer sheath	polyurethane PUR Ø 8.0 ± 0.4 mm	polyvinylchloride PVC Ø approx. 12 mm	polyethylene PE Ø approx. 11 mm	
Weight	approx. 78 kg/km	approx. 280 kg/km	approx. 100 kg/km	
Minimum bending radius		10 x cable diameter	5 x cable diameter	
Single bending	5 x cable diameter			
Repeated bending	10 x cable diameter			
Temperature Range				
During operation	- 40 °C up to + 70 °C ¹⁾			
During installation	- 5 °C up to + 50 °C			
Other Properties				
Flame retardant	acc. to IEC 60332-2-2	acc. to IEC 60332-3-24(cat C) and UL 13 (vertical tray)	acc. to IEC 60332-3-24(cat.C) and UL 13 (vertical tray)* *(without PE sheah)	
Oil resistant	acc. to ICEA S-73-532	acc. to ICEA S-73-532	acc. to ICEA S-73-532	
UV-resistant	--	UL 1581 article 1200	UL 1581 article 1200	
Connectors/Glands				
	M16	--	M16 / M12; 9-pin D-sub	
Further cable variations and part numbers on page D5				

¹⁾ + 75 °C with UL-approval



PROFIBUS DP 150 Ω

Part numbers / cable variations

Version	LEONI Kerpen type	Size	Part-no.			
			with UL ^{*)}		without UL	
			violet	blue	violet	blue
Basic with PVC	Standard	1 x 2 x AWG 22/1	76770301	76770302	76770501	76770502
Fast Assembly FA in PVC	suitable for assembly tool	1 x 2 x AWG 22/1	74220302	74220301	76220501	76220502
Flex in PVC	flexible	1 x 2 x AWG 22/19	76770303	76770304	76770503	76770504
Basic with PVC, SWA armoured	Basic, armoured	1 x 2 x AWG 22/1	7677301U	7677302U	7677501U	7677502U
Fast Assembly FA with PVC, SWA armoured	suitable for assembly tool	1 x 2 x AWG 22/1	7422302U	7422301U	7422501U	7422502U
Basic in LSZH	zero halogen, flame retardant	1 x 2 x AWG 22/1	79260301	79260302	79260501	79260502
Fast Assembly FA in LSZH	zero halogen, flame retardant	1 x 2 x AWG 22/1	74360302	74360301	74360501	74360502
Flex in LSZH	zero halogen, flame retardant	1 x 2 x AWG 22/19	76260303	76260304	79260503	79260504
Basic in LSZH, SWA armoured	zero halogen, flame retardant	1 x 2 x AWG 22/1	7926301U	7926302U	7926501U	7926502U
Flex with PUR	flexible	1 x 2 x AWG 22/19	--	--	82050000	82050001
Basic with PVC and additional PE-sheath	for direct burial	1 x 2 x AWG 22/1	--	--	7677501V	7677502V
					additional PE-sheath	additional PE-sheath
Fast Assembly FA with PVC and additional PE-sheath	for direct burial, suitable for assembly tool	1 x 2 x AWG 22/1	--	--	7422501V	7422502V
					additional PE-sheath	additional PE-sheath

^{*)} UL-File E107687 (PLTC)





PROFIBUS PA 100 Ω

The product range

For PROFIBUS PA LEONI Kerpen offers products, which are optimized for the miscellaneous applications in automation technology. LEONI Kerpen's cable versions fulfil basically type A according to IEC 61158-2, i.e. the laying-up of cables are pairs with screen.

Following cable versions are available:

- BASIC

Standard version for fixed installation.

- FAST ASSEMBLY FA

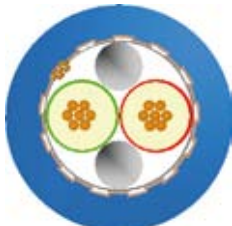
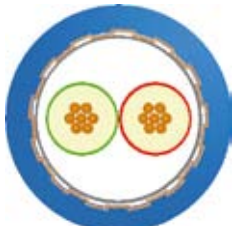
Such as standard version BASIC, but suitable for fast assembly with special tool (see chapter "assembly" on page H4).

- FLEX

Such as standard version BASIC, but with 19-strands conductor for flexible installation.

- LONG DISTANCE

Version with PE-insulation and sizes AWG 16/7 or AWG 14/7 as trunk cable with reduced voltage drop.

Profibus PA 100 Ω	PROFIBUS PA	BASIC TYPE A	FAST ASSEMBLY FA TYPE A	FLEX TYPE A
				
	1 x 2 x AWG 18/7	1 x 2 x AWG 18/7	1 x 2 x AWG 18/19	
	Application			
	Spur and trunk cable for fixed installation indoor and outdoor, on racks, in conduits.	Spur and trunk cable (suitable for fast assembly) for fixed installation indoor and outdoor, on racks, in conduits.	Spur and trunk cable for flexible installation indoor and outdoor.	
Electrical Properties				
Loop resistance	max. 43.6 Ω/km			
Screen resistance	nominal 12 Ω/km			
Impedance at (f = 31.25 kHz)	100 Ω ± 20 Ω			
Mutual capacitance	nominal 60 nF/km			
Capacitance unbalance to earth	max. 2 nF/km			
Attenuation @ f = 39 kHz	max. 3.0 dB/km			
Propagation delay change (7.9 kHz - 39 kHz)	max. 1.7 µs/km			
Inductance	nominal 0.70 mH/km			
Construction				
Conductor	plain annealed copper, stranded, AWG 18			
Insulation	foamed polyethylene with skin layer			
Colour code	a-core: green - b-core: red			
Screen	plastic coated aluminium tape in contact with drain wire and tinned copper wire braid	plastic coated aluminium tape in contact with tinned copper wire braid	plastic coated aluminium tape in contact with drain wire and tinned copper wire braid	
Inner sheath	--	extruded copolymer	--	
Outer sheath	polyvinylchloride PVC Ø 7.9 ± 0.3 mm	polyvinylchloride PVC Ø 8.1 ± 0.3 mm	polyvinylchloride PVC Ø 8.1 ± 0.3 mm	
Weight	approx. 85 kg/km	approx. 90 kg/km	approx. 90 kg/km	
Minimum bending radius	5 x cable diameter	5 x cable diameter		
Single bending			5 x cable diameter	
Repeated bending			10 x cable diameter	
Temperature Range				
During operation	- 40 °C up to + 70 °C ¹⁾			
During installation	- 5 °C up to + 50 °C			
Other Properties				
Flame retardant	acc. to IEC 60332-3-24 (cat. C) and UL 13 (vertical tray)			
Oil resistant	acc. to ICEA S-73-532			
UV-resistant	acc. to UL 1581 article 1200			
Connectors/Glands				
	M16 / M12			
Further cable variations and part numbers on page E5				

¹⁾ + 75 °C with UL-approval

PROFIBUS PA	LONG DISTANCE LD TYPE A	BASIC - ARMOUR SWA TYPE A	BASIC WITH XLPE INSULATION TYPE A	Profibus PA 100 Ω
	 1 x 2 x AWG 16/7 or 1 x 2 x AWG 14/7	 1 x 2 x AWG 18/7	 1 x 2 x AWG 18/7	
Application				
	Trunk cable for fixed installation indoor and outdoor, on racks, in conduits. Between Segment-Coupler and “Field-Barrier-Device”.	Spur and trunk cable for fixed installation indoor and outdoor, on racks, in conduits. Suitable for direct burial and increased mechanical stresses.	Spur and trunk cable for fixed installation indoor and outdoor, on racks, in conduits. Suitable for increased operating temperature.	
Electrical Properties				
Loop resistance	max. 28.5 Ω/km (AWG 16) max. 17.9 Ω/km (AWG 14)	max. 43.6 Ω/km		
Screen resistance	nominal 12 Ω/km			
Impedance (f = 31.25 kHz)	100 Ω ± 20 Ω			
Mutual capacitance	nominal 60 nF/km			
Capacitance unbalance to earth	max. 2 nF/km			
Attenuation @ f = 39 kHz	max. 3.0 dB/km			
Propagation delay change (7.9 kHz - 39 kHz)	max. 1.7 µs/km			
Inductance	nominal 0.70 mH/km			
Construction				
Conductor	plain annealed copper, stranded, AWG 16/7 or AWG 14/7	plain annealed copper, stranded, AWG 18		
Insulation	polyethylene PE	foamed polyethylene with skin layer	cross-linked polyethylene XLPE	
Colour code	a-core: green - b-core: red			
Screen	plastic coated aluminium tape in contact with drain wire and tinned copper wire braid			
Inner sheath	--	extruded thermoplastic material	--	
Armour	--	galvanised round steel wires SWA	--	
Outer sheath	polyvinylchloride PVC Ø approx. 9.5 mm (AWG16) Ø approx. 11.5 mm approx. (AWG14)	polyvinylchloride PVC Ø approx. 12 mm	polyvinylchloride PVC Ø approx. 10 mm	
Weight	approx. 110 kg/km (AWG 16) approx. 160 kg/km (AWG 14)	approx. 270 kg/km	approx. 115 kg/km	
Minimum bending radius.	5 x cable diameter	10 x cable diameter	8 x cable diameter	
Temperature Range				
During operation	- 40 °C up to + 70 °C ¹⁾		- 40 °C up to + 90 °C	
During installation	- 5 °C up to + 50 °C		- 5 °C up to + 50 °C	
Other Properties				
Flame retardant	acc. to IEC 60332-3-24 (cat. C) and UL 13 (vertical tray)			
Oil resistant	acc. to ICEA S-73-532			
UV-resistant	acc. to UL 1581 article 1200			
Connectors/Glands				
	M16 / M12			
Further cable variations and part numbers on page E5				

¹⁾ + 75 °C with UL-approval





PROFIBUS PA 100 Ω

Part numbers / cable variations

Version	LEONI Kerpen type	Size	Part-no.			
			with UL ^{*)}		without UL	
			blue	black	blue	black
Basic with PVC	standard	1 x 2 x AWG 18/7	76770100	76770101	76770601	76770602
Fast Assembly FA in PVC	suitable for assembly tool	1 x 2 x AWG 18/7	74220100	74220101	74220601	74220602
Flex in PVC	flexible	1 x 2 x AWG 18/19	76770200	76770201	76770603	76770604
Basic with PVC, Long Distance PVC	SWA armoured	1 x 2 x AWG 18/7	7677100V	7677101V	7677601U	7677602U
Long Distance	with reduced voltage drop	1 x 2 x AWG 16/7	79290100	79290101	79290601	79290602
Long Distance	with reduced voltage drop	1 x 2 x AWG 14/7	79290102	79290103	79290603	79290604
Basic in LSZH	zero halogen, flame retardant	1 x 2 x AWG 18/7	79260100	79260101	79260601	79260602
Fast Assembly FA in LSZH	zero halogen, flame retardant	1 x 2 x AWG 18/7	74360100	74360101	74360601	74360602
Flex in LSZH	flexible, zero halogen, flame retardant	1 x 2 x AWG 18/19	79260200	79260201	79260603	79260604
Basic, with XLPE-insulation	+ 90 °C operating temperature	1 x 2 x AWG 18/7	76990100	76990101	76990601	76990602
Basic in LSZH, SWA-armoured	zero halogen, flame retardant	1 x 2 x AWG 18/7	7926100U	7926101U	7926601U	7926602U
Long Distance in LSZH	zero halogen, flame retardant	1 x 2 x AWG 16/7	79300100	79300101	79300601	79300602
Long Distance in LSZH	zero halogen, flame retardant	1 x 2 x AWG 14/7	79300102	79300103	79300603	79300604

^{*)} UL-File E107687 (PLTC)



FOUNDATION Fieldbus 100 Ω

The product range

For FOUNDATION Fieldbus LEONI Kerpen offers products, which are optimized for the miscellaneous applications in automation technology. LEONI Kerpen's cable versions fulfil basically type A according to IEC 61158-2, i.e. the laying-up of cables are pairs with screen.

Following cable versions are available:

- BASIC

Standard version for fixed installation.

- FAST ASSEMBLY FA

Such as standard version Basic, but suitable for fast assembly with special tool (see chapter "assembly" on page H4).

- FLEX

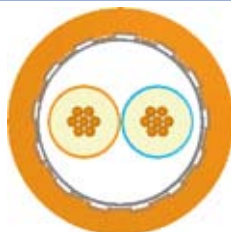
Such as standard version Basic, but with 19-strands conductor for flexible installation.

- ECO

Such as standard Basic, but without braided screen

- LONG DISTANCE

Version with PE-Insulation and sizes AWG 16/7 or AWG 14/7 as trunk cable with reduced voltage drop.

FOUNDATION Fieldbus 100 Ω	FOUNDATION FIELDBUS FF	BASIC TYPE A	FAST ASSEMBLY FA TYPE A	FLEX TYPE A
		 1 x 2 x AWG 18/7	 1 x 2 x AWG 18/7	 1 x 2 x AWG 18/19
Application				
		Spur and trunk cable for fixed installation indoor and outdoor, on racks, in conduits.	Spur and trunk cable for fixed installation indoor and outdoor, on racks, in conduits. Suitable for fast assembly.	Spur and trunk cable for flexible installation indoor and outdoor, on racks, in conduits.
Electrical Properties				
Loop resistance	max. 43.6 Ω/km			
Screen resistance	nominal 12 Ω/km			
Impedance at f = 31.25 kHz	100 Ω ± 20 Ω			
Mutual capacitance	nominal 60 nF/km			
Capacitance unbalance to earth	max. 2 nF/km			
Attenuation @ f = 39 kHz	max. 3.0 dB/km			
Propagation delay change (7.9 kHz - 39 kHz)	max. 1.7 µs/km			
Inductance	nominal 0.70 mH/km			
Construction				
Conductor	plain annealed copper, stranded, AWG 18			
Insulation	foamed polyethylene with skin layer			
Colour code	(+) -core: orange, (-) -core: blue			
Screen	plastic coated aluminium tape in contact with drain wire and tinned copper wire braid	plastic coated aluminium tape in contact with tinned copper wire braid	plastic coated aluminium tape in contact with drain wire and tinned copper wire braid	
Inner sheath	--	extruded copolymer	--	
Outer sheath	polyvinylchloride PVC Ø 7.9 ± 0.3 mm	polyvinylchloride PVC Ø 8.1 ± 0.3 mm	polyvinylchloride PVC Ø 8.1 ± 0.3 mm	
Weight	approx. 85 kg/km	approx. 90 kg/km	approx. 90 kg/km	
Minimum bending radius	5 x cable diameter	5 x cable diameter		
Single bending			5 x cable diameter	
Repeated bending			10 x cable diameter	
Temperature Range				
During operation	- 40 °C up to + 70 °C ¹⁾			
During installation	- 5 °C up to + 50 °C			
Other Properties				
Flame retardant	acc. to IEC 60332-3-24 (cat. C) and UL 13 (vertical tray)			
Oil resistant	acc. to ICEA S-73-532			
UV-resistant	acc. to UL 1581 article 1200			
Connectors/Glands				
	M16 / M12			
Further cable variations and part numbers on page E5				

¹⁾ + 75 °C with UL-approval

FOUNDATION FIELDBUS FF	LONG DISTANCE LD TYPE A	ECO - SWA ARMoured TYPE A	ECO TYPE A	FOUNDATION Fieldbus 100 Ω
	 1 x 2 x AWG 16/7 or 1 x 2 x AWG 14/7	 1 x 2 x AWG 18/7	 1 x 2 x AWG 18/7	
Application				
	Trunk cable for fixed installation indoor and outdoor, on racks, in conduits. Between Segment-Coupler and "Field-Barrier-Device".	Spur and trunk cable for fixed installation indoor and outdoor, on racks, in conduits. Suitable for direct burial and increased mechanical stresses.	Spur and trunk cable for fixed installation indoor and outdoor, on racks, in conduits.	
Electrical Properties				
Loop resistance	max. 28.5 Ω/km (AWG 16) max. 17.9 Ω/km (AWG 14)	max. 43.6 Ω/km		
Screen resistance	nominal 12 Ω/km	nominal 30 Ω/km		
Impedance at f = 31.25 kHz	100 Ω ± 20 Ω			
Mutual capacitance	nominal 60 nF/km			
Capacitance unbalance to earth	max. 2 nF/km			
Attenuation @ f = 39 kHz	max. 3.0 dB/km			
Variation du délai de propagation (7.9 kHz - 39 kHz)	max. 1.7 µs/km			
Inductance	nominal 0.70 mH/km			
Construction				
Conductor	plain annealed copper, stranded, AWG 16/7 or AWG 14/7	plain annealed copper, stranded, AWG 18		
Insulation	polyethylene PE	foamed polyethylene with skin layer		
Colour code	(+)-core: orange, (-)-core: blue			
Inner sheath	--	extruded copolymer	--	
Screen	plastic coated aluminium tape in contact with drain wire and tinned copper wire braid	plastic coated aluminium tape in contact with tinned copper wire		
Inner sheath	--	extruded thermoplastic material	--	
Armour		galvanised round steel wires SWA		
Outer sheath	polyvinylchloride PVC Ø approx. 9.5 mm (AWG 16) Ø approx. 11.5 mm (AWG 14)	polyvinylchloride PVC Ø approx. 12 mm	polyvinylchloride PVC Ø max. 8.2 mm	
Weight	approx. 110 kg/km (AWG 16/7) approx. 160 kg/km (AWG 14/7)	approx. 270 kg/km	approx. 85 kg/km	
Minimum bending radius	5 x cable diameter	10 x cable diameter	8 x cable diameter	
Temperature Range				
During operation	- 40 °C up to + 70 °C ¹⁾			
During installation	- 5 °C up to + 50 °C			
Other Properties				
Flame retardant	acc. to IEC 60332-3-24 (cat. C) and UL 13 (vertical tray)			
Oil resistant	acc. to ICEA S-73-532			
UV-resistant	acc. to UL 1581 article 1200			
Connectors/Glands				
	M16	--	M16 / M12	
Further cable variations and part numbers on page F5				

¹⁾ + 75 °C with UL-approval

FOUNDATION FIELDBUS FF		MULTIPAIRS SWA ARMoured TYPE A		
		 2 x 2 x AWG 18/7 PiMF	 5 x 2 x AWG 18/7 PiMF	 10 x 2 x AWG 18/7 PiMF
Application				
		Trunk cable for fixed installation indoor and outdoor, on racks, in conduits. Suitable for direct burial and increased mechanical stresses.		
Electrical Properties				
Loop resistance	max. 43.6 Ω/km			
Overall screen resistance	nominal 30 Ω/km			
Impedance at f = 31.25 kHz	100 Ω ± 20 Ω			
Mutual capacitance	nominal 60 nF/km			
Capacitance unbalance to earth	max. 2 nF/km			
Attenuation @ f = 39 kHz	max. 3.0 dB/km			
Propagation delay change (7.9 kHz - 39 kHz)	max. 1.7 µs/km			
Inductance	nominal 0.70 mH/km			
Construction				
Conductor	plain annealed copper, stranded, AWG 18			
Insulation	foamed polyethylene with skin layer			
Colour code	(+) -core: orange, (-) -core: blue, pair identification with numbered tapes			
Pair screen	plastic coated aluminium tape in contact with tinned copper wire braid			
Overall screen	plastic coated aluminium tape in contact with tinned copper wire braid			
Inner sheath	extruded thermoplastic material			
Armour	galvanised round steel wires SWA			
Outer sheath	polyvinylchloride PVC Ø approx. 17 mm	polyvinylchloride PVC Ø approx. 21 mm	polyvinylchloride PVC Ø approx. 27 mm	
Weight	approx. 470 kg/km	approx. 770 kg/km	approx. 1140 kg/km	
Minimum bending radius	8 x cable diameter			
Temperature Range				
During operation	- 40 °C up to + 70 °C			
During installation	- 5 °C up to + 50 °C			
Other Properties				
Flame retardant	acc. to IEC 60332-3-24 (cat. C) and UL 13 (vertical tray))			
Oil resistant	acc. to ICEA S-73-532			
UV-resistant	acc. to UL 1581 article 1200			
Connectors/Glands				
Further cable variations and part numbers on page F5				

Part numbers / cable variations

Version	LEONI Kerpen type	Size	Part-no.			
			with UL ^{*)}		without UL	
			orange	blue	orange	blue
Basic with PVC	standard	1 x 2 x AWG 18/7	76770102	76770103	76770605	76770606
Fast Assembly FA in PVC	suitable for assembly tool	1 x 2 x AWG 18/7	74220103	74220102	74220603	74220604
Flex in PVC	flexible	1 x 2 x AWG 18/19	76770203	76770202	76770607	76770608
Basic with PVC, SWA-armoured	Basic, SWA armoured	1 x 2 x AWG 18/7	7677102U	7677103U	7677605U	7677606U
Long Distance	with reduced voltage drop	1 x 2 x AWG 16/7	79290105	79290104	79290605	79290606
Long Distance	with reduced voltage drop	1 x 2 x AWG 14/7	79290107	79290106	79290607	79290608
Multipairs ,SWA-armoured ^{**)}	multipairs, individual screened	2 x 2 x AWG 18/7 PIMF	--	--	74790008	74790038
Multipairs ,SWA-armoured ^{**)}	multipairs, individual screened	5 x 2 x AWG 18/7 PIMF	--	--	74790009	74790039
Multipairs ,SWA-armoured ^{**)}	multipairs, individual screened	10 x 2 x AWG 18/7 PIMF	--	--	74790010	74790040
Multipairs ,SWA-armoured ^{**)}	multipairs, individual screened	20 x 2 x AWG 18/7 PIMF	--	--	74790011	74790041
Eco with PVC	with overall screen of aluminium bonded plastic tape	1 x 2 x AWG 18/7	74250100	74250101	74250601	74250602
Basic in LSZH	zero halogen, flame retardant	1 x 2 x AWG 18/7	79260102	79260103	74250605	74250606
Fast Assembly FA in LSZH	zero halogen, flame retardant	1 x 2 x AWG 18/7	74360103	74360102	74360603	74360604
Flex in LSZH	zero halogen, flame retardant	1 x 2 x AWG 18/19	79260203	79260202	79260607	79260608
Eco in LSZH	With overall screen of aluminium bonded plastic tape, zero halogen, flame retardant	1 x 2 x AWG 18/7	79270100	79270101	79270601	79270602
Long Distance in LSZH	zero halogen, flame retardant	1 x 2 x AWG 16/7	79300105	79300104	79300605	79300606
Long Distance in LSZH	zero halogen, flame retardant	1 x 2 x AWG 14/7	79300107	79300106	79300607	79300608
Eco with PVC, SWA-armoured ^{**)*)}	Eco, armoured	1 x 2 x AWG 18/7	7425100W	7425101W	7425601U	74251602U

^{*)} UL-File E107687 (PLTC)

^{**)*)} also available in zero halogen, flame retardant



***GigaLine*® Optical fibre cables**

The product range

Conventional links based on copper cables are now often reaching the limits of their capacity.

The use of GigaLine® optical fibre cables offers for the most diverse bus applications (e.g. High Speed Ethernet (HSE)) advantages in the following cases:

- when electromagnetic effects can occur
- when reliable potential separation is required
- when broad transmission ranges are required
- when low attenuation and thus long channels are necessary
- when crosstalk must not occur
- When sparks must not emerge (for explosive environments)
- When low weight and small dimensions are an advantage
- When increased security against tapping is required.

LEONI Kerpen's GigaLine® offers a comprehensive delivery program for optical fibre cables for virtually all applications.

Besides easy-to-assemble indoor cables with compact wire technology for the patch and floor area, universal cables for the backbones indoors and outdoors and the classical outdoor cables, LEONI Kerpen offers manufacturing options for a large number of additional designs such as GigaLine® outdoor cables with a corrugated steel sheath, a steel tape, or SWA armour or with additional lead covering as a protection against chemicals as well as zero halogen, flame retardant cable versions.

GigaLine		GigaLine® DX0 KL-J-V(ZN)HH Indoor Optical Fibre Cable (Breakout)	GigaLine® AT KL-AT-V(ZN)HY-fl Indoor Optical Fibre Cable (Breakout)	GigaLine® DQ KL-U-DQ(ZN)BH Universal Optical Fibre Cable, longitudinally watertight
				
	2 G/E ... (Figure 0)	2 G/E ... (round in shape)	1 x m G/E	
	Application			
		Floor cabling, suitable for direct plug mounting and splicing.	Floor cabling, suitable for direct plug mounting and splicing.	Campus-/backbone cabling, suitable for splicing, indoor installation in the case of increased mechanical requirements, outdoor installation in dry tubes.
	Construction			
Fibre	multi mode 50/125 µm or 62.5/125 µm and single mode 9..10/125 µm fibre qualities as well as colour code see page G6 / G7			
Core	Compact wires Ø approx. 0.9 mm	Compact wires Ø approx. 0.9 mm	Filled loose tube, central	
Strain relief	Aramid yarn above the core			Glass rovings as rodent protection under outer sheath
Inner sheath	Zero halogen compound, Ø approx. 2.1 mm, yellow, continuously numbered			--
Wrapping	--	Swellable tape		
Outer sheath	Zero halogen compound, orange or yellow approx. 3.1 x 5.2 mm	polyvinylchloride PVC, orange or yellow Ø 8.5 mm		Zero halogen compound FRNC , yellow ≤ 12 Fibre: Ø approx. 7.0 mm ≤ 24 Fibre: Ø approx. 7.5mm
Weight	approx. 18 kg/km	approx. 50 kg/km		≤ 12 Fibre: approx. 48 kg/km ≤ 24 Fibre: approx. 55 kg/km
Inductance				
Mechanical Properties				
Tensile stress	max. 600 (2 x 300) N		max. 1200 N	max. 1750 N
Transverse compression strength	permanent: max. 500 N/dm short-term: max. 750 N/dm		permanent: max. 1000 N/dm short-term: max. 1500 N/dm	permanent: max. 1500 N/dm short-term: max. 2500 N/dm
Minimum bending radius	min. 150 mm		min. 150 mm	
During Installation	min. 35 mm		min. 15 x outer-Ø	
During operation	min. 65 mm		min. 20 x outer-Ø	
Temperature Range				
During operation	- 10 °C up to + 60 °C		- 25 °C up to + 70 °C	
During installation	- 5 °C up to + 50 °C		- 5 °C up to + 50 °C	
Other Properties				
Flame retardant	acc. to IEC 60332-1		acc. to IEC 60332-3-24 (cat. C)	acc. to IEC 60332-3-24 (cat. C)
Connectors/Glands				
	Please find our considerable programme for plugs and components in our catalogue Solutions@Kerpen or visit our homepage www.leoni-kerpen.com .			
	Further cable variations and part numbers on page G4/G5			

	GigaLine® DQ KL-A-DQ(ZN)B2Y Outdoor Optical Fibre Cable, longitudinally watertight	GigaLine® DQ KL-A-DQ(ZN)2YW2Y Outdoor Optical Fibre Cable, longitudinally watertight	GigaLine® DQ KL-A-DQ(ZN)B2YSWAYfl Outdoor Optical Fibre Cable, longitudinally watertight	GigaLine
	 1 x m G/E ...	 1 x m G/E ...	 1 x m G/E ...	
Application				
	Campus-/backbone cabling, suitable for splicing, outdoor installation (direct burial) or in tubes.	Campus-/backbone cabling, suitable for splicing, outdoor installation (direct burial) or in tubes.	Campus-/backbone cabling, suitable for splicing, outdoor installation (direct burial) or in tubes, and increased mechanical stresses.	
Construction				
Fibre	multi mode 50/125 µm or 62.5/125 µm and single mode 9..10/125 µm fibre qualities as well as colour code see pages G6 / G7			
Core	filled loose tube, central			
Strain relief	glass rovings as rodent protection under outer sheath	aramid yarn above the core	aramid yarn above the core	
Inner sheath	--	polyethylene PE, black	polyethylene PE, black	
Wrapping	Swellable tape			
Armour	--	corrugated steel sheath	galvanised round steel wires SWA-Ø: 0.9 mm	
Outer sheath	polyethylene PE, black ≤ 12 Fibre: Ø approx. 7.0 mm ≤ 24 Fibre: Ø approx. 7.5 mm	polyethylene PE, black ≤ 12 Fibre: Ø approx. 12.5 mm ≤ 24 Fibre: Ø approx. 13.0 mm	polyvinylchloride PVC, black ≤ 12 Fibre: Ø approx. 12.5 mm ≤ 24 Fibre: Ø approx. 13.0 mm	
Weight	≤ 12 Fibre: approx. 38 kg/km ≤ 24 Fibre: approx. 43 kg/km	≤ 12 Fibre: approx. 160 kg/km ≤ 24 Fibre: approx. 170 kg/km	≤ 12 Fibre: approx. 250 kg/km ≤ 24 Fibre: approx. 265 kg/km	
Inductance				
Mechanical Properties				
Tensile stress	max. 1750 N	max. 2500 N	max. 1750 N	
Transverse compression strength	permanent: max. 1500 N/dm short-term: max. 2500 N/dm	permanent: max. 2500 N/dm short-term: max. 3500 N/dm	permanent: max. 1000 N/cm short-term: max. 3000 N/cm	
Minimum bending radius				
During installation	min.. 15 x outer-Ø	min.. 15 x outer-Ø	min.. 15 x outer-Ø	
During operation	min.. 20 x outer-Ø	min.. 20 x outer-Ø	min.. 20 x outer-Ø	
Temperature Range				
During operation	- 25 °C up to + 70 °C			
During installation	- 5 °C up to + 50 °C			
Other Properties				
Flame retardant	--	--	acc. to IEC 60332-1	
Connectors/Glands				
	Please find our considerable programme for plugs and components in our catalogue Solutions@Kerpen or visit our homepage www.leoni-kerpen.com .			
	Further cable variations and part numbers on page G4/G5			

GigaLine®
Optical Fibre-Cable
Part numbers / cable variations (1/2)

Version	LEONI Kerpen type	size	Part-no. Fibre type			
			G 50/125	G50/125 OM3	G 62.5/125	E 9...10/125
GigaLine® DXO	Indoor optical fibre cable, oval, zero halogen	2 G/E	8DA20011 orange	8DA50011 orange	8DB70011 orange	8DC70010 yellow
GigaLine® DX	Indor optical fibre cable, round	2 G/E	8BA22004 orange	8BA52004 orange	8BB77004 orange	8BC72004 orange
GigaLine® DQ	Unviersal optical fibre cable, zero halogen, longitudinally watertight	1 x 2 G/E	8UA200A1	8UA500A1	8UB700A1	8UC700A1
		1 x 4 G/E	8UA200A2	8UA500A2	8UB700A2	8UC700A2
		1 x 6 G/E	8UA200A3	8UA500A3	8UB700A3	8UC700A3
		1 x 8 G/E	8UA200A4	8UA500A4	8UB700A4	8UC700A4
		1 x 10 G/E	8UA200A5	8UA500A5	8UB700A5	8UC700A5
		1 x 12 G/E	8UA200A6	8UA500A6	8UB700A6	8UC700A6
GigaLine® DQ	KL-U-DQ(ZN)BH	1 x 16 G/E	8UA200A7	8UA500A7	8UB700A7	8UC700A7
		1 x 20 G/E	8UA200A8	8UA500A8	8UB700A8	8UC700A8
		1 x 24 G/E	8UA200A9	8UA500A9	8UB700A9	8UC700A9
		1 x 2 G/E	8AA200A1	8AA500A1	8AB700A1	8AC700A1
		1 x 4 G/E	8AA200A2	8AA500A2	8AB700A2	8AC700A2
		1 x 6 G/E	8AA200A3	8AA500A3	8AB700A3	8AC700A3
		1 x 8 G/E	8AA200A4	8AA500A4	8AB700A4	8AC700A4
		1 x 10 G/E	8AA200A5	8AA500A5	8AB700A5	8AC700A5
		1 x 12 G/E	8AA200A6	8AA500A6	8AB700A6	8AC700A6
		1 x 16 G/E	8AA200A7	8AA500A7	8AB700A7	8AC700A7
		1 x 20 G/E	8AA200A8	8AA500A8	8AB700A8	8AC700A8
		1 x 24 G/E	8AA200A9	8AA500A9	8AB700A9	8AC700A9
GigaLine® DQ	KL-A-DQ(ZN)BZY	1 x 2 G/E	8AA200A1	8AA500A1	8AB700A1	8AC700A1
		1 x 4 G/E	8AA200A2	8AA500A2	8AB700A2	8AC700A2
		1 x 6 G/E	8AA200A3	8AA500A3	8AB700A3	8AC700A3
		1 x 8 G/E	8AA200A4	8AA500A4	8AB700A4	8AC700A4
		1 x 10 G/E	8AA200A5	8AA500A5	8AB700A5	8AC700A5
		1 x 12 G/E	8AA200A6	8AA500A6	8AB700A6	8AC700A6
GigaLine® DQ	KL-A-DQ(ZN)BZY	1 x 16 G/E	8AA200A7	8AA500A7	8AB700A7	8AC700A7
		1 x 20 G/E	8AA200A8	8AA500A8	8AB700A8	8AC700A8
		1 x 24 G/E	8AA200A9	8AA500A9	8AB700A9	8AC700A9
		1 x 2 G/E	8AA200A1	8AA500A1	8AB700A1	8AC700A1
		1 x 4 G/E	8AA200A2	8AA500A2	8AB700A2	8AC700A2
		1 x 6 G/E	8AA200A3	8AA500A3	8AB700A3	8AC700A3

Version	LEONI Kerpen type	size	Part-no.			
			G 50/125	G50/125 OM3	G 62.5/125	E 9...10/125
GigaLine® DQ	Outdoor optical fibre cable, longitudinally watertight with corrugated steel sheath armoured	1 x 2 G/E	8AA20041	8AA50041	8AB70041	8AC70041
		1 x 4 G/E	8AA20042	8AA50042	8AB70042	8AC70042
		1 x 6 G/E	8AA20043	8AA50043	8AB70043	8AC70043
		1 x 8 G/E	8AA20044	8AA50044	8AB70044	8AC70044
		1 x 10 G/E	8AA20045	8AA50045	8AB70045	8AC70045
		1 x 12 G/E	8AA20046	8AA50046	8AB70046	8AC70046
		1 x 16 G/E	8AA20047	8AA50047	8AB70047	8AC70047
		1 x 20 G/E	8AA20048	8AA50048	8AB70048	8AC70048
		1 x 24 G/E	8AA20049	8AA50049	8AB70049	8AC70049
		1 x 2 G/E	8AA2W0A1	8AA5W0A1	8AB7W0A1	8AC7W0A1
GigaLine® DQ	Outdoor optical fibre cable, longitudinally watertight with SWA-armour	1 x 4 G/E	8AA2W0A2	8AA5W0A2	8AB7W0A2	8AC7W0A2
		1 x 6 G/E	8AA2W0A3	8AA5W0A3	8AB7W0A3	8AC7W0A3
		1 x 8 G/E	8AA2W0A4	8AA5W0A4	8AB7W0A4	8AC7W0A4
		1 x 10 G/E	8AA2W0A5	8AA5W0A5	8AB7W0A5	8AC7W0A5
		1 x 12 G/E	8AA2W0A6	8AA5W0A6	8AB7W0A6	8AC7W0A6
		1 x 16 G/E	8AA2W0A7	8AA5W0A7	8AB7W0A7	8AC7W0A7
		1 x 20 G/E	8AA2W0A8	8AA5W0A8	8AB7W0A8	8AC7W0A8
		1 x 24 G/E	8AA2W0A9	8AA5W0A9	8AB7W0A9	8AC7W0A9

	G50/125 „OM2e“	G50/125 „OM3“	G50/125 „OM3e“	G62.5/125 „OM1e“	E9...10/125 „OS1e“
Attenuations coefficient					
at 850 nm	max. 2.5 dB/km	max. 2.5 dB/km	max. 2.5 dB/km	max. 3.0 dB/km	
at 1300 nm	max. 0.7 dB/km	max. 0.7 dB/km	max. 0.7 dB/km	max. 0.7 dB/km	
at 1310 nm					max. 0.36 dB/km
at 1383 nm					max. 0.40 dB/km
at 1550 nm					max. 0.22 dB/km
Bandwidth					
at 850 nm	min. 600 MHz x km	min. 1500 MHz x km	min. 3500 MHz x km	min. 250 MHz x km	
at 1300 nm	min. 1200 MHz x km	min. 500 MHz x km	min. 500 MHz x km	min. 800 MHz x km	
Laser bandwidth					
at 850 nm		min. 2000 MHz x km	min. 4700 MHz x km		
Dispersion					
at 1310 nm					max. 3.5 ps/nm x km
at 1550 nm					max. 18 ps/nm x km
Segment length 1 Gigabit-Ethernet					
at 850 nm (1000 BASE SX)	min. 750 m	min. 900 m	min. 1000 m	min. 500 m	
at 1300 nm (1000 BASE LX)	min. 2000 m	min. 550 m	min. 550 m	min. 1000 m	
Segment length 10 Gigabit-Ethernet					
at 850 nm (10G BASE-SR)	min. 150 m	min. 300 m	min. 550 m	min. 65 m	
at 1300 nm (10G BASE-LX4)	min. 900 m	min. 300 m	min. 300 m	min. 450 m	
Numerical aperture					
nominal value	0.20	0.20	0.20	0.275	0.12
Refraction index (nominal value)					
at 850 nm	1.483	1.483	1.483	1.497	
at 1300 nm	1.478	1.478	1.478	1.493	
at 1310 nm					1.467
at 1550 nm					1.467
Test load					
	100 kpsi	100 kpsi	100 kpsi	100 kpsi	100 kpsi

Wires (in the case of stranded loose tubes)

Counting wire	red
Counting direction wire	white
Other wires	green for G50/125 blue for G62.5/125 yellow for E9...10/125
Dummy elements	natural colour

The wires are counted consecutively starting with the wire adjacent to the counting element. Dummy elements are not included in counting.

Fibres (in the case of loose tubes)

Fibre-No.	Colour
1	red
2	green
3	blue
4	yellow
5	white
6	grey
7	brown
8	violet
9	turquoise
10	black
11	orange
12	rose
13	red-black
14	green-black
15	blue-black
16	yellow-black
17	white-black
18	grey-black
19	brown-black
20	violet-black
21	turquoise-black
22	natural-black
23	orange-black
24	pink-black



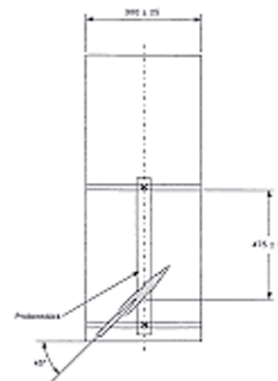
A) Improved fire behaviour

Cables with increased requirements with regard to the fire behaviour have to fulfil following tests:

IEC 60332-1

Test on a single core or a single cable

Outer-diameter of test pieces (mm)	Durability of flame application (s)
$D \leq 25$	60
$25 < D \leq 50$	120
$50 < D \leq 75$	240
$D > 75$	480

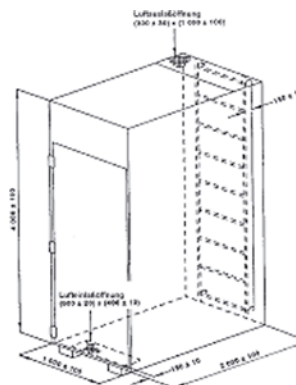


IEC 60332-3-24 (cat. C)

Test on bunched cables
in a test chamber

Total volume of non-metal material: 1.5 Liter/m

Durability of flame application: > 20 minutes



B) Halogen contents and smoke density

In areas where lives and material assets are endangered in case of a fire by toxic gases or smoke, so-called zero halogen, flame retardant cables are used (**LSZH** Low-Smoke-Zero-Halogen or **FRNC** Flame-Retardant-Non-Corrosive)

The properties are defined as follows:

Low smoke characteristic according to IEC 61034,
Light transmittance (L.T.): > 60 %

Amount of halogen acid acc. to IEC 60754-1,
0 %

Degree of acidity of gases acc. to IEC 60754-2,
pH-Value > 4.3

and

Conductivity $c < 10 \mu S/mm$

Oxygen index of sheaths in accordance
with ASTM-D 2863 (annex B), $\geq 35 \%$

Hauptgruppen					
III	IV	V	VI	VII	VIII
					4,0 He
10,8 B	12,0 C	14,0 N	16,0 O	19,0 F	20,2 Ne
27,0 Al	28,1 Si	31,0 P	32,1 S	35,5 Cl	39,9 Ar
69,7 Ga	72,6 Ge	74,9 As	79,0 Se	79,9 Br	83,8 Kr
114,8 In	118,7 Sn	121,8 Sb	127,6 Te	126,9 I	131,3 Xe
204,4 Tl	207,2 Pb	209,0 Bi	209,0 Po	210,0 At	222,0 Rn
81	82	83	84	85	86

C) Mechanical Protection

The primary purpose of armour is to protect the cable against mechanical damage during installation and operation.

The most common armour designs with their most important features are the following:

■ Armour of galvanised round steel wires (SWA)



Very good mechanical protection; reasonably good flexibility; suitable for tensile loads; coverage of over 90 %

■ Armour of galvanised steel wire braid (Q)

Lightweight armour to withstand tensile loads; permits the smallest bending radii of all armour designs; used mainly for small cable diameters; a coverage of at least 80 % and a wire diameter of 0.3 mm are recommended to achieve sufficient mechanical protection



■ Armour of corrugated steel tape (SR)



100 % covering of the cable assembly; good protection against rodents

D) Chemical protection

If the risk of oil and chemicals affecting the installed cable cannot be excluded this may affect the operation of the cables in long term.

The extent of the risk is determined by type, aggressive nature, condition and quantity of the medium, the duration of immersion and the temperature.

A suitable protection can be achieved by corresponding measures:

■ Lead sheath (M)

The safest, though most expensive protection against aromatic hydrocarbons and active chemicals.



■ Multilayer sheath ((L)2Y4Y)



This design combining aluminium tape and HDPE sheath with a covering of polyamide PA (Nylon), represents an excellent barrier against penetrating chemicals and can be used as an alternative to lead sheath.

Advantage: lighter, smaller diameter.

■ Oil resistant PVC sheath (Yö)

In contrast to standard PVC (Y) this compound is more resistant to oils and aliphatic hydrocarbons.

It passes the oil resistance test according to IEC 60811-2-1.

Fast Assembly



For assembly work with stripping tools LEONI Kerpen created FA Fast Assembly buscables, marked with FA. To do the assembly work in a professional manner, please follow the introduction step by step

Preadjusted stripping tool

Do not change the setting of the adjusting screws. The adjusting screws have already been adjusted for the bus system specified on the stripping tool.



1. Determining the stripping length

The centimetre scale on the tool will help you to measure the length. For stripping length, please consult the connector manufacturer's operating instructions. Add 7 mm to the stripping length specified in manufacturer's instructions and use the tip of your thumbnail to mark the length.



2. Inserting the cable into the stripping tool

Insert the length of cable you have measured into the stripping tool using your thumb as a guide. Close the clamp by turning the dial, for best results first click the dial by two notches.



3. Stripping the cable by rotating the tool

Rotate the stripping tool twice around the cable in the direction of the arrow. Close the clamp completely and rotate the stripping tool twice more around the cable.



4. Removing the stripping tool from the cable

Pull the stripping tool lengthways away from the cable. Avoid tilting the tool as this could damage the wires inside.



5. Results after removing the stripping tool

If the results are not satisfactory, it is possible that the blade cassette needs to be rotated or replaced.

6. Removing scrap insulation sheath

After you have opened the clamp you can remove the scrap.



7. Slitting the plastic foil

To remove the remaining plastic foil from the cable, slit the foil with a small slotted screwdriver.



8. Removing the plastic foil

The protective foil you have cut can now be removed easily. You can then attach the section of cable you have stripped to the connector.



Exchanging the blade cassette

a) We recommend using a small slotted screwdriver to open the blade cassette compartment, especially if the tool is new. **Warning: risk of injury.**



b) Both sides of the PROFIBUS blade cassette can be used. Remove the cartridge, rotate it vertically by 180° and then put it back into place. When working with PVC sheaths, the cartridge should be replaced after it has been used approx. 3,000 times (2 x 1,500). In the case of PUR sheaths, the cassette must be replaced after it has been used 300 times (2 x 150). Replacement cassettes can be purchased from your LEONI distributor.



Area of Application:

This stripping tool is solely intended for use as described in these instructions. Other uses may result in accidents, severe personal injury, or damage to the tool and/or cable. For your own safety, use only the accessories or additional devices recommended in these instructions or by the manufacturer. The adjusting screws have already been adjusted for the bus system specified on the stripping tool. Protect yourself from live parts. Do not work on live parts. Keep live parts away from the area in which you are working or cover them appropriately.

To avoid personal injury or damage to the tool or cable, ensure that repairs are carried out by authorised personnel only.



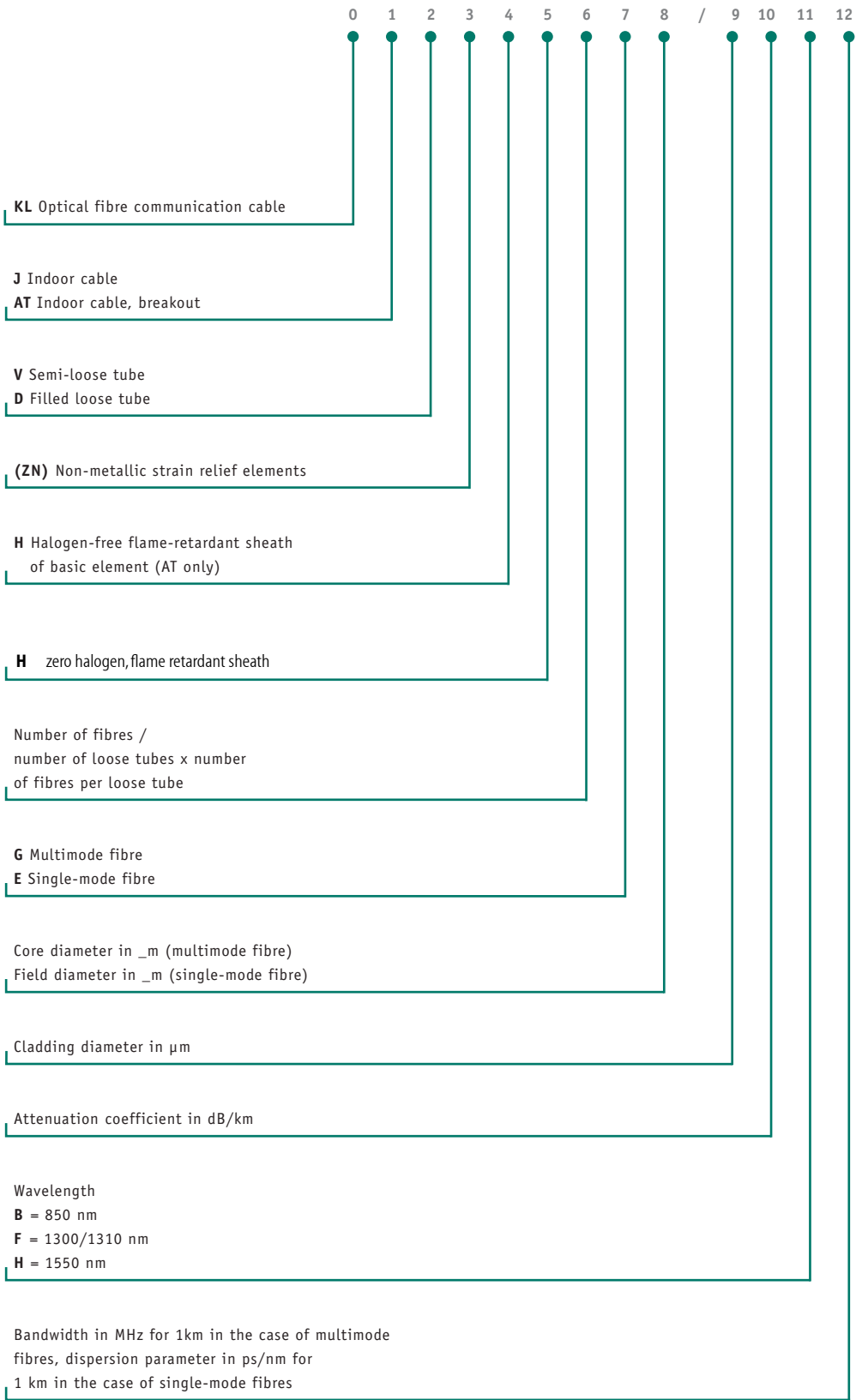
Cable abbreviations:

The abbreviations used by LEONI Kerpen for cables and construction elements refer as far as possible to DIN VDE standards.

FB-	Fieldbus cables
KS-	Communication cable copper
O2YS	Insulation of foamed polyethylene with skin layer
Y	Insulation or sheath of polyvinylchloride (PVC)
Yö	Sheath of oil-resistant polyvinylchloride (PVC)
Yv	Sheath of polyvinylchloride (PVC), thicker
Yfl	Sheath of flame-retardant polyvinylchloride (PVC)
-fl	Cable flame-retardant in compliance with IEC 60332-3
2X	Insulation or sheath of cross linked polyethylene (XLPE)
2Y	Insulation or sheath of polyethylene (PE)
4Y	Sheath of polyamide (PA)
6Y	Insulation or sheath of fluored ethylene-propylene (FEP)
11Y	Sheath of polyurethane (PUR)
3G	Inner sheath of elastomer
(L)2Y4Y	Laminated sheath
H	Sheath of zero halogen, flame retardant compounds (FRNC/LSZH)
(St)	Screen of aluminium bonded plastic tape
C	Screen of copper wire braid
(St+Ce)	Collective screen of aluminum bonded plastic tape and copper wire braid with drain wire
(St+C)	Collective screen of aluminum bonded plastic tape and copper wire braid
PiMF	Pair in metal foil
M	Lead sheath
Q	Armour of galvanized steel wire braid
B	Armour of 2-layers of galvanized steel tape
R	Armour of galvanized round steel wires
SWA	Armour of galvanized round steel wires acc. to British Standard
(SR)	Armour of corrugated steel tape

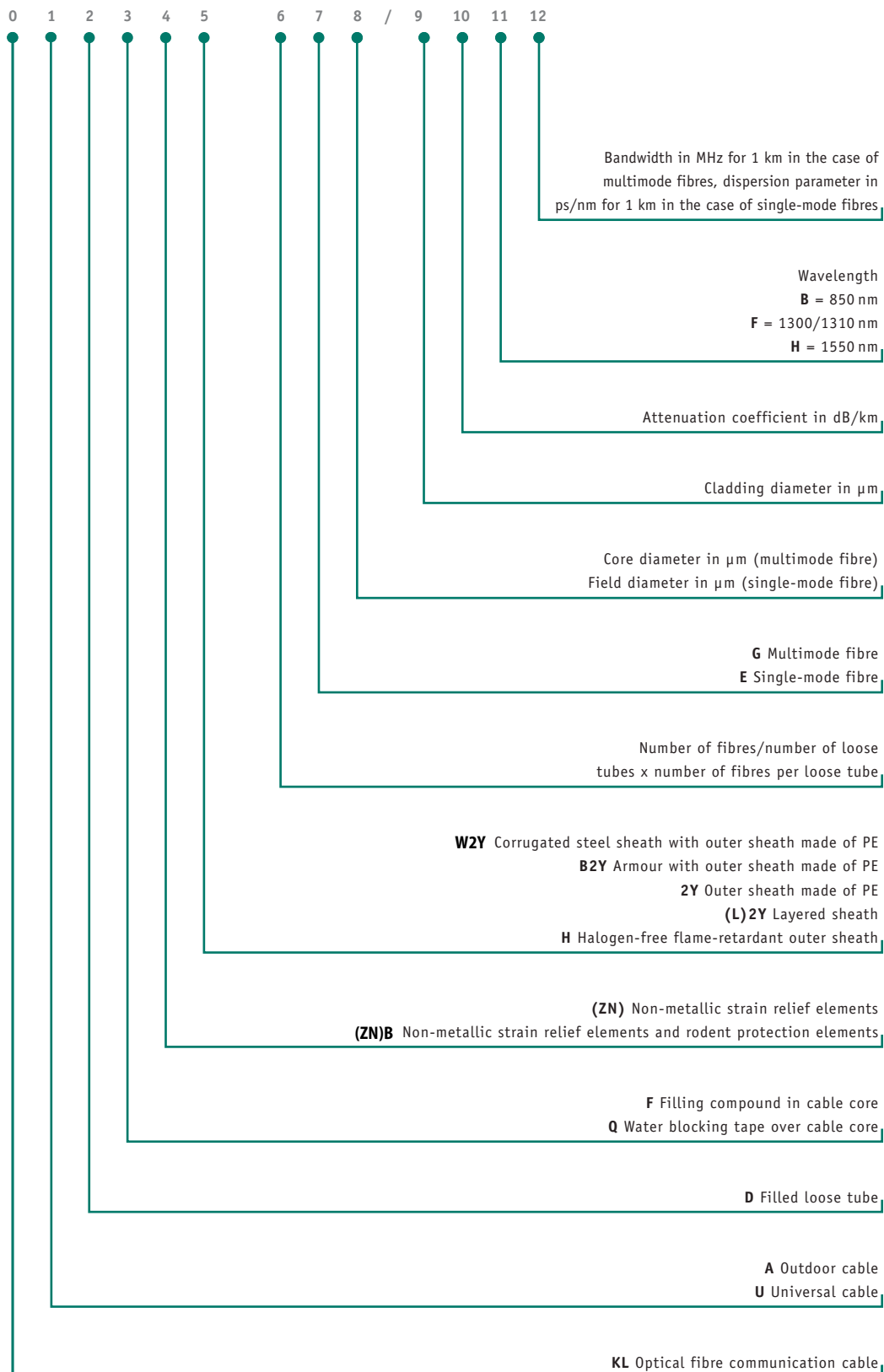
GigaLine® Abbreviations - for easy identification of the

Indoor optical fibre-cables



structural elements to be found in optical fibre cable

universal/outdoor optical fibre cables



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