

Cables for Data Transmission in Industrial Automation

ICON[®] Fieldbus Cables

MegaLine[®] Copper Cables

GigaLine[®] Fibre Optic Cables

Contents

Seite

Technology

Fieldbus Technology	B1
FISCO-Model	B5
BUS-Types according to IEC 61158-2	B6
Transmission Systems PROFIBUS, FOUNDATION Fieldbus	B8
Industrial Ethernet	B12
MICE-Concept	B13

Cable Programme

PROFINET, Industrial Ethernet	C1
PROFIBUS DP 150 Ω	D1
PROFIBUS PA 100 Ω	E1
FOUNDATION FIELDBUS 100 Ω	F1
Fibre Optic Cables for Industrial Ethernet, Profibus, FOUNDATION Fieldbus	G1

Design

Design Options	H1
----------------------	----

Assembly

Fast Assembly (FA)	I1
--------------------------	----

Tables

Cable Abbreviations	J1
---------------------------	----



Issue 060202

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 non-hazardous areas
- High transmission speeds
- Large amounts of data
- Real-time capabilities
- Deterministic
- Energy supply via bus



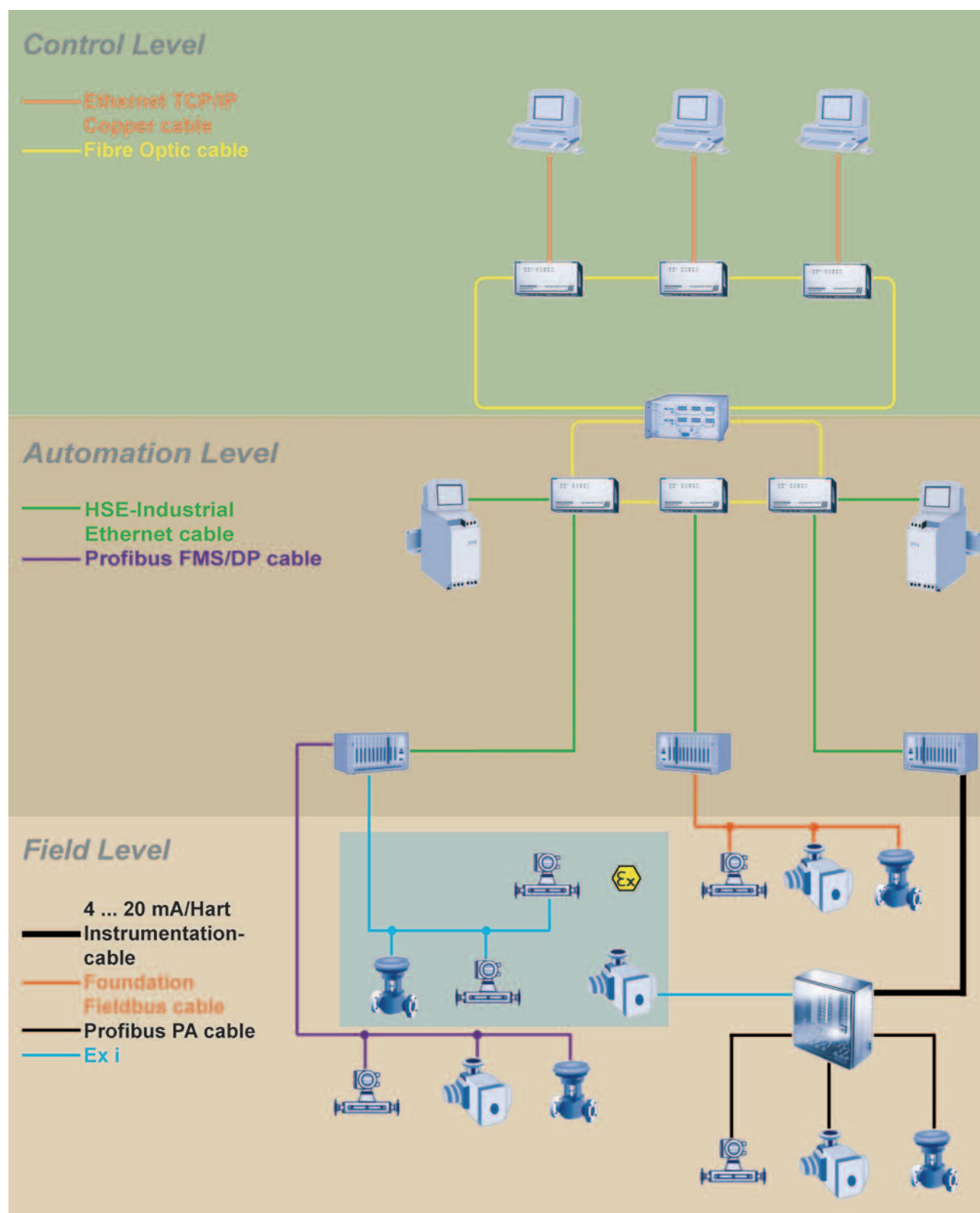
Levels of the Hierarchy

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.

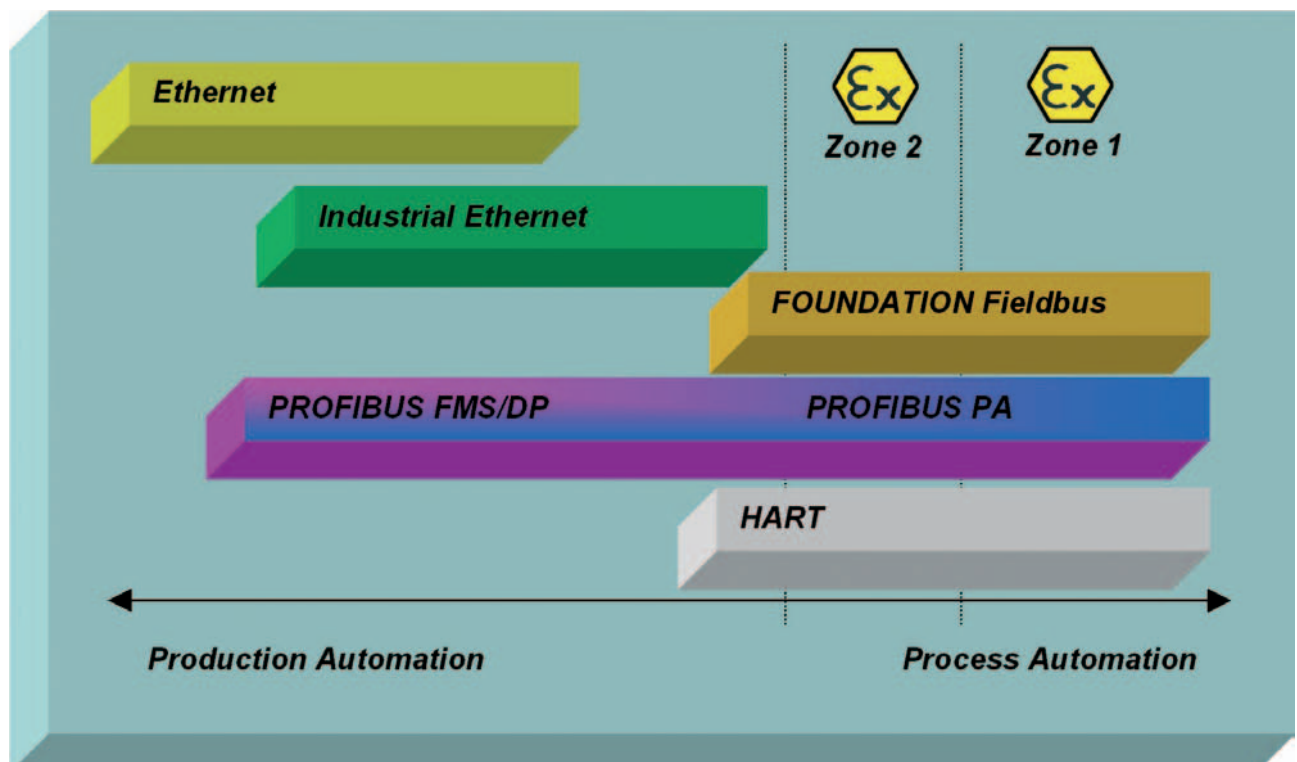
Typically, the systems used for the process industry are strongly decentralized, complex plants which can be very extensive. The demands made on response times are usually less critical: these can be in the range of several seconds.

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 milli-second 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: **1 km** for device group **IIC** and **5 km** 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 fo cable types for the data transfer range of 31.25 kbit/s

Parameter	Type A	Type B	Type C	Type D
Impedance at $f = 31.25 \text{ kHz}$	$100 \pm 30 \Omega$	$100 \pm 30 \Omega$	not specified	not specified
Max. conductor resistance	24 Ω/km	56 Ω/km	132 Ω/km	20 Ω/km
Max. attenuation at $f = 39 \text{ kHz}$	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 $\geq 30 \text{ m}$	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 $\mu\text{s}/\text{km}$	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:

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



Transmission Systems

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.

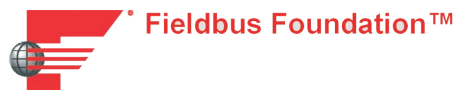
The transmission technology used MBP (Manchester Coded Bus Powered). MBP is synchronous transmission with a fixed transmission rate of 31.25 kbit/s and Manchester-II coding. The intrinsically safe PROFIBUS PA is connected to the PROFIBUS DP via segments couplers or links.

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

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.

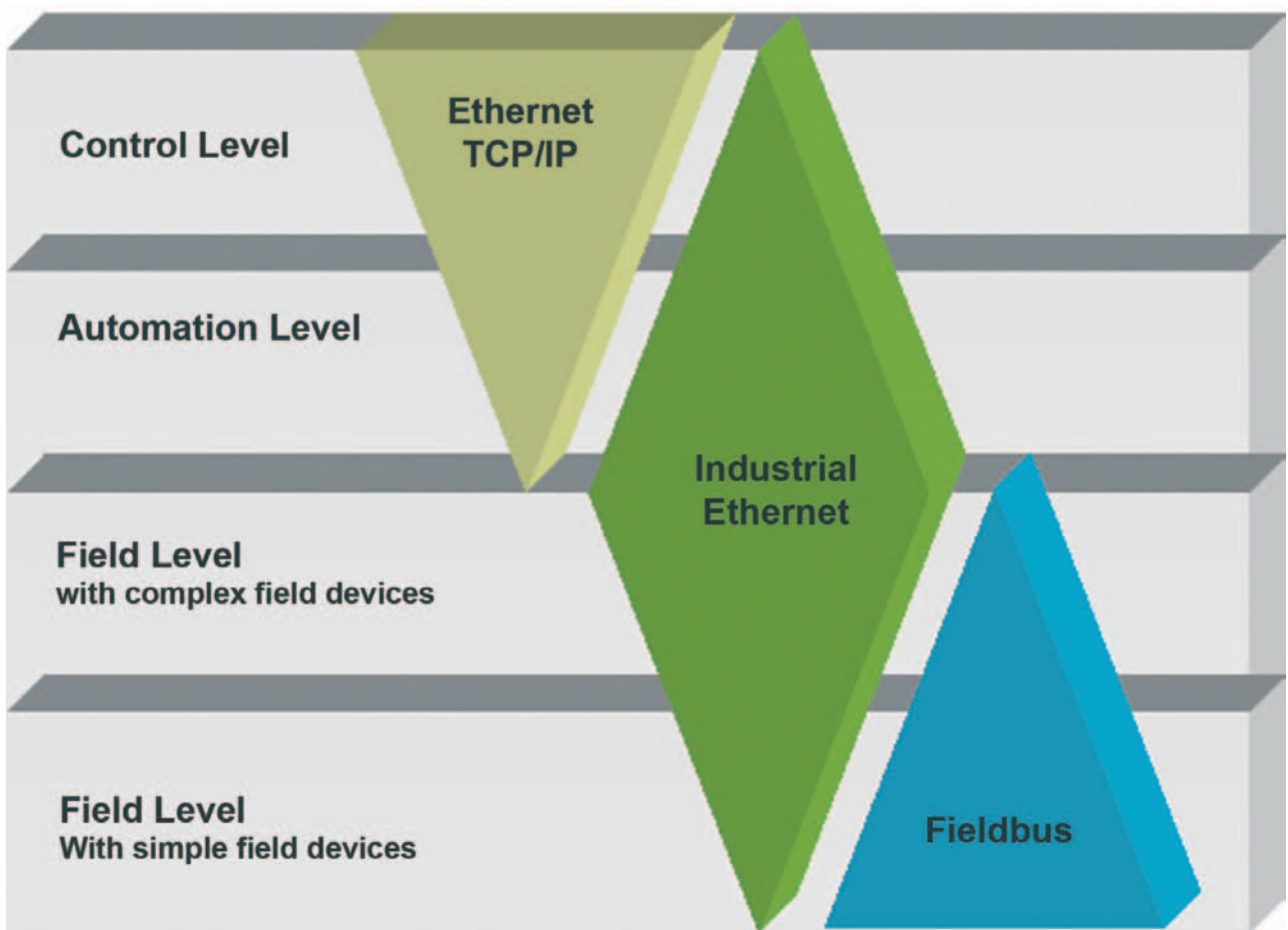


Industrial Ethernet

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:



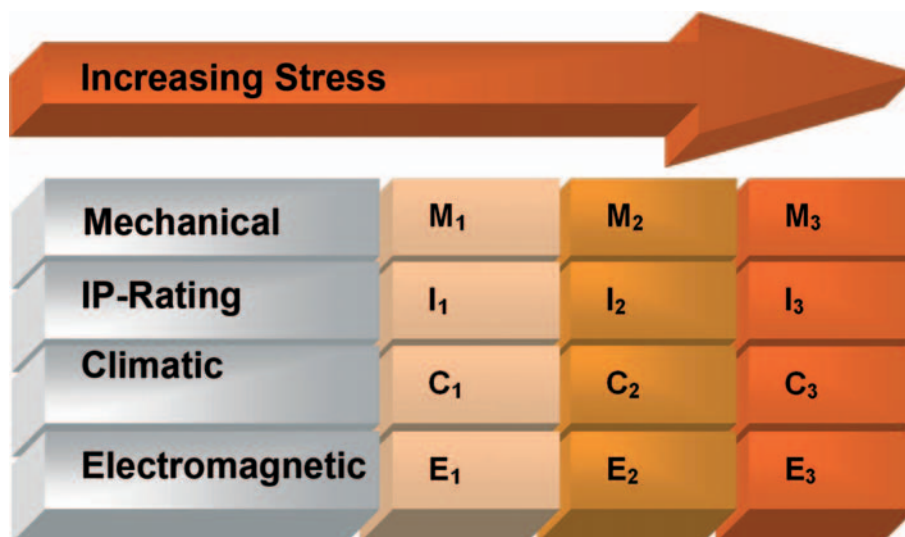
The M I C E – Concept

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:

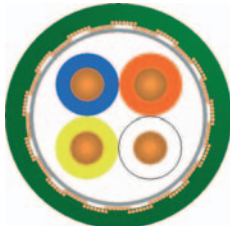
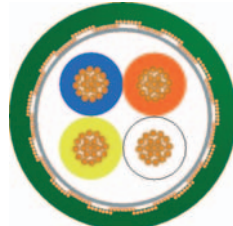

- High dust load
- High humidity
- Mechanical stress due to vibrations or impact
- High temperatures and temperature fluctuations
- Corrosive or contaminating media such as acids, alkalis and oils




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
 - Halogen-free
 - Oil-resistant
 - Radiation-proof
 - Perspiration-proof
 - Abrasion-proof
 - Suitable for drag chains
 - Heat-resistant



INDUSTRIAL ETHERNET	PROFINET TYP A CATEGORY 5	PROFINET TYP B CATEGORY 5	PROFINET TYP 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 prEN 50173-3 and prISO/IEC 24702 for indoor application (fixed installation)	Industrial secondary and tertiary cabling acc. to prEN 50173-3 and prISO/IEC 24702 for indoor application (flexible installation)	Industrial secondary and tertiary cabling acc. to prEN 50173-3 and prISO/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	nom. 33 dB		
Attenuation@Bandwidth frequency	nom. 24 dB/100 m		
Interference power sup- pression up to f = 1 GHz	nom. 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	PVC, green Ø approx. 6.6 mm	PVC, green Ø approx. 6.7 mm	PUR, green Ø approx. 6.8 mm
Weight	approx. 60 kg/km		
Min. bending radius	8 x cable diameter		
Temperature Range			
During operation During installation	- 20 °C up to + 70 °C - 5 °C up to + 50 °C		
Other Properties			
	flame retardant acc. to IEC 60332-3-24 (cat. C)		flame retardant acc. to IEC 60332-1
Connectors / Glands			
	see our catalogue Solutions@Kerpen or visit our homepage www.kerpen.com		
Further cable variations and part numbers on page C5			

INDUSTRIAL ETHERNET	MegaLine® 524SC HDIE CAT 5 HEAVY DUTY	MegaLine® 724 FLEX HDIE CAT 7 HEAVY DUTY	MegaLine® 724 FLEX HDIE CAT 6 HEAVY DUTY
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 prEN 50173-3 and prISO/IEC 24702 for indoor application (fixed installation)	Industrial secondary and tertiary cabling acc. to prEN 50173-3 and prISO/IEC 24702 for indoor application (fixed installation)	Industrial workplace, work area and patch panel acc. to prEN 50173-3 and prISO/IEC 24702 for indoor application (flexible installation)
Electrical Properties			
Conductor resistance	max. 95 Ω/km	max. 92 Ω/km	max. 170 Ω/km
Impedance (f = 100 MHz)	100 Ω ± 5 Ω		
Bandwidth	200 MHz	600 MHz	600 MHz
NEXT@Bandwidth frequency	nom. 33 dB	nom. 68 dB	nom. 63 dB
Attenuation@Bandwidth frequency	nom. 27 dB/100 m	nom. 5.2 dB/10 m	nom. 7.7 dB/10 m
Interference power sup- pression up to f = 1 GHz	nom. 90 dB		
Construction			
Conductor	plain annealed copper, AWG 24/1	plain annealed copper, AWG 24/7	plain annealed copper, 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	halogen-free compound FRNC Ø approx. 7 mm	halogen-free compound FRNC Ø approx. 8.8 mm	PUR yellow Ø approx. 6.3 mm
Weight	approx. 53 kg/km	approx. 75 kg/km	approx. 35 kg/km
Min. bending radius	8 x cable diameter	5 x cable diameter	5 x cable diameter
Temperature Range			
During operation During installation	- 20 °C up to + 70 °C - 5 °C up to + 50 °C		
Other Properties			
	flame retardant acc. to IEC 60332-3-24 (cat. C)		flame retardant acc. to IEC 60332-1
Connectors / Glands			
	see our catalogue Solutions@Kerpen or visit our homepage www.kerpen.com		
Further cable variations and part numbers on page C5			

INDUSTRIAL ETHERNET	MegaLine® 526SC FLEX HDIE CAT 5 HEAVY DUTY	MegaLine® 526/24MC SUPERFLEX HDIE CAT 5 HEAVY DUTY	MegaLine® 722 HDIE CAT 7 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 prEN 50173-3 and prISO/ IEC 24702 for indoor application (flexible installation)	Industrial cabling acc. to prEN 50173-3 and prISO/ IEC 24702 for indoor application (for drag chains)	Industrial cabling acc. to prEN 50173-3 and prISO/ IEC 24702 for outdoor application (fixed installation)
Electrical Properties			
Conductor resistance	max. 150 Ω/km	max. 125 Ω/km (AWG 26) max. 100 Ω/km (AWG 24)	max. 57.1 Ω/km
Impedance (f = 100 MHz)	100 Ω ± 5 Ω		
Bandwidth	200 MHz	100 MHz	1000 MHz
NEXT@Bandwidthnfrequenz	nom. 36 dB	nom. 45 dB	nom. 78 dB
Attenuation@Bandwidth frequency	nom.3.9 dB/10 m	nom.4.3 dB/10 m (AWG 26) nom. 3 dB/10 m (AWG 24)	56 dB/100 m
Interference power suppression up to f = 1 GHz	nom. 55 dB	nom. 55 dB	nom. 90 dB
Construction			
Conductor	plain annealed copper, AWG 26/7	plain annealed copper, AWG 26/19 u. 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, opt. coverage approx. 65 %
Inner sheath	--	elastomer	halogen-free compound
Outer sheath	PUR, yellow Ø approx. 6 mm	PUR, yellow Ø approx. 6.9 mm (AWG 26/19) Ø approx. 8.0 mm (AWG 24/19)	polyethylene PE above aluminium tape Ø approx. 12 mm
Weight	approx. 35 kg/km	approx. 60 kg/km (AWG 26/19) approx. 82 kg/km (AWG 24/19)	approx. 150 kg/km
Min. bending radius	8 x cable diameter	5 x cable diameter	8 x cable diameter
Temperature Range			
During operation	- 20 °C up to + 70 °C	- 20 °C up to + 85 °C	- 20 °C up to + 70 °C
During installation	- 5 °C up to + 50 °C	- 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) (without outer sheath)
Connectors / Glands			
see our catalogue Solutions@Kerpen or visit our homepage www.kerpen.com			
Further cable variations and part numbers on page C5			

MegaLine®

[illegible]

PROFIBUS DP 150 Ω

PROFIBUS DP 150 Ω



The Product-Range

For PROFIBUS DP 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**


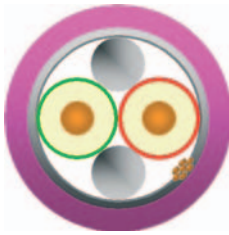

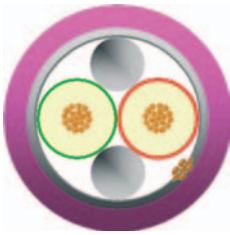
Standard version for fixed installation.

- **FAST ASSEMBLY FA**


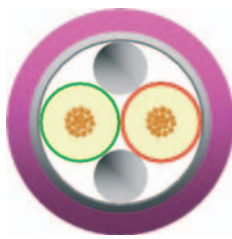
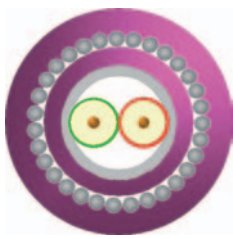
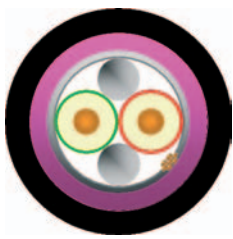
Such as standard version BASIC, but suitable for fast assembly with special tool (see chapter "assembly" on page I1).

- **FLEX**

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

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 (suitable for fast assembly) for fixed installation indoor and outdoor, on racks, in conduits.	Spur and trunk cable for flexible installation indoor and outdoor, on racks, in conduits
Electrical Properties			
Loop resistance	max. 110 Ω/km		
Screen resistance	nom. 9 Ω/km		
Impedance (f ≥ 3 MHz)	150 Ω ± 15 Ω		
Mutual capacitance	max. 30 nF/km		
Capacitance unbalance to earth	max. 1.5 nF/km		
Attenuation at f = 0.25 / 0.625 / 1.25 / 3.125 / 16 MHz	nom. 6 / 9 / 12 / 18 / 40 dB/km		nom. 6 / 9 / 14 / 23 / 47 dB/km
Inductance	nom. 0.90 mH/km		
Construction			
Conductor	plain annealed copper, solid, 0.64 mm Ø		plain annealed copper, 19strands, AWG 22
Insulation	foamed polyethylene with skin layer		
Colour code	a-core: green, b-core: red		
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 braid	plastic coated aluminium tape in contact with drain wire and tinned copper wire braid
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
Min. bending radius (single bending) (repeated bending)	5 x cable diameter	5 x cable diameter	5 x cable diameter 10 x cable diameter
Temperature Range			
During operation	- 40 °C up to + 70 °C ¹⁾ - 5 °C up to + 50 °C		
During installation			
Other Properties			
Flame retardant	acc. to IEC 60332-3-24 (cat. C) and UL 13 (vertical tray)		
Oil resistant	acc. to ICEA S-82-552 acc. to UL 1581 article 1200		
UV-resistant			
Connectors / Glands			
	M16 / M12; 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
			
	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, on racks, in conduits	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	nom.15 Ω/km	nom. 9 Ω/km	
Impedance (f ≥ 3 MHz)	150 Ω ± 15 Ω		
Mutual capacitance	max. 30 nF/km		
Capacitance unbalance to earth	max. 1.5 nF/km		
Attenuation at f = 0.25 / 0.625 / 1.25 / 3.125 / 16 MHz	nom. 6 / 9 / 14 / 23 / 47 dB/km	nom. 6 / 9 / 12 / 18 / 40 dB/km	
Inductance	nom. 0.90 mH/km		
Construction			
Conductor	plain annealed copper, 19strands, 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 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	polyvinylchloride PVC Ø approx. 11 mm
Weight	approx. 78 kg/km	approx. 280 kg/km	approx. 100 kg/km
Min. bending radius (single bending) (repeated bending)	5 x cable diameter 10 x cable diameter	8 x cable diameter	5 x cable diameter
Temperature Range			
During operation	- 40 °C up to + 70 °C ¹⁾ - 5 °C up to + 50 °C		
During installation			
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)*
Oil resistant	acc. to ICEA S-82-552	acc. to ICEA S-82-552	acc. to ICEA S-82-552
UV-resistant	--	UL 1581 article 1200	acc. to UL 1581 article 1200 *(without PE sheath)
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



PROFIBUS DP 150 Ω – Part numbers / cable variations

Version	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	76775024
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 FRLS	halogen-free, flame retardant	1 x 2 x AWG 22/1	79260301	79260302	79260501	79260502
Fast Assembly FA in FRLS	halogen-free, flame retardant	1 x 2 x AWG 22/1	74360302	74360301	74360501	74360502
Flex in FRLS	halogen-free, flame retardant	1 x 2 x AWG 22/19	76260303	76260304	79260503	79260504
Basic in FRLS, SWA-armoured	halogen-free, 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 additional PE-sheath	7677502V 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 additional PE-sheath	7422502V additional PE-sheath

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

PROFIBUS DP 150 Ω

PROFIBUS PA 100 Ω

PROFIBUS PA 100 Ω



The Product-Range

For PROFIBUS DP KERPEN offers products, which are optimized for the miscellaneous applications in automation technology. 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**


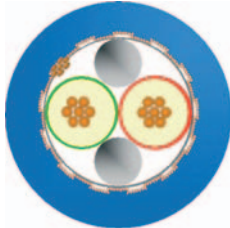
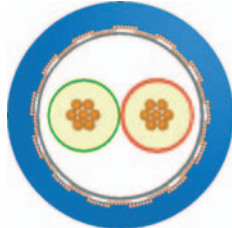
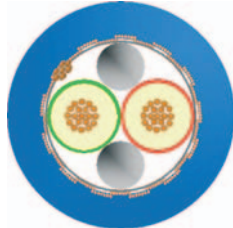
Such as standard version BASIC, but suitable for fast assembly with special tool (see chapter "assembly" on page I1).

- **FLEX**



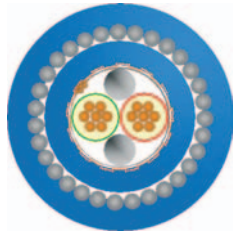

Such as standard version BASIC, but with 19-strands conductor for flexible installation.

- **LONG DISTANCE**

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

PROFIBUS PA	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		
Conductor resistance	nom. 12 Ω/km		
Impedance at f = 31.25 kHz	100 Ω ± 20 Ω		
Mutual capacitance	nom. 60 nF/km		
Capacitance unbalance to earth	max. 2 nF/km		
Attenuation at f = 39 kHz	max. 3.0 dB/km		
Propagation delay change (7.9 kHz – 39 kHz)	max. 1.7 µs/km		
Inductance	nom. 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		
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 braid	plastic coated aluminium tape in contact with drain wire and tinned copper wire braid
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
Min. bending radius	5 x cable diameter	5 x cable diameter	5 x cable diameter (single bending) 10 x cable diameter (repeated bending)
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-82-552		
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 SWA ARMoured TYPE A	BASIC WITH VPE INSULATION TYPE A
	 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	max. 43.6 Ω/km
Screen resistance	nom. 9 Ω/km		
Impedance at f = 31.25 kHz	100 Ω ± 20 Ω		
Mutual capacitance	nom. 60 nF/km		
Capacitance unbalance to earth	max. 2 nF/km		
Attenuation at f = 39 kHz	max. 3.0 dB/km		
Propagation delay change (7.9 kHz – 39 kHz)	max. 1.7 µs/km		
Inductance	nom. 0.70 mH/km	nom. 0.70 mH/km	nom. 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 tinned copper wire braid		
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 approx. 10 mm
Weight	approx. 110 kg/km (AWG 16) approx. 160 kg/km (AWG 14)	approx. 270 kg/km	approx. 115 kg/km
Min. 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-82-552		
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



PROFIBUS PA 100 Ω –

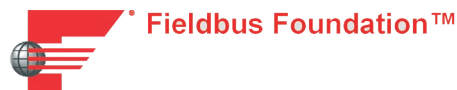
Part numbers / cable variations

Version	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, SWA-armoured	Basic, 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 FRLS	halogen-free, flame retardant	1 x 2 x AWG 18/7	79260100	79260101	79260601	79260602
Fast Assembly FA in FRLS	halogen-free, flame retardant	1 x 2 x AWG 18/7	74360100	74360101	74360601	74360602
Flex in FRLS	halogen-free, 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 FRLS, SWA-armoured	halogen-free, flame retardant	1 x 2 x AWG 18/7	7926100U	7926101U	7926601U	7926602U
Long Distance in FRLS	halogen-free, flame retardant	1 x 2 x AWG 16/7	79300100	79300101	79300601	79300602
Long Distance in FRLS	halogen-free, flame retardant	1 x 2 x AWG 14/7	79300102	79300103	79300603	79300604

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

FOUNDATION Fieldbus 100 Ω

FOUNDATION Fieldbus 100 Ω



The Product-Range

For FOUNDATION Fieldbus KERPEN offers products, which are optimized for the miscellaneous applications in automation technology. 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 I1).

- **FLEX**


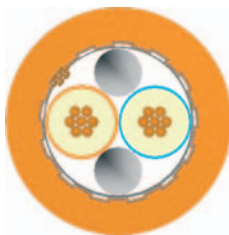
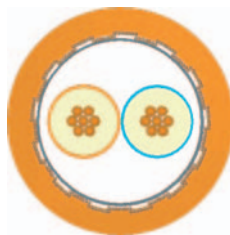
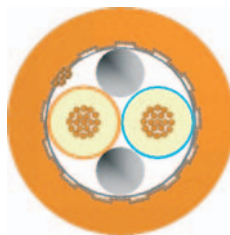
Such as standard version BASIC, but with 19-strands conductor for flexible installation.

- **Eco**


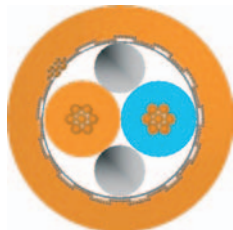
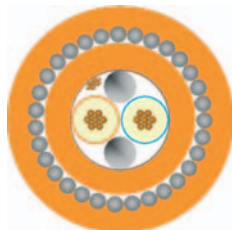
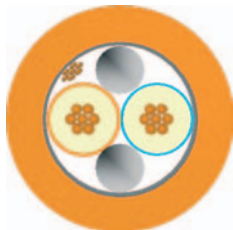
Such as standard BASIC, but without braided screen

- **LONG DISTANCE**


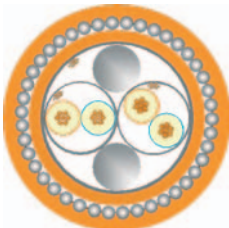
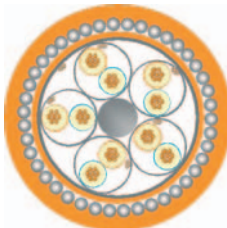
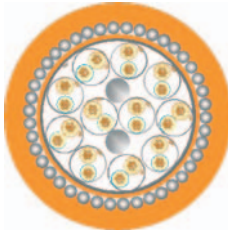
Version with PE-Insulation and sizes AWG 16/7 or AWG 14/7 as trunk cable with reduced voltage drop.

FOUNDATION FIELDBUS 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 (suitable for fast assembly) for fixed installation indoor and outdoor, on racks, in conduits.	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	nom. 9 Ω/km		
Impedance at f = 31.25 kHz	100 Ω ± 20 Ω		
Mutual capacitance	nom. 60 nF/km		
Capacitance unbalance to earth	max. 2 nF/km		
Attenuation at f = 39 kHz	max. 3.0 dB/km		
Propagation delay change (7.9 kHz – 39 kHz)	max. 1.7 µs/km		
Inductance	nom. 0.70 mH/km		
Construction			
Conductor	plain annealed copper, stranded, AWG 18		
Insulation	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 braid	plastic coated aluminium tape in contact with drain wire and tinned copper wire braid
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
Min. bending radius	5 x cable diameter	5 x cable diameter	5 x cable diameter (single bending) 10 x cable diameter (repeated bending)
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-82-552		
UV-resistant	acc. to UL 1581 article 1200		
Connectors / Glands			
	M16 / M12		
Further cable variations and part numbers on page F5			

¹⁾ +75°C with UL-Approval

FOUNDATION FIELDBUS FF	LONG DISTANCE LD TYPE A	ECO SWA ARMoured TYPE A	ECO TYPE A
			
	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	nom. 9 Ω/km	nom. 30 Ω/km	
Impedance at f = 31.25 kHz	100 Ω ± 20 Ω		
Mutual capacitance	nom. 60 nF/km		
Capacitance unbalance to earth	max. 2 nF/km		
Attenuation at f = 39 kHz	max. 3.0 dB/km		
Propagation delay change (7.9 kHz – 39 kHz)	max. 1.7 µs/km		
Inductance	nom. 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 drain 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
Min. 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-82-552		
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	nom. 18 Ω/km		
Impedance at f = 31.25 kHz	100 Ω ± 20 Ω		
Mutual capacitance	nom. 60 nF/km		
Capacitance unbalance to earth	max. 2 nF/km		
Attenuation at f = 39 kHz	max. 3.0 dB/km		
Propagation delay change (7.9 kHz – 39 kHz)	max. 1.7 µs/km		
Inductance	nom. 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 drain wire		
Overall Screen	plastic coated aluminium tape in contact with tinned copper drain wire		
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
Min. bending radius	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-82-552		
UV-resistant	acc. to UL 1581 article 1200		
Connectors / Glands			
Further cable variations and part numbers on page F5			

¹⁾ +75°C with UL-Approval



FOUNDATION FIELDBUS FF 100 Ω –

Part numbers / cable variations

Version	KERPEN-Type	Size	Part-No.	with UL ^{*)}			without UL		
				orange	blue	blue	orange	blue	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, 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		
Multipair, SWA-armoured ^{**)}	multipairs, individual screened	2 x 2 x AWG 18/7 PiMF		--	--	74790008	74790038		
Multipair, SWA-armoured ^{**)}	multipairs, individual screened	5 x 2 x AWG 18/7 PiMF		--	--	74790009	74790039		
Multipair, SWA-armoured ^{**)}	multipairs, individual screened	10 x 2 x AWG 18/7 PiMF		--	--	74790010	74790040		
Multipair, 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 FRLS	halogen-free, flame retardant	1 x 2 x AWG 18/7		79260102	79260103	74250605	74250606		
Fast Assembly FA in FRLS	halogen-free, flame retardant	1 x 2 x AWG 18/7		74360103	74360102	74360603	74360604		
Flex in FRLS	halogen-free, flame retardant	1 x 2 x AWG 18/19		79260203	79260202	79260607	79260608		
Eco in FRLS	with overall screen of aluminium bonded plastic tape, halogen-free, flame retardant	1 x 2 x AWG 18/7		79270100	79270101	79270601	79270602		
Long Distance in FRLS	halogen-free, flame retardant	1 x 2 x AWG 16/7		79300105	79300104	79300605	79300606		
Long Distance in FRLS	halogen-free, 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 halogen-free, flame retardant}

GigaLine® Optical Fibre-Cables

The Product-Range

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


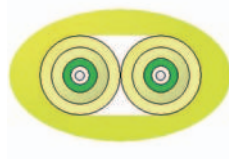
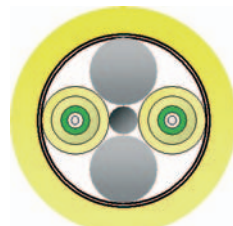

The use of GigaLine® optical fibre cables offers for the most diverse bus applications (e.g. High Speed Ethernet (HSE)) advantages in the following cases:



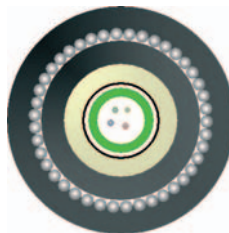
- when electromagnetic effects can occur
- when reliable potential separation is required
- when broad transmission ranges are required
- when low attenuation and thus long channels are necessary
- when crosstalk must not occur
- When sparks must not emerge (for explosive environments)
- When low weight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

KERPEN 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, 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 halogen free, flame retardant cable versions.



	GIGALINE® DXO KL-AT-V(ZN)HH INDOOR OPTICAL FIBRE CABLE (BREAKOUT)	GIGALINE® DX KL-AT-V(ZN)HY-FL INDOOR OPTICAL FIBRE CABLE (BREAKOUT)	GIGALINE® DQ KL-U-DQ(ZNS)H UNIVERSAL OPTICAL FIBRE CABLE, LONGITUDINALLY WATERTIGHT
	 2 G/E ... (Figure O)	 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	halogen free compound, Ø approx. 2.1 mm, yellow, continuously numbered		--
Wrapping	--	swellable tape	
Outer sheath	halogen free compound FRNC, orange or yellow approx. 3.1 x 5.2 mm	polyvinylchloride PVC, orange or yellow Ø 7.2 mm	halogen free compound FRNC, yellow ≤ 12 Fibre: Ø approx. 9.2 mm ≤ 24 Fibre: Ø approx. 9.7 mm
Weight	approx. 17 kg/km	approx. 50 kg/km	≤ 12 Fibre: approx. 85 kg/km ≤ 24 Fibre: approx. 90 kg/km
Inductance			
Mechanical Properties			
Tensile stress	max. 600 (2 x 300) N	max. 600 N	max. 2500 N
Transverse compression strength	permanent: max. 50 N/cm short-term: max. 100 N/cm	permanent: max. 50 N/cm short-term: max. 100 N/cm	permanent: max. 200 N/cm short-term: max. 500 N/cm
Min. bending radius	min. 150 mm	min. 150 mm	
During Installation			min. 20 x outer-Ø
During Opetration			min. 15 x outer-Ø
Temperature Range			
During operation	- 20 °C up to + 60 °C		
During installation	- 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 60332-1
Connectors / Glands			
	please find our considerable programme for plugs and components in our catalogue Solutions@Kerpen or visit our homepage www.kerpen.com .		
Further cable variations and part numbers on page G4/G5			

	GIGA LINE® DQ KL-A-DQ(ZNS)2Y OUTDOOR OPTICAL FIBRE CABLE, LONGITUDINALLY WATERTIGHT	GIGA LINE® DQ KL-A-DQ(ZN)2Y(SR)2Y OUTDOOR OPTICAL FIBRE CABLE, LONGITUDINALLY WATERTIGHT	GIGA LINE® DQ KL-A-DQ(ZN)2YSWAFL OUTDOOR OPTICAL FIBRE CABLE, LONGITUDINALLY WATERTIGHT
<div>GigaLine®</div>	<div></div> <div>1 x m G/E ...</div>	<div></div> <div>1 x m G/E ...</div>	<div></div> <div>1 x m G/E ...</div>
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 page G6 / G7		
core	filled loose tube, central		
Strain relief	glass rovings as rodent protection under the outer sheath	aramid yarn above the core	aramid yarn above the core
Inner sheath	--	Polyethylen PE, black	Polyethylen PE, black
Wrapping	swellable tape		
Armour		corrugated steel sheath	galvanised round steel wires SWA-Ø: 0.9 mm
Outer sheath	Polyethylen PE, black ≤ 12 Fibre: Ø approx. 9.2 mm ≤ 24 Fibre: Ø approx. 9.7 mm	polyvinylchloride PVC, 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. 70 kg/km ≤ 24 Fibre: approx. 75 kg/km	≤ 12 Fibre: approx. 135 kg/km ≤ 24 Fibre: approx. 140 kg/km	≤ 12 Fibre: approx. 250 kg/km ≤ 24 Fibre: approx. 265 kg/km
Inductance			
Mechanical Properties			
Tensile stress	max. 2500 N	max. 1000 N	max. 1000 N
Transverse compression strength	permanent: max. 200 N/cm short-term: max. 500 N/cm	permanent: max. 100 N/cm short-term: max. 300 N/cm	permanent: max. 100 N/cm short-term: max. 300 N/cm
Min. bending radius			
During Installation	min. 150 mm	min. 20 x outer-Ø	min. 20 x outer-Ø
During Opetration	min. 80 mm	min. 15 x outer-Ø	min. 15 x outer-Ø
Temperature Range			
During operation	- 20 °C up to + 60 °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.kerpen.com .		
Further cable variations and part numbers on page G4/G5			

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

Version	KERPEN-Type	Size	Part-No.			
			G 50/125	G50/125 OM3	G 62.5/125	E 9...10/125
GigaLine® DXO	Indoor optical fibre cable, oval, halogen-free	2 G/E	8DA20011 orange	8DA50011 orange	8DB70011 orange	8DC70010 yellow
GigaLine® DX	Indoor optical fibre cable, round	2 G/E	8BA22004	8BA52004	8BB77004 orange	8BC72004
GigaLine® DQ	Universal optical fibre cable, halogen-free, longitudinally watertight	1 x 2 G/E	8UA20001	8UA50001	8UB70001	8UC70001
		1 x 4 G/E	8UA20002	8UA50002	8UB70002	8UC70002
		1 x 6 G/E	8UA20003	8UA50003	8UB70003	8UC70003
		1 x 8 G/E	8UA20004	8UA50004	8UB70004	8UC70004
		1 x 10 G/E	8UA20005	8UA50005	8UB70005	8UC70005
		1 x 12 G/E	8UA20006	8UA50006	8UB70006	8UC70006
		1 x 16 G/E	8UA20007	8UA50007	8UB70007	8UC70007
		1 x 20 G/E	8UA20008	8UA50008	8UB70008	8UC70008
		1 x 24 G/E	8UA20009	8UA50009	8UB70009	8UC70009
		1 x 2 G/E	8AA20001	8AA50001	8AB70001	8AC70001
GigaLine® DQ	Universal optical fibre cable, longitudinally watertight	1 x 4 G/E	8AA20002	8AA50002	8AB70002	8AC70002
		1 x 6 G/E	8AA20003	8AA50003	8AB70003	8AC70003
		1 x 8 G/E	8AA20004	8AA50004	8AB70004	8AC70004
		1 x 10 G/E	8AA20005	8AA50005	8AB70005	8AC70005
		1 x 12 G/E	8AA20006	8AA50006	8AB70006	8AC70006
		1 x 16 G/E	8AA20007	8AA50007	8AB70007	8AC70007
		1 x 20 G/E	8AA20008	8AA50008	8AB70008	8AC70008
		1 x 24 G/E	8AA20009	8AA50009	8AB70009	8AC70009

Version	KERPEN-Type	Size	Part-No.			
			G 50/125	G50/125 OM3	Fibre Type	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	8AA200xx	8AA500xx	8AB700xx	8AC700xx
GigaLine® DQ	Outdoor optical fibre cable, longitudinally watertight with SWA-Armour	1 x 4 G/E	8AA200xx	8AA500xx	8AB700xx	8AC700xx
		1 x 6 G/E	8AA200xx	8AA500xx	8AB700xx	8AC700xx
		1 x 8 G/E	8AA200xx	8AA500xx	8AB700xx	8AC700xx
		1 x 10 G/E	8AA200xx	8AA500xx	8AB700xx	8AC700xx
		1 x 12 G/E	8AA200xx	8AA500xx	8AB700xx	8AC700xx
		1 x 16 G/E	8AA200xx	8AA500xx	8AB700xx	8AC700xx
		1 x 20 G/E	8AA200xx	8AA500xx	8AB700xx	8AC700xx
		1 x 24 G/E	8AA200xx	8AA500xx	8AB700xx	8AC700xx

GigaLine® Fibre Qualities

	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. 3.5 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 at 1383 nm at 1550 nm					max. 0.36 dB/km max. 0.40 dB/km max. 0.22 dB/km
Bandwidth					
at 850 nm	min. 600 MHz x km	min. 1500 MHz x km	min. 3000 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. 4000 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 at Gigabit-Ethernet					
at 850 nm (1000BASE-SX)	min. 750 m	min. 900 m	min. 1000 m	min. 500 m	
at 1300 nm (1000BASE-LX)	min. 2000 m	min. 550 m	min. 550 m	min. 1000 m	
Segment Length at 10 Gigabit-Ethernet					
at 850 nm (10GBASE-SR)	min. 110 m	min. 300 m	min. 550 m	min. 65 m	
at 1300 nm (10GBASE-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					
at 850 nm	nominal value 1.482	nominal value 1.482	nominal value 1.482	nominal value 1.496	
at 1300 nm	nominal value 1.477	nominal value 1.477	nominal value 1.482	nominal value 1.491	
at 1310 nm					nominal value 1.4675
at 1550 nm					nominal value 1.4681
Test Load					
	100 kpsi	100 kpsi	100 kpsi	100 kpsi	100 kpsi

GigaLine® Colour Codes

Wires (in the case of stranded loose tubes)

Counting wire	red
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
5	yellow
6	white
7	grey
8	brown
9	turquoise
10	black
11	orange
12	pink
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

Design Options

Design Options

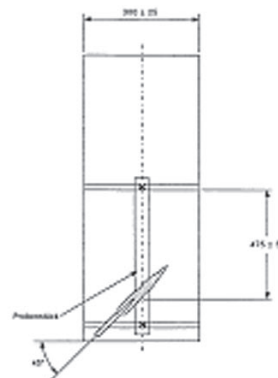
A) Improved Fire Behaviour

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-Ø 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

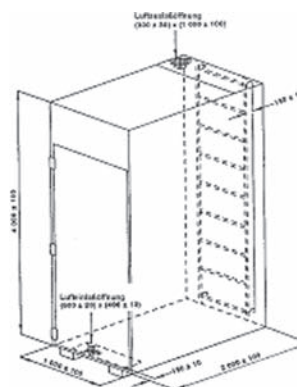


IEC 60332-3-24 (cat.C)

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 & Smoke Density

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

The properties are defined as follows:

Low smoke characteristic according to IEC 61034,
Light transmission (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 $c < 10 \mu\text{S}/\text{mm}$

Oxygen index of sheaths in accordance
with IEC 60332-3 (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
5	6	7	8	9	10
27,0 Al	28,1 Si	31,0 P	32,1 S	35,5 Cl	39,9 Ar
13	14	15	16	17	18
69,7 Ga	72,6 Ge	74,9 As	79,0 Se	79,9 Br	83,8 Kr
31	32	33	34	35	36
114,8 In	118,7 Sn	121,8 Sb	127,6 Te	126,9 I	131,3 Xe
49	50	51	52	53	54
204,4 Tl	207,2 Pb	209,0 Bi	(209) Po	(210) At	(222) 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:

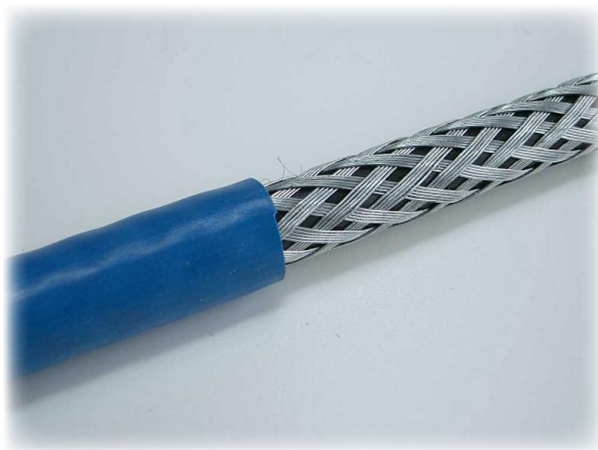
Armour of galvanised round steel wires (SWA)



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 (Pb)

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.

Assembly Work

Fast Assembly

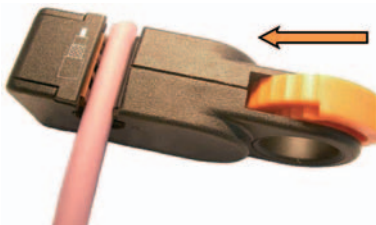
For assembly work with stripping tools KERPEN created FA Fast Assembly Buscables, marked with FA. To do the assembly work in a professional manner, please follow the introduction step by step:



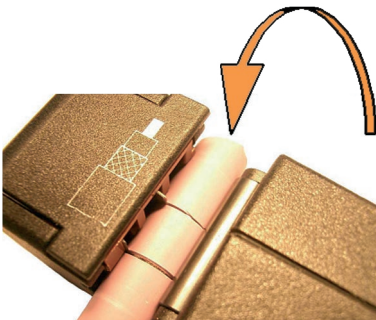
1. Stripping tool



2. Match up the cable end to the relevant length needed for the connector.



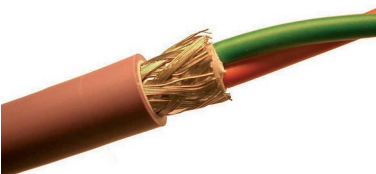
3. Insert the cable end into the stripping tool and clamp the cable firmly by using the pressure rolls. (Turn the orange coloured ring in direction of arrow).



4. Rotate the stripper in the direction which is defined by the arrow applied on the stripping tool. Execute about 4 turns.



5. Pull the stripping tool out of the cable while the clamp is still closed. The stripped sheath and screen should be displaced out of the stripping tool.



6. Bend the twisted pair with covering at the end of the screen. The covering will burst open and should be stripped.

Abbreviations

Cable Abbreviations:

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

FB-	Fieldbus cable
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)2Y	Laminated sheath
H	Sheath of halogenfree, flame retardant compounds (FRNC/FRLS)
(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 structural elements to be found in optical fibre cables

Indoor optical fibre cable

	0	1	2	3	4	5	6	7	8	/	9	10	11	12
KL Optical fibre communication cable														
J Indoor cable														
AT Indoor cable, breakout														
V Semi-loose tube														
D Filled loose tube														
(ZN) Non-metallic strain relief elements														
H Halogen-free flame-retardant sheath of basic element (AT only)														
H Halogen-free flame-retardant sheath														
Number of fibres / number of loose tubes x number of fibres per loose tube														
G Multimode fibre														
E Single-mode fibre														
Core diameter in μm (multimode fibre) Field diameter in μm (single-mode fibre)														
Cladding diameter in μm														
Attenuation coefficient in dB/km														
Wavelength B = 850 nm F = 1300/1310 nm H = 1550 nm														
Bandwidth in MHz for 1km in the case of multimode fibres, dispersion parameter in ps/nm for 1 km in the case of single-mode fibres														

Universal optical fibre/outdoor cables

