Industrial cabling technology

for Industrial Ethernet/PROFINET and PROFIBUS

Brochure · November 2008

SIMATIC NET

SIEMENS

Introduction

networks – the backbone of industrial communication

Powerful, open and rugged bus systems that ensure efficient communication in automation solutions, regardless of whether they are intended for data communication, or for process or field communication: Networks must be the reliable medium of data transmission in industrial communication.
Openness and flexibility of the individual bus systems in different topologies enable systems and their expansions to be linked. By using standardized bus systems, it is possible to connect standardized components from different suppliers without any problems. This provides maximum protection of investment, as existing networks can be extended without any adverse effects. Siemens provides all of the components for an integrated overall solution beyond the network's limits. This not only includes active network components but also industry-standard connection systems.

According to the standards ISO/IEC 11801 and EN 50173 for structured building cabling, corresponding standards were created:

- ISO/IEC 24702 for structured cabling of industrial buildings
- IEC 61918 for specific cabling in industrial plants

Use of the communication systems			
	Industrial Ethernet	PROFINET	PROFIBUS DP
Enterprise Resource Planning (ERP) (e.g. PC)	●	○	
Control (e.g. SIMATIC S7-300)	●	●	●
Motion Control (e.g. SIMOTION)	○	●	●
Intelligent field devices (e.g. ET 200S/CPU)		●	●
Simple field devices (e.g. ET 200)		●	●
Sensors/actuators		●	●
Drives (e.g. SINAMICS)	○	●	●
SIRIUS motor starters		●	●
SINUMERIK	○	●	●
Safety-oriented communication		●	●
not suitable ○ suitable ● ideally suitable			

Components for the network

Contents

Both passive network components (e.g. cables, connectors, bus terminals) and active network components (e.g. switches) are used in constructing an electrical or optical network. Network cabling in the industrial sector is a significantly greater challenge than in the office world.

Cables for data and energy

Data lines

Unlike cables in the office, industrial cables must be able to withstand an aggressive environment and high temperatures or have excellent resistance to lateral force. This is achieved by means of the special cable construction (star quad). The cables are silicon-free, which also makes them suitable for use in paintshops. Thanks to the low bending radius they withstand the high tensile loads that occur particularly when the cables are pulled into cable ducts.
The capacity to bear mechanical and chemical loads is an important criterion for industrial cables.
The shielded cable construction permits secure data transmission even in industrial areas subject to electromagnetic interference.

Power lines

Various rugged power cables are available for the construction of PROFINET/PROFIBUS networks. They are also silicon-free and can therefore also be used in paintshops. The cable jacket is resistant to mineral oil and grease and protects the power line in harsh industrial environments.

Passive and active components in the network

The active network components connect individual network segments to form a network structure. On removal or failure of a network component, the topology is forced to divide into separate partial segments. As a consequence, communication between the nodes in the two different sub-networks is no longer possible.

Communication or sub-network failures can be prevented by configuring ring or star topologies. These structures can be implemented with the aid of the SCALANCE X family of products.
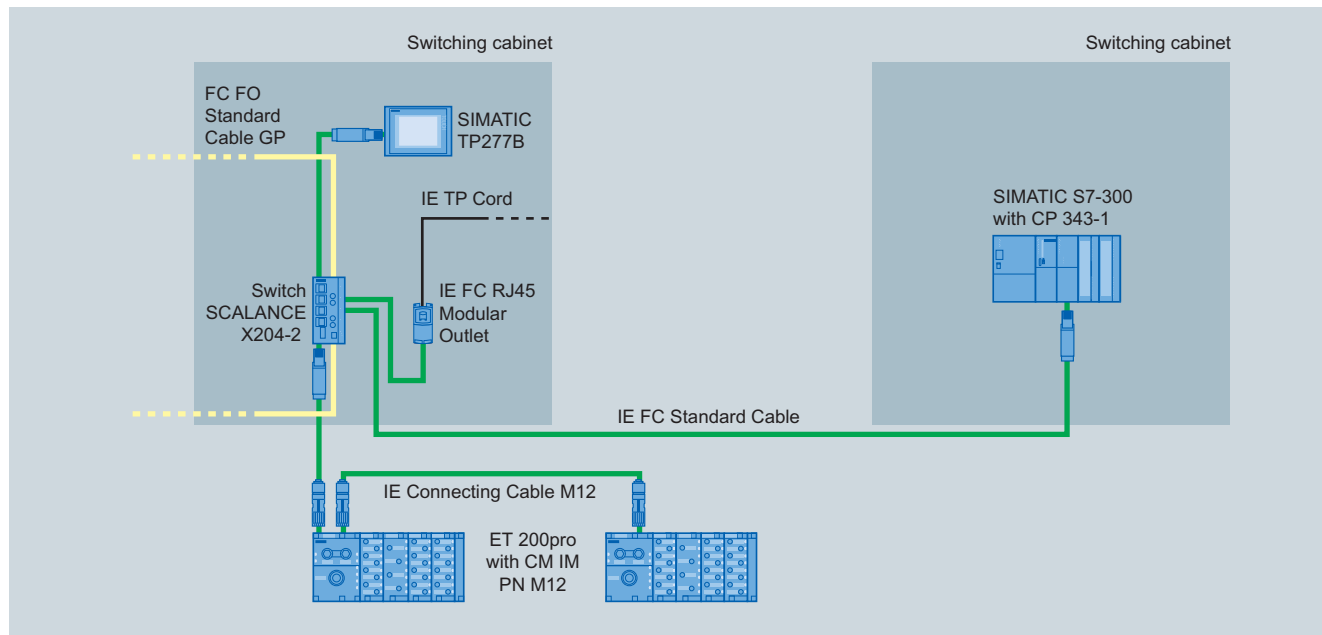
*Industrial Ethernet/PROFINET connection options for any application (ring and star topology)*

Ring topology

The ring topology is created by connecting the two ends of the lines of an active linear topology into a physical ring. A special redundancy mechanism ensures that the ring structure remains a logical line in normal circumstances and therefore prevents any message frames from circulating. On failure of a ring section or by means of active network components, the mechanism ensures that an alternative route is quickly available in the ring. The network does not break up into two segments. The effects of a network component fault are therefore confined to the failed component and any terminal equipment connected to it. If a ring section is interrupted, e.g. due to a broken cable, communication continues to function without any disturbance. The reconfiguration time in this case is less than in the office environment and thus meets the demands of the automation world.

Star topology

The star topology uses a central hub (switch). The individual nodes in the network are connected to the active network components via individual point-to-point connections.
The tree structure is created by the hierarchical arrangement in series of several star structures to form a single network.

In practice, depending on the requirements for the individual transmission routes, it may be a matter of combining fiber-optic cables and twisted-pair cables. Typical application examples include the Ethernet office networking or the networking of production cells in a production plant using Industrial Ethernet. In comparison with the ring or linear structure, the amount of cabling is considerably greater due to the long paths back to the star point.
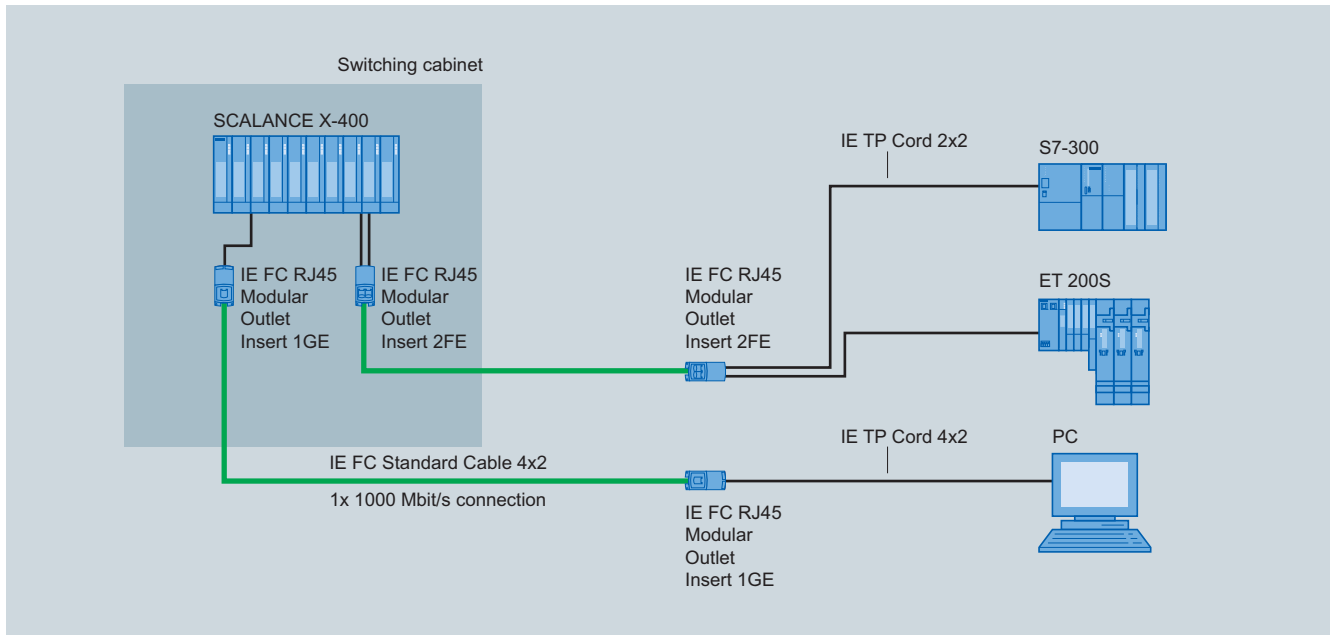
Connection for Fast and Gigabit Ethernet (linear topology)

Linear topology

In a linear network topology, the network component typically only has one or just a few connection points for network stations.
Furthermore, linear structures can also be constructed using devices with two integrated network interfaces.

A fault-free connection on-site in 60 seconds with FastConnect

Problems often occur on-site when laying the cabling for industrial plants: When stripping the cable, assembling the plug-in connector, or if cables are connected incorrectly.

If you want:
- perfectly matched components
- the installation of industry-standard network structures within the shortest possible time without specialist knowledge
- minimal time spent connecting terminals
- to avoid installation errors
- even easy assembly on-site
- and the resulting reduced overall costs during the lifespan of the system

then the quick-assembly system FastConnect from SIMATIC NET is the right system for you. It consists of a cable, connector and tool and can be used for Industrial Ethernet/PROFINET and PROFIBUS.

With optimally matched components, SIMATIC NET cables enable the installation of high-performance industrial network structures.

- Minimal installation time
- Easy stripping of outer sheath and braided shield in one step
- Simple connection method for Industrial Ethernet FastConnect cables
- Easy assembly thanks to preset FastConnect stripping tool
- Reliable shield contacting and strain relief
- M12 and RJ45 connection method for Industrial Ethernet/PROFINET and PROFIBUS

The advantages add up with FastConnect

With the FastConnect (FC) system for Industrial Ethernet, structured cabling from the office environment becomes industry-standard for installation in production halls:

- An integrated system of FC plug-in connectors and an extensive range of FC cables with appropriate UL approvals for Industrial Ethernet/PROFINET and PROFIBUS
- Error avoidance through the use of color coding, preset tools, and clearly specified materials
- Dependable screen contacts and strain relief as well as good EMC shielding for copper cabling
- The use of standard-compliant connection technology for Industrial Ethernet/PROFINET and PROFIBUS
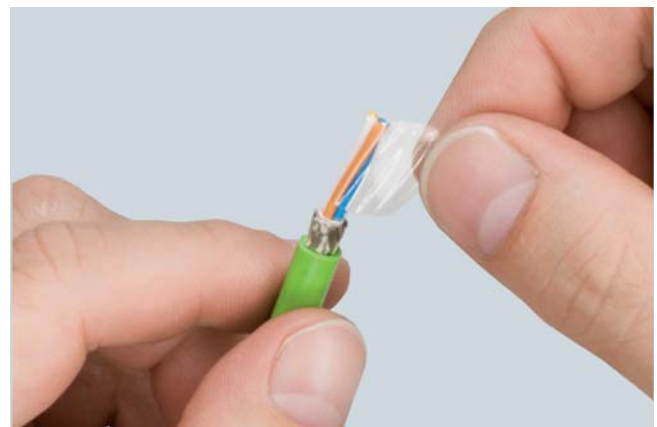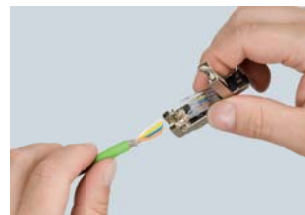
FastConnect for Industrial Ethernet

Industrial Ethernet/ PROFINET

Fast connection of:
- **RJ45 plug-in connectors 2 x 2 and 4 x 2** applying the insulation displacement method – using a stripping tool – to stripped 4 and 8-core IE FC bus cables
- **M12 plug-in connectors** by means of – stripping tool – to stripped 4-core IE FC bus cables

Stripping

Assembly with RJ45 plug-in connector

Assembly with M12 plug-in connector

FastConnect for PROFIBUS

PROFIBUS

Fast connection of:
* **Bus connector**
  by means of insulation
  displacement method
  – using stripping tool –
  to bared PB FC bus cables
* **M12 plug**
  – using stripping tool –
  to bared PB FC bus cables

**PROFIBUS PA
(hazardous area)**

Fast setup of:
* **Fieldbus segments**
  According to IEC 61158-2;
  terminals can be connec-
  ted with FC process cable
  or SpliTConnect M12 out-
  let/M12 jack

Stripping and assembly by means of insulation displacement

Stripping and assembly with M12 plug-in connector

SpliTConnect

Industrial Ethernet

network selection criteria

The type of network (electrical or optical, copper or fiber-optic cables) is determined by the environmental conditions in which it is to be constructed.

	Twisted pair network	Fiber-optic network
Flexibility of the network topology	● ● ● ●	● ● ● ●
Suitability for high transmission rates	● ● ● ○ [1]	● ● ● ● [1]
Inter-building networking	○ ○ ○ ○	● ● ● ●
EMC	● ● ● ○	● ● ● ●
Simple cable laying	● ● ● ○	● ● ● ○
Range of cables for special applications	Cables for indoors; trailing cables; ship wiring cables; FastConnect cables	Cables for indoors and outdoors; trailing cables; halogen-free cables
Effect of voltage failure	Failure of a subnetwork [2]	Failure of a subnetwork [2]
Effect of path failure	Network splits into two separately functioning subnetworks [3]	Network splits into two separately functioning subnetworks [3]
Max. network expansion	5000 m [4]	Up to 150 km: over 150 km, consider signal propagation delay
Max. distance between two network nodes/access points	100 m	50 m POF 100 m PCF 3000 m multi-mode 70000 m single mode
Max. length of connecting cable	100 m	50 m POF 100 m PCF 3000 m multi-mode 70000 m single mode
Pre-assembled cables	Yes	Yes
Assembly on site	without special tool; FastConnect technology	with special tool
Integrated diagnostics support	LED indicators; signaling contact; SNMP network management; Web-based management, PROFINET diagnostics	LED indicators; signaling contact; SNMP network management; Web-based management, PROFINET diagnostics
Redundant network structures	Electrical ring or doubling of the infrastructure (linear, star, tree)	Optical ring or doubling of the infrastructure (linear, star, tree)

1) Suitable for 10 Mbit/s, 100 Mbit/s and 1000 Mbit/s
2) Safeguard against subnetwork failure by means of redundant power supply
3) No effect with ring structure
4) With 50 switches in the ring

● ● ● ● suitable
● ● ● ○ partially suitable
● ● ○ ○
● ○ ○ ○
○ ○ ○ ○ not applicable

Electrical Industrial Ethernet network

Installation cables

Various cable designs are available for the construction of structured Industrial Ethernet cabling in the harsh industrial environment.
The UL and Cat5 Plus-certified 4 and 8-core FastConnect cables are available as:

- Standard cable for universal applications
- Trailing cable for moving machine parts
- Cable approved for laying in ships and offshore units
- Flexible cable for occasional movement
- Torsion-resistant cable for robotic applications (TP torsion cable)

IE FC stripping tool

The Industrial Ethernet FC stripping tool saves time when stripping the FC cables.
Due to the accurately preset cutting depths and spacing of the blades it is possible to remove the outer sheath and the braided shield of the FC cables to the precise measurement in a single operation. This rules out possible faults due to inaccurate stripping of the cable for assembly in the various components.

The 4 and 8-core FastConnect (FC) Industrial Ethernet cables have a radially symmetric design, which allows the use of a stripping tool FC stripping tool.
This allows plug-in connectors and patch outlets to be quickly and easily connected on-site.

IE FC TP cable 2 x 2
- The double shield makes it especially suitable for routing through industrial areas with strong electro-magnetic fields
- Simple connection without special tools to the insulation displacement contacts of the FC plugs
- Integrated grounding concept can be achieved via the outer shielding of the bus cable
- Printed meter marks
- Versatile application due to special bus cables
- Network is immune to interference thanks to double-shielded cables
- Silicone-free and therefore suitable for use in the automotive industry (e.g. in paint shops)
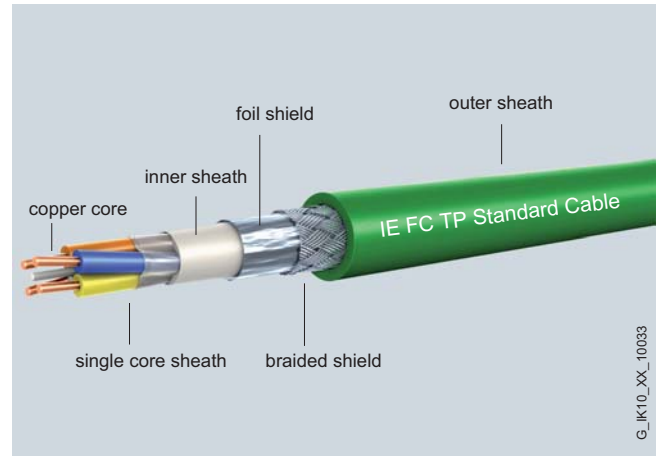
Industrial Ethernet FC TP standard cable

IE FC TP cable 4 x 2
- 8-core FastConnect installation cable for cabling system with Gigabit capability
- User-friendly stripping technique with IE FC stripping tool
- Simple connection to IE FC RJ45 modular outlet by means of insulation displacement technology
- Time is saved thanks to easy and quick installation
- Due to the 8-core cabling, it is possible today to implement 2 Fast Ethernet connections, but it will also be possible to upgrade to a Gigabit Ethernet connection in future
- Noise-immune network due to a consistent grounding concept

Possibilities of device networking with patch cables and outlets

When using the outlets in the control cabinet or in a control room, pre-assembled RJ45 patch cables are available in different versions (TP cord 4x2, TP cord 2x2 RJ45/sub D) for connecting network components or terminals

For flexibly connecting devices with different data rates, there is the Industrial Ethernet FC outlet RJ45 (10/100 Mbit/s) to 4-core Industrial Ethernet FC cables, or the Industrial Ethernet FC modular outlet (10/100/1000 Mbit/s) to 8-core Industrial Ethernet FC cables for connecting to terminals or data and power supply of remote stations (e.g. Access Point SCALANCE W).

Overview of electrical Industrial Ethernet cables

The following cables are offered for the various topologies, requirements or application areas:

Cable type		Designation	Characteristics	Area of application
Twisted pair		TP cord	Patch cables, with RJ45, 15 or 9-pin sub D connectors, pre-assembled	For connection of stations to network components within a control cabinet, up to 10 m cable length
FastConnect IE FC TP cable 2 x 2, 4-core for Fast Ethernet networks			Installation cables, insulation displacement technology, sold by the meter	For direct connection between network station and component, used for structured cabling, fast and easy connection of cables to the FC contacts
		IE FC TP standard cable GP 2x2	→	- Standard bus cable with rigid cores and special design for quick assembly; 4 rigid cores form a star quad
		IE FC TP flexible cable GP 2x2	→	- Flexible bus cable for the special application of occasional motion control; four cores (stranded) form a star quad
		IE FC TP FRNC cable GP 2 x 2	→	- Flexible, halogen-free cable for use in buildings (FRNC= Flame Retardant Non Corrosive); 4 cores (stranded) form a star quad for occasional movement
		IE FC TP trailing cable GP/ IE FC TP trailing cable 2x2	→	- Highly flexible bus cable for the special application of constant motion control in a tow chain, e.g. for continuously moving machine parts; 4 cores (stranded) form a star quad
		IE FC festoon cable GP 2 x 2	→	- Flexible cable for special continuous motion applications in a trailing cable/festoon, e.g. in crane systems; 4 cores (stranded) form a star quad
		IE FC TP food cable 2 x 2	→	- Flexible cable for special applications in the food, beverages and tobacco industries; 4 cores (stranded) form a star quad
		IE FC TP marine cable 2x2	→	- Bus cable for special marine applications; 4 cores (stranded) form a star quad, halogen-free, certified for marine applications
		IE TP torsion cable 2x2	→	- Highly flexible bus cable for the special application of continuous motion control, e.g. for use with robots; stranded core
IE FC TP cable 4 x 2, 8-core for Gigabit Ethernet networks		IE FC TP standard cable 4x2 (AWG 22)	→	- For setting up Industrial Ethernet networks up to 100 m in combination with the IE FC modular outlet and the TP cords
		IE FC TP cable 4x2 (AWG 24)	→	- For direct connection up to 60 m without patch technology with IE FC RJ45 plug 4x2 and IE FC TP cable 4x2 (AWG24)
		Connecting cable M12-180/M12-180	Pre-assembled with two 4-pin M12 connectors (IP65)	- 4-core connecting cable for IP65/IP67 components
Hybrid		IE hybrid cable	Hybrid cable for simultaneous transmission of data (10/100 Mbit/s) and energy (24 V/400 mA); insulation displacement technology, sold by the meter	Industrial and office sector; for IE FC RJ45 modular outlet and access point SCALANCE W with hybrid connector
Power		Energy cable	Power line, sold by the meter	For connection of signaling contact or 24 V DC power supply

Plug-in connector for Industrial Ethernet

IE FC RJ45 plug 90/145/180

The compact and rugged design of the plug-in connectors permits their use in the industrial environment and on all devices from the office world.
The Industrial Ethernet FastConnect RJ45 plugs allow easy and fast assembly of the 4-core Industrial Ethernet FC twisted pair installation cables in the field (PROFINET-compatible).
They are available for
• 90°
• 145° and
• 180° cable outlets
The rugged, industry-standard metal enclosure provides optimum protection against interference for data communication.
The integrated 4 insulation displacement contacts make the contacting of the FC cable versions easy and prevent faults.
As the plug-in connector has no small parts that can be lost, assembly is also possible under difficult conditions.
The FC RJ45 plugs allow point-to-point connections (100 Mbit/s) to be implemented for Industrial Ethernet between two terminals/network components up to 100 m without patch cables.
By latching the connector to the device casing (e.g. with SCALANCE X, CSM 377, SCALANCE S, S7-300 CPUs, CPs, or ET 200S), the plug-in connection is relieved of tension and bending strain.

Insert the cores according to the color-coding as far as the end stop and press down on the contact lid

Perfect assembly of a cable with FastConnect takes less than 60 seconds

SCALANCE X multi-port switch with RJ45 connection technology

Industrial Ethernet FC RJ45 plug

• Degree of protection IP20
• Easy on-site assembly for implementing direct device connections up to 100 m with IE installation cables, 4 and 8-core without patch systems

CP 443-1 Advanced with RJ45 connection technology

Plug-in connector for Industrial Ethernet

SCALANCE X208 with M12 connection technology

ET 200eco with M12 connection technology

ET 200pro with M12 connection technology

Industrial Ethernet FC M12 plug PRO

- IP65/67 degree of protection
- Easy assembly on-site for application-specific M12 plug-in cables by means of FastConnect M12 plug-in connectors that can be assembled in the field (IE FC M12 plug PRO, D-coded)

SCALANCE X with push-pull connection technology

Industrial Ethernet push-pull plug PRO

- IP65/67 degree of protection
- Data plug-in connector that can be assembled in the field for IE FC TP and POF/PCF cables for transmitting data up to 100 Mbit/s
- PROFINET-compatible
- Power plug-in connector suitable for on-site assembly for transmitting 2x24 V between Industrial Ethernet stations
- The plug-in connectors make contact with the device using a push-pull mechanism.

Patch technology for Industrial Ethernet

IE FC outlet RJ45

The FC outlet RJ45 is used for the transition from Industrial Ethernet FC cables to pre-assembled TP cords by means of a RJ45 socket.
It provides the following benefits:

- Rugged metal enclosure
- Insulation displacement contacts for fastest connection to Industrial Ethernet FC cables
- By arranging several FC outlets RJ45 in a row, it is possible to construct a patch panel with any density of connections (e.g. 16 outlets on 19" width is possible)
- DIN rail mounting and direct screw connection is possible

For time-saving and trouble-free connection of network components or terminal equipment, various RJ45 patch cables are available.
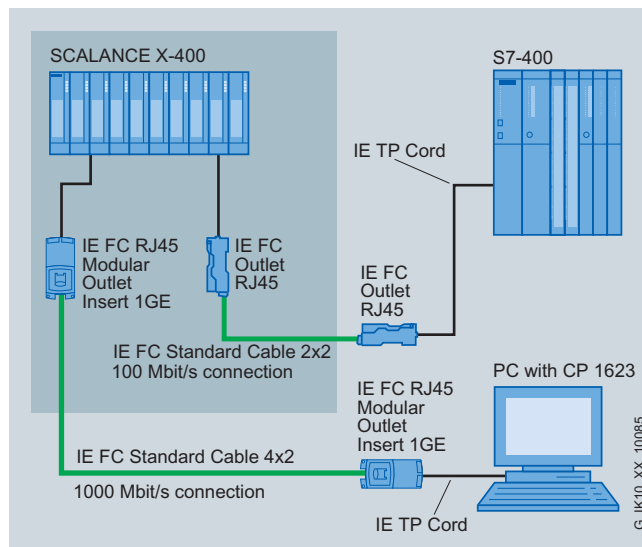
Cabling example with IE FC outlet RJ45

IE FC RJ45 modular outlet

Due to the continuous rise in transmission rates for Ethernet (10/100/1000 Mbit/s) and the service-neutral cabling from the office sector, an 8-core cabling system is also implemented by SIMATIC NET.
The Gigabit cabling system facilitates the transition from the 4-core Industrial Ethernet FastConnect cabling system to the 8-core, Gigabit cabling system.
The FC modular outlet can optionally be equipped with a replaceable insert with:
- 2x RJ45 sockets for 100 Mbit/s systems
- 1x RJ45 socket for 1000 Mbit/s systems
- 1x 24 V, 1x RJ45 socket for 100 Mbit/s systems

In this way it is possible not only to implement individual device connections, but also 100 Mbit/s double connections.
Just like the 4-core cabling system, this system also takes into account the conditions in the field of industrial automation.
Assembly is particularly easy, as no special tools are necessary (e.g. same FC stripping tool as for the 4-core cabling system).
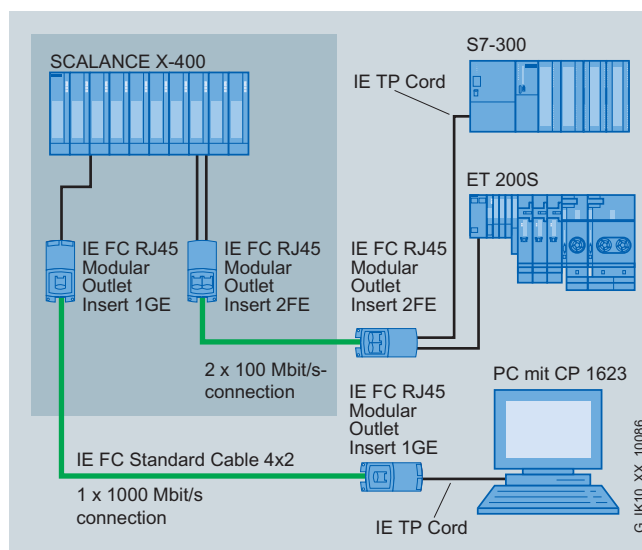
Cabling example with IE FC RJ45 modular outlet

Patch technology for Industrial Ethernet

Industrial Ethernet FC outlet RJ45

- Simple connection method for 4-core installation cables
- 10/100 Mbit/s transfer rates
- Degree of protection IP20
- Transition from rugged Industrial Ethernet FC cables (2 x 2) to pre-assembled TP cords
- Integrated insulation displacement contacts and RJ45 socket
- Patch fields are implemented with several RJ45 FC outlets
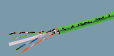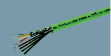
Industrial Ethernet FC RJ45 modular outlet

- Simple connection method for 8-core installation cables
- 10/100/1000 Mbit/s transfer rates
- Can be mounted inside or outside of control cabinets due to IP40 degree of protection
- Without swapping the cabling, it is possible to upgrade from 100 to 1000 Mbit/s with a replaceable insert
- Basis for implementing structured cabling according to ISO/IEC 24702

Electrical Industrial Ethernet network
Which connector fits which cable?

	Options for connecting Industrial Ethernet cables with plugs, terminals or devices (IE)									
	electrical									
	IE FC Cable 4x2		IE FC Cable 2x2	IE TP Cord 2x2	IE TP Cord 4x2	ITP cables	ITP connector cable	Hybrid cable	Power cable	
	IE FC Standard Cable GP 4x2 (AWG22)	IE FC Standard Cable GP 4x2 (AWG24) / IE FC Flexible Cable GP 4x2 (AWG24)	IE FC Standard Cable GP 2x2 / IE FC Flexible Cable GP 2x2 / IE FC Trailing Cable GP 2x2 / IE FC Torsion Cable GP 2x2 / IE FC Trailing Cable 2x2 / IE FC Marine Cable 2x2	IE TP Cord 9/RJ45 / IE TP XP Cord 9/RJ45 / IE TP Cord 9-45/RJ45 / IE TP XP Cord 9-45/RJ45 / IE TP Cord RJ45/15 / IE TP XP Cord RJ45/15 / IE TP XP Cord 9/9	IE TP Cord RJ45/RJ45 / IE TP XP Cord RJ45/RJ45	ITP Standard Cable / ITP FRNC Cable	ITP Standard Cable 9/15 / ITP XP Standard Cable 9/9 / ITP XP Standard Cable 15/15 / ITP FRNC Cable 9/15	Hybrid cable 2x2 + 4x0.34	Energy Cable 2 x 0,75	Energy Cable 5 x 1,5
IE FC RJ45 Modular Outlet	●				●			●		
IE FC Outlet RJ45			●	●	●					
IE FC RJ45 Plug 2x2			●							
IE FC RJ45 Plug 4x2		●								
M12 power connector A-coded									●	
M12 power connector D-coded			●							
IP67 hybrid connector								●		
ITP plug 9-pin/15-pin						●				
IE devices with Sub-D connection				●			●			
Devices with RJ45 connection				●	●					
Power Plug PRO										●
7/8" plug-in connector										●
IE RJ45 Plug PRO			●							

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Optical Industrial Ethernet network
Overview of optical cables

Fiber-optic cables

The fiber-optic cable (FOC) is used for the transmission of signals with the aid of electromagnetic waves within the range of optical frequencies.

The light beam is guided by total reflection at the transition from the core to the fiber cladding, which has a lower refractive index than the core.

The fiber-optic cable is provided with a coating. The term "fiber" is often also used for fiber-optic cables.

Glass FOC with SC connector

- Optical signal transmission
- Tap-proof, as fiber-optic cables do not emit radiation
- Unaffected by external noise fields
- No grounding problems
- Electrical isolation
- Low weight
- Simple cable laying due to rugged cable structure

PCF FOC with SC RJ connector

For Industrial Ethernet, fiber-optic cables are offered with fibers made of glass, PCF or POF:

- Glass FOC:
  Duplex cable for fiber-optic networks both indoors and outdoors and for use on ships or offshore installations for medium to long distances (3 km with multi-mode and up to 26 km with single mode)
- PCF-FOC:
  Duplex cable for PCF networks both indoors and outdoors for smaller automation networks (50 m with POF, 100 m with PCF) with simple on-site assembly
- POF-FOC:
  Duplex cable for POF networks indoors for smaller automation networks (50 m with POF, 100 m with PCF) with simple on-site assembly

Optical Industrial Ethernet network
Overview of optical cables

Glass fiber-optic cables

- Used for the optical Industrial Ethernet and PROFIBUS network
- Rugged construction for industrial applications both indoors and outdoors
- Halogen-free design for use in buildings
- Trailing cable for special applications with forced motion control
- High interference immunity, as they are not sensitive to electromagnetic interference
- Available pre-assembled

Plastic/PCF fiber-optic cable

SIMATIC NET plastic and PCF fiber-optic cables are used for the construction of optical PROFINET and Industrial Ethernet networks indoors. Devices with integral optical interface (SC RJ connection system) are, for example, SCALANCE X200-4P IRT, SCALANCE X201-3P IRT, SCALANCE X202-2P IRT, SCALANCE X101-1POF, ET 200S. Plastic and PCF-FOCs are easy to assemble on site using SC RJ connectors. The maximum cable length between two devices is 50 m for POF and 100 m for PCF fiber-optic cables. PCF cables are also available pre-assembled with 2 SC RJ plugs.

PCF fiber-optic cables

- Duplex cable for PCF networks in indoor and outdoor applications
- Electrical isolation of PROFINET/Ethernet devices
- Protection of the transmission route against electromagnetic interference
- Cable lengths up to 100 m possible
- Rugged standard cables, designed for industrial use

POF fiber-optic cables

- Duplex cable for POF networks in indoor and outdoor applications
- Electrical isolation of PROFINET/Ethernet devices
- Protection of the transmission route against electromagnetic interference
- Cable lengths up to 50 m possible
- Rugged standard cables, designed for industrial use
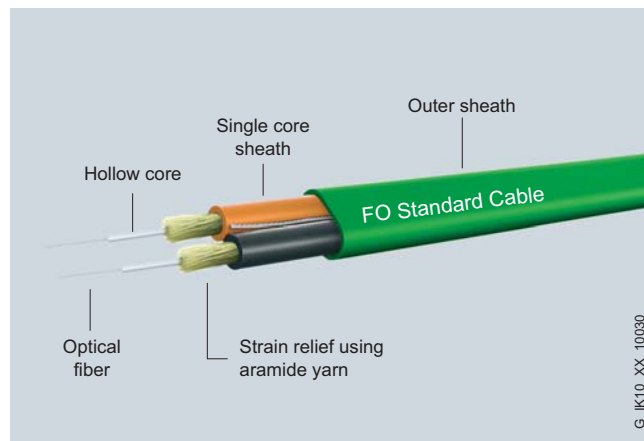
Glass fiber-optic standard cable
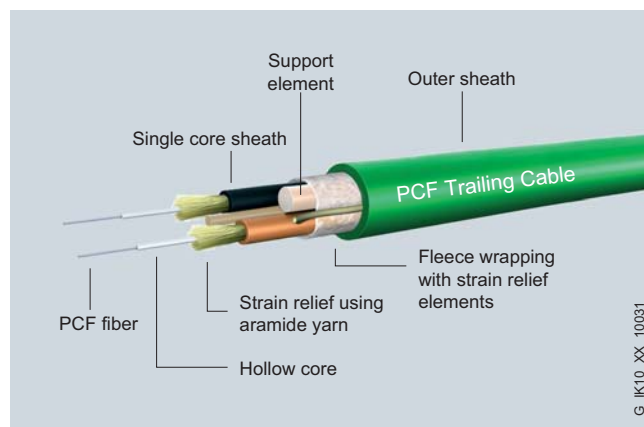
PCF fiber-optic trailing cable
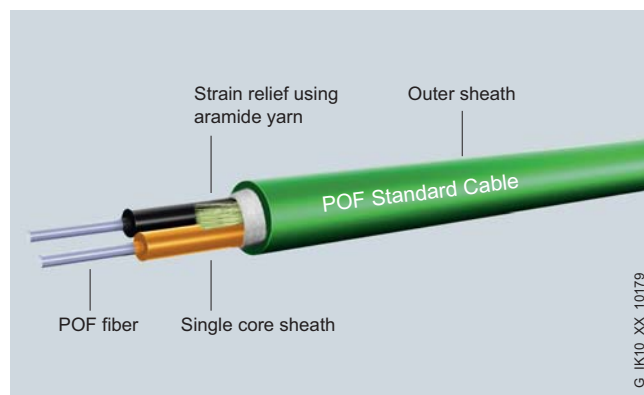
POF fiber-optic standard cable

Optical Industrial Ethernet network
Overview of optical cables

This overview shows which Industrial Ethernet connector can be assembled with which cable.

Cable type		Designation	Characteristics	Area of application
FastConnect			Glass fiber, sold by the meter or pre-assembled with 4 BFOC or SC connectors	Laying in indoor and outdoor areas Cable versions:
		FO standard cable GP (50/125)		- Rugged standard cable for universal applications
		FO ground cable (50/125)		- Watertight cable in lateral and longitudinal direction for use outdoors; with non-metallic rodent protection; laying in the ground is possible
		FO trailing cable GP (50/125) FO trailing cable (50/125) SIENOPYR marine duplex fiber-optic cable (62.5/125)		- Cable for use in tow chains - Halogen-free, tread-resistant, flame-retardant cable with marine approval for laying in ships and offshore installations
Fiber-optic Plastic			Plastic fiber-optic cable, sold by the meter or pre-assembled (PCF-FOC) with 4 SC RJ connectors	Laying in indoor and outdoor areas Cable versions:
		POF standard cable GP 980/1000		- POF-FOC standard cable for permanent cabling indoors up to 50 m with PVC sheath
		POF trailing cable 980/1000		- POF-FOC trailing cable for moving applications (e.g. trailing cable) up to 50 m with rugged PUR sheath
		PCF standard cable GP 200/230		- POF-FOC standard cable for permanent cabling indoors and outdoors up to 100 m with rugged PVC sheath
		PCF trailing cable 200/230		- POF-FOC trailing cable for high mechanical loads indoors and outdoors up to 100 m with rugged PUR sheath
		PCF trailing cable GP 200/230		- POF-FOC trailing cable for lower mechanical loads indoors and outdoors up to 100 m with PVC sheath

Optical Industrial Ethernet network
Which connector fits which cable?

	Options for connecting Industrial Ethernet cables with plugs, terminals or devices						
	Optical						
	Fiber-optic cable 50/125 μm	Fiber-optic cable 62.5/125 μm	PCF fiber optic cable	Fiber-optic cable with BFOC connector	Fiber-optic cable with SC plug	POF-FOC 980/1000 μm	Fiber-optic cable with SC RJ plug
	FO Standard Cable GP / FO Trailing Cable / FO Trailing Cable GP / FO Ground Cable	FIBER OPTIC standard cable / INDOOR Fiber Optic indoor cable / Flexible Fiber Optic trailing cable / SIENOPYR marine duplex fiber optic cable	PCF Standard Cable GP / PCF Trailing Cable GP / PCF Trailing Cable	Preassembled FOC with BFOC connector	Preassembled FOC with SC connector	POF Standard Cable GP / POF Trailing Cable	Preassembled FOC with SC RJ connector
BFOC connector	●	●					
IE devices with BFOC connection				●			
SC plug	●						
IE devices with SC connection					●		
SC RJ plug			●			●	
IE devices with SC RJ connection							●
IE SC RJ POF Plug PRO						●	
IE SC RJ PCF Plug PRO			●				

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PROFIBUS

network selection criteria

The type of network (electrical or optical, copper or fiber-optic cables) is determined by the environmental conditions in which it is to be constructed.

Criteria	Electrical network		Optical network		
	RS 485 according to IEC 61158/ 61784	IEC 61158-2 (PA)	Plastic	PCF	Glass
EMC	● ● ● ○ 1)	● ● ● ○	● ● ● ●	● ● ● ●	● ● ● ●
Inter-building networking	● ● ○ ○ 1)	● ● ○ ○	● ● ● ●	● ● ● ○ 5)	● ● ● ●
Range	● ● ○ ○ 2)	● ● ○ ○	● ● ● ●	● ● ○ ○	● ● ● ●
Suitability for high transmission rates	● ● ● ○ 4)	—	● ● ● ○	● ● ● ●	● ● ● ●
Simple connector assembly	● ● ● ●	● ● ● ●	● ● ● ○	● ● ○ ○ 3)	● ○ ○ ○ 3)
Simple cable laying	● ● ● ○	● ● ● ○	● ● ○ ○	● ● ○ ○	● ● ○ ○
Equipotential bonding measures required	Yes	Yes	No	No	No
Cables for special applications	● ● ● ●	● ○ ○ ○	● ○ ○ ○	● ○ ○ ○	● ● ○ ○
Use with moving stations	● ● ○ ○	—	○ ○ ○ ○	○ ○ ○ ○	● ● ○ ○
Use in intrinsically safe environment	—	● ● ● ●	—	—	—

1) Lightning protection measures required
2) Depending on the transmission rate
3) Trained personnel and special tool required
4) Careful laying required
5) Outer conductor required (on request)

● ● ● ● suitable
● ● ● ○ partially suitable
● ● ○ ○
● ○ ○ ○
○ ○ ○ ○

— not applicable

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Network selection criteria

Criteria		Electrical network	Optical network	
		Electrical PROFIBUS	with OLM	with integr. interface/ OBT
Transition media	Plastic [1]	–	●	●
	PCF	–	●	●
	Glass	–	●	–
	Shielded two-core cable	●	–	–
Distances	max. network size	9.6 km [5]	90 km	9.6 km
	between two nodes	up to 1 km [3]	up to 15 km [2]	up to 300 m [2]
Topology	Bus	●	–	–
	Line	–	●	●
	Tree	●	●	–
	Ring	–	●	–
Transmission protocols		all	all	DP
Connection of nodes via	OLM	–	●	–
	Integrated interfaces	●	–	● [4]
	Bus terminal	●	–	●
	Bus connector	●	–	–
Electr. network segments connectable		●	●	–

1) Plastic optical fiber is also referred to as polymer optical fiber (POF)
2) Depending on type of cable used
3) Depending on data rate used and performance
4) Integrated interfaces (ET 200M, ET 200X)
5) for PROFIBUS PA 1.9 km

● suitable
– Irrelevant to this application

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There are different networking options for PROFIBUS net-works, depending on the respective application:

• Electrical data transmission by means of shielded twisted-pair cables with circular cross-section available as standard type, with PE or PUR sheath, halogen-free design, cables for use underground, in tow chains or specially for hazardous areas. With the PROFIBUS FastConnect system, the PROFIBUS copper cables can be quickly and easily assembled on-site.

• Optical data transmission via fiber-optic cable with glass or plastic fibers for indoor or outdoor applications, as trailing cable or as halogen-free version.
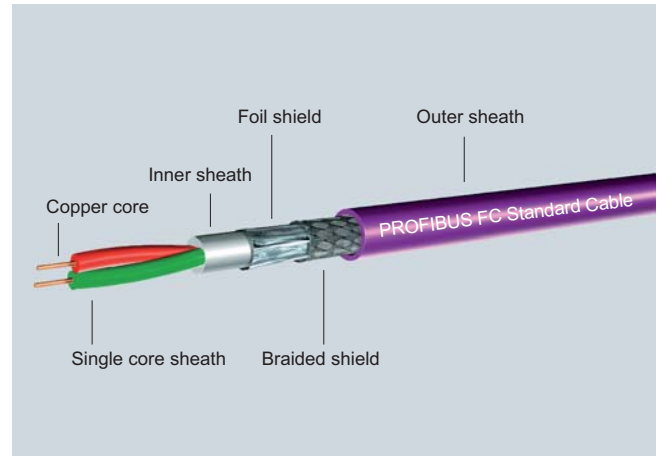
PROFIBUS FC standard cable

PROFIBUS bus cables

The design of the FastConnect (FC) bus cables is radially symmetric and allows the use of a stripping tool. This means that the bus connectors can be assembled quickly and easily.

PB FC plug 180

■ A wide variety of possible applications thanks to special bus cables (e.g. underground cable, trailing cable, use in hazardous areas)
■ Network is immune to interference thanks to double shielded cables and a uniform grounding concept
■ Time saving due to simple and fast connector assembly with FastConnect cables
■ Silicon-free, therefore particularly suitable for use in the automotive industry (e.g. on paint shop conveyors)
■ Flame-retardant bus cable (halogen-free)
■ Easy length measurement thanks to printed meter

Electrical PROFIBUS network
Overview of PROFIBUS bus cables

The following applies for all PROFIBUS bus cables:

- Due to the double shielding, they are particularly suitable for laying in industrial environments subject to electromagnetic interference.

- A consistent grounding concept can be implemented via the outer sheath and the ground terminals of the bus terminal.
- The printed meter marks simplify assembly.

Cable type		Designation	Characteristics	Area of application
				For the construction of PROFIBUS networks, the following different types of silicon-free cables are offered for the different applications:
Bus cables with FastConnect technology			Quick and easy connector assembly with the aid of the stripping tool. Shielded and twisted 2-core cables constructed with radial symmetry.	
		PROFIBUS FC standard cable GP		- Standard cable for universal applications
		FC robust cable		- Special cable for chemically and mechanically demanding environments
		FC food cable		- Special cable for the food, beverages and tobacco industries
		FC ground cable		- Special cable for routing underground
		FC flexible cable		- Special cable for use in tow chains
		FC trailing cable		- Trailing cable for moving machine parts (stranded wire)
		FC FRNC cable GP		- Halogen-free and flame-retardant cable
		FC process cable GP		- Bus cable for fieldbus systems compliant with IEC 61158-2 (hazardous and non-hazardous
Bus cables without FastConnect technology			Shielded, twisted-pair cable with circular cross-section; sold by the meter	
		PROFIBUS Festoon cable GP Torsion cable		- Special cable for festoon suspension - Special cable for use on machine parts where the cable is subject to torsion (stranded)
		ECOFAST hybrid cable GP		- Hybrid cable for data transmission and voltage supply to ECOFAST stations (stranded)
		SIENOPYR marine cable		- Halogen-free, tread-resistant, flame-retardant cable with marine approval for permanent laying in ships and offshore installations

Cable type		Designation	Characteristics	Area of application
Plug-in cables		**PROFIBUS Connecting cable 830-1T**	Twisted-pair conductors (cores of stranded copper) with a braided shield and a 9-pin sub D connector at both ends. Both ends of the cable are terminated with a resistor combination (cannot be switched off).	Via the PROFIBUS 830-1T connecting cable, the connection between an electrical PROFIBUS interface and a PROFIBUS station (OLM, OBT and end station) can be established with up to 12 Mbit/s.
		PROFIBUS Connecting cable 830-2	PROFIBUS standard bus cable with two 9-pin connectors (90° angled), pre-assembled. One connector of the pre-assembled connecting cable is equipped with a programming device interface.	The connecting cable 830-2 is used for connecting PROFIBUS stations (e.g. HMI) to PLCs at transmission rates of up to 12 Mbit/s.
		PROFIBUS M12 connecting cable	Pre-assembled connecting cable (PROFIBUS FC trailing cable) with two 5-pin M12 plugs/sockets	The PROFIBUS M12 connecting cable is used to connect PROFIBUS nodes (e.g. SIMATIC ET 200) with degree of protection IP65
		7/8" connecting cable	Pre-assembled connecting cable with two 5-pin 7/8" plugs/sockets	The 7/8" connecting cable is used for supplying power to PROFIBUS stations (e.g. SIMATIC ET 200) with degree of protection IP65
Hybrid		**PROFIBUS hybrid standard cable GP**	**Hybrid cable with two energy cores (1.5 mm²), sold by the meter**	The hybrid cable is used for supplying data and energy to the ET 200pro Cable versions: - Standard cable for universal applications - rugged, trailing-type and weld spatter-proof hybrid cable, e.g. for use in welding cells

Optical PROFIBUS network
Overview of optical cables

Fiber-optic cable (FOC)

The fiber-optic cable (FOC) is used for the transmission of signals with the aid of electromagnetic waves within the range of optical frequencies.
The light beam is guided by total reflection at the transition from core to fiber cladding, which has a lower refractive index than the core.
The fiber-optic cable is provided with a coating. The term "fiber" is often also used for fiber-optic cables.

Advantages
• Optical signal transmission
• Tap-proof, as fiber-optic cables do not emit radiation
• Unaffected by external noise fields
• No grounding problems
• Electrical isolation
• Low weight
• Easy to lay

For PROFIBUS, fiber-optic cables with glass and plastic fibers are offered for indoor and outdoor applications as well as for use on ships and offshore installations:

Glass fiber-optic cables
• Used for the optical Industrial Ethernet and PROFIBUS network
• Rugged construction for industrial applications both indoors and outdoors
• Halogen-free design for use in buildings
• Trailing cable for special applications with forced motion control
• High interference immunity, as they are not sensitive to electromagnetic interference
• Available pre-assembled
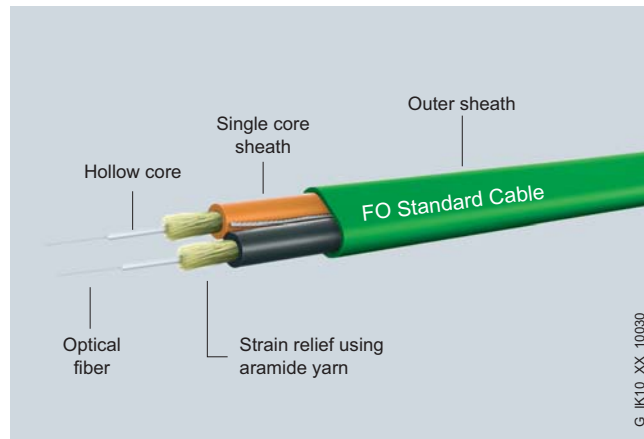
Glass fiber-optic standard cable
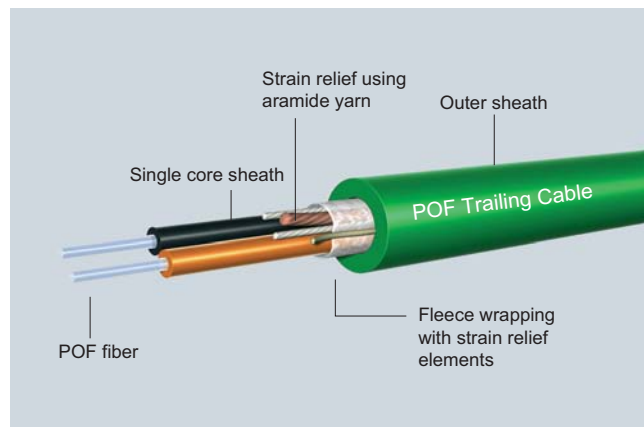
POF fiber-optic trailing cable
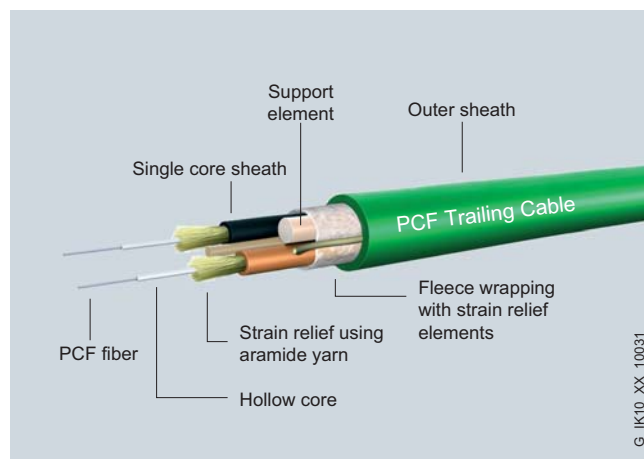
PCF fiber-optic trailing cable

Plastic/PCF fiber-optic cable

SIMATIC NET plastic and PCF fiber-optic cables are used for the construction of optical PROFIBUS networks or for optical linking of segments using RS485 technology in indoor and outdoor applications. They can be assembled on site using 2x2 simplex or 2x2 BFOC connectors. The maximum cable length between two DP devices is 300 m. Longer cable lengths up to 400 m can be implemented with PCF-FOC.

POF fiber-optic cables
• Electrical isolation of PROFIBUS devices and PROFIBUS segments
• Protection of the transmission route against electromagnetic interference
• Cable lengths up to 80 m using plastic fiber-optic cables
• Rugged standard fiber-optic cables, designed for industrial use

PCF fiber-optic cables
• Electrical isolation of PROFIBUS devices and PROFIBUS segments
• Protection of the transmission route against electromagnetic interference
• Up to 400 m using PCF fiber-optic cables
• Rugged standard fiber-optic cables, designed for industrial use

SIMATIC NET PCF fiber-optic cables are used to construct optical indoor and outdoor PROFIBUS DP networks. Their special construction facilitates connector assembly on site. PCF fiber-optic cables can readily be assembled on site using 2 x 2 simplex connectors or 2 x 2 BFOC connectors (bayonet fiber-optic connectors). The maximum cable length between two DP devices is 300 m and between two OLMs 400 m. Two assembly cases are offered for this:
• Assembly case for BFOC connectors
• Assembly case for simplex connectors

PROFIBUS DP devices with integrated optical interface (simplex connection technology) are e.g. OBT, CP 342-5 FO, CP 5613 FO, IM 153-2 FO, IM 467 FO.

Assembly made easy

PCF fiber-optic cables are easily assembled on site with 2 x 2 simplex connectors or 2 x 2 BFOC connectors using the PCF fiber-optic cable termination kit.
Two versions of the assembly case are available for PCF fiber-optic cables:
• Assembly case for HP simplex connectors;
  for local assembly of HP simplex connectors;
  comprising a stripping tool, buffer stripping tool, Kevlar cutters, crimping tool, fiber breaking tool and microscope
• Assembly case for BFOC connectors;
  for local assembly of BFOC connectors;
  comprising a stripping tool, buffer stripping tool, Kevlar cutters, fiber breaking tool, and microscope.

The termination kits provide the following benefits
• Simple installation of the unassembled cable in industrial plants
• Flexible connector assembly on PCF FOCs possible on site (HP simplex, BFOC connector)
• Prevention of faults by simply checking the assembled connectors on site using a microscope
• Simple repair of PCF FOC in the field by laying new PCF cable

Simplex connector

BFOC connector

Optical PROFIBUS network

Overview of optical PROFIBUS bus cables

Cable type		Designation	Characteristics	Area of application
Fiber-optic			Glass fiber, sold by the meter or pre-assembled with 4 BFOC or SC connectors	Laying in indoor and outdoor areas
		FO standard cable GP (50/125)		Cable versions: - Rugged standard cable for universal applications
		FO ground cable (50/125)		- Watertight cable in lateral and longitudinal direction for use outdoors; with non-metallic rodent protection; laying in the ground is possible
		FO trailing cable GP (50/125) **FO trailing cable (50/125)** **SIENOPYR marine duplex fiber-optic cable (62.5/125)**		- Cable for use in tow chains - Halogen-free, tread-resistant, flame-retardant cable with marine approval for laying in ships and offshore installations
		PROFIBUS plastic fiber-optic	Plastic/PCF fiber-optic cable; sold by the meter or pre-assembled.	Plastic and PCF fiber-optic cables are used for the construction of optical PROFIBUS DP networks in indoor applications.
		Duplex core		- Up to 80 m with low mechanical loads, e.g. laboratory structures
		Standard cable		- Up to 50 m, with Kevlar tension elements
		PROFIBUS PCF plastic fiber-optic standard cable		- Up to 400 m, with Kevlar tension elements

Connection components for PROFIBUS

	Electrical network		Optical network	
	RS 485 according to IEC 61158/EN 50170	IEC 61158-2 (PA)	with OLM	with integral interface/OBT
Network topology	Bus, tree	Bus, tree	Linear, star, ring	Linear
Transmission media	Shielded two-wire line	Shielded two-wire line for intrinsically safe and non-intrinsically safe areas	Plastic FOC PCF FOC Glass FOC	Plastic FOC PCF FOC
Tools and accessories	FastConnect stripping tool	FastConnect stripping tool	Tools for assembling BFOC connectors for plastic FOC	Tools for assembling simplex connectors for plastic FOC
Connection method	Bus connector	SpliTConnect system	BFOC connector	Simplex connector
Connection components	Bus terminal	SpliTConnect system	OLM	OBT
Pre-assembled cables	Connecting cable 830-1T Connecting cable 830-2	- - -	INDOOR cable with BFOC Standard glass cable with BFOC Trailing cable with BFOC Standard PCF cable with BFOC Standard plastic cable with BFOC	Standard PFC cable with simplex connectors and insertion tool
Lightning protection	Basic protection Low-voltage protection	To be implemented by means of structural measures	Not required	Not required
Electrical network segment can be connected via	repeater	- - -	Optical link module (OLM)	Optical bus terminal (OBT)
Diagnostics tool	Hardware test unit BT 200	Not available	Signaling contact and internal measuring sockets; Level measuring unit upon request	Level measuring unit upon request
Documentation	Manual for PROFIBUS networks	Manual for PROFIBUS networks	Manual for PROFIBUS networks	Manual for PROFIBUS networks

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Electrical and optical PROFIBUS network
Which connector fits which cable?

	Options for connecting PROFIBUS cables with plugs, terminals or devices													
	Electrical								Optical					
	PROFIBUS FC bus cables	PROFIBUS bus cables	Connecting cables	ECOFAST cable	Hybrid cable	Power cable	PROFIBUS FC Bus cable (PROFIBUS PA)	Bus terminal	Fiber-optic cable 50/125 µm	Fiber-optic cable 62.5/125 µm	PCF fiber optic cable 200/230 µm	POF-FOC 980/1000 µm	Fiber-optic cable with BFOC connector	Fiber-optic cable with Simplex connector
	PROFIBUS FC Standard Cable / PROFIBUS FC Standard Cable IS GP / PROFIBUS FC Robust Cable / PROFIBUS FC Food Cable / PROFIBUS FC Ground Cable / PROFIBUS FC FRNC Cable / PROFIBUS FC Trailing Cable	PROFIBUS Festoon Cable / PROFIBUS Flexible Cable	Connecting cable 830-2 / Connecting cable 830-1T / PROFIBUS M12 plug-in cable	ECOFAST Hybrid Cable / ECOFAST Hybrid Cable GP	PROFIBUS Hybrid Standard Cable GP / PROFIBUS Hybrid Robust Cable	Power Cable 5 x 1.5	PB FC Process Cable	12M bus terminal	FO Standard Cable GP / FO Trailing Cable / FO Trailing Cable GP / FO Ground Cable	FIBER OPTIC standard cable / INDOOR Fiber Optic indoor cable / Flexible Fiber Optic trailing cable / SIENOPYR marine duplex fiber-optic cable	PCF Standard Cable GP / PCF Trailing Cable / PCF Trailing Cable GP	Plastic fiber optic standard cable	Preassembled FOC with BFOC connector	Preassembled FOC with simplex connector
PB FastConnect connector	●	●												
PB bus connector	●	●												
ECOFAST connector				●										
PB M12 plug / socket (B-coded)	●	●												
7/8" Power connector						●								
PB devices with Sub-D / M12 interface			●					●						
ET 200pro	●	●			●									
Bus terminal 12M	●	●												
SpliTConnect system							●							
BFOC connector									●	●	●			
PB devices with BFOC connection													●	
Simplex connector											●	●		
PB devices with simplex interface														●

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The right cable for every application

In order to maintain fault-free, long-term operation of the industrial data networks, every user must precisely analyze the type of environment where the cable will be used prior to installation. This influences the selection of the correct type of cable. Depending on whether the cable should be used in fixed or moving applications (e.g. use in tow chains), you can select between cables with rigid or flexible cores. In addition the outer sheath of a cable must protect the internal construction against environmental influences. By adding UV stabilizers to the material for the sheaths, the cables can also be laid in outdoor applications (e.g. on cable racks).

Special approvals

SIMATIC NET cables are also certified for special applications, e.g. for ships and offshore facilities, or for the American and Canadian markets (UL listing such as OFN/OFNG for FOC or CM/CMG for copper cables).
Current information on certifications can be found in the technical data for the corresponding ~~products under: www.siemens.de/automation/mall~~

Note

You can order components supplementary to the SIMATIC NET cabling system from your local contact. Technical advice on this subject is available from:

J. Hertlein, IA SE PS
Tel.: + 49 911/750 44 65
Fax: + 49 911/750 99 91
E-mail: juergen.hertlein@siemens.com

Sheath material	Application
PVC (polyvinyl chloride): Material with good mechanical properties and resistance to chemicals	Standard for industrial applications for indoor and outdoor areas (e.g. in cable racks)
PUR (polyurethane): Halogen-free material with excellent mechanical strength and resistance to chemicals (abrasion-resistant)	Cables subject to considerable movement (tow chains), with high mechanical or chemical stresses, for harsh industrial environments
PE (polyethylene): Particularly resistant to moisture affecting the cable continuously	Use in damp or humid environments both indoors (e.g. in food and beverage industry) and outdoors and for laying directly into the ground
FRNC (Flame Retardant Non Corrosive): Material which behaves well in a fire, mostly self-extinguishing, which does not produce any harmful gases in the event of a fire; serious secondary damage is avoided.	Standard applications with high fire safety requirements

The elasticity of polyurethane is retained over a wide temperature range (-20 °C to +80 °C).
In special applications such as welding robots in the automotive industry, the resistance to welding sparks can be further increased by a radial meshing of the material.

Further information

More on SIMATIC NET:
www.siemens.com/simatic-net

Information and ordering platform:
www.siemens.com/automation/mall

All about FastConnect:
www.siemens.com/fastconnect