SIMATIC NET

PROFIBUS Networks

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2 Topologies of SIMATIC NET PROFIBUS Networks
3 Configuring Networks
4 Passive Components for Electrical Networks
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A The SIMATIC NET Optical Link Module (OLM) for PROFIBUS
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6GK1970–5CA10–0AA1 C79000–G8976–C099 Release 02

Technische Änderungen vorbehalten.


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We have checked the contents of this manual for agreement with the hardware described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcome.

Technical data subject to change.

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SIEMENS

SIMATIC NET

PROFIBUS Networks

| Description | C79000–B8976–C106/02 |
Note

We would point out that the contents of this product documentation shall not become a part of or modify any prior or existing agreement, commitment or legal relationship. The Purchase Agreement contains the complete and exclusive obligations of Siemens. Any statements contained in this documentation do not create new warranties or restrict the existing warranty.

We would further point out that, for reasons of clarity, these operating instructions cannot deal with every possible problem arising from the use of this device. Should you require further information or if any special problems arise which are not sufficiently dealt with in the operating instructions, please contact your local Siemens representative.

General

These devices are electrically operated. In operation, certain parts of these devices carry a dangerously high voltage.

Failure to heed warnings may result in serious physical injury and/or material damage.

Only appropriately qualified personnel may operate this equipment or work in its vicinity. Personnel must be thoroughly familiar with all warnings and maintenance measures in accordance with these operating instructions.

Correct and safe operation of this equipment requires proper transport, storage and assembly as well as careful operator control and maintenance.

Personnel qualification requirements

Qualified personnel as referred to in the operating instructions or in the warning notes are defined as persons who are familiar with the installation, assembly, startup and operation of this product and who possess the relevant qualifications for their work, e.g.:

> Training in or authorization for connecting up, grounding or labelling circuits and devices or systems in accordance with current standards in safety technology;

> Training in or authorization for the maintenance and use of suitable safety equipment in accordance with current standards in safety technology;

> First Aid qualification.
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Important Information

Note

SIMATIC NET is the new name of the previous SINEC product range.

Our networks now have the following names:

<table>
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<th>New:</th>
<th>Previously:</th>
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<td>SINEC H1</td>
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<tr>
<td>PROFIBUS</td>
<td>SINEC L2</td>
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<tr>
<td>AS–Interface</td>
<td>SINEC S1</td>
</tr>
</tbody>
</table>

During the initial transitional phase, products may still have the name SINEC printed on them.

Caution!

Appendix A “SIMATIC NET Optical Link Module (OLM) for PROFIBUS”
Table 2: “Maximum Possible Lengths of RS 485 Bus Segments at Ports 1 and 2”

The values in this table must be replaced by the values in Tables 3.1 and 3.2 in this manual.
Symbols

- PROFIBUS 830-1 connecting cable
- LAN cable (twisted pair)
- Simplex fiber optic cable
- Duplex fiber optic cable
- Bus terminal not terminated
- Bus terminal terminated
- Bus connector not terminated
- Bus connector terminated
- Data terminal equipment active (or passive) node
- Data terminal equipment passive node
- RS 485 repeater
- Optical link plug (OLP)
- Optical link module (OLM P4/S4/S4–1300)
- Optical link module (OLM P3/S3/S3–1300)
- Important instructions
- Steps to be taken by the user.
1 PROFIBUS Networks
1 PROFIBUS Networks

1.1 Local Area Networks in Manufacturing and Process Automation

1.1.1 General Introduction

The performance of control systems is no longer simply determined by the programmable logic controllers, but also to a great extent by the environment in which they are located. Apart from plant visualization, operating and monitoring, this also means a high-performance communications system.

Distributed automation systems are being used increasingly in mining and process automation. This means that a complex control task is divided into smaller “handier” subtasks with distributed control systems. As a result, efficient communication between the distributed systems is an absolute necessity. Such structures have, for example, the following advantages:

- Independent and simultaneous startup of individual sections of plant/system
- Smaller, clearer programs
- Parallel processing by distributed automation systems

This results in the following:

- Shorter reaction times
- Reduced load on the individual processing units
- System-wide structures for handling additional diagnostic and logging functions
- Increased plant/system availability since the rest of the system can continue to operate if a substation fails.

A comprehensive, high-performance communications system is a must for a distributed system structure.

With SIMATIC NET, Siemens provides an open, heterogeneous communications system for various levels of process automation in an industrial environment. The SIMATIC NET communications systems are based on national and international standards according to the ISO/OSI reference model.

The basis of such communications systems are local area networks (LANs) which can be implemented in one of the following ways:

- Electrically
- Optically
- As an electrical/optical combination
1.1.2 System Overview

SIMATIC NET is the name of the communications networks connecting SIEMENS programmable controllers, host computers, work stations and personal computers.

SIMATIC NET includes the following:
- The communications network consisting of transmission media, suitable attachment and transmission components and the corresponding transmission techniques
- Protocols and services used to transfer data between the devices listed above
- The modules of the programmable controller or computer that provide the connection to the LAN (communications processors “CPs” or “interface modules”).

To handle a variety of tasks in automation engineering, SIMATIC NET provides different communications networks to suit the particular situation.

The topology of rooms, buildings, factories, and complete company complexes and the prevalent environmental conditions mean different requirements. The networked automation components also make different demands on the communications system.

To meet these various requirements, SIMATIC NET provides the following communications networks complying with national and international standards:

Industrial Ethernet
A communications network for the cell area using baseband technology complying with IEEE 802.3 and using the CSMA/CD medium access technique (Carrier Sense Multiple Access/Collision Detection). The network is operated on:
- 50 Ω triaxial cable
- 100 Ω twisted pair cable
- Glass fiber-optic cable

AS-Interface
The actuator sensor interface (AS-i) is a communications network for automation at the lowest level for connecting binary actuators and sensors to programmable logic controllers via the AS-i bus cable.

PROFIBUS
Within the open, heterogeneous SIMATIC NET communications system, PROFIBUS is the network for the cell and field area intended primarily for an industrial environment.

The PROFIBUS network complies with the PROFIBUS standard EN 50170 (1996). This means that all products comply with this standard. The SIMATIC NET PROFIBUS components can also be used with SIMATIC S7 to create a SIMATIC MPI subnet (MPI = Multipoint Interface).

The following systems can be connected:
- SIMATIC S5/S7/M7 programmable controllers
- ET 200 distributed I/O system
- SIMATIC programming devices/PCs
- SIMATIC operator control and monitoring devices or systems
- SICOMP IPCs
- SINUMERIK CNC numerical controls
- SIMODRIVE sensors
- SIMOVERT master drives
PROFIBUS Networks

- SIMADYN D digital control system
- SIMOREG
- Micro-/Midimaster
- SIPOS reversing power controllers/actuators
- SIPART industry/process controllers
- MOBY identification systems
- SIMOCODE low-voltage switch gear
- Circuit breakers
- SICLIMAT COMPAS compact automation stations
- TELEPERM M process control system
- Devices from other manufacturers with a PROFIBUS connection

PROFIBUS networks can be implemented with the following:
- Shielded, twisted pair cables (characteristic impedance 150 Ω)
- Glass and plastic fiber-optic cables

The various communications networks can be used independently or if required can also be combined with each other.
1.2 Foundation of the PROFIBUS Network

1.2.1 Standards

SIMATIC NET PROFIBUS is based on the following standards and directives:

EN 50170-1-2: 1996
   General Purpose Field Communication System
   Volume 2 : Physical Layer Specification and Service Definition

PROFIBUS Users Organization guidelines:
   PROFIBUS implementation instructions for Draft DIN 19245 Part 3
   Optical transmission techniques for PROFIBUS
   Version 1.1 dated 07.1993

EIA RS-485: 1983
   Standard for Electrical Characteristics of Generators and Receivers
   for Use in Balanced Digital Multipoint Systems
1.2.2 Access Techniques

Network access on PROFIBUS corresponds to the method specified in EN 50170, Volume 2 “Token Bus” for active and “Master-Slave” for passive stations.

The access technique is not dependent on the transmission medium. Figure 1.1 “PROFIBUS Access Technique” shows the hybrid technique with active and passive nodes. This is explained briefly below:

> All active nodes (masters) form the logical token ring in a fixed order and each active node knows the other active nodes and their order in the logical ring (the order does not depend on the topological arrangement of the active nodes on the bus).

> The right to access the medium, the “Token”, is passed from active node to active node in the order of the logical ring.

> If a node has received the token (addressed to it), it can send frames. The time in which it is allowed to send frames is specified by the token holding time. Once this has expired, the node is only allowed to send one high priority message. If the node does not have a message to send, it passes the token directly to the next node in the logical ring. The token timers (“max. Token Holding Time” etc.) are configured for all active nodes.

> If an active node has the token and if it has connections configured to passive nodes (master-slave connections), the passive nodes are polled (for example values read out) or data are sent to the slaves (for example setpoints).

> Passive nodes never receive the token.

This access technique allows nodes to be included or removed from the ring during operation.
1.2.3 Transmission Techniques

The physical transmission techniques used depend on the SIMATIC NET PROFIBUS transmission medium:

- RS-485 for electrical networks on shielded, twisted pair cables and
- Optical techniques according to the PROFIBUS User Organization guideline /3/ on fiber-optic cables.

1.2.3.1 Transmission Techniques According to EIA Standard RS-485

The RS-485 transmission technique corresponds to balanced data transmission complying with the EIA Standard RS-485 /4/. This transmission technique is specified in the PROFIBUS standard EN 50170 for data transmission on twisted pair cables.

The medium is a shielded, twisted pair cable. The maximum length of a segment depends on the following:

- The transmission rate
- The type of cable being used
- The number of nodes
- The type and number of overvoltage protectors.

Features:

- Bus or tree structure with repeaters, bus terminals, and bus connectors for attaching PROFIBUS nodes
- Simple, consistent installation and grounding concept

The RS-485 transmission technique in PROFIBUS has the following physical characteristics:

<table>
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<tr>
<th>Network topology:</th>
<th>Bus, terminated at both ends with the characteristic impedance; attachment of nodes either directly using bus connectors or via bus terminals with connecting cables. The use of a maximum of 9 RS 485 repeaters (see Chapter 5) allows a network span between two nodes of a maximum of 10 segment lengths at the appropriate data rate.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium:</td>
<td>Shielded, twisted pair cable</td>
</tr>
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<td>Possible segment lengths: (depending on the cable type, see Table 3.1 )</td>
<td>1,000 m for transmission rates up to 93.75 Kbps, 800 m for transmission rate of 187.5 Kbps, 400 m for transmission rate of 500 Kbps, 200 m for transmission rate of 1.5 Mbps, 100 m for transmission rates 3.6 and 12 Mbps</td>
</tr>
<tr>
<td>Number of nodes:</td>
<td>Maximum 32 on one bus segment, Maximum 127 per network when using repeaters</td>
</tr>
<tr>
<td>Transmission rates:</td>
<td>9.6 Kbps, 19.2 Kbps, 93.75 Kbps, 187.5 Kbps, 500 Kbps, 1.5 Mbps, 3 Mbps, 6 Mbps, 12 Mbps</td>
</tr>
</tbody>
</table>
### 1.2.3.2 Transmission Techniques for Optical Components

The optical version of SIMATIC NET PROFIBUS is implemented with optical link modules (OLMs) and optical link plugs (OLPs).

Due to the unidirectional characteristic of the optical fibers, optical networks are implemented by point-to-point connections between the active components.

The medium used is either glass or plastic fiber-optic cable.

Using OLMs and OLPs, optical networks with a bus, star and ring structure can be created.

**Features:**

- Large distances can be achieved between two DTEs (connections OLM-OLM to 15,000 m)
- Electrical isolation between nodes and transmission medium
- No electromagnetic interference
- No lightning conductors required
- Simple laying of fiber-optic cables
- High availability of the LAN due to the use of a two-fiber ring topology
- Extremely simple attachment technique using plastic fiber-optic cables over shorter distances.

The optical transmission technique has the following characteristics:

<table>
<thead>
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<th>Network topology:</th>
<th>Bus, star or ring structure with OLMs, single-fiber ring structure with OLPs</th>
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<td>Medium:</td>
<td>Fiber-optic cable with glass or plastic fibers</td>
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<td>Connection lengths (point-to-point)</td>
<td>With glass fibers up to 15,000 m dependent on the fiber and OLM type</td>
</tr>
<tr>
<td>OLM:</td>
<td>0 m to 80 m</td>
</tr>
<tr>
<td>OLP:</td>
<td>1 m to 25 m</td>
</tr>
<tr>
<td>Transmission rate OLM:</td>
<td>9.6 Kbps, 19.2 Kbps, 93.75 Kbps, 187.5 Kbps, 500 Kbps, 1.5 Mbps</td>
</tr>
<tr>
<td>OLP:</td>
<td>93.75 Kbps, 187.5 Kbps, 500 Kbps, 1.5 Mbps</td>
</tr>
<tr>
<td>Number of nodes:</td>
<td>Maximum 127 per network</td>
</tr>
</tbody>
</table>
2 Topologies of SIMATIC NET PROFIBUS Networks
2 Topologies of SIMATIC NET PROFIBUS Networks

2.1 Topologies of Electrical Networks

Electrical SIMATIC NET PROFIBUS networks can be operated at the following transmission rates:

9.6 Kbps, 19.2 Kbps, 93.75 Kbps, 187.5 Kbps, 500 Kbps, 1.5 Mbps, 3 Mbps, 6 Mbps and 12 Mbps

Depending on the transmission rate, transmission medium, and network components different segment lengths and therefore different network spans can be implemented.

The bus attachment components can be divided into two groups:

- Components for transmission rates from 9.6 Kbps to a maximum of 1.5 Mbps
- Components for data rates from 9.6 Kbps to a maximum of 12 Mbps

The media used are the SIMATIC NET PROFIBUS cables described in Chapter 4. The technical information below applies only to networks implemented with these cables and SIMATIC NET PROFIBUS components.

On networks for transmission rates up to ≤1.5 Mbps, all nodes are connected to the LAN cables via bus connectors, RS 485 bus terminals or RS 485 repeaters. Each bus segment must be terminated at both ends with its characteristic impedance. This cable terminator is integrated in the RS 485 repeaters, the RS 485 bus terminals and the bus connectors and can be activated if required. Before the cable terminator can be activated, the component must be supplied with power. With the RS 485 bus terminals and the bus connectors, this power is supplied by the connected data terminal equipment (DTE), whereas the RS 485 repeater has its own power supply.

The RS 485 transmission technique allows the connection of a maximum of 32 attachments (DTEs and repeaters) per bus segment. The maximum permitted cable length of a segment depends on the transmission rate used, the LAN cable used and the number of overvoltage protection modules, if applicable.

By using RS 485 repeaters, segments can be interconnected. A maximum of 9 repeaters can be used between any two nodes. Both bus and tree structures can be implemented.

Figure 2.1 shows a typical topology using the RS 485 technique with 3 segments and 2 repeaters.

![Figure 2.1: Topology Using the RS 485 Technique](image)

Extending the span of the network using repeaters means longer transmission times that may, under certain circumstances, need to be taken into account during configuration (see Section 3.3).
2.1.1 Components for Transmission Rates up to 1.5 Mbps

All SIMATIC NET bus attachment components can be used for transmission rates ≤ 1.5 Mbps.

2.1.2 Components for Transmission Rates up to 12 Mbps

The following bus attachment components can be used for transmission rates up to ≤ 12 Mbps:

- PROFIBUS bus connector with axial cable outlet
  (Order no. 6GK1 500-0EA00)

- RS 485 bus connector with vertical cable outlet
  Without PG interface
  (Order no. 6ES7 972-0BA10-0XA0)
  With PG interface
  (Order no. 6ES7 972-0BB10-0XA0)

- RS 485 bus connector with swivelling cable outlet
  Without PG interface
  (Order no. 6ES7 972-0BA20-0XA0)
  With PG interface
  (Order no. 6ES7 972-0BB20-0XA0)

- PROFIBUS RS 485 repeater
  24 V DC, casing with IP 20 degree of protection
  (Order no. 6ES7 972-0AA00-0XA0)

- SIMATIC S5/S7 PROFIBUS connecting cable for connecting programming devices at 12 Mbps
  preassembled with 2 sub-D connectors, length 3 m
  (Order no. 6ES7 901-4BD00-0XA0)
2.2 Topologies of Optical Networks

In SIMATIC NET PROFIBUS, optical networks are implemented with the following devices:

- Optical Link Module (OLM)
- Optical Link Plug (OLP)

In optical networks, the distance between two network components does not depend on the transmission rate. Exception: Redundant optical two-fiber rings

2.2.1 Topologies with OLMs

The OLMs have two electrical channels that are functionally independent of each other (similar to the channels on a repeater) and depending on the version, they have one or two optical channels.

Please note that the two electrical channels are neither isolated electrically from each other nor from the 24 V operating voltage.

The OLMs are suitable for transmission rates of 9.6 Kbps to 1500 Kbps. The transmission rate is detected automatically.

Table 2.1 shows a list of the various versions of the OLMs and the distances that can be covered with them.

<table>
<thead>
<tr>
<th>OLM</th>
<th>P3</th>
<th>P4</th>
<th>S3</th>
<th>S4</th>
<th>S3-1300</th>
<th>S4-1300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of channels</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Electrical</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>– Optical</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Usable fiber types</td>
<td>Maximum distance between two OLMs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Plastic fiber cable</td>
<td>980/1000 μm</td>
<td>80 m</td>
<td>80 m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– HCS* fiber</td>
<td>200/230 μm*</td>
<td>600 m</td>
<td>600 m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Glass fiber cable</td>
<td>50 / 125 μm*</td>
<td>2,000 m</td>
<td>2,000 m</td>
<td>10,000 m</td>
<td>10,000 m</td>
<td></td>
</tr>
<tr>
<td>– 62.5 / 125 μm</td>
<td>2,850 m</td>
<td>2,850 m</td>
<td>10,000 m</td>
<td>10,000 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– 10 / 125 μm*</td>
<td>15,000 m</td>
<td>15,000 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Special types, see Section 6.1.3

Table 2.1: OLM Versions, Maximum Distances Between Two Modules

Only the following modules can be connected optically:

- OLM/P with OLM/P
- OLM/S with OLM/S
- OLM/S-1300 with OLM/S-1300
Bus Topologies with OLMs

Figure 2. 2 shows a typical example of a bus topology

In a bus structure, the individual SIMATIC NET PROFIBUS OLMs are connected together in pairs by duplex fiber-optic cables.

At the start and end of a bus, OLMs with one optical channel are adequate, in between, OLMs with two optical channels are required.

The DTEs are attached to the electrical interfaces of the OLMs. Either individual DTEs or complete PROFIBUS segments with a maximum of 31 nodes can be connected to each RS 485 interface.

By using the echo function, the individual fiber-optic sections can be monitored by the optical link modules.

If an OLM fails or if there is a permanent break on the fiber-optic cable between two OLMs, the bus divides into two separate buses both of which can continue working without problems.
Star Topologies with OLMs

Several optical link modules are grouped together via an electrical bus to form a star coupler. Further OLMs are connected to the star coupler via duplex fiber-optic cables. The use of modules with one or two optical interfaces is possible.

The free electrical channels of the star coupler are available for the connection of further DTEs. With the OLMs connected via the duplex fiber-optic cables, both DTEs and electrical bus segments can be connected. Depending on the requirements and the distance, the duplex cables can be implemented with plastic or glass fibers.

Using the echo function, the connected OLMs can monitor the fiber-optic sections. Even if only one transmission direction is lost, the segmentation triggered by the monitoring function leads to safe disconnection of the OLM from the star coupler. The remaining network can continue to work without problems.

The star coupler can be made up with OLM/P, OLM/S and OLM/S-1300 versions either all of one type or mixed. If an OLM/P is used in the star coupler, the DTEs can also be connected directly with a duplex cable via optical link plugs (OLPs).

In this case, the echo function is not supported, transmission path monitoring and error signaling with the OLM signaling contact are no longer possible.
Ring Topologies with OLMs

The optical link modules can be used to create both single-fiber rings and two-fiber rings.

**Single-Fiber Ring Structures**

![Diagram of an Optical Single-Fiber Ring Topology](image)

*Figure 2.4: Example of an Optical Single-Fiber Ring Topology*

The OLMs of the ring are connected together by simplex cables. For this topology, OLMs with one optical interface are adequate. If required, a DTE or an electrical segment can be connected to each electrical channel.

With this topology, the monitoring function must be activated on all OLMs involved since the data flow control in the ring uses the echo function. A signal to be transmitted is fed into the optical ring by the OLM, runs through the ring completely and is received by the same module as an echo and then removed from the ring.

> If the fiber is interrupted or if one of the OLMs fails, the entire ring is no longer capable of communication.

> In a single-fiber ring with several OLMs, no OLPs can be used.
If the distance between two OLMs turns out to be too long, a structure as shown in Figure 2.5 can be implemented.

Figure 2.5: Alternative Cabling of a Network Structure in an Optical Single-Fiber Ring Topology
Redundant Cables in Point-to-Point Links

This network topology is used in an “optical” connection of several DTEs or RS 485 segments. By using a redundant point-to-point link with two optical link modules OLM/P4, OLM/S4 or OLM/S4-1300, a high degree of availability is achieved even if one of the optical transmission paths fails completely.

A detected cable break is indicated by the signaling contact of both OLMs.

If there is a switchover to the redundant cable (for example due to a cable break), there is a brief switchover time during which correct data transmission is not possible. To prevent this interfering with operation, it is advisable to set the frame repetitions on the PROFIBUS master to at least 3.

When implementing a redundant optical point-to-point connection, the following points are important:

> To increase availability, the duplex cables should be laid so that they are separate from each other.
> The maximum distances between two modules as shown in Table 2.1 must be adhered to.
> The maximum permitted difference in length between the parallel fiber-optic sections is restricted depending on the transmission rate (see Table 2.2).

<table>
<thead>
<tr>
<th>Transmission Rate in Kbps</th>
<th>9.6</th>
<th>19.2</th>
<th>93.75</th>
<th>187.5</th>
<th>500</th>
<th>1,500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum permitted difference in length between the parallel fiber-optic sections in meters</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>10,000</td>
<td>4,000</td>
<td>1,300</td>
</tr>
</tbody>
</table>

Table 2.2: Permitted Difference in Length Between the Two Optical Sections of a Redundant Point-to-Point Link
Redundant Optical Rings (two-fiber rings)

Redundant optical rings are a special form of bus topology. By closing the optical bus to form a ring, a high degree of operational reliability is achieved.

![Network Structure in a Redundant, Optical, Two-Fiber Ring Topology](image)

A break on a fiber-optic cable between two modules is detected by the modules and the network is reconfigured to form an optical bus. The entire network remains operational.

If a module fails, only the DTEs or electrical segments attached to the module are separated from the ring; the remaining network remains operational as a bus.

The problem is indicated by LEDs on the modules involved and by their signaling contacts.

After the problem is eliminated, the modules involved cancel the segmentation automatically and the bus is once again closed to form a ring.

**The permitted path length is the smaller value from Tables 2.1 and 2.3.**

**If there is a cable break or similar, there is a switchover time delay during which correct data transfer is not possible. To ensure that the application is not adversely affected by the switchover, it is advisable to set the number of frame repetitions on the PROFIBUS master to at least 3.**

**To increase the availability, the duplex cables for the outgoing and incoming paths in the ring should be routed separately.**

When implementing a redundant optical ring, remember the following points:

- The maximum distances between two modules are as shown in Table 2.1.
- The maximum permitted fiber-optic cable length between two adjacent OLMs depends on the selected transmission rate.

<table>
<thead>
<tr>
<th>Transmission rate in Kbps</th>
<th>9.6</th>
<th>19.2</th>
<th>93.75</th>
<th>187.5</th>
<th>500</th>
<th>1,500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum possible distance between two modules in meters</td>
<td>15,000</td>
<td>15,000</td>
<td>8,500</td>
<td>4,200</td>
<td>1,600</td>
<td>530</td>
</tr>
</tbody>
</table>

Table 2.3: Cable Lengths in Redundant Optical Rings
2.2.2 Topologies with OLPs

Optical link plugs (OLPs) are a cost effective way of connecting passive PROFIBUS devices (slaves) using an optical fiber ring. Figure 2.8 shows a configuration with 4 cascaded OLPs.

![Figure 2.8: Optical Single-Fiber Ring with 4 Cascaded OLPs](image)

An OLM/P3 or OLM/P4 is required to connect the master to the ring. The master can be connected via one of the electrical interfaces or when using the OLM/P4 via a free optical interface. The free electrical interfaces of the OLMs can be used for the connection of additional DTEs (masters or slaves) or electrical segments.

Further options with OLPs include:

> Connection of a PROFIBUS master to an OLM (point-to-point link)
> Connection of an RS 485 repeater which has several PROFIBUS slaves connected to its second segment (but no masters!)

![Figure 2.9: Connection of PROFIBUS Masters or an RS 485 Repeater via an OLP](image)
The OLP is supplied with power by the PROFIBUS device and does not require its own power supply. This means that the electrical PROFIBUS interface (RS 485 interface) at a voltage of +5V must provide an output current of ≥ 80 mA. The distance between two OLPs can be between 1 m and 25 m. The simplex connectors supplied with every OLP are designed for the connection of a simplex cord. For the connection between an OLP and OLM/P there is a partly preassembled cable with a BFOC connector fitted at one end (BFOC pigtail set 2x50 m). For the precise technical data of the OLP, please refer to Appendix B of this manual.

Please note the following:

- OLPs can only be operated at transmission rates between 93.75 Kbps and 1.5 Mbps. The transmission rate must be set on the OLP using jumpers.
- Ten OLPs and one OLM/P can be operated in an optical single-fiber ring. It is possible to increase the cascading depth by reducing the total span of the ring (see Appendix B).
- In a single-fiber ring, the OLM/P must be set to mode 1 * . Path monitoring and a signaling contact are not available.
- The minimum and maximum cable distances between two adjacent OLPs or between an OLP and OLM/P must be maintained (see Table 2.4).

<table>
<thead>
<tr>
<th>From</th>
<th>TO</th>
<th>OLP</th>
<th>OLM/P</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLP</td>
<td></td>
<td>L (min) = 1 m</td>
<td>L (min) = 0 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L (max) = 25 m</td>
<td>L (max) = 46 m</td>
</tr>
<tr>
<td>OLM/P</td>
<td></td>
<td>L (min) = 1 m</td>
<td></td>
</tr>
<tr>
<td>(output power = standard) *</td>
<td></td>
<td>L (max) = 34 m</td>
<td></td>
</tr>
<tr>
<td>OLM/P</td>
<td></td>
<td>L (min) = 33 m</td>
<td></td>
</tr>
<tr>
<td>(output power = high) *</td>
<td></td>
<td>L (max) = 58 m</td>
<td></td>
</tr>
</tbody>
</table>

* see Appendix A, OLM Manual

Table 2.4: Length Restrictions in Single-Fiber Rings with OLPs and OLM/Ps
3 Configuring Networks
3 Configuring Networks

3.1 Configuring Electrical Networks

PROFIBUS networks were specially designed for use in an industrial environment and one of their main features is their degree of immunity to electromagnetic interference resulting in high data integrity. To achieve this degree of immunity, certain guidelines must be adhered to when configuring electrical networks.

The following parameters must be taken into account when planning an electrical network:

- The transmission rate required for the task
  (within a network, only one uniform transmission rate can be used)
- The required number of nodes
- The type of network components required (bus terminals, bus connectors, connecting cables)
- The LAN cables to be used
- The required segment lengths
- The electromagnetic and mechanical environment of the cabling (for example surge voltage protection, cable route)
- The number of RS 485 repeaters between any two DTEs is limited to a maximum of 9
- Increasing the overall span of a network by using repeaters can lead to longer transmission times that may need to be taken into account when configuring the network (see Section 3.3).

Regardless of the transmission rate, the ends of all segments must be terminated by turning on the terminating resistor in the connector. After the terminating resistor has been turned on, no further cable sections are permitted.

The terminating resistor is only effective when it is supplied with voltage. This means that the corresponding DTE or the RS 485 repeater must be supplied with power.

The power supply to terminating resistors must not be interrupted by turning off the DTE or repeater or by unplugging the bus connector or connecting cable.
3.1.1  Segments for Transmission Rates up to a Maximum of 500 Kbps

The following maximum segment lengths can be implemented with the SIMATIC NET PROFIBUS LAN cables:

<table>
<thead>
<tr>
<th>Transmission Rate in Kbps</th>
<th>Segment Length for Cable Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>– LAN Cable</td>
</tr>
<tr>
<td></td>
<td>– LAN Cable with PE Sheath</td>
</tr>
<tr>
<td></td>
<td>– Underground Cable</td>
</tr>
<tr>
<td></td>
<td>– Trailing Cable</td>
</tr>
<tr>
<td></td>
<td>– LAN Cable for Festoons</td>
</tr>
<tr>
<td>9.6</td>
<td>1000 m</td>
</tr>
<tr>
<td>19.2</td>
<td>1000 m</td>
</tr>
<tr>
<td>93.75</td>
<td>1000 m</td>
</tr>
<tr>
<td>187.5</td>
<td>800 m</td>
</tr>
<tr>
<td>500</td>
<td>400 m</td>
</tr>
<tr>
<td></td>
<td>900 m</td>
</tr>
<tr>
<td></td>
<td>900 m</td>
</tr>
<tr>
<td></td>
<td>900 m</td>
</tr>
<tr>
<td></td>
<td>700 m</td>
</tr>
<tr>
<td></td>
<td>400 m</td>
</tr>
</tbody>
</table>

Table 3.1: Possible Segment Lengths

The maximum permitted number of nodes on any segment is 32.
3.1.2 Segments for a Transmission Rate of 1.5 Mbps

Each attachment of a node to the LAN cable represents a capacitive mismatch that has no effect at lower transmission rates. At a transmission rate of 1.5 Mbps, however, problems can arise due to these mismatches if the following guidelines in terms of type, number and distribution of node attachments is not adhered to.

The following maximum segment length can be implemented with the SIMATIC NET PROFIBUS LAN cable:

<table>
<thead>
<tr>
<th>Transmission Rate in Kbps</th>
<th>Segment Length for Cable Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.500</td>
<td>– LAN Cable</td>
</tr>
<tr>
<td></td>
<td>– LAN Cable with PE Sheath</td>
</tr>
<tr>
<td></td>
<td>– Underground Cable</td>
</tr>
<tr>
<td></td>
<td>– Trailing Cable</td>
</tr>
<tr>
<td></td>
<td>– LAN Cable for Festoons</td>
</tr>
</tbody>
</table>

200 m

Table 3.2: Possible Segment Lengths

To be able to define permitted configurations, a method is necessary with which the attached components can be evaluated in terms of their capacitive bus load. This is achieved by assigning value factors to the components (see Table 3.3).

PROFIBUS interfaces implemented as 9-pin sub D female connectors (CPs, OLMs...), do not have their own value factors. These are already taken into account in the values listed in the table.

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Value (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus terminal with 1.5 m long connecting cable (Order no. 6GK1 500-0AA00, Version 2)</td>
<td>1.5</td>
</tr>
<tr>
<td>Bus terminal with 1.5 m long connecting cable, with PG interface (Order no. 6GK1 500-0DA00, Version 2)</td>
<td>1.5</td>
</tr>
<tr>
<td>Bus terminal with 3.0 m long connecting cable (Order no. 6GK1 500-0BA00, Version 2)</td>
<td>2.5</td>
</tr>
<tr>
<td>PG connecting cable 1.5 m long (Order no. 6XV1 830-1AH15, Version 2)</td>
<td>1.0</td>
</tr>
<tr>
<td>Bus connector (Order no. 6ES7 972-0BA30-0XA0)</td>
<td>0.7</td>
</tr>
<tr>
<td>Bus connector with axial cable outlet (Order no.: 6GK1 500-0EA0)</td>
<td></td>
</tr>
<tr>
<td>Bus connector with 90° cable outlet (Order no.: 6ES7 972-0BA10-0XA0)</td>
<td></td>
</tr>
<tr>
<td>Bus connector with 90° cable outlet with PG interface (Order no.: 6ES7 972-0BB10-0XA0)</td>
<td></td>
</tr>
<tr>
<td>Bus connector with swivelling cable output (Order no.: 6ES7 972-0BA20-0XA0)</td>
<td>0.1</td>
</tr>
<tr>
<td>Bus connector with swivelling cable output with PG interface (Order no.: 6ES7 972-0BB20-0XA0)</td>
<td></td>
</tr>
<tr>
<td>RS 485 repeater (attachment of bus segments)</td>
<td>0.1</td>
</tr>
<tr>
<td>OLM (channel 2)</td>
<td>0.5</td>
</tr>
<tr>
<td>SIMATIC S5/S7 connecting cable (Order no.: 6ES7 901-4BD00-0XA0)</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Table 3.3: Values for Segments at 1.5 Mbps

At a transmission rate of 1.5 Mbps, the following rules apply to the permitted number of nodes and their distribution/layout on a SIMATIC NET PROFIBUS segment:

1. The maximum permitted number of nodes on one segment is 32.
2. The sum of value factors of all the connection elements in a segment must be ≤ 25.
3. The rules for the distance between adjacent connection elements are as follows (distance in this case is the length of the LAN cable):
   3.1 If the distance between adjacent connection elements is greater than 10 m, the value factors of the DTEs can be ignored.
3.2 If the distance between adjacent connections elements is greater than the sum of the two
value factors of the elements in meters, the layout is not critical and no additional conditions
need to be taken into account.
The value factor of the PG connecting cable, SIMATIC S5/S7 connecting cable must be added
to the value factor of the corresponding connection element.

3.3 If the distance between two elements is less than the minimum distance described in 3.2, the elements
form a group and are subject to the following conditions:
– Connection elements can be arranged close to each other if the sum of their value factors does
not exceed the value 5.
– The distance in meters between two adjacent groups must be at least as great as the sum of the
value factors of both groups.

Table 3.4 shows examples illustrating the configuration rules.

<table>
<thead>
<tr>
<th>No special conditions if the length of the LAN cable between two DTEs &gt; 10 m</th>
<th>LAN cable &gt; 10 m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[Diagram of DTE, DTE connected by a LAN cable &gt; 10 m]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No special conditions if the length of the LAN cables between two DTEs is greater than the sum of value factors of both DTEs.</th>
<th>LAN cable e.g. 5 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>If a bus terminal or a bus connector has a PG interface, a connected PG connecting cable must be taken into account when calculating the value factors.</td>
<td>V = 1.5 + 1.0 + 0.1 = 2.6</td>
</tr>
<tr>
<td>5 m &gt; 3 m (sum of the value factors in meters)</td>
<td>[Diagram of DTE, PG, LAN cable, V values]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Take into account the value factors of a group if the sum of the value factors is greater than the LAN cable between the DTEs.</th>
<th>LAN cable e.g. 0.5 m group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elements can be close to each other providing the total value factor of a group does not exceed 5.</td>
<td>V = 1.5 + 1.5</td>
</tr>
<tr>
<td>0.5 m &lt; 3 m ⇒ group formed ⇒ Sum of value factors ≤ 5</td>
<td>[Diagram of DTE, DTE connected by a LAN cable 0.5 m]</td>
</tr>
</tbody>
</table>
### 3.1.3 Segments for Transmission Rates up to a Maximum of 12 Mbps

<table>
<thead>
<tr>
<th>Transmission Rate in Mbps</th>
<th>Segment Length for Cable Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LAN Cable</td>
</tr>
<tr>
<td></td>
<td>LAN Cable with PE Sheath</td>
</tr>
<tr>
<td></td>
<td>Underground Cable</td>
</tr>
<tr>
<td></td>
<td>Trailing Cable</td>
</tr>
<tr>
<td></td>
<td>LAN Cable for Festoons</td>
</tr>
<tr>
<td>3</td>
<td>100 m</td>
</tr>
<tr>
<td>6</td>
<td>100 m</td>
</tr>
<tr>
<td>12</td>
<td>100 m</td>
</tr>
</tbody>
</table>

Table 3.5: Possible Segment Lengths

When planning segments for transmission rates up to a maximum of 12 Mbps, the following factors must be taken into account:

- To attach DTEs to the bus segments, only the bus connectors listed in Section 2.1.2 must be used.
- The maximum length of a segment must not exceed 100 m.
- The number of nodes (including RS 485 repeaters) in one segment is restricted to a maximum of 32.

Note:
In some applications, several bus connectors are used at “electrically” short distances (in other words the cable length between adjacent connectors is less than 1 m), for example when there are several slaves in one cubicle. If you have this type of configuration, you should avoid having more than one bus connector disconnected at the same time for longer periods. Disconnecting more than one bus connector does not necessarily mean errors but may well reduce the reliability (immunity to noise) of a segment.
3.1.4 Configuring Electrical Networks with RS 485 Repeaters

To increase the number of nodes (>32) or to extend the cable length between two nodes, segments can be connected together using RS 485 repeaters to form a network. Figure 3.1 illustrates how several segments can be connected together with repeaters to create a network.

The RS 485 repeaters can be set to all transmission rates from 9.6 Kbps to 12 Mbps.

When configuring an electrical network with RS 485 repeaters, the following conditions must be taken into account:

- The maximum segment length for the transmission rate must be adhered to (see Table 3.1, Table 3.2, and Table 3.5)
- The maximum number of components (nodes, RS 485 repeaters, OLMs) in one segment is restricted to 32. There may be further restrictions at a transmission rate of 1.5 Mbps (see Section 3.1.2).
- The maximum number of nodes in one network is limited to 127.
- A maximum of 9 RS 485 repeaters can be installed between two nodes.
3.2 Configuring Optical Networks

When configuring optical PROFIBUS networks, the following parameters must be taken into account:

> Using optical components, only point-to-point links can be established.
> The maximum signal attenuation of the transmission path (the power budget) must be within the permitted values.
> The minimum or maximum permitted transmission rates of the components (only one uniform transmission rate can be used in a network).
> The cascading rules for the components used.
> The maximum permitted number of nodes in the network.
> In large-span networks, the transmission delay time.

3.2.1 Fiber-Optic Transmitters and Receivers

An optical transmission path consists of a transmitter, the optical fiber, and a receiver.

![Diagram of a Fiber-Optic Link](image)

The transmitter in an optical digital transmission system consists of a signal converter that converts the digital signals from the electronics into a pulse type suitable for the electro-optical converter, and an electro-optical converter (E/O converter) that converts the electric pulses to optical signals. In SIMATIC NET PROFIBUS, LEDs (LED = Light Emitting Diode) are used as E/O converters. The LEDs are specially adapted to the various transmission media.

The transmission media used in SIMATIC NET PROFIBUS are as follows:

> Plastic fiber-optic cables
> Glass fiber-optic cables

For more detailed information about the various fiber-optic cables for SIMATIC NET PROFIBUS, refer to Chapter 6.

The receiver of a digital optical transmission system consists of an optoelectronic converter (a photodiode), that converts the optical signals to electrical signals and a signal converter that converts the electrical pulses received from the diode into signals compatible with the connected electronics.
The characteristics and technical data of the transmitters and receivers depend on the modules used.

The attenuation of the transmission path is determined by the following factors:

- The choice of optical fiber
- The wavelength of the transmit diodes
- The type of connector
- With glass optical fibers, the number of splices (including repair splices)
- The length of the optical fiber (cable length)
- The system margin on the link (for example for aging and temperature dependency of the LEDs and photodiodes).

### 3.2.2 Optical Power Budget of a Fiber-Optic Transmission System

The transmitted optical power $P_{\text{out}}$ and the received optical power $P_{\text{rec}}$ are specified in dBm, the attenuation caused by connectors and the fiber is specified in dB.

dBm is a reference unit and describes the logarithmic ratio of the power level to the reference power $P_0 = 1\text{mW}$. The following formula applies:

$$P_x \text{ [in dBm]} = 10 \cdot \log(P_x \text{ [in mW]} / P_0)$$

**Examples:**

<table>
<thead>
<tr>
<th>Transmitter Power $P_x$</th>
<th>Transmitter Power as Logarithmic Power Ration $P_x$ to $P_0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mW</td>
<td>+ 10 dBm</td>
</tr>
<tr>
<td>1 mW</td>
<td>0 dBm</td>
</tr>
<tr>
<td>1 µW</td>
<td>− 30 dBm</td>
</tr>
</tbody>
</table>

Depending on the fiber being used, the minimum and maximum optical power that can be coupled into a fiber is specified. This power is reduced by the attenuation of the connected transmission path resulting from the fiber itself (length, absorption, scattering, wavelength) and the connectors used.

The receiver is characterized by its optical sensitivity and its dynamic range. When configuring an optical link, you should make sure that the power reaching the receiver does not exceed its dynamic range. If the power falls below the minimum, this increases the bit error rate (BER) due to the signal-to-noise ratio of the receiver. If the maximum received power is exceeded, saturation and overload effects increase pulse distortion and therefore also increase the BER.

The power budget of an optical link not only takes into account the attenuation in the fiber itself, temperature and aging effects but also the attenuation values of the connectors and splices and therefore provides exact information about whether or not an optical link can be implemented. The starting point for calculating the maximum transmission path length is the minimum transmitter power that can be coupled into the fiber type. To simplify matters, the budget is calculated in dBm and dB.

The following is subtracted from the minimum transmitter power:

- The attenuation of the fiber $a_{\text{FIB}}$ [in dB/km or dB/m] (see manufacturers data)
- The input power required at the receiver

The coupling losses at the send and receive diodes are already taken into account in the information about the transmitter power and receiver sensitivity.
With transmission paths using glass fibers, the following aspects must also be taken into account:

- The attenuation of splices
- Attenuation of connectors
- When calculating the power budget, a system margin of at least 3 dB (at a wavelength of 860 nm) or at least 2 dB (at a wavelength of 1310 nm) must be maintained.

Along with the splices, any repair splices must also be taken into account. Depending on the route of the cables and the risk of mechanical damage one or more future repairs (approximately 1 per 500 m) should also be included in the budget. A repair always means two splices since a new section of cable must be inserted (the length depending on the accuracy of the test equipment).

If the calculation produces a system margin > 0 dB, the transmission path can, in principle, be implemented. If the system margin calculated is < 0 dB, the transmission path will not be reliable in its currently planned form. This means that the transmission path may well function when it is first started up since components are normally better than their rated performance (particularly when brand new) but due to aging, replacement of components as a result of repairs and changing environmental conditions, the BER will tend to rise to an unreliable level the longer the equipment is in use.

To avoid possible errors during the installation of the transmission path, with glass fibers, the installed links should be measured before starting up the system and the values logged.

To avoid overload on the receiver, the received power must be less than the maximum permitted input power $P_{\text{rec, max}}$. This is always the case when the maximum possible transmitter output power $P_{\text{out, max}}$ is less than $P_{\text{rec, max}}$. If, however, $P_{\text{out, max}} > P_{\text{rec, max}}$, the difference must be “reduced” by using a suitably long transmission medium.

With SIMATIC NET PROFIBUS components, overload is only possible when using plastic fibers. In this case, check the information in the descriptions/installation instructions!

Section 3.2.3 of this manual contains a work sheet for calculating the power budget of glass fiber-optical links.
3.2.3 Calculating the Power Budget of Glass Fiber Optical Links with OLMs

The following work sheets show typical calculations of the power budget for SIMATIC NET PROFIBUS glass optical fibers, one with OLM/S3, OLM/S4 at a wavelength of 860 nm and one with OLM/S3-1300 and OLM/S4-1300 at a wavelength of 1300 nm.

At a wavelength of 850 nm (1300 nm), the data sheets specify attenuation values of 3.1 dB/km (0.8 dB/km) for the glass optical fiber. The OLM/S3 and OLM/S4 transmit at a wavelength of 860 nm (OLM/Sx-1300 at a wavelength of 1310 nm). The attenuation of 3.5 dB/km (1.0 dB/km) assumed in the calculation takes into account not only this deviation but also the temperature dependency of the LEDs.

Power budget for OLM/S3, S4 for a point-to-point link with the wavelength $\lambda = 860$ nm

Attenuation on the cable

<table>
<thead>
<tr>
<th>Fiber type</th>
<th>Attenuation $a_{FOC}$</th>
<th>Cable length $L$</th>
</tr>
</thead>
<tbody>
<tr>
<td>62.5/125 µm</td>
<td>3.5 dB/km</td>
<td>2.85 km</td>
</tr>
</tbody>
</table>

$L^* a_{FOC} = 10$ dB

Attenuation for connectors

<table>
<thead>
<tr>
<th>$a_{Conn}$</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4 dB</td>
<td>0</td>
</tr>
</tbody>
</table>

$\text{Number} * a_{Conn} = 0$ dB

Attenuation caused by splices

<table>
<thead>
<tr>
<th>$a_{Spl}$</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 dB</td>
<td>0</td>
</tr>
</tbody>
</table>

$\text{Number} * a_{Spl} = 0$ dB

Attenuation of the transmission path

$a_{Path} = 10$ dB

Data of the OLM/S3, S4 power that can be coupled into 62.5/125 µm fibers

<table>
<thead>
<tr>
<th>$P_{out, \text{min}}$</th>
<th>$P_{out, \text{max}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$-15$ dBm</td>
<td>$-10$ dBm</td>
</tr>
</tbody>
</table>

Receiver sensitivity

<table>
<thead>
<tr>
<th>$P_{rec, \text{min}}$</th>
<th>$P_{rec, \text{max}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$-28$ dBm</td>
<td>$-10$ dBm</td>
</tr>
</tbody>
</table>

Maximum permitted attenuation

$a_{max} = P_{out, \text{min}} - P_{rec, \text{min}} = 13$ dB

System margin

$a_{max} - a_{Path} = 3$ dB

Overload strength

$P_{out,\text{max}} - P_{rec, \text{max}} = 0$ dB

The transmission path can be implemented as planned.
Power budget for OLM S3-1300, S4-1300 for a point-to-point connection with wavelength $\lambda = 1310$ nm

Attenuation on cable

<table>
<thead>
<tr>
<th>Fiber type</th>
<th>Attenuation $a_{FOC}$</th>
<th>Cable length $L$</th>
<th>$L^* a_{FOC} =$</th>
</tr>
</thead>
<tbody>
<tr>
<td>62.5/125 µm</td>
<td>1.0 dB/km</td>
<td>10 km</td>
<td>10.0 dB</td>
</tr>
</tbody>
</table>

Attenuation for connectors

<table>
<thead>
<tr>
<th>$a_{Conn}$</th>
<th>Number</th>
<th>$Number \times a_{Conn}$</th>
<th>+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 dB</td>
<td>0</td>
<td></td>
<td>0 dB</td>
</tr>
</tbody>
</table>

Attenuation caused by splices

<table>
<thead>
<tr>
<th>$a_{Spl}$</th>
<th>Number</th>
<th>$Number \times a_{Spl}$</th>
<th>+</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 dB</td>
<td>0</td>
<td></td>
<td>0 dB</td>
</tr>
</tbody>
</table>

Attenuation of the transmission path

$a_{Path} =$ 10 dB

Data of the OLM/S3-1300, S4-1300 power that can be coupled into 62.5/125 µm fibers

<table>
<thead>
<tr>
<th>$P_{out, min}$</th>
<th>$P_{out, max}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>–17 dBm</td>
<td>–14 dBm</td>
</tr>
</tbody>
</table>

Receiver sensitivity

<table>
<thead>
<tr>
<th>$P_{rec, min}$</th>
<th>$P_{rec, max}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>–29 dBm</td>
<td>–3 dBm</td>
</tr>
</tbody>
</table>

Maximum permitted attenuation

$a_{max} = P_{out, min} - P_{rec, min} =$ 12 dB

System margin

$a_{max} - a_{Path} =$ 2 dB

Overload strength

$P_{out, max} - P_{rec, max} =$ –11 dB

The transmission link can be implemented as planned.

The maximum length of fiber-optic cable that can be supplied in one piece depends on the cable type but is approximately 3 km per drum. Longer links must therefore be put together using more than one piece of cable. To connect the sections of cable, coupling elements or splices must be used reducing the maximum possible cable length due to their attenuation.
## Blank form for a power budget using OLMs

Attenuation for OLM/S3, S4, S3-1300 or S4-1300 for a point-to-point link with wavelength $\lambda = \cdots$

### Attenuation on cable

<table>
<thead>
<tr>
<th>Fiber type (µm)</th>
<th>Attenuation $a_{FOC}$ in dB/km</th>
<th>Cable length $L$ in km</th>
<th>$L \cdot a_{FOC}$ = dB</th>
</tr>
</thead>
</table>

### Attenuation of connectors

<table>
<thead>
<tr>
<th>$a_{Conn}$ (dB)</th>
<th>Number</th>
</tr>
</thead>
</table>

$\text{Number} \cdot a_{Conn} +$ dB

### Attenuation caused by splices

<table>
<thead>
<tr>
<th>$a_{Spl}$ (dB)</th>
<th>Number</th>
</tr>
</thead>
</table>

$\text{Number} \cdot a_{Spl}$ dB

### Attenuation of the transmission path

Power that can be coupled into µm fibers

<table>
<thead>
<tr>
<th>$P_{out, \text{min}}$ (dBm)</th>
<th>$P_{out, \text{max}}$ (dBm)</th>
</tr>
</thead>
</table>

### Receiver sensitivity

<table>
<thead>
<tr>
<th>$P_{rec, \text{min}}$ (dBm)</th>
<th>$P_{rec, \text{max}}$ (dBm)</th>
</tr>
</thead>
</table>

### Maximum permitted attenuation

$a_{max} = P_{out, \text{min}} - P_{rec, \text{min}}$ dB

### System margin

$a_{max} - a_{Path}$ dB

### Overload strength

$P_{out, \text{max}} - P_{rec, \text{max}}$ dB
3.2.4 Cascading Rules for Redundant Optical Rings using OLMs

The maximum permitted number of modules in a redundant optical ring is determined by the following parameters:

- The transmission rate
- The fiber type being used
- The OLM types being used

Table 3.6 describes the maximum possible number of modules in a redundant optical ring.

<table>
<thead>
<tr>
<th>OLM Type/Fiber Type</th>
<th>OLM/P4 980/1000 µm</th>
<th>OLM/P4 200/230 µm</th>
<th>OLM/S4 62.5/125 µm</th>
<th>OLM/S4-1300 62.5/125 µm</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.6</td>
<td>59</td>
<td>58</td>
<td>140</td>
<td>115</td>
</tr>
<tr>
<td>19.2</td>
<td>59</td>
<td>57</td>
<td>129</td>
<td>92</td>
</tr>
<tr>
<td>93.75</td>
<td>58</td>
<td>50</td>
<td>81</td>
<td>42</td>
</tr>
<tr>
<td>187.5</td>
<td>56</td>
<td>43</td>
<td>55</td>
<td>42</td>
</tr>
<tr>
<td>500</td>
<td>70</td>
<td>40</td>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td>1,500</td>
<td>78</td>
<td>30</td>
<td>41</td>
<td>41</td>
</tr>
</tbody>
</table>

Table 3.6: Maximum Number of Modules in an Optical Two-Fiber Ring

The information in Table 3.6 applies to the “Extended” switch setting (only on modules with glass optical fibers). The information assumes the use of the maximum possible distances between two modules. If the distances between two modules are less than the maximum, the possible number of modules increases (Appendix A, see Section 4.6).

Please note that all modules in the ring must be optically interconnected.

There must be no electrical segment in the ring.

3.2.5 Power Budget for Optical Single-Fiber Rings with OLPs

Table 2.4 shows the possible lengths of links between two OLPs in an optical single-fiber ring. A specific calculation of the signal attenuation is therefore not necessary.

3.2.6 Cascading Rules for Optical Single-Fiber Rings with OLPs

10 OLPs and 1 OLM/P can be operated in a single-fiber optical ring (see Appendix B).
3.3 Propagation Time

The system reaction time of a PROFIBUS network /1/ depends largely on the following:

- The type of system being used (single or multiple master system)
- The maximum reaction time of the individual nodes
- The amount of data to be transmitted
- The bus configuration (topology, cable lengths, active network components)

The bus parameters are adapted (configured) to the particular PROFIBUS network using configuration software such as COM PROFIBUS or COM ET 200.

Using optical link modules, extremely large PROFIBUS networks can be created. These allow the use of long optical fiber links and the cascading of large numbers of components. Each time the data packet passes through an OLM there is a delay. The propagation time consisting of the time required on the cable and the delay caused by the OLMs must be taken into account in the network configuration.

The next sections contain information about the following:

- Checking that a PROFIBUS DP single master system adheres to the standard bus parameters.
- Configuring the bus parameters taking into account the cable transmission times and the module delays if the standard bus parameters cannot be adhered to or if the system is not a PROFIBUS DP single master system (PROFIBUS network with FMS, FDL or MPI protocol or DP multiple master system).
- A simple example illustrates how to adapt the bus parameters for an OLM bus using COM PROFIBUS.
### 3.3.1 PROFIBUS DP Single Master Systems

PROFIBUS DP single master systems require a fast system reaction time. To ensure the best possible system reaction time, the PROFIBUS standard specifies bus parameters for these networks. This section describes how a given PROFIBUS DP network with one master and a large network span is checked to make sure it adheres to these parameters.

The bus parameters of the PROFIBUS standard result in a maximum permitted propagation time on the communications path between two PROFIBUS nodes. To simplify matters, the propagation time is converted to a path distance. The path distance is the distance that could be covered by a frame within this time (see Table 3.7).

> The path distance represents an ideal transmission path and must not be confused with the real transmission path (optical fiber or LAN cable) that is restricted to certain lengths.

<table>
<thead>
<tr>
<th>Transmission rate</th>
<th>Kbps</th>
<th>9.6</th>
<th>19.2</th>
<th>93.75</th>
<th>187.5</th>
<th>500</th>
<th>1500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum cable distance on the master to any slave</td>
<td>km</td>
<td>302</td>
<td>151</td>
<td>30.9</td>
<td>15.4</td>
<td>17.8</td>
<td>9.2</td>
</tr>
</tbody>
</table>

Table 3.7: Maximum Path Distance Between Master and Slave

Each active network component delays the data packet by an amount that is also converted to a path distance (delay equivalent).

<table>
<thead>
<tr>
<th>Transmission rate</th>
<th>Kbps</th>
<th>9.6</th>
<th>19.2</th>
<th>93.75</th>
<th>187.5</th>
<th>500</th>
<th>1500</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLM delay equivalent</td>
<td>km</td>
<td>31.25</td>
<td>15.63</td>
<td>3.2</td>
<td>1.6</td>
<td>0.6</td>
<td>0.2</td>
</tr>
<tr>
<td>OLP delay equivalent</td>
<td>km</td>
<td>15.63</td>
<td>7.82</td>
<td>1.6</td>
<td>0.8</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>RS 485 repeater delay equivalent</td>
<td>km</td>
<td>10.63</td>
<td>5.31</td>
<td>1.11</td>
<td>0.55</td>
<td>0.23</td>
<td>0.29</td>
</tr>
</tbody>
</table>

Table 3.8: Delay Equivalents of OLMs, OLPs and RS 485 Repeaters

To check whether a PROFIBUS single master system is capable of functioning, the communications path with the highest propagation time (worst-case path) must be determined:

- All the communications paths from the master to any slave must be taken into account.
- For each communications path, the path distances consisting of the LAN cable and optical cables are totalled. If the path includes an active network component (OLM or repeater), its delay equivalent for the particular transmission rate is added to the path distance.

For a PROFIBUS DP single master system, the longest communications path (while keeping to the bus parameters specified in the PROFIBUS standard) must be less than or equal to the maximum path distance for the transmission rate being used (see Table 3.7).

If this is not the case, the bus parameters must be adapted to the network configuration (see 3.3.2).
Notes:

> If the network includes a redundant optical ring this must be considered as an abstract optical bus. This means that at the OLM via which the master enters the redundant ring, the shorter of the two optical links is omitted (see Figure 3.3).

![Diagram showing length calculation](image)

**Length calculation:** $100 \text{ m} + 320 \text{ m} + 200 \text{ m} + \text{OLM delay time equivalent} + \text{shorter FO path}$

Figure 3.3: Determining the Longest Communication Path in the Redundant Optical Ring

> If the network contains an optical single-fiber ring, the path distance is the length of the single-fiber ring divided by 2.
The following graph shows the achievable network span at the specified OLM cascading depth and transmission rate for PROFIBUS DP single master systems with OLMs. The permitted network configurations according to the bus parameters specified in the PROFIBUS standard are in the area below the straight-line curves.

Figure 3.4: Permitted PROFIBUS DP Single Master Systems Adhering to the Bus Parameters Specified in the PROFIBUS Standard
3.3.2 Adapting the Bus Parameters

This section describes how long propagation times can be compensated by configuring the bus parameters. The causes of high propagation times are long sections of cables or high cascading depths of active components.

The following steps are necessary to adapt the bus parameters:

1. First, find out the communications path with the highest propagation time (worst-case path):
   - All the communications paths between PROFIBUS nodes communicating with each other must be taken into account.
   - For each communications path, the path distances consisting of the LAN cable and fiber-optic cable are totalled. If an active network component is in the path (OLM, OLP or repeater), its delay equivalent at the transmission rate being used is added to the path distance (see Table 3.8).
   - The longest communications path is then the worst-case path.

   Notes:
   - If the network includes a redundant optical ring this must be considered as an abstract optical bus. This means that at the OLM via which the master enters the redundant ring, the shorter of the two optical links is omitted (see Figure 3.4).
   - If the network contains an optical single-fiber ring, the path distance is the length of the single-fiber ring divided by 2.

2. The worst-case path must then be converted from kilometers to bit times:
   Configuration packages such as COM PROFIBUS or COM ET200 use monitoring times in the unit “bit time”. The bit time is the time required to send one bit. It depends on the transmission rate being used. How to convert path distances (in kilometers) to bit times is shown in the following table.

<table>
<thead>
<tr>
<th>Transmission Rate in Kbps</th>
<th>Propagation Time in Bit Times per Kilometer</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.6</td>
<td>0.05</td>
</tr>
<tr>
<td>19.2</td>
<td>0.10</td>
</tr>
<tr>
<td>93.75</td>
<td>0.47</td>
</tr>
<tr>
<td>187.5</td>
<td>0.94</td>
</tr>
<tr>
<td>500.0</td>
<td>2.50</td>
</tr>
<tr>
<td>1500.0</td>
<td>7.50</td>
</tr>
</tbody>
</table>

   Table 3.9: Converting Path Distances in Kilometers to Bit Times

3. The “Slot Time T_slot” bus parameter (wait to receive time) must be extended by twice the propagation time (outward and return path):
   - The PROFIBUS network is initially configured using the configuration software (for example COM PROFIBUS) ignoring the propagation time. For information about using the configuration software, please refer to the relevant description.
   - Double the propagation time (propagation time for outward and return path) is added to the “Slot Time T_slot” bus parameter and the bus parameters that are dependent on the slot time are recalculated.

   Increasing the slot time also increases the reaction times in the PROFIBUS network.

The individual steps are illustrated below based on an example.
3.3.3 Example

A PROFIBUS DP network with one master and three slaves is installed as an optical bus with two OLM/S3-1300 modules and two OLM/S4-1300 modules (similar to the configuration shown in Figure 2.2). The master is at the top end of the network and is connected via an OLM/S3-1300. 8 km away there is an OLM/S4-1300 to which an ET200U is connected (slave 1). 10 km from slave 1 there is a further OLM/S4-1300 with an ET200B installed (slave 2). 10 km further on, the optical bus is completed by an OLM/S3-1300 to which an ET200M is connected (slave 3). The PROFIBUS is operated at a transmission rate of 1,500 Kbps.

Step 1: Determining the Worst-Case Path

The worst-case path in this configuration is between the stations master and slave 3. The length of the worst-case path is as follows:

- 0.2 km (OLM/S3-1300 master) + 8 km (FO cable)
- + 0.2 km (OLM/S4-1300 slave 1) + 10 km (FO cable)
- + 0.2 km (OLM/S4-1300 slave 2) + 10 km (FO cable)
- + 0.2 km (OLM/S3-1300 slave 3)

= 28.8 km

The lengths of the electrical connecting cables between the master or slave and the OLM are included in the fiber-optic cable lengths.

Step 2: Calculating the Worst-Case Path in Bit Times

28.8 km correspond to 28.8 * 7.5 = 216 bit times.

Step 3: Increasing the “Slot Time” Bus Parameter

Network configuration with COM PROFIBUS produces the following structure (ignoring OLMs and the fiber-optic cable).
For this configuration, ignoring OLMs and fiber-optic cables, COM PROFIBUS sets the following bus parameters (Function Configure—>Bus Parameters, Set Parameters):

![Bus Parameter Settings - 1500.0 kbaud](image)

The slot time of 300 bit times is increased by 2 * 216 to take into account the propagation time for the outward and return path in the slot time. The new slot time is therefore $300 + 2 \times 216 = 732$ bit times.

To enter the new slot time, you first select the Configuration—>Bus Parameters function. You then select the setting “Adjustable” in the bus profile list box.

![Bus Parameters](image)

With “Set Parameters...” you display the dialog in which the user can set the bus parameters. First, however, the following warning is displayed:
This warning points out that the response times will be increased.

After you click OK, the bus parameter setting dialog is displayed. Initially, the first set of calculated values is entered in the upper area of the dialog and the slot time increased to 732 bit times. By activating the calculate button, all the bus parameters dependent on the slot time are recalculated.

The PROFIBUS network is operable using these bus parameters.
4 Passive Components for Electrical Networks
4 Passive Components for Electrical Networks

4.1 SIMATIC NET PROFIBUS Cables

A variety of SIMATIC NET PROFIBUS cables are available allowing optimum adaptation to a variety of environments.

All the information about segment lengths and transmission rates refer only to these cables and can only be guaranteed for these cables.

When laying bus cables:

> Do not twist them
> Do not stretch them
> Do not crimp them

The following conditions must also be adhered to for the particular cable type:

> The permitted bending radii for bending once and repeated bending
> The temperature range for laying and operation
> The maximum permitted tensile stress

Table 4.1 is an overview of the LAN cables for PROFIBUS showing their mechanical and electrical characteristics.

If you require a cable with characteristics that are not covered by the range of products described here, please contact your local SIEMENS office or representative (Appendix C.3).

General instructions about laying cables can be found in Appendix D.
### Table 4.1: LAN Cables for PROFIBUS

<table>
<thead>
<tr>
<th>Technical Data</th>
<th>Standard LAN Cable</th>
<th>LAN Cable with PE Sheath</th>
<th>Underground Cable</th>
<th>Trailing Cable</th>
<th>LAN Cable for Festoons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order Number</td>
<td>6XV1 830 –0AH10</td>
<td>6XV1 830 –0BH10</td>
<td>6XV1 830 –3AH10</td>
<td>6XV1 830 –3BH10</td>
<td>6XV1 830 –3CH10</td>
</tr>
<tr>
<td>Attenuation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>at 16 MHz</td>
<td>&lt; 42 dB/km</td>
<td>&lt; 42 dB/km</td>
<td>&lt; 45 dB/km</td>
<td>&lt; 49 dB/km</td>
<td>&lt; 49 dB/km</td>
</tr>
<tr>
<td>at 38.4 kHz</td>
<td>&lt; 22 dB/km</td>
<td>&lt; 22 dB/km</td>
<td>&lt; 25 dB/km</td>
<td>&lt; 25 dB/km</td>
<td>&lt; 25 dB/km</td>
</tr>
<tr>
<td>at 9.6 kHz</td>
<td>&lt; 4 dB/km</td>
<td>&lt; 4 dB/km</td>
<td>&lt; 4 dB/km</td>
<td>&lt; 4 dB/km</td>
<td>&lt; 4 dB/km</td>
</tr>
<tr>
<td>Characteristic impedance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>at 9.6 kHz</td>
<td>270 ± 27 Ω</td>
<td>270 ± 27 Ω</td>
<td>270 ± 27 Ω</td>
<td>270 ± 27 Ω</td>
<td>270 ± 27 Ω</td>
</tr>
<tr>
<td>at 38.4 kHz</td>
<td>185 ± 18.5 Ω</td>
<td>185 ± 18.5 Ω</td>
<td>185 ± 18.5 Ω</td>
<td>185 ± 18.5 Ω</td>
<td>185 ± 18.5 Ω</td>
</tr>
<tr>
<td>at 3 to 20 MHz</td>
<td>150 ± 15 Ω</td>
<td>150 ± 15 Ω</td>
<td>150 ± 15 Ω</td>
<td>150 ± 15 Ω</td>
<td>150 ± 15 Ω</td>
</tr>
<tr>
<td>Rated value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.C. loop resistance</td>
<td>≤ 110 Ω/km</td>
<td>≤ 110 Ω/km</td>
<td>≤ 110 Ω/km</td>
<td>≤ 133 Ω/km</td>
<td>≤ 133 Ω/km</td>
</tr>
<tr>
<td>Shield resistance</td>
<td>≤ 9.5 Ω/km</td>
<td>≤ 9.5 Ω/km</td>
<td>≤ 12 Ω/km</td>
<td>≤ 14 Ω/km</td>
<td>≤ 14 Ω/km</td>
</tr>
<tr>
<td>Effective capacitance at 1 kHz</td>
<td>approx. 28.5 nF/km</td>
<td>approx. 28.5 nF/km</td>
<td>approx. 28 nF/km</td>
<td>approx. 28 nF/km</td>
<td>approx. 28 nF/km</td>
</tr>
<tr>
<td>Operating voltage (effective)</td>
<td>≤ 100 V</td>
<td>≤ 100 V</td>
<td>≤ 100 V</td>
<td>≤ 100 V</td>
<td>≤ 100 V</td>
</tr>
<tr>
<td>Cable type standard code</td>
<td>02Y(ST)CY 1x2x0.64/2.55–150 KF 40 FR VI</td>
<td>02Y(ST)C2Y 1x2x0.64/2.55–150 SW</td>
<td>02Y(ST) CY2CY 1x2x0.64/2.55–150 KF 40 SW</td>
<td>02Y(ST)C11Y 1x2x0.64/2.55–150 LI petrol</td>
<td>02Y(ST)(ZG)11Y 1x2x0.64/2.55–150 LI petrol</td>
</tr>
<tr>
<td>Sheath Material Color Diameter</td>
<td>PVC violet 8.0 ± 0.4 mm</td>
<td>PE black 8.0 ± 0.4 mm</td>
<td>PE/PVC black 10.2 ± 0.4 mm</td>
<td>PUR petrol 8.5 ± 0.4 mm</td>
<td>PUR petrol 9.7 ± 0.3 mm</td>
</tr>
<tr>
<td>Permitted ambient conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Operating temperature</td>
<td>–40 °C + 60 °C</td>
<td>–40 °C + 60 °C</td>
<td>–40 °C + 60 °C</td>
<td>–40 °C + 60 °C</td>
<td>–40 °C + 60 °C</td>
</tr>
<tr>
<td>– Transport/storage temperature</td>
<td>–40 °C + 60 °C</td>
<td>–40 °C + 60 °C</td>
<td>–40 °C + 60 °C</td>
<td>–40 °C + 60 °C</td>
<td>–40 °C + 60 °C</td>
</tr>
<tr>
<td>– Installation temperature</td>
<td>–40 °C + 60 °C</td>
<td>–40 °C + 60 °C</td>
<td>–40 °C + 60 °C</td>
<td>–40 °C + 60 °C</td>
<td>–40 °C + 60 °C</td>
</tr>
<tr>
<td>Bending radii First and final bend</td>
<td>≥ 75 mm</td>
<td>≥ 75 mm</td>
<td>≥ 75 mm</td>
<td>≥ 45 mm</td>
<td>≥ 50 mm</td>
</tr>
<tr>
<td>repeated bending</td>
<td>≥ 150 mm</td>
<td>≥ 150 mm</td>
<td>≥ 150 mm</td>
<td>≥ 65 mm</td>
<td>≥ 80 mm</td>
</tr>
<tr>
<td>Max. tensile strength</td>
<td>100 N</td>
<td>100 N</td>
<td>100 N</td>
<td>100 N</td>
<td>200 N</td>
</tr>
<tr>
<td>Weight approx.</td>
<td>60 kg/km</td>
<td>52 kg/km</td>
<td>85 kg/km</td>
<td>63 kg/km</td>
<td>74 kg/km</td>
</tr>
<tr>
<td>Halogen free</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Behavior in fire</td>
<td>flame-retardant according to VDE 0472 T804 test type C</td>
<td>flammable</td>
<td>flame-retardant according to VDE 0472 T804 test type B</td>
<td>flame-retardant according to VDE 0472 T804 test type B</td>
<td>flame-retardant according to VDE 0472 T804 test type B</td>
</tr>
<tr>
<td>Oil resistance</td>
<td>conditionally resistant to mineral oil and greases</td>
<td>conditionally resistant to mineral oil and greases</td>
<td>conditionally resistant to mineral oil and greases</td>
<td>good resistance to mineral oil and greases</td>
<td>good resistance to mineral oil and greases</td>
</tr>
<tr>
<td>UV resistance</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

---

1) Electrical characteristics 20 °C, tested according to DIN 47250 Part 4 or DIN VDE 0472
2) Trailing cable types for the following requirements:
   – min. 5 million bending cycles at the specified bending radius and max. acceleration of 4 m/s²
3) Cable can only be connected directly via RS 485 bus terminals, OLMs or repeater
4) Cable cannot be connected to bus connector with insulation piercing technique (6ES7 972-0BA30-0XA0).
4.1.1 Standard LAN Cable

The LAN cable with the order number 6XV1 830-0AH10 is the standard LAN cable for SIMATIC NET PROFIBUS networks. It meets the requirements of EN 50170, cable type A, with solid copper cores (22 gauge).

The LAN cable is intended for fixed installation in buildings or in an environment protected from the climate (in-house cabling).

The combination of twisted wires, foil shield and braid shield make the cable particularly suitable for industrial environments subject to electromagnetic interference.

The design of the cable also guarantees stable electrical and mechanical characteristics after the cable has been installed. The 6XV1 830-0AH10 LAN cable is UL listed.

Due to the composition of the sheath material, the LAN cable has the following characteristics:

- Flame-retardant
- Self-extinguishing in case of fire
- Resistant to water and steam
- Conditionally resistant to mineral oils and greases
- Sheath material not free of halogens
4.1.2 Underground Cable

The underground cable 6GK1 830-3AH10 meets the requirements of EN 50170, cable type A, with solid copper cores (22 gauge). The internal structure of the cable corresponds to that of the standard LAN cable, the electrical characteristics are identical. Due to its additional PE outer sheath, this cable is suitable for underground cabling (campus cabling).

The characteristics of the underground cable differ from those of the standard LAN cable as follows:

- Improved resistance to abrasion
- Improved resistance to oil and grease complying with VDE 0472, Part 803, Test Type B
- Resistant to UV radiation
- Heavier
- Greater outer diameter
- The sheath material is flammable

When using the underground cable remember that bus connectors cannot be fitted directly.

Although the outer diameter of the underground cable is greater than that of the LAN cable, the bending radii during installation and operation remain the same as those of the LAN cable.

Due to the PVC inner sheath, the underground cable is not free of halogens.
4.1.3 LAN Cable with PE Sheath

Figure 4.3: Cross Section of the LAN Cable with PE Sheath

The LAN cable with PE sheath 6XV1 830-0BH10 complies with the specification EN 50170, Cable Type A, with solid copper cores (22 gauge). It is designed for fixed installation within buildings (in-house cabling). The internal structure of the cable (wires, filler, shield) is identical to that of the standard LAN cable. The characteristics of the sheath material, polyethylene (PE), differ from those of the standard LAN cable as follows:

- The material is free of halogens
- Improved resistance to abrasion
- Resistance to oil and grease complying with VDE 0472 Part 803, Test Type B
- Resistant to UV radiation
- The sheath material is flammable

The LAN cable with PE sheath is particularly suited for use in the food, beverages and tobacco industry.
4.1.4 Trailing Cable

The trailing cable 6XV1 830-3BH10 corresponds to the specification EN 50170 Cable Type A, with stranded copper cores (approximately 24 gauge - 19/36) with the exception of the higher loop resistance.

In contrast to the standard LAN cable, the cores of the trailing cable are of stranded copper. In conjunction with the special combination of braid shield, foil shield, fleece layer and the sheath material polyurethane, the cable is extremely flexible while retaining highly constant electrical characteristics.

The characteristics of the trailing cable differ from those of the standard LAN cable as follows:

- The sheath material is free of halogens (polyurethane, PUR)
- Extremely good resistance to abrasion
- Resistant to mineral oils and grease
- Extremely good resistance to UV radiation
- Small bending radii for installation and operation
- Due to the smaller copper diameter the loop resistance and HF attenuation are greater
- The sheath material is flame resistant

The trailing cable is designed for a minimum of 5 million bending cycles at the specified bending radius and a maximum acceleration of 4 m/s² and is therefore particularly suitable for installation in drag chains.

⚠️ Note:
During installation and operation, all the mechanical restrictions involving the cable such as bending radii, tensile stress etc. must be adhered to.
Due to the increased loop resistance, somewhat shorter segment lengths are permitted at low transmission rates (see Table 3.1). At transmission rates $\geq 500$ Kbps, the trailing cable has the same values as the standard bus cable.

The stranded cores must be fitted with wire-end ferrules (0.25 mm$^2$ in compliance with DIN 46228) before screwing them to the terminals.

The bus connector using the installation piercing technique (6ES7 972-0BA30-0XA0) cannot be fitted.
4.1.5 LAN Cable for Festoons

The LAN cable for festoons 6XV1 830-3CH10 complies with the specification EN 50170, Cable Type A, with stranded copper cores (approximately 24 gauge - 19/36) apart from the higher loop resistance.

The internal structure is practically identical to that of the trailing cable. By inserting an additional layer of polyamide fibers, this cable is suitable for free suspension between two points.

The characteristics of the LAN cable for festoons differ from those of the standard LAN cable as follows:

- The sheath material is free of halogens (polyurethane, PUR)
- Good resistance to abrasion
- Good resistance to mineral oils and grease
- Good resistance to UV radiation
- Small bending radii both during installation and operation
- Greater tensile strength due to the layer of polyamide fibers (the cable can be suspended)
- Due to the smaller cross section of the conductors, the loop resistance and the HF attenuation are somewhat higher
- The sheath material is flame resistant

The LAN cable for festoons is designed for at least 5 million bending cycles at the specified bending radius and at a maximum acceleration of 4 m/s².
Note:
During installation and operation all mechanical restrictions such as bending radii, tensile stress etc. must be adhered to.

Example of installation:

Figure 4. 7: Use of the PROFIBUS Cable for Festoons

Due to the increased loop resistance, somewhat shorter segment lengths are permitted at low transmission rates (see Table 3.1). At transmission rates $\geq 500$ Kbps, the trailing cable has the same values as the standard bus cable.

Due to its larger outer diameter, bus connectors cannot be fitted directly to the LAN cable for festoons

The stranded cores must be fitted with wire-end ferrules (0.25 mm² in compliance with DIN 46228) before screwing them to the terminals.
4.2 RS 485 Bus Terminal

4.2.1 Design and Functions

The RS 485 bus terminal is used to connect data terminal equipment (DTEs) with an RS 485 interface to the LAN cable. It includes the following:

> 6 terminal blocks for conductors with a cross-sectional area \( \leq 1.5 \text{ mm}^2 \) for connection of the incoming and outgoing LAN cable and if necessary the protective earth (PE)

> Screw down clamps for field contact

> A switch ("Bus terminated") to allow termination at the end of an electrical segment with the characteristic impedance

> A connecting cable preassembled, (either 1.5 m or 3 m long) with a 9-pin sub D male connector for director connection to a DTE.

The sub D connector is plugged into the sub D female connector of the DTE and secured by screws. If the terminating resistor is activated, the RS 485 bus terminal requires current of maximum 5mA at a power supply of 5 V between pins 5 and 6 of the connector from the DTE.

Table 4.2 shows the pinout of the 9-pin sub D connector

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NC</td>
<td>Not used</td>
</tr>
<tr>
<td>2</td>
<td>NC</td>
<td>Not used</td>
</tr>
<tr>
<td>3</td>
<td>B (RXD/TXD-P)</td>
<td>Data line B (receive/transmit data P)</td>
</tr>
<tr>
<td>4</td>
<td>NC</td>
<td>Not used</td>
</tr>
<tr>
<td>5</td>
<td>M5V2 (DGND)</td>
<td>Data ground</td>
</tr>
<tr>
<td>6</td>
<td>P5V2 (VP)</td>
<td>Voltage plus</td>
</tr>
<tr>
<td>7</td>
<td>NC</td>
<td>Not used</td>
</tr>
<tr>
<td>8</td>
<td>A (RXD/TXD-N)</td>
<td>Data line A (receive/transmit data N)</td>
</tr>
<tr>
<td>9</td>
<td>NC</td>
<td>Not used</td>
</tr>
</tbody>
</table>

Table 4.2: Pinout of the Sub D Connector
The RS 485 bus terminal with additional PG interface (see Figure 4.9) has an additional 9-pin sub D female connector on the front panel for connecting, for example a programming device using a PROFIBUS connecting cable 830-1. The pinout is identical to that shown in Table 4.2.

![Image of RS 485 bus terminal with additional PG interface]

Figure 4.9: RS 485 Bus Terminal with Additional PG Interface

The SIMATIC NET PROFIBUS RS 485 bus terminals are only suitable for transmission rates \( \leq 1.5 \) Mbps.
4.2.2 Installing/Connecting LAN Cables

RS 485 bus terminals can be installed in three ways:

- By snapping them on to a 35 mm standard rail (DIN EN50022-35x7.5)
- By screwing the unit to a mounting plate using two tin-plated fillister head screws. Figure 4.10 shows the drilling diagram for mounting the unit.

Figure 4.10: Drilling Diagram for the RS 485 Bus Terminal

- Wall mounting (brick, concrete). Fittings required: 2 x 5 mm plugs, 2 round head wood screws size 3.5 mm and 2 washers 4.3 mm inner diameter. The holes must be drilled as shown in Figure 4.10.

Please make sure that the RS 485 bus terminal is accessible for maintenance and installation work even during operation.

To connect the LAN cable, follow the steps below (see Figure 4.11):

- Open the LAN cable at the point at which the bus terminal will be inserted.
- Strip approximately 33 mm of the outer sheath. Make sure when removing the sheath that the braid shield is not damaged.
- Remove a length of approximately 12 mm of the braid shield and foil shield (the foil shield can be left somewhat longer) and cut off the two fillers leaving about 10 mm visible.
- Fold back the braid shield over the cable sheath.
- Remove approximately the last 10 mm of insulation from the cores.
- Fit the bus cable to the terminal so that the braid shield is lying bare under the cable clamp.
- Screw the ends of the cores to the corresponding terminals (if the cores are stranded, the wire-end ferrules with 0.25 mm² in compliance with DIN 46228 must be used).
- If the bus terminal is at the end of a segment, the integrated terminating resistor must be turned on (switch set to “Bus terminated”).

The shield clamps are used solely to contact the shields and are not suitable as strain-relief clamps. This means that the LAN cables must be secured as close as possible to the RS 485 bus terminals to provide mechanical strain relief.
The two groups of terminals for signal wires A and B are identical. If the terminating resistor is activated (only at the end of a segment) one pair of terminals (A,B) must remain unconnected. When the terminating resistor is activated, the bus terminal requires the 5 V voltage supply of the DTE to ensure problem-free operation in the segment. The DTE must therefore be turned on and the sub D connector inserted and secured by screws.

The same wires (green or red must always be connected to the same terminal A or B in all bus terminals and with all bus connections) and be uniform throughout the segment.

The following scheme is recommended for a PROFIBUS LAN:

Terminal A: green wire
Terminal B: red wire

Figure 4.11: Preparing the LAN Cable for Connection to the RS 485 Bus Terminal
4.2.3 Grounding

If the RS 485 bus terminal is mounted on a rail (see Figure 4.12), the shield clamp makes large-area contact with the rail via an internal spring. To connect the cable shield with local ground, a connection between the rail over as shorter distance as possible to local earth is adequate (see also Appendix D).

Figure 4.12: Ways of Installing and Grounding the RS 485 Bus Terminal

- The grounding bar must be connected to the closest possible local ground with a copper conductor with at least 6 mm$^2$ cross-section.

- The rail must have a good conducting surface (for example tin plated).

- If the bus terminal is mounted on a wall, at least one PE terminal must be connected to local ground. This connection should be over the shortest possible distance.
### 4.2.4 Technical Data of the RS 485 Bus Terminal

#### Technical Data of the RS 485 Bus Terminal

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector to DTE</td>
<td>9-pin sub D male connector</td>
</tr>
<tr>
<td>Transmission rate</td>
<td>9.6 to 1,500 Kbps</td>
</tr>
<tr>
<td>PG interface (optional)</td>
<td>9-pin sub D female connector</td>
</tr>
<tr>
<td>Power supply range</td>
<td>4.75 to 5.25 V DC</td>
</tr>
<tr>
<td>Current consumption:</td>
<td></td>
</tr>
<tr>
<td>Terminating resistor on</td>
<td>5 mA</td>
</tr>
<tr>
<td>Terminating resistor off</td>
<td>0 mA</td>
</tr>
<tr>
<td>Environmental conditions:</td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>0 to 55 °C</td>
</tr>
<tr>
<td>Storage/transport temperature</td>
<td>–25 to 70 °C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>F complying with DIN 40040 15% to 95% at 25 °C no condensation</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
</tr>
<tr>
<td>Dimensions (W x H x D) in mm</td>
<td>RS 485 50 x 135 x 47</td>
</tr>
<tr>
<td></td>
<td>RS 485/PG 50 x 135 x 52</td>
</tr>
<tr>
<td>Weight (incl. 1.5 m connecting cable)</td>
<td>RS 485, RS 485/PG approx. 310 g</td>
</tr>
</tbody>
</table>
4.3 Bus Connector

Using the bus connector for SIMATIC NET PROFIBUS:

- Data terminal equipment (DTEs) with an electrical interface complying with EN 50170 can be connected directly to the SIMATIC NET PROFIBUS cable
- Electrical segments or DTEs can be connected to Channel 1 of an optical link module (OLM)
- Data terminal equipment (DTEs) or programming devices can be connected to a repeater.

The versions of the bus connectors shown in Table 4.4 are optimized for the connectable devices.

<table>
<thead>
<tr>
<th>Order numbers without PG interface</th>
<th>6ES7 972-0BA10-0XA0</th>
<th>6ES7 972-0BA20-0XA0</th>
<th>6ES7 972-0BA30-0XA0</th>
<th>6GK1 500-0EA00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical features</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable outlet</td>
<td>vertical</td>
<td>swivelled 0° or 30°</td>
<td>angled 30°</td>
<td>axial</td>
</tr>
<tr>
<td>Suitable for transmission rates</td>
<td>9.6 Kbps to 12 Mbps</td>
<td>9.6 Kbps to 12 Mbps</td>
<td>9.6 Kbps to 1.5 Mbps</td>
<td>9.6 Kbps to 12 Mbps</td>
</tr>
<tr>
<td>Terminating resistor</td>
<td>integrated, on/off</td>
<td>integrated, on/off</td>
<td></td>
<td>integrated, on/off</td>
</tr>
<tr>
<td>Power supply</td>
<td>DC 4.75 V to 5.25 V</td>
<td>DC 4.75 V to 5.25 V</td>
<td></td>
<td>DC 4.75 V to 5.25 V</td>
</tr>
<tr>
<td>Current consumption</td>
<td>5 mA</td>
<td>5 mA</td>
<td>5 mA</td>
<td>5 mA</td>
</tr>
<tr>
<td>Permitted ambient conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>0 °C to +60 °C</td>
<td>0 °C to +55 °C</td>
<td>0 °C to +60 °C</td>
<td>0 °C to +55 °C</td>
</tr>
<tr>
<td>Transport/storage temperature</td>
<td>–25 °C to +80 °C</td>
<td>–25 °C to +80 °C</td>
<td>–25 °C to +80 °C</td>
<td>–25 °C to +70 °C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>max. 75% at +25 °C</td>
<td>max. 75% at +25 °C</td>
<td>max. 75% at +25 °C</td>
<td>max. 95% at +25 °C</td>
</tr>
<tr>
<td>Degree of protection</td>
<td>IP20</td>
<td>IP20</td>
<td>IP20</td>
<td>IP20</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Dimensions in mm (H x L x D)</td>
<td>15.8 x 54 x 34</td>
<td>15.8 x 54 x 34</td>
<td>15 x 58 x 34</td>
<td>15 x 57 x 39</td>
</tr>
<tr>
<td>• Weight Connectable cables</td>
<td>approx. 40 g</td>
<td>approx. 40 g</td>
<td>approx. 30 g</td>
<td>approx. 100 g</td>
</tr>
<tr>
<td>Outer diameter</td>
<td>7.3 – 8.7 mm</td>
<td>7.3 – 8.7 mm</td>
<td>7.3 – 8.7 mm</td>
<td>7.6 – 8.9 mm</td>
</tr>
<tr>
<td>Conductor area</td>
<td>0.14 – 1.5 mm²</td>
<td>0.14 – 1.5 mm²</td>
<td>0.60 – 0.68 mm</td>
<td>0.14 – 1.5 mm²</td>
</tr>
</tbody>
</table>

Table 4.3: Bus Connectors for SIMATIC NET PROFIBUS
When using the bus connectors, note the following points:

- If the cable length between two bus connectors > 2 m, the bus cable should be secured as close as possible to the connectors to ensure strain relief.
- The LAN cable for festoons and the underground cable cannot be attached to the bus connectors because the outer diameter is too large.
- The bus connector with the 30° cable outlet (6ES7 972-0BA30-0XA0) is only permitted for data transmission rates \( \leq 1.5 \text{ Mbps} \) and must not be used at the ends of segments since it does not have a terminating resistor. This connector is suitable for use with LAN cables with stranded conductors.
- When used in wiring closets or cabinets, not only the positioning of the connector but also the permitted bending radius of the LAN cable must be taken into account (the cables must not be pinched when the door of the wiring closet is closed).
- The fillers (support elements in the cables) are cut back to the same length as the braid shield.

The two pairs of terminals for signal wires A and B are identical.
If the terminating resistor is activated (only at the end of a segment) one pair of terminals (A,B) must remain unconnected.
When the terminator resistor is activated, the bus terminal requires the 5 V voltage supply of the DTE to ensure problem-free operation in the segment. The DTE must therefore be turned on and the sub D connector inserted and secured by screws.

The same wires (green or red must always be connected to the same terminal A or B in all bus terminals and with all bus connections) and be uniform throughout the segment.

The following scheme is recommended for a PROFIBUS LAN:
- Terminal A: green wire
- Terminal B: red wire
<table>
<thead>
<tr>
<th>Order numbers</th>
<th>6ES7 972-0BA10-0XA0</th>
<th>6ES7 972-0BA20-0XA0</th>
<th>6ES7 972-0BA30-0XA0</th>
<th>6GK1 500-0EA00</th>
</tr>
</thead>
<tbody>
<tr>
<td>without PG interface</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use in PLC with int. interface</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S7-300</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S7-400</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M7-300</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M7-400</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S5-95U/DP</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Use in PLC with</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IM 308-C</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP 5431 FMS/DP</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP 342-5</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP 343-5</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP 443-5</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use in PG with MPI interface</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use in PG with</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP 5412/CP 5611</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>CP 5411</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>CP 5511</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>I/O devices</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>ET 200M</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ET 200B</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ET 200L</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ET 200U</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIMATIC NET OPs</td>
<td>(OP5/OP7/OP15/OP17/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(OP25/OP35/OP37)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLM</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Use in SINUMERIK 840 C and 805 SM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IM 328N</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>IM 329N</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use in NC 840 D and FM NC SIMODRIVE 611 MCU</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP 342-5</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use in TI 505</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TI 505 FIM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TI 505 PROFIBUS-DP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RBC</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.4: Where the Bus Connectors Can Be Used
4.3.1 Fitting the Bus Connector with Vertical Cable Outlet

Points to note when installing the bus connector with vertical cable outlet (order number 6ES7 972-0BA10-0XA0 or 6ES7 0BB10-0XA0):

- Prepare the ends of the cables as shown in Figure 4.13.
- Remove the last 22.5 mm of the cable sheath from the end of the cable (do not damage the braid shield)
- Remove the braid shield, foil shield and fillers leaving 7.5 mm to the edge of the sheath
- Remove the last 6 mm of insulation from the cores

- Open the casing of the bus connector by undoing the screws and removing the cover.
- Fit wires A and B into the screw terminals and secure them (with stranded cores, use wire-end ferrules with 0.25 mm² in compliance with DIN 46228)
- Press the cable sheath between the clips. This secures the cable.
- Make sure that the cable shield makes good contact to the shield clamp.
- Make sure that the fillers and the fleece foil (for example with the trailing cable) do not cover the shield foil.
- Fasten the cover again with the screws.
- If the bus connector is at the end of a segment, activate the terminating resistor.

Figure 4.13: Preparing the End of the Cable for Attachment to the Bus Connector with Vertical Cable Outlet
4.3.2 Fitting the Bus Connector with Swivelling Cable Outlet

The bus connector with the swivelling cable outlet (order number 6ES7 972-0BA20-0XA0 or 6ES7 972-0BB20-0XA0) can be operated with either a vertical cable outlet or with the cable outlet angled at 30°.

Connect the bus connector with the swivelling output as follows:

- Prepare the end of the LAN cable as shown in Figure 4.14 (the foil shield, fillers and support elements must be shortened to the length of the braid shield).

Please note the following:
- With the vertical cable outlet, the ends of the two LAN cables must be prepared differently
- With the angled cable outlet, not only the two bus cables also the two conductors of one cable must be prepared differently.

- Open the casing of the bus connector by undoing the screws and lifting up the cover.
- Remove the cover from the latching element.
- The bus connector with swivelled cable output is supplied with the cable output in the angled position. If you want the cable outlet to be vertical, then
  - Undo the left screw on the latching element
  - Lift the latching element slightly
  - Turn the element inwards
  - Tighten the left screw of the latching element again to fix the cable outlet in position.
- Fit wires A and B into the screw terminal (with stranded cores use the wire-end ferrules with 0.25 mm² in compliance with DIN 46228). Bending the free ends of the wires makes installation easier.
- Place the bus cables in the clamping hinge.
- Screw down the wires in the terminals.
- Make sure that the braid shield lies on the contact surfaces of the connector.
- Close the cover of the bus connector and secure it with the screws.
- Activate the terminating resistor on the two bus connectors at the ends of the segment.

Figure 4.14: Preparing the Cable Ends for the Bus Connector with Vertical Cable Outlet
Figure 4.15: Preparing the Cable Ends for the Bus Connectors with **Angled** Cable Outlet
4.3.3 Installing the Bus Connector with 30° Cable Outlet

Points to note when installing the bus connector with the 30° cable outlet (order number 6ES7 972-0BA30-0XA0):

- The bus connector with the 30° cable outlet is only permitted for data transmission rates \( \leq 1.5 \text{ Mbps} \).

- The bus connector with the 30° cable outlet does not have an integrated terminating resistor. It must therefore not be used at the end of a segment.

- The bus connector with the 30° cable output is not suitable for cables with stranded conductors (for example the trailing cable or the LAN cable for festoons).

![Diagram of cable ends]

Figure 4.16: Preparing the Cable Ends for Attachment to the Bus Connector with the 30° Cable Outlet

- Prepare the bus cables as shown in Figure 4.16. Note that there are differences in the wire lengths both between the cables and in the individual cables themselves. The insulation is not removed from the ends of the wires.
- Open the casing by undoing the screws and removing the cover.
- Press the bus cables into the strain relief clips. The cable shield must make good contact with the metal part.
- Insert the wires into the holes above the piercing terminals.
- Press the wires gently into the piercing terminals with your thumb.
- Make sure that the braid shield is lying on the contact surfaces of the connector.
- Secure the cover with the screws.
4.3.4 Installing the Bus Connector with Axial Cable Outlet

Points to note about installing the bus connector with axial cable outlet (order number 6GK1 500-0EA00):

- Prepare the ends of the cables as shown in Figure 4.17

![Diagram of cable preparation](image)

Figure 4.17: Preparing the Ends of the Cable for the Bus Connector with Axial Cable Outlet

- Undo the screws in the casing and remove the cover.
- Feed the wires into the required terminals of the screw terminal blocks.
- Press the cable sheath between the two clips.
- Make sure that the cable sheaths are lying on the metal conductor.
- Secure the wire ends by screwing down the terminals (with stranded conductors, use the wire-end ferrules with 0.25 mm² in compliance with DIN 46228).
- Make sure that the braid shield is lying on the contact areas of the connector.
- Replace the cover and screw it tight.
- Activate the terminating resistor if the bus connector is at the end of a segment.
4.4 Cable Connections

The underground cable and the LAN cable for festoons cannot be fitted directly into the bus connectors because the diameter of the sheath is too large. These cables can be connected to network components in the following ways:

> With the underground cable, the PE outer sheath can be removed, the inner cable can then be prepared just like the standard LAN cable. Due to the weight of the cable, however extra strain relief is necessary by securing the outer sheath regardless of the connector used.

> Both cables can be connected to the terminals in which the shield is contacted with a shield support clamp and the wires are connected to terminal blocks (for example bus terminals, repeaters, Channel 2 of the OLM).

If the two different cables must be connected within a section without bus connection elements, remember the following conditions:

> The length of the interruption in the shield must be as short as possible (commercially available plug-in connectors with metallic cases providing all round shielding of the connection are ideal).

> The cross-sectional area of the braid shield of the cable must not be reduced in the plug-in connector.

> The permitted cable diameter for the plug-in connectors must be taken into account (possibly cable outlets of different sizes).

> The combination of socket and plug should be mounted on a metallic flange. This flange is then connected to local ground via the shortest possible route using a wire with a cross-sectional area $\geq 6 \text{ mm}^2$ (protection against the possibility of parasitic voltages).

> If you are establishing a connection between the underground cable and standard LAN cable, it is advisable to locate the junction at the primary surge voltage protector (see Appendix D).
5 RS 485 Repeater
5  RS 485 Repeater

5.1 Application of the RS 485 Repeater

What is an RS 485 Repeater?
An RS 485 repeater amplifies data signals on LAN cables and connects bus segments.

Using the RS 485 Repeater
You require an RS 485 repeater in the following situations:

> When there are more than 32 stations connected to the bus
> When electrically isolated bus segments are required or
> When the maximum cable length of a segment (standard LAN cable) is exceeded (see Table 5.1).

<table>
<thead>
<tr>
<th>Transmission Rate</th>
<th>Maximum Cable Length of a Segment (in m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.6 to 93.75 Kbps</td>
<td>1000</td>
</tr>
<tr>
<td>187.5 Kbps</td>
<td>800</td>
</tr>
<tr>
<td>500 Kbps</td>
<td>400</td>
</tr>
<tr>
<td>1.5 Mbps</td>
<td>200</td>
</tr>
<tr>
<td>3 to 12 Mbps</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 5.1: Maximum Cable Length of a Segment (Standard LAN Cable)

Rules
If you want to install the bus with RS 485 repeaters, the following rules apply:

> A maximum of 9 RS 485 repeaters can be connected in series.
> The maximum cable length between two nodes must not exceed the values in Table 5.2:

<table>
<thead>
<tr>
<th>Transmission Rate</th>
<th>Maximum Cable Length Between Two Nodes (in m) with RS 485 Repeaters</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.6 to 93.75 Kbps</td>
<td>10000</td>
</tr>
<tr>
<td>187.5 Kbps</td>
<td>8000</td>
</tr>
<tr>
<td>500 Kbps</td>
<td>4000</td>
</tr>
<tr>
<td>1.5 Mbps</td>
<td>2000</td>
</tr>
<tr>
<td>3 to 12 Mbps</td>
<td>1000</td>
</tr>
</tbody>
</table>

Table 5.2: Maximum Cable Length Between Two Nodes (Standard LAN Cables)
5.2 Appearance of the RS 485 Repeater (6ES7 972-0AA00-0XA0)

Appearance of the RS 485 Repeater

Table 5.3 shows the elements of the RS 485 repeater:

<table>
<thead>
<tr>
<th>Front View of the Repeater</th>
<th>No.</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>①</td>
<td>Terminal for connecting the power supply of the RS 485 repeater (pin &quot;M5.2&quot; is the reference ground if you want to measure the voltage between terminals &quot;A2&quot; and &quot;B2&quot;).</td>
</tr>
<tr>
<td></td>
<td>②</td>
<td>Shield clamp for strain relief and grounding the LAN cable of bus segment 1 or bus segment 2</td>
</tr>
<tr>
<td></td>
<td>③</td>
<td>Terminal for the LAN cable of bus segment 1</td>
</tr>
<tr>
<td></td>
<td>④</td>
<td>Terminating resistor for bus segment 1</td>
</tr>
<tr>
<td></td>
<td>⑤</td>
<td>Switch for transmission rate the settings are as follows: 0: Bus segments not connected 1: 9.6 Kbps 2: 19.2 Kbps 3: 93.75 Kbps 4: 187.5 Kbps 5: 500 Kbps 6: 1.5 Mbps 7: 3 Mbps 8: 6 Mbps 9: 12 Mbps</td>
</tr>
<tr>
<td></td>
<td>⑥</td>
<td>Terminating resistor for bus segment 2</td>
</tr>
<tr>
<td></td>
<td>⑦</td>
<td>Terminal for the LAN cable of bus segment 2</td>
</tr>
<tr>
<td></td>
<td>⑧</td>
<td>Catch for mounting and removing the RS 485 repeater on a standard rail</td>
</tr>
<tr>
<td></td>
<td>⑨</td>
<td>Interface for PG/OP on bus segment 1</td>
</tr>
</tbody>
</table>

Table 5.3: Description and Functions of the RS 485 Repeater

Terminal M5.2 of the power supply (see Table 5.3, ①) is used as the reference ground for signal measurements if problems occur and must not be wired up.
**Technical Data**

Table 5.4 shows the technical data of the RS 485 repeater:

<table>
<thead>
<tr>
<th>Technical Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td></td>
</tr>
<tr>
<td>– Rated voltage</td>
<td>24 V DC</td>
</tr>
<tr>
<td>– Ripple</td>
<td>18 V to 30 V DC</td>
</tr>
<tr>
<td>Power consumption at rated voltage</td>
<td></td>
</tr>
<tr>
<td>– Without load on the PG/OP connector</td>
<td>100 mA</td>
</tr>
<tr>
<td>– Load on the PG/OP connector (5 V/90 mA)</td>
<td>130 mA</td>
</tr>
<tr>
<td>– Load on the PG/OP connector (24 V/100 mA)</td>
<td>200 mA</td>
</tr>
<tr>
<td>Electrical isolation</td>
<td>yes, 500 V AC</td>
</tr>
<tr>
<td>Redundant mode</td>
<td>no</td>
</tr>
<tr>
<td>Transmission rate</td>
<td>9.6 Kbps to 12 Mbps</td>
</tr>
<tr>
<td>Degree of protection</td>
<td>IP 20</td>
</tr>
<tr>
<td>Dimensions W × H × D (in mm)</td>
<td>45 × 128 × 67</td>
</tr>
<tr>
<td>Weight (including packing)</td>
<td>350 g</td>
</tr>
</tbody>
</table>

Table 5.4: Technical Data of the RS 485 Repeater
Pinout of the Sub D Connector (PG/OP Connector)

The 9-pin sub D connector has the following pinout:

<table>
<thead>
<tr>
<th>Layout</th>
<th>Pin No.</th>
<th>Signal Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>M24V</td>
<td>Chassis 24 V</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>RxD/TxD-P</td>
<td>Data line B</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>RTS</td>
<td>Request To Send</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>M5V2</td>
<td>Data reference voltage (of station)</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>P5V2</td>
<td>Power plus (from station)</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>P24V</td>
<td>24 V</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>RxD/TxD-N</td>
<td>Data line A</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

Table 5.5: Pin Assignment of the 9-Pin Sub D Connector PG/OP Connector

Block Diagram

Figure 5.1 shows the block diagram of the RS 485 repeater:

- Bus segment 1 and bus segment 2 are electrically isolated.
- Bus segment 2 and the PG/OP connector are electrically isolated.
- Signals are amplified:
  - between bus segment 1 and bus segment 2
  - between the PG/OP connector and bus segment 2

![Block Diagram of the RS 485 Repeater](image-url)
5.3 Possible Configurations with the RS 485 Repeater

Overview

The following section shows the configurations in which you can use the RS 485 repeater:

- Segment 1 and Segment 2 terminated on the RS 485 repeater
- Segment 1 terminated on the RS 485 repeater and Segment 2 connected through on the RS 485 repeater
- Segment 2 terminated on the RS 485 repeater and Segment 1 connected through on the RS 485 repeater
- Segment 1 and Segment 2 connected through on the RS 485 repeater

Terminating Resistor On/Off

Figure 5. 2 shows the setting for the terminating resistor:

![Terminating Resistor On/Off Diagram](image)

Figure 5. 2: Setting of the Terminating Resistor

Segments 1 and 2 Terminated

Figure 5. 3 shows how to connect the RS 485 repeater to the ends between two segments:

![Segments 1 and 2 Terminated Diagram](image)

Figure 5. 3: Connecting Two Bus Segments to the RS 485 Repeater (1)
Segment 1 Terminated, Segment 2 Connected Through

Figure 5.4 shows the connection between two segments via an RS 485 repeater with one segment connected through:

- Do not terminate bus segment 2
- Terminate bus segment 1

Figure 5.4: Connection of Two Bus Segments on the RS 485 Repeater (2)

Segments 1 and 2 Connected Through

Figure 5.5 shows the connection of two segments via an RS 485 repeater with both LAN cables connected through on the repeater.

- Do not terminate bus segment 1
- Do not terminate bus segment 2

Figure 5.5: Connection of two Bus Segments on the RS 485 Repeater (3)
5.4 Installing and Uninstalling the RS 485 Repeater

Overview

You can install the RS 485 repeater as follows:

- On a rail for S7-300
- or
- On a standard rail (DIN EN 500 22-35x7.5)

Installation on a Rail for S7-300

To install the RS 485 repeater on a rail for S7-300s, the catch on the rear of the RS 485 repeater must first be removed (see Figure 5.6):

1. Insert a screwdriver below the tongue of the catch (1) and
2. Push the screwdriver towards the rear of the module (2). Hold the screwdriver in this position!
   Result: The catch is released from the RS 485 repeater.
3. With your free hand lift the catch up as far as it will go and then remove the catch (3).
   Result: The catch is removed from the RS 485 repeater.
4. Fit the RS 485 repeater onto the rail for an S7-300 (4).
5. Push it towards the back as far as it will go (5).
6. Tighten the securing screw with a torque of 80 to 110 Ncm (6).

Figure 5.6: Installing the RS 485 Repeater on a Standard Rail for an S7-300
Removing the Repeater from an S7-300 Rail

To remove the RS 485 repeater from the S7-300 rail:

1. Undo the screw securing the RS 485 repeater (1) and
2. Pull the RS 485 repeater out and up (2).

![Diagram of RS 485 Repeater Removal]

Figure 5. 7: Removing the RS 485 Repeater from the S7-300 Rail

Installation on a Standard Rail

To be able to install the repeater on a standard rail, the catch must be present on the back of the RS 485 repeater:

1. Fit the RS 485 repeater on to the standard rail from above and
2. Push it towards the back until the catch locks it in place.

Removing the RS 485 from the Standard Rail

To remove the RS 485 repeater from the standard rail:

1. Press down the catch on the bottom of the RS 485 repeater using a screwdriver and
2. Pull the RS 485 repeater out and upwards to remove it from the standard rail.
5.5 Ungrounded Operation of the RS 485 Repeater

Ungrounded Operation

Ungrounded operation means that chassis and PE are not connected.

The ungrounded operation of the RS 485 repeater allows you to operate electrically isolated bus segments.

Figure 5. 8 shows the change in the potentials resulting from using the RS 485 repeater.

Figure 5. 8: Ungrounded Operation of ET200 Bus Segments
5.6 Connecting the Power Supply

Cable Type
To connect the 24 V power supply, use flexible cables with a cross section of 0.25 mm$^2$ to 2.5 mm$^2$ (AWG 26 to 14). Use suitable wire-end ferrules for the wire cross section.

Rules for Cabling
Appendix D contains detailed information about cabling.

Connecting the Power Supply
To connect the power supply of the RS 485 repeater:
1. Strip the insulation from the wire for the 24 V DC power supply.
2. Connect the cable to terminals "L+", "M" and "PE".
5.7 Connecting the LAN Cables

Connect the PROFIBUS LAN cable to the RS 485 repeater as follows:

1. Cut the PROFIBUS LAN cable to the required length.
2. Strip the insulation from the PROFIBUS LAN cable as shown in Figure 5.9.
   
   The braided shield must be folded back on to the cable. Only then can the shield clamp serve as strain relief and as the shield contact.

![Figure 5.9: Lengths for Stripping the Cable to Connect it to the RS 485 Repeater](image)

3. Connect the PROFIBUS LAN cable to the RS 485 repeater:
   
   Connect the same wires (green/red for the PROFIBUS LAN cable) to the same terminal A or B (in other words always connect Terminal A with a green wire and Terminal B with a red wire or vice versa).

4. Tighten the shield clamps so that the shield makes good contact with the clamp.
6 Passive Components for Optical Networks
6 Passive Components for Optical Networks

6.1 Fiber-Optic Cables

With fiber-optic cables, data is transferred by the modulation of electromagnetic waves in the range of visible and invisible light. The materials used are high-quality plastic and glass fibers.

This chapter describes only the fiber-optic cables from the SIMATIC NET range intended for PROFIBUS. The various types of fiber-optic cable allow components to be connected together in a way suitable for the operating and environmental conditions.

Compared with electrical cables, fiber-optic cables have the following advantages:

- Electrical isolation of the nodes and segments
- No grounding problems
- No impairment by external electromagnetic interference
- No lightning protection required
- No interference emission along the transmission path
- Light weight
- Depending on the fiber type, cable lengths of several kilometers are possible even at high transmission rates
- The transmission rate does not affect the maximum permitted cable length

For technological reasons, only point-to-point connections are possible with fiber-optic cables, in other words, one transmitter is connected to one receiver. For duplex transmission between two nodes, two fibers are therefore necessary (one for each transmission direction).

With the optical components for PROFIBUS, bus, star and ring structures can be implemented.

6.1.1 Plastic Fiber-Optic Cables

Plastic fiber-optic cables are used to connect optical link modules with connectors for plastic optical cables (OLM/P) and optical link plugs (OLPs). Under certain circumstances, this is a cost-effective alternative to traditional glass fiber-optic cables.

Table 6.1 shows a list of plastic fiber-optic cables available for PROFIBUS and outlines their essential characteristics.

Plastic fiber-optic cables can be obtained by the meter or preassembled with connectors attached at either one or both ends.
### Simplex cable
- **Order number:** 5DX7 123-3DA50
- **Cable type (standard code):** i-VYY1P
- **Fiber type:** Step index
- **Core diameter:** 980 μm
- **Core material:** Polymethyl methacrylate
- **Cladding:** 1000 μm outer diameter
- **Cladding material:** Fluorinated special polymer
- **Core jacket:** PVC, gray
- **Outer jacket:** PVC, red
- **Number of cores:** 1
- **Attenuation dB/km at 650 nm:** ≤ 200
- **Strain relief:** Kevlar fibers
- **Maximum permitted tensile stress**
  - Brief: ≤ 250 N
  - Permanent: ≤ 100 N
- **Transverse compressive strength per 10 cm length**
  - Brief: ≤ 100 N/cm
  - Permanent: ≤ 10 N/cm
- **Bending radii**
  - Brief: ≥ 30 mm
  - Permanent: ≥ 80 mm
- **Permitted ambient conditions**
  - Operating temperature: –30 °C to +70 °C
  - Transport and storage temperature: –35 °C to +85 °C
- **Behavior in fire:** Flame-resistant acc. to flame test VW–1 to UL 1581
- **Outer dimensions:** 3.6 ± 0.02 mm Ø
- **Weight:** 15.5 kg/km

### Simplex cord
- **Order number:** 5DX6 312-4AA01
- **Cable type (standard code):** i-VY1P
- **Fiber type:** Step index
- **Core diameter:** 980 μm
- **Core material:** Polymethyl methacrylate
- **Cladding:** 1000 μm outer diameter
- **Cladding material:** Fluorinated special polymer
- **Core jacket:** PVC, gray
- **Outer jacket:** PVC, red
- **Number of cores:** 1
- **Attenuation dB/km at 650 nm:** ≤ 150
- **Strain relief:** Kevlar fibers
- **Maximum permitted tensile stress**
  - Brief: ≤ 35 N
  - Permanent: ≤ 10 N
- **Transverse compressive strength per 10 cm length**
  - Brief: ≤ 35 N/cm
  - Permanent: ≤ 5 N/cm
- **Bending radii**
  - Brief: ≥ 10 mm
  - Permanent: ≥ 30 mm
- **Permitted ambient conditions**
  - Operating temperature: –30 °C to +70 °C
  - Transport and storage temperature: –35 °C to +85 °C
- **Behavior in fire:** Flame-resistant acc. to flame test VW–1 to UL 1581
- **Outer dimensions:** 2.2 ± 0.07 mm Ø
- **Weight:** 3.8 kg/km

### Twin cable
- **Order number:** 5DX7 123-3DB50
- **Cable type (standard code):** i-VYY2P
- **Fiber type:** Step index
- **Core diameter:** 980 μm
- **Core material:** Polymethyl methacrylate
- **Cladding:** 1000 μm outer diameter
- **Cladding material:** Fluorinated special polymer
- **Core jacket:** PVC, gray
- **Outer jacket:** PVC, red
- **Number of cores:** 2
- **Attenuation dB/km at 650 nm:** ≤ 200
- **Strain relief:** Kevlar fibers
- **Maximum permitted tensile stress**
  - Brief: ≤ 250 N
  - Permanent: ≤ 100 N
- **Transverse compressive strength per 10 cm length**
  - Brief: ≤ 100 N/cm
  - Permanent: ≤ 10 N/cm
- **Bending radii**
  - Brief: ≥ 10 mm
  - Permanent: ≥ 30 mm
- **Permitted ambient conditions**
  - Operating temperature: –30 °C to +70 °C
  - Transport and storage temperature: –35 °C to +85 °C
- **Behavior in fire:** Flame-resistant acc. to flame test VW–1 to UL 1581
- **Outer dimensions:** 3.6 x 7.4 mm ± 0.02 mm
- **Weight:** 30.4 kg/km

### Duplex cord
- **Order number:** 5DX6 322-4AA01
- **Cable type (standard code):** i-VY2P
- **Fiber type:** Step index
- **Core diameter:** 980 μm
- **Core material:** Polymethyl methacrylate
- **Cladding:** 1000 μm outer diameter
- **Cladding material:** Fluorinated special polymer
- **Core jacket:** PVC, gray
- **Outer jacket:** PVC, red
- **Number of cores:** 2
- **Attenuation dB/km at 650 nm:** ≤ 200
- **Strain relief:** Kevlar fibers
- **Maximum permitted tensile stress**
  - Brief: ≤ 250 N
  - Permanent: ≤ 100 N
- **Transverse compressive strength per 10 cm length**
  - Brief: ≤ 100 N/cm
  - Permanent: ≤ 10 N/cm
- **Bending radii**
  - Brief: ≥ 10 mm
  - Permanent: ≥ 30 mm
- **Permitted ambient conditions**
  - Operating temperature: –30 °C to +70 °C
  - Transport and storage temperature: –35 °C to +85 °C
- **Behavior in fire:** Flame-resistant acc. to flame test VW–1 to UL 1581
- **Outer dimensions:** 2.2 x 4.4 mm ± 0.01 mm
- **Weight:** 7.8 kg/km

---

**Table 6.1:** Technical Data of the Plastic Cords and Cables
6.1.1.1 Simplex and Duplex Cords 2.2 mm Ø

The simplex cord has a single, strong plastic fiber and an outer diameter of 2.2 mm. Due to the large diameter of the core, connectors can be fitted easily without special tools (see Appendix E). The cords are not suitable for areas in which mechanical stress is to be expected. Their main application is to implement the connection between two OLPs and between an OLP and an OLM.

The duplex cord consists of two simplex cords each with a diameter of 2.2 mm. The jackets of the two cords are welded together. The cords can be separated from each other easily when fitting connectors.

When using simplex and duplex cords, remember the following points:

> Do not bend beyond the minimum bending radii during installation and operation.
> Avoid kinking or crimping the cords.
> With the duplex cord, the bending radius applies to bending the “broad” surface of the cord. Bends in the thin edge of the cord must be avoided.
> Install the cords so that they are not subjected to any excessive pressure and so that they are not liable to be at any time during operation.
> Cords exiting a housing or a closet must be provided with additional strain relief. To avoid any possible damage to the plug-in connector, it is generally advisable to provide additional strain relief close to the connector for cords with free ends longer than 2 m.
> The cords are not suitable for outdoor applications
> Due to the high optical power that can be transmitted, overload effects can occur. The specifications for cord lengths (minimum length, maximum length) must be adhered to.

The simplex cord can be ordered in meters and preassembled as a BFOC Pigtail Set 2x50 m, with a BFOC (bayonet fiber-optic connector) at one end.

For order numbers, please refer to the catalog IK 10.
6.1.1.2 Simplex and Twin Cables 3.6 mm

The simplex cable (3.6 mm) contains the same optical fiber as the cords. The additional layer of Kevlar fibers and the additional outer PVC jacket make the simplex cable suitable for installation in areas where mechanical strain can be expected as well as in cable channels. Fitting connectors to the cable is simple (see Appendix E).

The twin cable (3.6 mm) consists of two simplex cables with the outer jackets joined by a small PVC bridge. The two cables can be separated easily to allow connectors to be fitted to the ends.

When using simplex and duplex cables, remember the following points:

> Do not bend beyond the minimum bending radii during installation and operation.
> Avoid kinking or crimping the cables.
> With the duplex cable, the bending radius applies to bending the “broad” surface of the cable. Bends in the thin edge of the cable must be avoided.
> Install the cables so that they are not subjected to any excessive pressure and so that they are not liable to be at any time during operation.
> Cables exiting a housing or a closet must be provided with additional strain relief. To avoid any possible damage to the plug-in connector, it is generally advisable to provide additional strain relief close to the connector for cables with free ends longer than 2 m.
> The cables are not suitable for outdoor applications
> Due to the high optical power that can be transmitted, overload effects can occur. The specifications for cable lengths (minimum length, maximum length) must be adhered to.

Both cables are available in meters or preassembled with BFOC connectors. For the order numbers, please refer to Catalog IK10.

The main application of these cables is to connect OLM/P3 and OLM/P4 modules, if necessary over greater distances.
6.1.2 Glass Fiber-Optic Cables

When using glass fiber-optic cables with PROFIBUS, 62.5/125 µm graded index fibers are preferred. Depending on the wavelength of the transmitter, transmission paths of up to several kilometers can be implemented with these glass fiber cables (with the OLM/Sx-1300, segment lengths up to 10 km are possible).

<table>
<thead>
<tr>
<th></th>
<th>Standard Cable</th>
<th>Trailing Cable</th>
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<tbody>
<tr>
<td>Order number: (sold in meters)</td>
<td>6XV1 820-5AH10</td>
<td>6XV1 820-6AH10</td>
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<tr>
<td>Fiber type</td>
<td>Multimode graded index 62.5 / 125 µm</td>
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<tr>
<td>Attenuation at 850 nm</td>
<td>≤ 3.1 dB/km</td>
<td>≤ 0.8 dB/km</td>
</tr>
<tr>
<td>Attenuation at 1300 nm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modal band width at 850 nm</td>
<td>≥ 200 MHz*km</td>
<td></td>
</tr>
<tr>
<td>Modal band width at 1300 nm</td>
<td>≥ 600 MHz*km</td>
<td></td>
</tr>
<tr>
<td>Number of fibers</td>
<td>2</td>
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<tr>
<td>Cable structure</td>
<td>Solid cord</td>
<td>Splittable outdoor cable</td>
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</thead>
<tbody>
<tr>
<td>Basic element</td>
</tr>
<tr>
<td>Strain relief</td>
</tr>
<tr>
<td>Outer jacket of the cable</td>
</tr>
<tr>
<td>Strain relief</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Mechanical dimensions</th>
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<tbody>
<tr>
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<tr>
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</tr>
<tr>
<td>Weight</td>
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<td>Bending radii</td>
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</table>

<table>
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<tr>
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<tr>
<td>Operation</td>
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<tr>
<td>Storage</td>
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<table>
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<th>Special features</th>
</tr>
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<tbody>
<tr>
<td>Behavior in fire</td>
</tr>
<tr>
<td>Halogen free</td>
</tr>
</tbody>
</table>

Table 6.2: Technical Data of the Glass Fiber-Optic Cables
Points to note when using glass fiber-optic cables:

- Due to the lower power that can be coupled into glass fibers compared with the plastic fiber-optic cables, connectors must be kept clean. If a plug or socket is not in use, it should be sealed using the dust caps supplied.
- During installation, the fiber-optic cables must not be twisted, stretched or crimped. The specified limit values for tensile stress, bending radii and temperature ranges must be adhered to. During installation, the attenuation values can change slightly, these deviations are however reversible.
- Although the BFOC connectors have integrated strain relief and provide protection against kinking, it is advisable to secure the cable additionally as close as possible to the connector to protect it from mechanical stress.
- When installing the cables over long distances, it is advisable to include one or more future repair splices in the power loss budget.
- Fiber-optic cables are not susceptible to electromagnetic interference! This means that the cables can be laid in conduits along with other cables (for example 230 V/380 V power supply cables) without any problems occurring. When the cables are installed in cable conduits, make sure that when other cables are pulled through, the maximum strain on the fiber-optic cables is not exceeded.

6.1.2.1 Standard Glass Fiber-Optic Cable

The standard PROFIBUS glass fiber-optic cable (Figure 6.3) is a high-quality, duplex cable suitable for installation both in buildings and outside.

The standard cable is available as follows:
- By the meter, without connectors, maximum section length 4,000 m
- Preassembled with 4 BFOC connectors with anti-kink sleeves, maximum length 1,000 m

The BFOC connectors can be fitted to both fibers using a special tool; this should however only be performed by trained personnel (see Appendix E).

The order numbers and length codes for the cables can be found in the current Catalog IK10.

Please note that the specified bending radius is only for bends on the “broad” side of the cable. Bends involving the narrow edge of the cable must be avoided since they can lead to compression and stretching of the core within the cable.

![Figure 6.3: Structure of the Standard Glass Fiber-Optic Cable](image-url)
6.1.2.2 Glass Fiber-Optic Trailing Cable

The PROFIBUS glass fiber-optic trailing cable (Figure 6. 4) was developed for the special situation in which the cable must be capable of movement, for example when connected to machine parts that are constantly in motion (drag chains). The cable is designed for 100,000 bending cycles through ± 90° (at the specified minimum bending radius). The trailing cable can be used both indoors and outdoors. Due to its round cross section, it is easy to install. The cable is constructed of halogen-free material.

The trailing cable is available as follows:
– In meters, without connectors, maximum length 2,000 m
– Preassembled with 4 BFOC connectors with an anti-kink sleeve, maximum length 650 m

The order numbers and length key can be found in the current IK10 catalog.

![Diagram of Glass Fiber-Optic Trailing Cable]

Figure 6. 4: Structure of the Glass Fiber-Optic Trailing Cable

Note:
During installation and operation, all the mechanical restrictions such as bending radii, tensile strain etc. must be adhered to.
Figure 6.5: Example of Using the Glass Fiber-Optic Trailing Cable in a Drag Chain
6.1.3 Special Cables

In addition to the fiber-optic cables listed in the SIMATIC NET catalog, there are also a large number of special cables and installation accessories available. Listing all the different versions goes beyond the scope both of the catalog and this manual.

The technical data of the optical PROFIBUS components produced by Siemens specifies the fiber-optic fiber types with which these components can be connected.

With glass fiber-optic cables, the 62.5 µm core diameter fiber is used as the standard, with plastic fiber-optic cables the standard core diameter is 980 µm.

Please note that using fibers with other core diameters or attenuation properties than the fiber types listed in the SIMATIC NET catalog changes the distances that can be covered.

The following fiber types are also commonly used:

- **50 µm Fiber**
  This fiber is used particularly in Europe in Telecom applications instead of the 62.5 µm fiber. Due to the smaller core diameter, the optical power that can be coupled into the cable and the distance that can be covered are reduced.

- **10 µm Fiber**
  For transmission over extremely long distances, the single index (monomode) fiber is used. Only devices with extremely high quality transmit and receive elements and connectors can be connected to the monomode fiber, such as the OLM/S3-1300 and OLM/S4-1300 with which distances up to 15 km can be covered.

- **Hard-Polymer Cladded-Silica fiber (HCS® fiber) or Polymer-Cladded fiber (PCF fiber)**
  The PCF fiber is used instead of plastic fibers (polymer fibers) to be able to cover greater distances. It has a core of quartz glass and plastic cladding.
  With the OLM/P3 or OLM/P4, instead of the maximum 80 m with 980/1000 µm plastic fibers, the 200/230 µm CUPOFLEX PLUS PCF fiber allows distances up to 600 m between two OLMs.

A wide variety of cable types can be implemented, for example:

- Simplex cables with only 1 fiber
- Bundled cords (cables with hollow cords capable of accommodating several fibers)
- Cables with rodent protection for underground installation
- Halogen-free cables, for example for use in underground train systems
- Hybrid cables with fibers and copper conductors in one jacket
- Certified cables, for example for use on ships

If you require fiber-optic cables for particular applications, please contact your Siemens representative (see Appendix C.3).
6.2 Fiber-Optic Connectors

Fiber-optic connectors are impaired by dirt and mechanical damage to the head surfaces.

6.2.1 Connectors for Plastic Fiber-Optic Cables

Fitting connectors to plastic fiber-optic cables is relatively simple. The following connectors are available:

Simplex Connectors

Two simplex connectors are supplied with each optical link plug (OLP). The simplex connectors are required to connect the OLPs in a single-fiber optical ring. The simplex connectors can be fitted easily (see Appendix E). Simplex connectors cannot be ordered separately.

The simplex connectors do not provide strain relief. If there is a longer section of cable free at the end of the cable, it is advisable to secure the cable mechanically as close as possible to the interface.
BFOC Connectors

Two BFOC connectors are supplied with each OLM/P3 and 4 BFOC connectors are supplied with each OLM/P4. The BFOC connectors allow precision fiber-optic cable connections. The construction of the BFOC connector allows the strain relief of cables to be used. This is necessary for installing longer fiber-optic cable connections, for example between OLM/P modules. The BFOC connectors can also be ordered separately.

Refer to Appendix E for information about fitting connectors.

![BFOC Connector with Accessories](image)

**Figure 6.7:** BFOC Connector with Accessories (Crimp Sleeves and Anti-Kink Sleeves) for Cable and Cord

Duplex Connectors

The HP duplex connector is used only in conjunction with the preassembled duplex cord, 2.2 mm Ø BFOC/HP duplex. The cord is intended for connecting integrated fiber-optic interfaces with components of the OLM/P type.

![Preassembled Duplex Cord with Duplex Connector](image)

**Figure 6.8:** Preassembled Duplex Cord with Duplex Connector

* The HP duplex connectors do not provide strain relief. If there is a longer section of cable free at the end of the cable, it is advisable to secure the cable mechanically as close as possible to the interface.

* The dust protectors should only be removed from the transmit and receive elements immediately before physically establishing the connection.
6.2.2 Connectors for Glass Fiber Cables

In PROFIBUS, only BFOC connectors are used for glass fiber-optic cables. Generally, SIMATIC NET preassembled cables are used.

If it is necessary to fit connectors on site,
– SIEMENS provides this service (see Appendix C.3)
– BFOC connectors and special tools can be ordered (see IK10).

Connectors for glass fiber-optic cables should only be fitted by trained staff. When correctly assembled, they allow extremely low coupling attenuation and the characteristics of the link attain a high degree of reproducibility even after plugging in many times.

To allow the use of glass fiber-optic cables even if trained staff are not available, the glass fiber-optic cables are supplied preassembled with four BFOC connectors.

To assemble the cables on site, the cable can be ordered separately.

Refer to the current SIMATIC NET IK10 catalog for ordering data.

Protect open connections from dust and dirt (dust caps)

Only remove the dust cap immediately before establishing the physical connection.
SIEMENS

Description and Operating Instructions
SINEC L2 Optical Link Modules

OLM/P3
OLM/P4
OLM/S3
OLM/S4
OLM/S3-1300
OLM/S4-1300
Order nos.

SINEC L2 OLM/P3  6GK1 502-3AA10
SINEC L2 OLM/P4  6GK1 502-4AA10
SINEC L2 OLM/S3  6GK1 502-3AB10
SINEC L2 OLM/S4  6GK1 502-4AB10
SINEC L2 OLM/S3-1300  6GK1 502-3AC10
SINEC L2 OLM/S4-1300  6GK1 502-4AC10
Description and Operating Instructions  6ZB5 530-1AF01-0BA0

Note

The information contained in this description relates to SINEC L2 OLM, revision level 2 (order no. 6GK1 502-... 10). The functionality described here is not featured in full by modules of revision level 1 (order nos. 6GK1 502-... 00). Information on these modules can be found in the description of the “Optical Link Module SINEC L2FO OLM Version 1.0 11/94“, order no. 6ZB5 530-1AD01-0BA0.
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   A Maximum number of modules in an optical ring  
   B Electrical parameters of RS 485 bus lines  
   C Bibliography
Please note that the contents of these operating instructions do not form part of or represent an amendment to any prior or existing agreement, assurance or legal relationship. All obligations of the Siemens company arise from the relevant purchase contract, which also contains the complete and solely valid warranty conditions. These contractual warranty provisions are neither extended nor restricted by the content of these operating instructions.

General

This equipment is electrically powered. Precise attention is therefore to be paid to the safety requirements specified in the operating instructions with regard to the voltages to be applied.

WARNING: Non-observance of warnings can result in serious injuries and/or material damage.

Only appropriately qualified personnel may work on this equipment or in its vicinity. The personnel concerned must be fully familiar with all the warnings and maintenance measures outlined in these operating instructions.

Proper, safe operation of this equipment presupposes appropriate transportation, storage and assembly as well as careful operation and maintenance.

Personnel qualification standard required

The term "Qualified personnel" as used in these operating instructions/warnings refers to personnel familiar with installation, assembly, commissioning and operation of the product concerned in addition to being suitably qualified for the tasks involved. Such qualifications include:

- Training, instruction or authorisation with respect to activation and deactivation, grounding and marking of circuits and devices/systems in line with current safety engineering standards
- Training or instruction in the areas of upkeep and use of appropriate safety equipment in line with current safety engineering standards
- Instruction in First Aid
1 Introduction

The SINEC L2 Optical Link Modules

- OLM/P3,
- OLM/P4,
- OLM/S3,
- OLM/S4,
- OLM/S3-1300 and
- OLM/S4-1300

are designed for use in optical PROFIBUS field bus networks. They permit conversion of electrical PROFIBUS interfaces (RS 485) into optical PROFIBUS interfaces and vice versa.

The modules can be integrated into existing PROFIBUS field bus networks, making full use of all the advantages offered by optical transmission technology. Optical link modules can also be used to configure a complete PROFIBUS field bus network with line, star or ring topology.

To enhance field-bus network reliability, the modules OLM/P4, OLM/S4 and OLM/S4-1300 enable a redundant network configuration to be established.

Every module has 3 or 4 mutually independent ports (channels), each of which in turn consists of a transmitter and a receiver.

Tables 1 and 2 illustrate the various module connection possibilities and the maximum ranges of the individual ports.

The operating voltage is 24 V DC. A redundant power supply can be provided to increase operational reliability.

Port 1 is a 9-pin Sub-D connector (female), and port 2 is a 2-pole screw terminal block with shielding clamp. The optical fibers are connected via BFOC/2.5 sockets. Five multi-color LEDs indicate the current operating status and any malfunctions.

<table>
<thead>
<tr>
<th>OLM/</th>
<th>P3</th>
<th>P4</th>
<th>S3</th>
<th>S4</th>
<th>S3-1300</th>
<th>S4-1300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ports</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>- Electrical</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>- Optical</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Possible fiber types

- Polymer
  - 980/1000 µm 80 m 80 m
- Silica
  - 10/125 µm
  - 50/125 µm
  - 62.5/125 µm 2850 m 2850 m 10 000 m 10 000 m

Table 1: The table indicates the number of electrical and optical ports per module, the types of fiber which can be used and the maximum possible optical fiber distances between two modules.

Fig. 1: Optical Link Modules OLM/P4, OLM/S4 showing position of LED indicators and individual ports
Various module faults can be signalled for example to a master station by way of a signalling contact (relay with floating contacts).

The mechanical structure is a compact, rigid metal housing which can either be mounted on a top-hat rail or on any flat base.

For standard use, no adjustment is required on start-up. For special applications, the configuration can be set to suit individual requirements with a maximum of six slide switches readily accessible from outside the housing.

SINEC L2 Optical Link Modules comply with DIN 19 245 Part 1 as well as with the technical directive “PROFIBUS optical transmission technology” issued by the PROFIBUS user organisation, PNO.

The use of a passive optical PROFIBUS star coupler is not supported.

<table>
<thead>
<tr>
<th>Transmission rate in kbit/s</th>
<th>Type A line in m</th>
<th>Type B line in m</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.6</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>19.2</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>93.75</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>187.5</td>
<td>1000</td>
<td>600</td>
</tr>
<tr>
<td>500.0</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>1500.0</td>
<td>200</td>
<td>–</td>
</tr>
</tbody>
</table>

*Table 2: Max. possible length of RS 485 bus segments at ports 1 and 2 (as per PROFIBUS-DP and DIN 19 245). The electrical parameters of the two possible line types are listed in the Appendix.*
2 General Functions

2.1 Mode-independent functions

Transmission rate
The SINEC L2 Optical Link Modules support all the transmission rates specified in DIN 19 245:
- 9.6 kbit/s
- 19.2 kbit/s
- 93.75 kbit/s
- 187.5 kbit/s
- 500 kbit/s
- 1500 kbit/s

The modules recognize the transmission rate automatically on start-up and assume the appropriate configuration.

The outputs of all ports are disabled until the transmission rate has been recognized. A change in transmission rate during operation is recognized by the modules, which then effect corresponding reconfiguration.

Signal regeneration
The SINEC L2 Optical Link Modules regenerate the signal shape and amplitude of the data received.

This function permits cascading of any number of modules with line topology. A maximum of between 41 to 144 modules may be used in a fiber optic ring topology. Further details are provided in the following sections and in the Appendix.

Protection against permanent network usage
Each receiver monitors the RS 485 bus segment connected to it for permanent network usage. If the usage period exceeds the maximum permissible transmission time at a given receiver, transfer of the received data is blocked.

Blocking is terminated if the receiver does not detect any light pulses for a minimum of 13 bit periods.

2.2 Mode-dependent functions

The following functions are only available in standard mode 0. Details are given in the following sections.

Echo line monitoring
The “Transmit echo”, “Monitor echo” and “Suppress echo” functions of the SINEC L2 Optical Link Modules enable the connected optical links to be actively monitored for interruption of the fiber optic cable. All echo functions are active in standard mode irrespective of the type of network topology being used.

Transmit echo
If a SINEC L2 Optical Link Module receives a telegram via any port, this telegram is transmitted on all other ports. If the receiving port is an optical port, the module retransmits the telegram on the corresponding optical transmitter back to the sender.

Monitor echo
If an Optical Link Module transmits a telegram – not an echo! – to an optical port, the module expects an echo. If the echo is not received after a fixed time, an echo monitoring error is signalled by the red LED for the appropriate port.

Suppress echo
At the start of telegram transmission, the corresponding receiver is separated from the other ports until the echo has been completely received.

Segmentation
In the event of an echo monitoring error on an optical port, the optical link module assumes a line interruption and blocks the transmitter of this port from transmitting data. The connected field bus sub-network is thus segmentated (isolated).
Modules will transmit start-up support pulses to a segmented port. These regularly received light pulses indicate the serviceability of the optical link to the partner module (if there is a break in one of the fibers in a duplex fiber optic cable) and prevent segmentation by the partner module.

Segmentation is cancelled automatically when the optical receiver detects another light pulse.

**Start-up support**

Start-up and checking of the optical lines are possible even during the installation phase before terminal units have been connected to a field bus network.

If an optical receiver fails to detect light pulses for at least 5 seconds, the corresponding optical transmitter transmits a short light pulse. This causes the port LED of the partner module to light briefly if the fiber optic cable is intact. These start-up support pulses are suppressed internally and not transferred to the other ports.
3 Network Topologies

All the network topologies envisaged in the PNO directive “PROFIBUS optical transmission technology” can be implemented using the SINEC L2 Optical Link Modules.

- Transmitter-to-receiver link
- Line topology
- Ring topology (one-fiber ring)
- Star topology

Combinations made up from these basic types are also possible, as is any combination of one or more electrical RS 485 bus segments with these network topologies.

If a highly reliable field bus network is required – e.g. breakage of a fiber optic cable – network availability can be enhanced by way of a redundant network configuration. The following redundant network topologies can be configured:

- Line redundancy for transmitter-to-receiver links
- Redundant optical ring

3.1 Line topology

Fig. 2: Network structure with optical line topology

The individual Optical Link Modules are connected in pairs by way of duplex fiber optic cables.

Optical Link Modules with one optical port suffice at the start and end of a line; modules with two optical ports are required in between. Individual terminal units or complete PROFIBUS segments with a maximum of 31 users can be connected to each Optical Link Module via the electrical ports with RS 485 interfaces.

The advantage of this type of topology is that long distances can be covered. Echo functions (mode 0) permit monitoring of the fiber optic line with the two connected Optical Link Modules.

If one Optical Link Module fails or a fiber optic cable breaks, the overall network is divided up into two subnetworks, within which trouble-free operation remains possible.

If individual transmitter-to-receiver links are to be configured, i.e. only two OLM are connected, use can be made of two Optical Link Modules with one optical port each.
3.2 Star topology

![Diagram of a star topology network]

*Fig. 3: Network structure with optical star topology and active PROFIBUS star coupler*
With this topology, several Optical Link Modules are combined to form an active PROFIBUS star coupler, to which remote Optical Link Modules are connected by way of duplex fiber optic cables. The Optical Link Modules of the star coupler are interconnected via one of the electrical ports. The other electrical ports in this network structure can be used for connection of terminal units or RS 485 segments.

Optical Link Modules with one or two optical ports can be employed for configuring an active PROFIBUS star coupler.

Optical Link Modules with one optical port suffice for connecting a terminal unit or RS 485 bus segment to the active star coupler.

The echo function (mode 0) provides monitoring of the fiber optic line between two connected Optical Link Modules.

Even if only one transmission direction fails, the segmentation function linked to the monitoring ensures reliable isolation of the entire link from the network. With star topology, only the terminal unit on the faulty line is thus disconnected from the network, thus trouble-free operation is maintained in the rest of the network.

To enhance the availability of the overall network, it is advisable to have a redundant power supply (see Section 4.8 “Connection of power supply”) for the active PROFIBUS star coupler.
The SINEC L2 Optical Link Modules are interlinked using individual fiber optic cables. Optical Link Modules with one optical port suffice. A terminal unit or RS 485 bus segment can optionally be connected to each electrical port.

This type of topology is only possible with monitoring functions activated (mode 0) as the data flow in the ring is controlled by the echo functions.

A telegram to be transmitted is launched onto the optical ring by the Optical Link Module, passes completely through the ring, is re-received as an echo by the same module and taken from the ring.

In contrast to the echo monitoring error described in Section 2.2, this process results in a special error signalling pattern in the event of a break in the ring.

On account of the missing echo signal, each transmitting Optical Link Module detects a break in the overall ring and indicates this by way of the red LED “CH3”. In a network with active terminal units, the situation will therefore be such that an error is generally signaled by several modules, thus making it more difficult to localize the break. Evaluation of the signalling contact, on the other hand, is unambiguous as this only responds with respect to those modules which have the optical receiver directly connected to the interrupted line.
If the launching of telegrams into the ring is interrupted, the response of the LED “CH3” again clearly only relates to the module concerned. Communication between all ring users is disrupted in the event of a break in the ring.

One-fiber ring topology features a relatively simple and inexpensive structure.

**Note:** All modules within a ring must be interconnected by way of fiber optic cables. Electrical connections do not constitute a ring.

If problems are encountered with the configuration of one-fiber ring topology on account of excessively long fiber-optic line sections, connections can also be implemented as shown in Fig. 5.

In this case, each module is linked – in spatial terms – with the next module except for one. Two adjacent modules are to be interconnected at the start and end of every such line. This avoids individual “excessively long” fiber-optic line sections (for example return path for a closing line to form a ring).

Optical one-fiber ring topology is activated with the following DIP switch settings:
- Mode 0
- Redundancy function off
This type of network topology is employed for "optical" connection of several terminal units or RS 485 segments. The use of a redundant transmitter-to-receiver link with two Optical Link Modules OLM/P4, OLM/S4 or OLM/S4-1300 guarantees maximum availability.

If required, several redundant transmitter-to-receiver links can be electrically cascaded via port 1 or 2 to provide line topology.

The modules detect the total failure of an optical line from the absence of light pulses and segment the appropriate transmission path. This fault is indicated by the lighting (red) of the LED “CH3” or “CH4” and response of the signalling contact. The segmentation is cancelled by the modules automatically once the fault has been eliminated.

To improve the overall system reliability, it is suggested that different physical routing of the duplex fiber optic cables of the two optical ports be provided.

The maximum permissible difference in length between the redundant duplex fiber optic cables is governed by the transmission rate being used. The corresponding values are given in Table 3.

To ensure trouble-free operation, the parameter T_{SDR} described in the PROFIBUS Standard DIN 19 245 must be set for all terminal units to a value $\geq 11$. This is generally the case but should be checked if communication problems are continuously encountered. How to change the setting is described in the manufacturer's documentation for the connected terminal unit.

The redundant transmitter-to-receiver link is activated with the following DIP switch settings:

- Mode 0
- Redundancy function on

<table>
<thead>
<tr>
<th>Transmission rate in kbit/s</th>
<th>9.6</th>
<th>19.2</th>
<th>9.75</th>
<th>187.5</th>
<th>500</th>
<th>1500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. perm. difference in length between redundant fiber optic lines in m</td>
<td>15000</td>
<td>15000</td>
<td>15000</td>
<td>10000</td>
<td>4000</td>
<td>1300</td>
</tr>
</tbody>
</table>

Table 3: Permissible difference in length between the two optical lines of a redundant transmitter-to-receiver link. The maximum possible distances between two modules should also be noted. The values can be taken from Table 1 or the Technical Data. Simultaneous compliance with both limit values is always to be ensured.
3.5 Redundant optical ring (two-fiber ring)

Fig. 7: Network structure with redundant optical two-fiber ring topology

This network topology is a special form of line topology. A high degree of network reliability is attained by “closing” the optical line. A redundant optical ring can be configured with Optical Link Modules OLM/P4, OLM/S4 or OLM/S4-1300.

The failure of a fiber optic cable between two Optical Link Modules has no effect on network availability. If, on the other hand, an Optical Link Module is faulty, only the terminal unit or RS 485 segment directly connected to the module is affected. The modules detect the total failure of an optical line from the absence of light pulses and segment the corresponding transmission path. This fault is indicated by the lighting (red) of the LED “CH3” or “CH4” and response of the signalling contact. Segmentation is automatically cancelled by the modules once the fault has been eliminated.

The maximum fiber optic cable length between two adjacent Optical Link Modules is governed by the transmission rate being used (see Table 4).

If problems are encountered with the configuration of a redundant optical ring on account of excessively long fiber-optic line sections, connections can also be implemented as shown in Fig. 8.

In this case, each module is linked – in spatial terms – with the next module except for one. Two adjacent modules are to be interconnected at the start and end of every such line. This avoids individual “excessively long” fiber-optic line sections.

To ensure trouble-free operation, the parameter $T_{SDF}$ described in the PROFIBUS Standard DIN 19 245 must be set for all terminal units to a value $\geq 11$. This is generally the case but should be checked if communication problems are continuously encountered.
How to change the setting is described in the manufacturer’s documentation for the connected terminal unit.

**Note:** All modules within a ring must be interconnected by way of fiber optic cables. Electrical connections do not constitute a ring.

A redundant optical ring is activated with the following DIP switch settings:

- Mode 0
- Redundancy function on

<table>
<thead>
<tr>
<th>Transmission rate in kbit/s</th>
<th>9.6</th>
<th>19.2</th>
<th>93.75</th>
<th>187.5</th>
<th>500</th>
<th>1500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. transmission distance between two modules in m</td>
<td>15000</td>
<td>15000</td>
<td>8500</td>
<td>4200</td>
<td>1600</td>
<td>530</td>
</tr>
</tbody>
</table>

*Table 4: Reduction in transmission distance with redundant optical ring topology as a function of transmission rate. The maximum possible distances between two modules as per Table 1 are also to be noted. In the event of different limit values, compliance with the lower value in each case is always to be ensured.*

![Fig. 8: Alternative wiring system for network structure with redundant optical two-fiber ring topology](image-url)

- RS 485 bus line
- Fiber optic cable
4 Start-Up

4.1 Safety precautions

⚠️ The SINEC L2 Optical Link Modules are only to be used in the manner indicated in this version of the “Description and Operating Instructions”. Particular attention is to be paid to all warnings and items of information relating to safety.

⚠️ The Optical Link Modules are only to be run off a safety extra-low voltage as per IEC 950/EN 60 950/VDE 0805 of max. +32 V (typ. +24 V).

⚠️ Pay attention to the electrical limit values when connecting voltage to the signalling contacts. The connected voltage must also correspond to a safety extra-low voltage as per IEC 950/EN 60 950/VDE 0805.

⚠️ Never connect the Optical Link Modules to 110 V - 240 V mains voltage.

⚠️ The installation location is to be selected so as to ensure compliance with the climatic limit values indicated in the Technical Data.

Notes on CE marking

The Optical Link Modules comply with the specifications of the following “European Directive” as well as with the harmonized European Standards (EN) quoted therein:


Compliance with the EMC limit values required by this legislation (see Technical Data) presupposes observance of the “Description and Operating Instructions” and in particular the installation specifications indicated in Section 4.8 “Installation”.

▶ Ensure adequate grounding of the Optical Link Modules by providing a low-impedance, low-inductance connection between the top-hat rail or base plate and the local ground.

▶ Make exclusive use of shielded and twisted two-wire leads as RS 485 bus line.

▶ Ensure that shield of RS 485 bus line makes proper, reliable contact with shielding clamp of Optical Link Module (port 2 only).

▶ Screw on securing flange of both terminal blocks.

In accordance with the above EU Directive, the EU Conformity Declarations are kept at the disposal of the appropriate authorities by

Siemens AG
Automation Group
Industrial Communication SINEC (AUT93)
P.O. Box 4848
D-90327 Nuremberg

The modules satisfy the following requirements:

<table>
<thead>
<tr>
<th>Area of use</th>
<th>Demand on Noise emission</th>
<th>Demand on Noise immunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential area</td>
<td>EN 50081-1: 1993</td>
<td>EN 50082-1: 1992</td>
</tr>
</tbody>
</table>
4.2 General notes

The first step is to select the network topology appropriate to the application. Start-up of the Optical Link Modules is then to be performed as follows:

- Check and if necessary adjust the DIP switches
- Connect optical bus lines
- Install Optical Link Modules
- Connect electrical RS 485 bus lines
- Connect power supply and signalling contacts

**Note:** As an alternative to the sequence of start-up operations listed here, the process described in Section 4.9 employing the start-up support can also be used.

Special applications require alteration of the DIP-switch factory settings:

- **Mode change**
  - If a unit from different manufacturer is used (not a SINEC L2 Optical Link Module) in the optical network segment

- **Activation of redundancy function**
  (Optical Link Modules OLM/P4, OLM/S4 and OLM/S3-1300)
  - Enhanced network operational reliability

- **Connection of terminating resistor combination on port 2**
  - Connecting lead between Optical Link Module and terminal unit more than 5 meters long
  - At start and end of RS 485 bus segment

- **Setting of network configuration**
  (Optical Link Modules OLM/S3, OLM/S4, OLM/S3-1300 and OLM/S4-1300)
  - “Standard” or “Extended” is to be selected depending on the length of the fiber optic cables, the number of modules and the data rate to be transmitted

- **Increased optical transmission power**
  (Optical Link Modules OLM/P3 and OLM/P4)
  - If optical distance to be covered is more than 50 meters

![Fig. 9: Top view of Optical Link Module indicating position of DIP switches and screw terminal block for power supply/signalling contacts. The illustration shows the factory settings of the DIP switches (switches S₁ to S₆ set to “0”).](image-url)
4.3 Mode change

The mode setting affects both optical ports on the OLM/P4, OLM/S4 and OLM/S4-1300 versions.

**Standard mode; mode 0**

This mode is used solely for optical interconnection of SINEC L2 Optical Link Modules. This applies to all the network topologies described and is the mode set at the factory.

The echo functions constantly check for breaks in the fiber optic cables connected to the Optical Link Module.

**Note:** A non-used optical port results in fiber-optic cable break signalling by the “CH3/CH4” LED and the signalling contact. This situation can be suppressed using a fiber optic link between the transmit and receive sockets of the port not being used (optical short circuit).

**Mode 1**

This mode is used for connecting a SINEC L2 Optical Link Module to another fiber optic network component as per the PROFIBUS directive (optical/electrical converter, e.g. SINEC L2 star coupler AS 501 or optical bus terminal PF/SF) which does not transmit, expect or accept an echo.

There is no fiber optic cable monitoring or segmentation.

**Note:** Ring topologies are not possible in mode 1.
4.4 Activation of redundancy function

To enhance reliability, the following redundant network configurations can be structured with the SINEC L2 Optical Link Modules OLM/P4, OLM/S4 and OLM/S4-1300:

- Line redundancy with transmitter-to-receiver links
- Redundant optical ring

- Mode 0 is to be set for all modules directly interlinked via optical fibers.
- The redundancy function is to be activated for all modules directly interconnected via optical fibers.
- Pay attention to the fiber optic cable length requirements as per Tables 1, 3 and 4.
- All modules within a ring must be interconnected via fiber optic cables.

Redundancy function

**OFF**
(Factory settings)

**ON**

To effect changeover, use a pointed object to move the slide switch S2 (Redundancy) to the appropriate position.

4.5 Connection of terminating resistor combination

Port 2 can be provided with terminating and pull-up/pull-down resistors by altering the setting of the slide switches S3 and S4.

This is necessary in the following situations:

- For connection of an Optical Link Module to the start and end of an RS 485 bus segment
- For electrical connecting leads (Optical Link Module – terminal unit) more than 5 meters long. In this case, the connecting lead is also to be terminated with an appropriate resistor combination on the terminal unit end.

Port 2 not terminated
(Factory settings)

Port 2 terminated

To effect changeover, use a pointed object to move the slide switches S3 and S4 (Termination) to the appropriate position. The settings of S3 and S4 must always be the same. Different switch settings can result in transmission interference.

Note: If use is made of port 1, it may have to be provided with an external resistor combination.

Fig. 10: Connection of terminating and pull-up/pull-down resistors to port 2. The stated resistance values are optimized for a type A bus line (refer to Appendix B).
4.6 Setting network configuration

"Standard" or "Extended" is to be selected depending on the length of the fiber optic cables, the number of modules and the data rate to be transmitted. Selection is made by altering the setting of slide switch S5. The following settings are required, depending on module type and network topology:

► Line and star topology
- Always select "Standard" setting.
- "Extended" is to be selected for Optical Link Modules OLM/S3-1300 and OLM/S4-1300 when the distance between two modules is more than 10.8 km and the transmission rate is 1500 kbit/s.

► Ring topology
- Select "Standard" for up to 16 modules in the ring.
- Calculate setting using Table 5 for 17 or more modules in the ring.

Note:
- This setting is not needed with Optical Link Modules OLM/P3 and OLM/P4.
- With ring topology, set all modules to the same configuration.
- Pay attention to the fiber-optic cable length requirements as per Tables 1, 3 and 4.

Example:
Assuming:
- Ring topology (one-fiber ring)
- 26 x OLM/S3
- Fiber optic cable length 38.5 km
- Transmission rate 500 kbit/s

48 < l + 0.6n < 92
48 < 54.1 < 92
→ S5 = 1

As a guide to planning, Appendix A contains a table indicating the maximum number of cascadable modules in an optical ring.
### 4.7 Increasing optical transmission power

If required, the optical transmission power of the SINEC L2 Optical Link Modules for polymer optical fibers **OLM/P3** and **OLM/P4** can be separately increased.

The increased transmission power is only to be used for distances between 50 and 80 meters. In this setting, there is a risk of another optical fiber network component connected to the Optical Link Module as per the PROFIBUS directive (optical/electrical converter) being overdriven.

- The slide switch S₆ has no function on the SINEC L2 Optical Link Module with three ports **OLM/P3**.

<table>
<thead>
<tr>
<th>Transmission power</th>
<th>S₅</th>
<th>S₆</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Standard&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission distance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 50 m (Factory settings)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transmission power</th>
<th>S₅</th>
<th>S₆</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;High&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased transmission</td>
<td></td>
<td></td>
</tr>
<tr>
<td>distance 50 - 80 m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For changeover, use a pointed object to move the slideswitches S₅ and S₆ (Optical Power) to the appropriate position.
4.8 Installation

Connection of optical bus lines

- Use a duplex fiber optic cable with BFOC/2.5 connectors to connect the individual Optical Link Modules. A simplex fiber optic cable is to be employed for one-fiber ring topology.
- Make sure that each optical input ☐ is connected to an optical output ☐ at the opposite end ("cross-over link").

The corresponding BFOC port sockets are marked on the lower front panel.
- Ensure sufficient strain relief for the fiber optic cables and pay attention to their minimum bending radii.
- Unused BFOC sockets are to be covered with the protective caps supplied. Incident ambient light, and in particular great ambient brightness, can affect the network.
- The ingress of dust may impair operation of the optical components.
- Pay attention to the maximum fiber optic cable lengths and the types of fibers which can be used as indicated in Table 1 and the Technical Data.

Connection specification for “redundant optical ring”

When
- adding an Optical Link Module to a redundant optical ring or
- replacing an Optical Link Module in a redundant optical ring

pay attention to the following connection sequence so as to ensure trouble-free data transfer between the PROFIBUS users:

- Initially only connect one duplex fiber optic cable to an arbitrary optical port.
- Depending on the chosen voltage supply, switch on the module by attaching the 5-pole terminal block or the 9-pin sub-D connector.
- Wait until the system LED (green) lights (recognition of transmission rate).
- Then connect the second duplex fiber optic cable.
Mounting Optical Link Modules

The SINEC L2 Optical Link Modules can either be mounted on a 35 mm top-hat rail as per EN 50 022 or directly on a flat surface.

- The installation location is to be selected so as to ensure compliance with the climatic limit values given in the Technical Data.
- Make sure there is sufficient space for connection of the bus and power supply lines.
- To facilitate installation of the fiber optic cables, they are to be connected before mounting the Optical Link Modules.
- The modules are only to be installed on a mounting plate or top-hat rail with low-impedance and low-inductance grounding. No other grounding measures are required.

**Installation on top-hat rail**
- Engage upper snap-in hooks of module in rail and press underside (as shown in Fig. 12) onto rail until it is heard to engage.
- Disassembly involves pulling down the locking slide.

**Installation on mounting plate**
- The Optical Link Modules are provided with three through-holes to permit installation on any flat surface – e.g. on the mounting plate of a switch cabinet.
- Make three holes in the mounting plate in line with the drilling pattern in Fig. 13.
- Secure the modules with machine bolts (e.g. M3 x 40).
- Ensure reliable electrical connection between module housing and mounting plate by placing toothed washers under the bolt heads, which then pierce the existing varnish.
**Connection of electrical RS 485 bus lines**

The SINEC L2 Optical Link Modules feature two separate electrical ports with RS 485 interfaces.

- **Port 1**: A short-circuit-proof 5 V output is provided at pins 5 and 6 for supplying external pull-up/pull-down resistors. The pin assignment corresponds to the standard PROFIBUS assignment.

- **Port 2**: An external terminating resistor combination is to be fitted if the module is at the start or end of a bus segment (use bus connector with integrated switchable terminating resistor combination).

**Connection of electrical RS 485 bus lines**

To avoid interference, ports 1 and 2 are not to be operated on the same RS 485 bus segment.

- The RS 485 bus line uses shielded and twisted two-wire leads. Appendix B lists the electrical parameters of the two types recommended by the appropriate Standard. The design of the Optical Link Modules is optimized for line type A. Use appropriate resistance values when employing a type B line and an external terminating resistor combination (port 1).

**Fig. 14: Port 1 – assignment of Sub-D connector**

**Fig. 15: Port 2 – assignment of two-pole terminal block**

There is no electrical isolation between the RS 485 bus lines RxD/TxD–N and RxD/TxD–P, the supply voltage and the housing (ground potential). Attention is therefore to be paid to the following safety precautions:

- Never connect Optical Link Modules via RS 485 bus lines to system components to which a different ground potential is being applied. The differences in voltage could destroy the modules.
- Never connect up any RS 485 bus lines which are laid entirely or partly outdoors, as otherwise lightning striking in the vicinity could destroy the modules. Fiber optic cables are to be used for bus connections which are routed out of buildings.

**Port 1**

Port 1 is a 9-pin sub-D connector. The pin assignment corresponds to the standard PROFIBUS assignment. A short-circuit-proof 5 V output is provided at pins 5 and 6 for supplying external pull-up/pull-down resistors.

- For connection of a terminal unit, make use of a lead fitted on either end with a 9-pin sub-D connector (male) with a max. length of 5 m (no terminating resistor combination required).
- For connection of an RS 485 bus segment, make use of a bus connector (looping-through of RS 485 bus line). An external terminating resistor combination is to be fitted if the module is at the start or end of a bus segment (use bus connector with integrated switchable terminating resistor combination).

**Port 2**

Port 2 is a two-pole terminal block.

- Connect the RS 485 bus line to the terminal block as shown in Fig. 15. Ensure proper electrical connection between braided screen and shielding clamp. If necessary, fold back braided screen over outer sheath of bus line to obtain a sufficiently large cable diameter for clamping.
- Additional strain relief is to be used if the RS 485 bus line is to be subjected to considerable strain.
- Two RS 485 bus lines with a cross-section of 2 x 0.65 mm² can be connected to the terminal block – e.g. for configuring an active PROFIBUS star coupler.
- Secure the terminal block by screwing on the flange.
Connection of power supply

The Optical Link Module is only to be supplied with a regulated safety extra-low voltage as per IEC 950/EN 60 950/VDE 0805 of max. +32 V (typ. +24 V). This is fed in either via the 9-pin sub-D connector or via the 5-pole terminal block on top of the module. The individual supplies are electrically isolated.

- Assignment of sub-D connector: Pin 2 (\(\perp\)) and Pin 7 (+24 V); assignment of terminal block: L1+/+24 V and M/\(\perp\).
- To enhance operational reliability, the Optical Link Module can also be provided with a redundant supply by way of the terminals L2+/+24 V* and M/\(\perp\). If the normal voltage supply fails, the module switches automatically to the redundant power supply. There is no load distribution between the individual supplies.
- Secure the terminal block by screwing on the flange.

A relay with floating contacts is provided as signalling contact at the 5-pole terminal block on top of the module. This permits signalling, for example to a master station, of the following network and module faults:

- No voltage supply or internal voltage supply defective; with redundant supply: failure of all supply voltages (system LED does not light)
- Recognition of excessively long transmission time or connected RS 485 bus line defective or RS 485 interface of connected terminal unit defective or RS 485 interface of Optical Link Module defective ("CH1" or "CH2" lights – red)
- Excessively long transmission time or continuous lighting (more than 12 consecutive low bits received) or with mode 0: Echo monitoring error detected (break in fiber optic cable, failure of echo-forming partner unit) ("CH3" or "CH4" lights – red)

Relay limit values
- Max. switching voltage: 60 VDC; 42 VAC
- Max. switching current: 1.0 A

The voltage connected to the relay must also correspond to a safety extra-low voltage as per IEC 950/EN 60 950/VDE 0805.
4.9 Start-up using start-up support (mode 0)

Pay attention to the information given in the preceding Section 4.8 with regard to all the operations to be performed.

- Install the Optical Link Modules.
- Connect the voltage supply.
  - The system LED flashes (red). Transmission rate not yet recognized.
- For all optical fiber lines: Connect fiber optic cables to partner module and check operability by way of LEDs.
  - The LEDs “CH3/CH4” light at intervals of 5 seconds. They indicate that start-up support pulses are being received and that the fiber optic cables are functioning properly.
- Once all fiber optic cables have been properly connected:
  - Connect two PROFIBUS stations to the PROFIBUS network (with PROFIBUS-DP: Connect at least one master station).
  - The “System” LEDs on all modules stop flashing (red) and switch to being continuously lit (green) (transmission rate recognized).
  - If there is only one active PROFIBUS user connected, which only transmits token messages to itself, this results in faults being indicated at the LEDs “CH3/CH4”.
- Then connect all other terminal units and RS 485 bus segments and wire up the signalling contacts if required.

4.10 Extension of existing network segments (OLM revision level 1)

- Existing line, star and one-fiber ring network topologies can be extended with OLM revision level 1. A maximum of two segments – configured in each case from up to 6 modules with revision level 1 – can be interconnected by one segment configured from modules with revision level 2.
- Existing redundant optical rings cannot be extended by way of modules with revision level 2 (exception: existing ring has less than 7 modules).

A defective module with revision level 1 can however be replaced by a module with revision level 2.

**Note:** The OLM revision level can be seen from the order number on the sticker on the side of the module:
- Revision level 1: 6GK1 502-...00
- Revision level 2: 6GK1 502-...10
5 LED Indicators

**System**
Red/green LED
- Not lit: No voltage supply or internal voltage supply defective
- Flashing red: Transmission rate not yet recognized; start-up phase
- Green light: Transmission rate recognized, voltage supply OK

**CH1 and CH2** (Channel)
Red/yellow LED
- Not lit: Data not being received
- Red light: Recognition of excessively long transmission time or connected RS 485 bus line defective or RS 485 interface of connected terminal unit defective or RS 485 interface of Optical Link Module defective
- Yellow light: Data being received

**CH3 and CH4** (Channel)
Red/yellow LED
- Not lit: Data not being received
- Red light: Excessively long transmission time or continuous lighting (more than 12 consecutive low bits received) or with mode 0: Echo monitoring error detected (break in fiber optic cable, failure of echo-forming partner unit)
- Flashing yellow: In mode 0: Start-up support pulses of partner received
- Yellow light: Data being received

*Fig. 19: LED indicators on front panel*
# Troubleshooting

## 6 Troubleshooting

### LED indication

<table>
<thead>
<tr>
<th>System</th>
<th>Possible causes of trouble</th>
<th>Signalling contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ not lit</td>
<td>- Failure of supply voltage</td>
<td>Signal</td>
</tr>
<tr>
<td>▶ flashing red</td>
<td>- Transmission rate not yet recognized (no PROFIBUS user transmitting; transmission rate greater than 1.5 Mbit/s; no link with partner module transmitting telegrams; transmission rate not in line with PROFIBUS standard)</td>
<td>No signal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CH1, CH2</th>
<th>Possible causes of trouble</th>
<th>Signalling contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ not lit</td>
<td>- Break in one or both cores of RS 485 bus line</td>
<td>No signal</td>
</tr>
<tr>
<td>▶ red light</td>
<td>- Cores A and B of RS 485 bus line interchanged</td>
<td>Signal</td>
</tr>
<tr>
<td>▶ yellow light</td>
<td>- Fault with non-terminated RS 485 bus segment: Break in one or two cores of the RS 485 bus line and cores A and B interchanged on connection (e.g. core A connected to CH2 B, break in CH2 A or core B connected to CH2 A, break in CH2 B)</td>
<td>No signal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CH3, CH4 (mode 0)</th>
<th>Possible causes of trouble</th>
<th>Signalling contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ not lit</td>
<td>- Break in one or both cores of RS 485 bus line</td>
<td>No signal</td>
</tr>
<tr>
<td>▶ flashing yellow (every 5 s)</td>
<td>- Module receiving start-up support pulses from connected partner module (no data transfer)</td>
<td>No signal</td>
</tr>
<tr>
<td>▶ red light</td>
<td>- Transmit and receive optical fibers interchanged</td>
<td>Signal</td>
</tr>
<tr>
<td></td>
<td>- Connected partner module defective (no transmission, also no start-up support pulses)</td>
<td>No signal</td>
</tr>
</tbody>
</table>

### Transmission rate not yet recognized, “System” LED flashes (red)

<table>
<thead>
<tr>
<th>Possible causes of trouble</th>
<th>Signalling contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Transmit and receive optical fibers interchanged</td>
<td>No signal</td>
</tr>
<tr>
<td>- Connected partner module defective (no transmission, also no start-up support pulses)</td>
<td>No signal</td>
</tr>
</tbody>
</table>

### Transmission rate recognized, “System” LED flashes (green)

<table>
<thead>
<tr>
<th>Possible causes of trouble</th>
<th>Signalling contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Incorrect network configuration setting (check optical fiber lengths and module cascading level)</td>
<td>No signal</td>
</tr>
<tr>
<td>- With redundant optical ring: Redundancy function not activated; must be switched on at all modules in ring</td>
<td>No signal</td>
</tr>
<tr>
<td>- Break in transmit optical fiber to partner module (echo monitoring error) → signalling contact of partner module indicates fault</td>
<td>No signal</td>
</tr>
<tr>
<td>- Periodic error (see above)</td>
<td>No signal</td>
</tr>
<tr>
<td>- Only one active PROFIBUS user connected, which only transmits token messages to itself; fault indication must disappear after switching in a second user</td>
<td>No signal</td>
</tr>
</tbody>
</table>
Troubleshooting

If all indications are OK, but communication problems are still encountered (e.g. no acknowledgement, unexpected telegrams), a check is made on the monitoring times (for example the slot time) set for the PROFIBUS users. Details are given in the descriptions of the appropriate PROFIBUS terminal units.

In the case of large PROFIBUS networks with numerous modules and long lines, allowance needs to be made when setting the monitoring times for the delay caused by network components and lines (transmission delay). This involves determining the transmission delay time (TTD): The transmission delay time is the maximum time which elapses when transmitting a telegram on the transmission medium from transmitter to receiver.

**Note:** If the planning software being used to configure the PROFIBUS network does not support the PROFIBUS parameter TTD, then the two times min. TSDR and max. TSDR are to be extended instead by 2 x TTD (reaction time of responder is extended by the outward and return transmission delay time).

**Calculation of transmission delay time TTD**

The first step is to determine the transmission link with the longest transfer time between telegram transmitter and receiver.

No allowance is made for PROFIBUS users which do not communicate with one another (e.g. DP slave with DP slave).

Indicators of long transfer times are:

- Long optical fiber or copper lines
- High cascading level of active components

1. Delay time of optical fiber and RS 485 lines

The delay time is approx. 5 µs for each km of line. Converted to bit periods this gives:

<table>
<thead>
<tr>
<th>Transmission rate in kbit/s</th>
<th>Delay time in µs per km</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.6</td>
<td>0.05</td>
</tr>
<tr>
<td>19.2</td>
<td>0.10</td>
</tr>
<tr>
<td>93.75</td>
<td>0.47</td>
</tr>
<tr>
<td>187.5</td>
<td>0.94</td>
</tr>
<tr>
<td>500.0</td>
<td>2.50</td>
</tr>
<tr>
<td>1500.0</td>
<td>7.50</td>
</tr>
</tbody>
</table>

*Table 6: Delay times of optical fiber and RS 485 bus lines*

For calculating the line delay time, the maximum line length in km is multiplied by the delay time corresponding to the transmission rate (see table).

2. Delay time of Optical Link Modules

The processing time per module is 1.5 bit periods. The overall processing delay results from the number of modules passed between telegram transmitter and receiver multiplied by 1.5 bit periods.

3. Delay time of other active PROFIBUS network components

The delay time is to be taken from the respective product documentation.

4. Transmission delay time TTD

The overall delay time is the sum total of the values determined in 1, 2, and 3.
7 Technical data

<table>
<thead>
<tr>
<th>Modul</th>
<th>OLM/P3</th>
<th>OLM/S3</th>
<th>OLM/S3-1300</th>
<th>OLM/S4-1300</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OLM/P4</td>
<td>OLM/S4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating voltage</td>
<td>18 V - 32 V DC (redundant inputs isolated)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety extra-low voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current input</td>
<td>max. 220 mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output voltage (pin 5)</td>
<td>5 V ±5%/-10%; short-circuit-proof</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output current (pin 5)</td>
<td>≤7 mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission rate</td>
<td>9.6; 19.2; 93.75; 187.5; 500; 1500 kBit/s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission rate setting</td>
<td>automatic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bit error rate</td>
<td>&lt;10⁻⁹</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input, ports 1 to 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bit length</td>
<td>0.53 to 1.46 t_bit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jitter</td>
<td>-0.03 to +0.03 t_bit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output, ports 1 to 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bit length</td>
<td>0.99 to 1.01 t_bit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jitter</td>
<td>-0.003 to +0.003 t_bit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signal processing time</td>
<td>≤1.5 t_bit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(any input/output)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Electrical ports**

- Input/output signal: RS 485 level
- Input electric strength: -10 V to +15 V
- Pin assignment of port 1: as per DIN 19 245 Part 1
- Electrical isolation: no
- Terminating resistors: connection to port 2

**Optical ports**

- Optical source: LED
- Launchable optical power:
  - into fiber 10/125: -19.5 dBm
  - into fiber 50/125: -17 dBm
  - into fiber 62.5/125: -17 dBm
  - into fiber 100/140: -12.5 dBm
  - into fiber 980/1000 ("Standard" transm. power): -11 dBm
  - into fiber 980/1000 ("High" transm. power): -5 dBm
- Wavelength: 660 nm, 860 nm, 1310 nm
- Receiver sensitivity:
  - Standard: -27 dBm
  - High: -28 dBm
- Receiver overdrive limit:
  - Standard: -29 dBm
  - High: -3 dBm
## Technical data

<table>
<thead>
<tr>
<th>Module</th>
<th>OLM/P3</th>
<th>OLM/P4</th>
<th>OLM/S3</th>
<th>OLM/S4</th>
<th>OLM/S3-1300</th>
<th>OLM/S4-1300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission distance with 2 dB(^1)/3 dB(^2) system reserve/line attenuation</td>
<td>-</td>
<td>-</td>
<td>0 - 15000 m/9.5 dB(^1)</td>
<td>-</td>
<td>0 - 10000 m/12 dB(^1)</td>
<td></td>
</tr>
<tr>
<td>with fiber 10/125 (0.5 dB/km)</td>
<td>-</td>
<td>-</td>
<td>0 - 2000 m/9 dB(^2)</td>
<td>-</td>
<td>0 - 10000 m/12 dB(^1)</td>
<td></td>
</tr>
<tr>
<td>with fiber 50/125 (860 nm: 3.0 dB/km; 1310 nm: 1.0 dB/km)</td>
<td>-</td>
<td>0 - 50 m/16 dB(^1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>with fiber 62.5/125 (860 nm: 3.5 dB/km; 1310 nm: 1.5 dB/km)</td>
<td>-</td>
<td>0 - 2850 m/13 dB(^2)</td>
<td>0 - 10000 m/12 dB(^1)</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>with fiber 100/140 (5.0 dB/km)</td>
<td>-</td>
<td>0 - 3100 m/15.5 dB(^2)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>with fiber 980/1000 (0.25 dB/m)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>“Standard” transmission power</td>
<td>0 - 50 m/16 dB(^1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>“High” transmission power</td>
<td>50 - 80 m/22 dB(^1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Connectors</td>
<td>BFOC/2.5</td>
<td>BFOC/2.5</td>
<td>BFOC/2.5</td>
<td>BFOC/2.5</td>
<td>BFOC/2.5</td>
<td>BFOC/2.5</td>
</tr>
<tr>
<td><strong>EMC protection</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise emission</td>
<td>EN 55011 class B</td>
<td>EN 55011 class B</td>
<td>EN 55011 class B</td>
<td>EN 55011 class B</td>
<td>EN 55011 class B</td>
<td>EN 55011 class B</td>
</tr>
<tr>
<td>to shield connection and housing components:</td>
<td>±8 kV relay discharge</td>
<td>±8 kV relay discharge</td>
<td>±8 kV relay discharge</td>
<td>±8 kV relay discharge</td>
<td>±8 kV relay discharge</td>
<td>±8 kV relay discharge</td>
</tr>
<tr>
<td>Noise immunity, electromagnetic fields</td>
<td>IEC 801-3: 10 V/m</td>
<td>IEC 801-3: 10 V/m</td>
<td>IEC 801-3: 10 V/m</td>
<td>IEC 801-3: 10 V/m</td>
<td>IEC 801-3: 10 V/m</td>
<td>IEC 801-3: 10 V/m</td>
</tr>
<tr>
<td>Noise immunity, conducted interference</td>
<td>IEC 801-4</td>
<td>IEC 801-4</td>
<td>IEC 801-4</td>
<td>IEC 801-4</td>
<td>IEC 801-4</td>
<td>IEC 801-4</td>
</tr>
<tr>
<td>to power supply lines: ±2 kV</td>
<td>to shielded RS 485 bus lines: ±2 kV</td>
<td>to shielded RS 485 bus lines: ±2 kV</td>
<td>to shielded RS 485 bus lines: ±2 kV</td>
<td>to shielded RS 485 bus lines: ±2 kV</td>
<td>to shielded RS 485 bus lines: ±2 kV</td>
<td>to shielded RS 485 bus lines: ±2 kV</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>0 °C to +60 °C</td>
<td>0 °C to +60 °C</td>
<td>0 °C to +60 °C</td>
<td>0 °C to +60 °C</td>
<td>0 °C to +60 °C</td>
<td>0 °C to +60 °C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40 °C to +70 °C</td>
<td>-40 °C to +70 °C</td>
<td>-40 °C to +70 °C</td>
<td>-40 °C to +70 °C</td>
<td>-40 °C to +70 °C</td>
<td>-40 °C to +70 °C</td>
</tr>
<tr>
<td>Relative humidity (non-condensing)</td>
<td>&lt;95%</td>
<td>&lt;95%</td>
<td>&lt;95%</td>
<td>&lt;95%</td>
<td>&lt;95%</td>
<td>&lt;95%</td>
</tr>
<tr>
<td>Degree of protection</td>
<td>IP 40</td>
<td>IP 40</td>
<td>IP 40</td>
<td>IP 40</td>
<td>IP 40</td>
<td>IP 40</td>
</tr>
<tr>
<td>Weight</td>
<td>500 g</td>
<td>500 g</td>
<td>500 g</td>
<td>500 g</td>
<td>500 g</td>
<td>500 g</td>
</tr>
<tr>
<td>Dimensions</td>
<td>39.5 x 110 x 73.2 mm</td>
<td>39.5 x 110 x 73.2 mm</td>
<td>39.5 x 110 x 73.2 mm</td>
<td>39.5 x 110 x 73.2 mm</td>
<td>39.5 x 110 x 73.2 mm</td>
<td>39.5 x 110 x 73.2 mm</td>
</tr>
<tr>
<td>Housing material</td>
<td>Die-cast zinc</td>
<td>Die-cast zinc</td>
<td>Die-cast zinc</td>
<td>Die-cast zinc</td>
<td>Die-cast zinc</td>
<td>Die-cast zinc</td>
</tr>
</tbody>
</table>

Technical data only listed for types OLM/P3 and OLM/P4 also apply to versions OLM/S3, OLM/S4, OLM/S3-1300 and OLM/S4-1300.
8 Appendix

A Maximum number of modules in an optical ring

To assist with the planning of PROFIBUS field bus networks employing optical ring topology, Table 7 gives the maximum possible number of Optical Link Modules in a ring. Using less than the maximum possible distance leads to a considerable increase in the number of modules. All modules within a ring must be interconnected via fiber optic cables. Electrical connections do not constitute a ring.

<table>
<thead>
<tr>
<th>Transmission rate in kbit/s</th>
<th>OLM/S3-1300</th>
<th>OLM/S4-1300</th>
<th>OLM/S3-1300</th>
<th>OLM/S4</th>
<th>OLM/S3</th>
<th>OLM/P3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10/125 µm</td>
<td>50+62.5/125 µm</td>
<td>62.5/125 µm</td>
<td>50/125 µm</td>
<td>980/1000 µm</td>
<td></td>
</tr>
<tr>
<td>9.6</td>
<td>102</td>
<td>115</td>
<td>140</td>
<td>144</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>19.2</td>
<td>77</td>
<td>92</td>
<td>129</td>
<td>135</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>93.75</td>
<td>42</td>
<td>42</td>
<td>81</td>
<td>94</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>187.5</td>
<td>42</td>
<td>42</td>
<td>55</td>
<td>68</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>500.0</td>
<td>41</td>
<td>41</td>
<td>41</td>
<td>41</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>1500.0</td>
<td>41</td>
<td>41</td>
<td>41</td>
<td>41</td>
<td>78</td>
<td></td>
</tr>
</tbody>
</table>

Table 7: This table lists the maximum number of cascadable modules in an optical ring. The table relates to the switch setting “Extended” (only for modules with glass-fiber cables). The data are based on utilisation of the maximum possible distance between two modules, which is governed by the type of module, the fiber used and the reduction in distance as per Table 4.

B Electrical parameters of RS 485 bus lines

The following cable can be used for connecting an RS 485 bus segment and individual terminal units to the Optical Link Modules:
- Type A as per PROFIBUS-DP; (DIN 19 245 Part 2)
- Type B as per DIN 19 245 Part 1; 04.91; Section 3.1.2.3

Pay attention to restricted range and transmission rate of type B line as per Table 2.
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- G. Mahlke, P Gössig:
  „Lichtwellenleiterkabel: Grundlagen, Kabeltechnik“
  3rd edition, Berlin 1992

- Technical directive:
  „Optische Übertragungstechnik für PROFIBUS“, Publisher PROFIBUS-Nutzerorganisation e. V., Karlsruhe

- DIN 19245 Part 1 (04.91):
  „Messen, Steuern, Regeln; PROFIBUS Teil 1; Process Field Bus; Übertragungstechnik, ...“

- DIN 19245 Part 2 (10.91):
  „Messen, Steuern, Regeln; PROFIBUS Teil 3; Process Field Bus; Dezentrale Peripherie (DP)“

- EIA Standard RS-485 (April 1983):
  „Standard for electrical characteristics of generators and receivers for use in balanced digital multipoint systems“
B Appendix
SIMATIC NET
Optical Link Plug (OLP) for PROFIBUS
B  The SIMATIC NET Optical Link Plug (OLP) for PROFIBUS

Figure B. 1: Optical Link Plug (OLP)

B.1  Components

1 x optical link plug
2 x HP simplex connector for plastic fiber-optic cable 980/1000 μm
1 x installation manual

The product does not include the following:

> Plastic fiber-optic cable, available in meters
> Tools for fitting the HP simplex connector
> Plastic fiber-optic cable, one end preassembled with BFOC connector for OLM/P (BFOC pigtails)
B.2 Function

B.2.1 Technical Description

The SIMATIC NET OLP (Optical Link Plug) is used to implement optical PROFIBUS networks with a ring topology (optical single-fiber ring with plastic fiber-optic cable). A SIMATIC NET OLM/P3 (Optical Link Module) or an OLM/P4 is required as the coordinator of the optical ring (see B5 /1/). One 1 OLM/P3 or OLM/P4 exists in each single-fiber ring.

The OLP is plugged directly into the 9-pin sub D female connector of a PROFIBUS device and is supplied with power via this connector. The conditions for using the OLP with a PROFIBUS device are as follows:

- The PROFIBUS device must have a PROFIBUS interface implemented as a 9-pin sub D female connector and have sufficient space to plug in the OLP and to attach the plastic fiber-optic cable. The cable must not be bent beyond the minimum bending radius of the fiber-optic cable being used.
- The PROFIBUS interface of the device provides at least 80 mA for external devices at the 5 V power terminal of the RS 485 interface (pins 5 and 6).
- The PROFIBUS device is a passive device (slave, for example an input/output module from the ET200 range).

The optical link plug can also be used as follows:

- If the OLP is connected on a point-to-point link with an OLM/P3 or OLM/P4, an active device (master) can also be connected to the OLP (see Figure B. 2).
- The OLP can be plugged into the PG interface of the RS 485 repeater if only passive PROFIBUS devices are connected to bus segment 2. On bus segment 1, only the OLP can be connected (see Figure B. 2).

⚠️ Make sure that your equipment meets the conditions for using the OLP. For further information, refer to the description of your PROFIBUS device.

Active PROFIBUS devices (masters) and further slave devices are connected via the OLM/P3 or OLM/P4 to the single-fiber ring.

Figure B. 2: Possible Configurations using an OLP
### B.2.2 Technical Data

#### Power supply
<table>
<thead>
<tr>
<th>Parameter</th>
<th>min.</th>
<th>typ.</th>
<th>max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage</td>
<td>4.5</td>
<td>5</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>Current consumption</td>
<td>60</td>
<td>80</td>
<td></td>
<td>mA</td>
</tr>
</tbody>
</table>

#### RS 485 Interface
<table>
<thead>
<tr>
<th>Parameter</th>
<th>min.</th>
<th>typ.</th>
<th>max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input dielectric strength</td>
<td>-8</td>
<td></td>
<td>+12</td>
<td>V</td>
</tr>
<tr>
<td>Terminating resistors</td>
<td>no</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idle setting</td>
<td>100 kΩ Pull up/down</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pinout</td>
<td>DIN19245 Part 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Optical Interface
<table>
<thead>
<tr>
<th>Parameter</th>
<th>min.</th>
<th>typ.</th>
<th>max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiver sensitivity</td>
<td>-21.6</td>
<td>-9.5</td>
<td>-5.5</td>
<td>dBm</td>
</tr>
<tr>
<td>Receiver wavelength</td>
<td>660</td>
<td></td>
<td></td>
<td>nm</td>
</tr>
<tr>
<td>Transmit power (LED)</td>
<td>-13.4</td>
<td>-8.6</td>
<td>-5.5</td>
<td>dBm</td>
</tr>
<tr>
<td>Transmitter wavelength</td>
<td>640</td>
<td>650</td>
<td>660</td>
<td>nm</td>
</tr>
<tr>
<td>Plastic fiber</td>
<td>980/1000</td>
<td></td>
<td></td>
<td>µm</td>
</tr>
<tr>
<td>Cable attenuation</td>
<td>250</td>
<td></td>
<td></td>
<td>dB/km</td>
</tr>
</tbody>
</table>

#### Digital Section
<table>
<thead>
<tr>
<th>Parameter</th>
<th>min.</th>
<th>typ.</th>
<th>max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal delay opt. input -&gt; opt. output</td>
<td>0.75</td>
<td></td>
<td>Bit time</td>
<td></td>
</tr>
<tr>
<td>Signal delay opt. input -&gt; RS485 output</td>
<td>0.75</td>
<td></td>
<td>Bit time</td>
<td></td>
</tr>
<tr>
<td>Signal delay RS485 input -&gt; opt. output</td>
<td>40</td>
<td>220</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Bit duration opt. input channel</td>
<td>0.7</td>
<td>1</td>
<td>1.3</td>
<td>Bit time</td>
</tr>
<tr>
<td>Bit duration (*1) RS485 and opt. output channel</td>
<td>0.99</td>
<td>1</td>
<td>1.01</td>
<td>Bit time</td>
</tr>
</tbody>
</table>

*1: Does not apply to the stop bit, this can be shortened or extended by ±1/8 bit time

#### Transmission rate
<table>
<thead>
<tr>
<th>Rate</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>93.75</td>
<td>Kbps</td>
</tr>
<tr>
<td>187.5</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td></td>
</tr>
</tbody>
</table>

#### Environmental Conditions
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interference emission</td>
<td>EN 55011 (Limit class B)</td>
</tr>
<tr>
<td>Immunity to static discharge</td>
<td>IEC 801-2: 2 kV</td>
</tr>
<tr>
<td>Immunity to electromagnetic fields</td>
<td>IEC 801-3: 10 V/m</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>0 °C to +60 °C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40 °C to +70 °C</td>
</tr>
<tr>
<td>Relative humidity (no condensation)</td>
<td>&lt; 95%</td>
</tr>
<tr>
<td>Type of protection</td>
<td>IP 20</td>
</tr>
<tr>
<td>Weight</td>
<td>30 g</td>
</tr>
<tr>
<td>Dimensions</td>
<td>16 x 44 x 50 mm</td>
</tr>
<tr>
<td>Casing material</td>
<td>NORYL-SE1-GSN1, glass fiber reinforced</td>
</tr>
</tbody>
</table>
### B.2.3 Applications

The OLP has been tested for connection to the following PROFIBUS devices:

<table>
<thead>
<tr>
<th>Device Name</th>
<th>Master Slave</th>
<th>Remarks</th>
<th>OLP can be used</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIMATIC S5</td>
<td>M + S</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>IM 308–C</td>
<td>M + S</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>CP 5431 FMS/DP</td>
<td>M</td>
<td>Optical interface already integrated</td>
<td>yes</td>
</tr>
<tr>
<td>S5–95U/DP</td>
<td>M + S</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>SIMATIC S7–300</td>
<td>M + S</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>CP 342–5</td>
<td>M + S</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>CPU 314</td>
<td>M</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>CPU 315–2–DP</td>
<td>M + S</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>SIMATIC S7–400</td>
<td>M</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>CP 343–5</td>
<td>M</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>CP 443–5</td>
<td>M + S</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>CPU 413–2 DP</td>
<td>M</td>
<td>Cover of the connector compartment cannot be closed</td>
<td>no</td>
</tr>
<tr>
<td>CPU 414–2 DP</td>
<td>M</td>
<td>Cover of the connector compartment cannot be closed</td>
<td>no</td>
</tr>
<tr>
<td>PC Modules</td>
<td>M</td>
<td>Cable leaves in an upwards direction</td>
<td>yes</td>
</tr>
<tr>
<td>Distributed I/Os</td>
<td>S</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>ET 200M, IM 153</td>
<td>S</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>ET 200U, IM 318–C</td>
<td>S</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>ET 200B</td>
<td>S</td>
<td>All versions</td>
<td>yes</td>
</tr>
<tr>
<td>ET 200L</td>
<td>S</td>
<td>Operating current too low</td>
<td>no</td>
</tr>
<tr>
<td>ET 200C</td>
<td>S</td>
<td>No sub D connector present</td>
<td>no</td>
</tr>
<tr>
<td>ET 200X</td>
<td>S</td>
<td>No sub D connector present</td>
<td>no</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>–</td>
<td>See conditions for use</td>
<td>yes</td>
</tr>
<tr>
<td>Repeater RS 485</td>
<td>–</td>
<td>Operating current too low</td>
<td>no</td>
</tr>
<tr>
<td>OLM, channel 1</td>
<td>–</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>DP Interface Module for Power Switch 3WN6 DP/RS 485</td>
<td>S</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>SIMOCODE–DP, Motor Contactor and Control Device 3UF50</td>
<td>S</td>
<td></td>
<td>no</td>
</tr>
<tr>
<td>DP Interface Module for Hand–Held Unit PSION DP/RS232</td>
<td>S</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>DP/AS–i Link IP20</td>
<td>S</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>TI</td>
<td>M</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>SIMATIC TI505 FIM</td>
<td>M</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>SIMATIC TI505 PROFIBUS–DP RBC</td>
<td>S</td>
<td></td>
<td>yes</td>
</tr>
</tbody>
</table>
B.2.4 Length Restrictions for Plastic Fiber-Optic Cables

The following table shows the length restrictions for fiber-optic cables:

| Fiber : POF 980/1000 µm | Attenuation : max. 250 dB/km | System margin : 2 dB |

<table>
<thead>
<tr>
<th>From OLP</th>
<th>To OLP/M/P</th>
<th>OLP (output power = standard)</th>
<th>OLP/M/P (output power = high)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLP</td>
<td>L(<em>\text{min}) = 1 m, L(</em>\text{max}) = 25 m</td>
<td>L(<em>\text{min}) = 1 m, L(</em>\text{max}) = 34 m</td>
<td>L(<em>\text{min}) = 33 m, L(</em>\text{max}) = 58 m</td>
</tr>
<tr>
<td>OLM/P</td>
<td>L(<em>\text{min}) = 0 m, L(</em>\text{max}) = 46 m</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Refer to the OLM manual B5 /1/.

Make sure that the minimum and maximum fiber-optic cable lengths are adhered to between two neighboring OLPs or between an OLM and OLP.

B.2.5 OLP Cascading Depth

The number of OLPs that can be operated in a single–fiber ring is limited. Using the maximum plastic fiber-optic cable lengths, the following cascading depths are possible depending on the transmission rate.

<table>
<thead>
<tr>
<th>Transmission rate (Kbps)</th>
<th>93.75</th>
<th>187.5</th>
<th>500</th>
<th>1500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum number of OLPs in the single–fiber ring</td>
<td>13</td>
<td>12</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

If the maximum plastic fiber-optic cable lengths are not used, you can increase the OLP cascading depth. In this case, the configuration must be checked.

The following maximum lengths for an OLP single–fiber ring must not be exceeded (depending on the transmission rate):

<table>
<thead>
<tr>
<th>Transmission rate (Kbps)</th>
<th>93.75</th>
<th>187.5</th>
<th>500</th>
<th>1500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum permitted ring length (m)</td>
<td>21320</td>
<td>10660</td>
<td>4000</td>
<td>1334</td>
</tr>
</tbody>
</table>

When calculating the ring length, the lengths of all the plastic fiber-optic cables are totalled. The delay time equivalent at the transmission rate being used is added for each OLP in the ring (see following table).

<table>
<thead>
<tr>
<th>Transmission rate (Kbps)</th>
<th>93.75</th>
<th>187.5</th>
<th>500</th>
<th>1500</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLP delay time equivalent (m)</td>
<td>1600</td>
<td>800</td>
<td>300</td>
<td>100</td>
</tr>
</tbody>
</table>

The single–fiber ring cannot function if the calculated total length of the ring is greater than the maximum permitted ring length.

If the total calculated ring length exceeds the maximum ring length, the PROFIBUS network cannot be implemented.

Example:

You want to implement a single-fiber ring with a transmission rate of 1500 Kbps (permitted maximum ring length 1334 m, OLP delay time equivalent 100 m). The total of all the plastic fiber-optic cables in the single-fiber ring is 130 m. 1 OLM/P3 and 12 OLPs are required.
This results in a ring total length of 130 m + 12 x 100 m = 1330 m. This value is below the permitted maximum ring length of 1334 m, this PROFIBUS network with 12 OLPs can be implemented.
B.3 Installation

B.3.1 Unpacking

✓ Check that the package is supplied complete (see delivery note).
✓ Remove the packing material from all the components.
✓ Check the individual components for damage.

⇒ Only install undamaged components

B.3.2 Settings

Using jumpers X0 and X1 inside the casing, the OLP can be set for operation at transmission rates of 1500 Kbps, 500 Kbps, 187.5 Kbps and 93.75 Kbps.

When supplied, the OLP is set to 1500 Kbps.

You can check the current setting of the transmission rate through the window in the casing.

To change the transmission rate, follow the steps below:

✓ Open the casing by raising the cover at the point marked by X in the figure below and then lift off the casing.

⇒ Caution: Do not touch any electronic components since these can be damaged by electrostatic discharge!

✓ Set the transmission rate by changing the jumper settings for X1 and X0.

<table>
<thead>
<tr>
<th>Transmission Rate</th>
<th>X1</th>
<th>X0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500 Kbps</td>
<td>2-3</td>
<td>2-3</td>
</tr>
<tr>
<td>500 Kbps</td>
<td>2-3</td>
<td>1-2</td>
</tr>
<tr>
<td>187.5 Kbps</td>
<td>1-2</td>
<td>2-3</td>
</tr>
<tr>
<td>93.75 Kbps</td>
<td>1-2</td>
<td>1-2</td>
</tr>
</tbody>
</table>

✓ Close the casing by positioning the cover on the base section and pressing down until it clips into place.

⇒ All the transmission components in a PROFIBUS network must be set to the same transmission rate.
The SIMATIC NET OLM/P3 or OLM/P4 installed as the coordinator of the optical single–fiber ring must be set as follows:

√ Set the OLM mode 1 (switch off path monitoring, switch S1 = 1).

☞ Note that with an OLM/P4, the mode setting is effective for both optical channels.

√ Switch off the redundancy function (switch S2 = 0).

√ Set the switches S3 = 1 and S4 = 1 if the OLM is operated via channel 2
  - at the start or end of an RS 485 bus segment, or
  - if it is connected to a DTE with an electrical connecting cable longer than 5 m.
  Otherwise, leave the default setting of the switches (S3 = 0 and S4 = 0).

√ Set the optical power of channel 3 or channel 4 as follows:
  S5 = 0: Connection of OLP to OLM/P channel 3
  Cable length from OLM/P to first OLP between 2 m and 34 m
  S5 = 1: Connection of OLP to OLM/P channel 3,
  Cable length from OLM/P to first OLP between 33 m and 58 m
  S6 = 0: Connection of OLP to OLM/P channel 4,
  Cable length from OLM/P to first OLP between 2 m and 34 m
  S6 = 1: Connection of OLP to OLM/P channel 4,
  Cable length from OLM/P to first OLP between 33 m and 58 m

The transmission rate on the OLM is set automatically.

For information about the settings and installing the OLM, please refer to the OLM manual.
B.3.3 Assembling the Plastic Fiber-Optic Cable

Each OLP is supplied with two simplex connectors of the HFBR 4531. This connector can be fitted without any special tools. You simply require the following:

- Sharp knife
- Insulation stripper
- 600 grit abrasive paper
- Lint-free cotton cloth
- Cleaning alcohol

Procedure:

✔ Remove the last 5 mm of the jacket of the plastic fiber-optic cable with the insulation stripper.

⚠️ Caution: The fiber-optic cable must not be scratched.

✔ Fit the fiber-optic cable into the HB simplex connector as far as it will go. Make sure that the fiber extends at least 3 mm beyond the tip of the connector.

✔ Secure the fiber by closing and locking the rear section of the connector.

✔ Cut the fiber so that it extends 1.5 mm beyond the connector.

✔ Lay the abrasive paper on a flat solid surface and grind the fiber until it is flush with the tip of the connector by rubbing the tip of the connector over the abrasive paper describing a figure of 8.

✔ Clean away any remnants from the tip of the connector using a cloth dipped in alcohol.

⚠️ Caution:
If the fiber still extends beyond the HP simplex connector and the connector is inserted into the OLP, the transmit and receive elements of the OLP may be damaged.
B.3.4 Installation

✓ Connect the assembled plastic fiber-optic cable to the OLP as follows:
  - Insert the HP simplex connector with the incoming signal into the blue
    receive socket
  - Insert the HP simplex connector with the outgoing signal into the gray
    transmit socket.

⚠️ Plastic fiber-optic cables can be damaged by bending them beyond the minimum bending radius or by crimping them.

⚠️ Make sure that the plug and socket are free of any dirt.

✓ Insert the OLP into the 9-pin sub D female connector of the RS 485 interface of the PROFIBUS device with the power supply switched off.

⚠️ Note: Only insert or remove the OLP when the PROFIBUS slave is turned off.

✓ Secure the OLP by tightening the screw.
B.3.5 Connection to the RS 485 Repeater

✓ Connect the RS 485 segment to the terminal block of bus segment 2 as described in the installation instructions for the RS 485 repeater.

Caution:
Bus segment 1 of the RS 485 repeater must not be connected and only PROFIBUS slaves must be connected to bus segment 2.

✓ Connect the assembled plastic fiber-optic cable to the OLP, as follows:
  - Insert the HP simplex connector with the incoming signal into the blue receiving socket.
  - Insert the HP simplex connector with the outgoing signal into the gray transmit socket.

Plastic fiber-optic cables can be damaged by bending them beyond the minimum bending radius or by crimping them.

Make sure that the plug and socket are free of any dirt.

✓ Connect the OLP to the PG/OP interface with the RS 485 repeater turned off.

Caution: Only insert or remove the OLP when the power supply to the RS 485 repeater is turned off.

✓ Secure the OLP by tightening the screw.
B.3.6 Connection to a PROFIBUS Master

If the master in an optical single-fiber ring is connected via an OLP, the single-fiber ring must not contain any further OLPs.

The OLP can be operated with the PROFIBUS devices listed in Section B.2.3.

✓ Connect the assembled plastic fiber-optic cable to the OLP, as follows:
  - Insert the HP simplex connector with the incoming signal into the blue receiving socket.
  - Insert the HP simplex connector with the outgoing signal into the gray transmit socket.

❄ Fiber-optic cables can be damaged by bending them beyond the minimum bending radius or by crimping them.

❄ Make sure that the plug and socket are free of any dirt.

✓ Connect the OLP to the 9-pin sub D socket of the RS 485 interface of the PROFIBUS master (MPI interface) with the device switched off.

❄ Caution: Only insert or remove the OLP when the PROFIBUS master is switched off.

✓ Secure the OLP by tightening the screw.
B.4 Startup

B.4.1 Avoiding Problems

✔ Keep to the ESD guidelines (Electrostatically Sensitive Devices), particularly when the OLP is open.

✔ Risk of injury to eyes: Do not look into the transmit socket/fiber-optic cable directly.

✔ Handling the plastic fiber-optic cable: Do not bend beyond the minimum bending radius, do not crimp, keep free of dust.

✔ Insert/remove the OLP only when the host device is turned off.

B.4.2 How to Start Up

After switching on the power supply to the PROFIBUS device, the OLP is ready for operation immediately.

If the optical single-fiber ring is correctly installed, the yellow channel display LED of the corresponding optical channel of the OLM/P is lit as soon as data are exchanged between the PROFIBUS master and the PROFIBUS slaves (function display).

If the channel display LED does not light up or there are problems in communication, check whether one of the following faults or errors is causing the problem:

➢ Is the PROFIBUS master transmitting?
  The master transmits when the yellow channel display LED on the OLM lights up for the channel to which the PROFIBUS master is connected.

➢ Is the setting for the transmission rate the same on all OLPs as on the PROFIBUS network?

➢ Is the power supply turned on for all passive PROFIBUS devices in the single-fiber ring?

➢ Is the power supply switched on for the OLM/P?

➢ Are the fiber-optic cables correctly connected (optical input connected to optical output)?

➢ Are the fiber-optic cable lengths and number of cascaded OLPs within the limits?

➢ Are the mode switches set correctly on the OLM?

B.4.3 Uninstalling the OLP

✔ Switch off the PROFIBUS slave.

✔ Loosen the screw securing the OLP.

✔ Remove the OLP from the RS 485 interface of the PROFIBUS device.

✔ Remove the fiber-optic cable by pulling out the connector.

**Caution:**

When removing a fiber-optic cable, never pull the cable itself. Make sure you only pull the connector.
B.5 References

/1/ SIMATIC NET Optical Link Module OLM
Description and manual, Version 2.0

/2/ EN 50170-1-2: 1996
General Purpose Field Communication System
Volume 2: Physical Layer Specification and Service Definition
Notes on the CE Approval for SIMATIC NET Products

Product Name: Optical Link Plug (OLP) 6GK1502-1AA00
EC Directive: The SIMATIC NET product listed above meets the requirements of EC directive 89/336/EEC “Electromagnetic Compatibility”.
EMV89/336/EEC: The CE conformity certificates are kept for the authorities responsible according to the EC directive listed above at the following address:
SIEMENS Aktiengesellschaft
Bereich Automatisierungstechnik
AUT 93
Postfach 4848
D–90327 Nürnberg
Federal Republic of Germany

Area of Application: The product meets the following requirements:

<table>
<thead>
<tr>
<th>Area of Application</th>
<th>Requirements For Noise Emission</th>
<th>Noise immunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>EN 50081–1: 1992</td>
<td>EN 50082–1: 1992</td>
</tr>
</tbody>
</table>

Installation Guidelines: This product meets the requirements providing that you adhere to the installation instructions during installation and operation as described in this document.

Working on the Product: To protect the product from static electric discharge, personnel must first discharge any static electrical charge from their bodies before touching the module.

Note: The product was tested in a device that meets the requirements of the standards above. If the module is operated in a device that does not meet these standards, there is no guarantee that values quoted can be maintained.
Appendix
General Information
# General Information

## C.1 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al</td>
<td>Aluminum</td>
</tr>
<tr>
<td>AS–Interface</td>
<td>Actuator-Sensor Interface</td>
</tr>
<tr>
<td>AWG</td>
<td>American Wire Gauge</td>
</tr>
<tr>
<td>BER</td>
<td>Bit Error Rate</td>
</tr>
<tr>
<td>BFOC</td>
<td>Bajonet Fiber Optic Connector</td>
</tr>
<tr>
<td>CP</td>
<td>Communications Processor</td>
</tr>
<tr>
<td>CSMA/CD</td>
<td>Collision Sense Multiple Access/Collision Detection</td>
</tr>
<tr>
<td>Cu</td>
<td>Copper</td>
</tr>
<tr>
<td>DIN</td>
<td>Deutsche Industrie Norm (German Industrial Standard)</td>
</tr>
<tr>
<td>DTE</td>
<td>Data Terminal Equipment</td>
</tr>
<tr>
<td>EIA</td>
<td>Electronic Industries Association</td>
</tr>
<tr>
<td>EN</td>
<td>European Standard</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic Compatibility</td>
</tr>
<tr>
<td>ESD</td>
<td>Electrostatically Sensitive Devices</td>
</tr>
<tr>
<td>FMS</td>
<td>Fieldbus Message Specification</td>
</tr>
<tr>
<td>FO</td>
<td>Fiber-Optic</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institution of Electrical and Electronic Engineers</td>
</tr>
<tr>
<td>ISO/OSI</td>
<td>International Standards Organization / Open System Interconnection</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>MPI</td>
<td>Multipoint Interface</td>
</tr>
<tr>
<td>NRZ</td>
<td>Non Return to Zero</td>
</tr>
<tr>
<td>OLM</td>
<td>Optical Link Module</td>
</tr>
<tr>
<td>OLP</td>
<td>Optical Link Plug</td>
</tr>
<tr>
<td>OP</td>
<td>Operator Panel</td>
</tr>
<tr>
<td>PE</td>
<td>Polyethylene</td>
</tr>
<tr>
<td>PG</td>
<td>Programming Device</td>
</tr>
<tr>
<td>PMMA</td>
<td>Polymethyl methacrylate</td>
</tr>
<tr>
<td>PNO</td>
<td>PROFIBUS Users Association</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>PROFIBUS–DP</td>
<td>PROFIBUS Distributed (Peripheral) I/Os</td>
</tr>
<tr>
<td>PUR</td>
<td>Polyurethane</td>
</tr>
<tr>
<td>PVC</td>
<td>Polyvinyl chloride</td>
</tr>
<tr>
<td>SELV</td>
<td>Safety Electrical Low Voltage</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriter Laboratories</td>
</tr>
<tr>
<td>UV</td>
<td>Ultraviolet</td>
</tr>
<tr>
<td>V</td>
<td>Value</td>
</tr>
<tr>
<td>VDE</td>
<td>Verein Deutscher Elektroingenieure (Institute of German Electrical/Electronic Engineers)</td>
</tr>
</tbody>
</table>
C.2 References

SIMATIC NET PROFIBUS is based on the following standards and guidelines:

/1/ EN 50170–1–2: 1996
General Purpose Field Communication System
Volume 2 : Physical Layer Specification and Service Definition

PROFIBUS Users Organization guidelines:
/2/ PROFIBUS–Implementierungshinweise zum Entwurf DIN 19245 Teil 3
Version 1.0 vom 14.12.1995

/3/ Optische Übertragungstechnik für PROFIBUS
Version 1.1 von 07.1993

Standard for Electrical Characteristics of Generators and Receivers
for Use in Balanced Digital Multipoint Systems

/5/ Distributed I/O system ET 200, Release 3
Order number: EWA 4NEB 780 6000–01b

/6/ SIMATIC NET Industrial Communication Catalog IK10
SiEMENS AG
Automation group
Geschäftszeig
Industrielle Kommunikation SIMATIC NET
Postfach 4846, D–90327 Nürnberg

/7/ DIN VDE 0100 Teil 410
Errichten von Starkstromanlagen mit Nennspannungen bis 1000 V; Schutzmaßnahmen;
Schutz gegen gefährliche Körperströme.

und

DIN VDE 0100 Teil 540
Errichten von Starkstromanlagen mit Nennspannungen bis 1000 V; Auswahl und Errichtung
elektrischer Betriebsmittel; Erdung, Schutzleiter, Potentialausgleichsleiter

/8/ DIN EN 60950,
Sicherheit von Einrichtungen der Informationstechnik einschließlich elektrischer Büromaschinen
(IEC950; 1991, modifiziert und IEC 950A1; 1992
Deutsche Fassung EN 60950; 1992 + A1: 1993
DIN Deutsches Institut für Normung e.V. Berlin

/9/ VG 95375, Teil 3
Elektromagnetische Verträglichkeit, Grundlagen und Maßnahmen für die Entwicklung von Systemen,
Teil 2: Verkabelung, Dezember 1994
DIN Deutsches Institut für Normung e.V. Berlin
C.3 Who to Contact

If you have technical questions about using the products described and your problem is not dealt with in the documentation, please contact your Siemens representative or dealer. The addresses are listed in our Catalog IK 10, in CompuServe (go autforum >> library area SIMATIC NET) and on the Internet (http://www.aut.simaticnet.de).

Our Hotline is also available to help you with problems:
Tel.: +49(911) 895–7000 (Fax–7001)

Our Customer Support on the Internet provides useful information and answers to common questions. Under FAQ (Frequently Asked Questions), you will find a variety of information about our entire range of products.

The address of the aut home page in the World Wide Web of Internet is as follows:
http://www.aut.siemens.de.
Appendix

Installing Cables
D Installing Cables

Appendix D explains the following procedures when installing PROFIBUS networks:
> Cabling in an industrial environment
> How to protect from surge voltages

D.1 Installing PROFIBUS Cables

D.1.1 General

When installing LAN cables, two aspects must be taken into account:
> Mechanical protection and
> Electrical protection (EMC = electromagnetic compatibility)

D.1.2 Mechanical Protection

In many automation systems, the LAN cables are the most important connections between individual components in the system. Damage or breaks on the cable providing these connections lead to problems and often to a breakdown of the entire automation system.

To avoid accidental damage to LAN cables, they should be installed where they are clearly visible and separate from all other cables (to improve the EMC characteristics, it is often advisable to install LAN cables in their own cable channels or in metallic, electrically conductive conduits). These measures also make it easier to troubleshoot the cabling system.

Installation of electrical LAN cables in a safe area is also supported by using the passive RS 485 bus terminal at low data rates ($\leq$ 1.5 Mbps). These allow the connection of DTEs and permit service or maintenance on the DTEs without needing to move the actual LAN cable.

The measures for mechanical protection apply both to electrical and optical cables.

Particular care is necessary when installing redundant LAN cables. Redundant cables should always be installed using different routes to avoid simultaneous damage by the same event.

When installing LAN cables, make sure that they are not subjected to undue strain after they have been installed. Problems can, for example, occur when cables are installed on the same cable rack or in the same cable conduit (assuming that they do not interfere electrically with each other) and then new cables are pulled through (during repair, when extending the system).

When installing trailing cables and cables for festoons, make sure that the cables are not kinked or crimped by other cables and equipment when the cables are moved.

The following measures are recommended to protect LAN cables mechanically:
> When cable cannot be installed on a cable rack, it should be installed in a conduit (PG 11-16)
> In areas where the cable is subject to mechanical stress, install the cable in a heavy-gauge aluminum conduit, otherwise in a heavy-gauge plastic conduit (see Figure D.1)
> When 90° bends are necessary, a break in the conduit is acceptable only when there is no likelihood of damage to the cable (see Figure D.2).
> In areas where the cable is likely to be walked on or driven over, the cable must be protected from damage by a closed heavy-gauge aluminum or steel conduit. As an alternative the cable can be laid in a metal cable gutter.

For information about installing LAN cables outside buildings and underground, refer to Appendix D.2.
Figure C. 1:  Mechanical Protection of the LAN Cable

Figure C. 2:  Interrupting the Conduit at an Expansion Joint
D.1.3 Electrical Protection

The topic “electrical protection” involves two areas:

> Electrical protection complying with DIN VDE 0100 or corresponding local regulations
> Electrical protection in the sense of “electromagnetic compatibility” (EMC).

Electrical protection complying with DIN VDE 0100 is not described in this chapter. This is only important for devices with a main power system connection. The corresponding operator manuals and installation manuals contain instructions about these aspects of protection. All other active devices have a +24V DC connection. The 24V power supply must meet the requirements for “Safety Extra-Low Voltage” (SELV complying with DIN EN 60950 /6/).

Electrical protection in the sense of EMC is largely regulated for the individual components of a system by European standards. All the components of SIMATIC NET PROFIBUS meet the requirements for devices used in an industrial environment, as documented by the CE approval.

Adherence to these regulations can only be guaranteed when using components for SIMATIC NET PROFIBUS.
D.2 Installing Electrical LAN Cables

Wiring and cables in a system conduct voltages and currents. Depending on the application, the amplitudes can be of an order much higher than the signal voltage on the cable. Switching supply voltages can, for example, produce sharply rising surge voltage peaks in the kV range. If other cables are laid parallel to the LAN cable, data exchange on the LAN cables can be disturbed by crosstalk. To achieve problem-free operation of the bus system, certain rules must be adhered to when installing cables.

Fiber-optic cables are not affected by electrical interference and while mechanical protection is necessary, the EMC guidelines do not apply. Cables for Telecom have special rules generally specified for a particular country (in Germany, Telecom cables must not be laid along with other cables).

It is useful to group wires and cables into various categories according to the signals they carry, possible interference signals and their sensitivity to interference. In the information shown below, it is assumed that all the components within an automation system and all the plant components controlled by the system (for example machines, robots etc.) at least meet the requirements of the European standards for electromagnetic compatibility in an industrial environment.

It is assumed that the cables for analog signals, data signals and process signals are always shielded.

The cable/signal types are assigned to the following categories:

Category I:

> LAN cables for
  > SIMATIC NET PROFINET
  > SINEC L1
  > Industrial Ethernet (Industrial Twisted Pair, drop cable, triaxial cable for indoor use, coaxial cables for 10BASE5 and 10BASE2)
  > AS-Interface

> Shielded cables for data signals (for example PG, OP, printer, counter inputs)
> Shielded cables for analog signals
> Shielded and unshielded cables for safety extra-low voltages (≤ 60 V)
> Shielded cables for process signals with levels ≤ 25 V
> Coaxial cables (triaxial) for monitors

Category II:

> Shielded and unshielded cables for DC voltages > 60 V and ≤ 400 V
> Shielded and unshielded cables for AC voltages > 25 V and ≤ 400 V

Category III:

> Shielded and unshielded cables for DC and AC voltages > 400 V

Category IV:

> Signal cables of categories I to III at risk from direct lightning strikes (for example connections between components in different buildings)

Cables from the same category can be bundled together or laid directly beside each other on the same cable rack.
D.2.1 Cabling Within Buildings

D.2.1.1 Cabling Within Closets

When cabling within wiring closets, note the following points:

- The clearance between cables of different categories should always be as large as possible to reduce crosstalk to a minimum.
- Where cables of different categories cross, they should cross at right angles (wherever possible avoid sections where the cables run parallel).
- If there is not enough space to maintain a clearance $\geq 10$ cm, the cables should be arranged according to their categories in metal, conductive channels. These channels can then be arranged next to each other. The metal, conductive channels should be screwed to the struts of the rack or the closet walls making low-resistance and low-inductance contact.
- The shields of all cables entering the wiring closet must be secured as close as possible to the point of entry and should make large area contact with closet ground. Parallel routing of incoming cables and internal closet wiring between the point of entry into the closet and the shield clamp should be avoided at all costs even with cables of the same category.

**When removing the sheath of the cable, make sure that the braid shield of the cables is not damaged.**

- When selecting contact elements, remember that the cables for SIMATIC NET PROFIBUS have an outer diameter including the braided shield of approximately 6 mm.
- To allow good contact between grounding elements, tin-plated or galvanically stabilized surfaces are ideal. With galvanized surfaces, the necessary contact should be achieved using suitable screws. Painted surfaces should be avoided at the contact points.

![Figure C.3: Contacting the Shield at the Point of Entry to a Closet](image)

**Parallel routing of incoming cables and internal closet wiring between the point of entry into the closet and the shield clamp should be avoided at all costs even with cables of the same category.**

**Shield clamps/contacts must not be used as strain relief.**
D.2.1.2 Cabling Outside Closets

When laying the cable outside cabinets but within buildings, note the following points:

- The clearances shown in Figure C.4 must be maintained between the various cable categories and when laying cables on common cable racks.

\[
\begin{align*}
\text{Cable category I} & \quad \geq 10 \text{ cm} \\
\text{Cable category II} & \quad \geq 10 \text{ cm} \\
\text{Cable category III} & \quad \geq 50 \text{ cm} \\
\text{Cable category IV} & \quad \geq 20 \text{ cm} \\
\end{align*}
\]

Figure C.4: Minimum Clearances Between the Cable Categories Outside Closets

- If the cables are laid in metal cable channels, the channels can be arranged directly beside each other. The channel for category IV should then be next to the channel for category III.

- If there is only one common metal channel available for all categories, either the clearances shown in Figure C.4 should be maintained or if this is not possible for lack of space, the individual categories should be separated from each other by metallic partitions. The partitions must be connected to the channel making low-resistance and low-inductance contact.

- Metallic, conducting cable channels or racks must be included in the equipotential bonding system of the building between the system components. To achieve this, the individual segments of the channels/racks must be connected together making low-resistance and low-inductance contact and be connected to the building grounding network as often as possible. Expansion junctions and jointed connections must be bridged by flexible ground bars.

- The connections between the individual channel segments must be protected against corrosion (long-term stability).

- Cable routes should cross each other at right angles.

- With connections between different sections of a building (for example separated by expansion joints) with their own reference point for the building ground network, an equipotential bonding conductor (equivalent copper cross section $\geq 10\text{mm}^2$) should be laid parallel to the cables. This equipotential bonding cable can be omitted if metallic, conducting cable channels or racks are used.

- If equipotential bonding is necessary, this must be implemented independent of the shield or shields of the LAN cable(s).

- Wires and cables of category IV must be installed with particular care. The shields and inner conductors can carry dangerously high voltages and currents. Between the point of entry to the building and the overvoltage protector, bare wires should be protected to prevent them being touched.
D.2.2 Cabling Outside Buildings

For communications between buildings and between buildings and external facilities, the use of fiber-optic cables is generally recommended!

Due to the optical transmission principle, fiber-optic cables are not affected by electromagnetic interference. Measures for equipotential bonding and overvoltage protection are unnecessary with fiber-optic cables.

When installing electrical LAN cables between buildings, between buildings and external facilities and on the roofs of buildings or exposed constructions (for example cranes) the following rules must be observed:

> The wiring/cables must be protected against lightning strikes, in other words measures must be taken to make sure that lightning cannot strike the cable directly.
> There must be adequate equipotential bonding between the buildings and external facilities independent of the LAN cables.
> The cables should be laid as close as possible and parallel to the equipotential bonding bar.
> The shields of the cables must be connected to the grounding network as close as possible to the point of entry to the building or facility.
> The signal lines must be protected from surge voltages.
> If the cables are installed in cable conduits that protect them from dampness, all SIMATIC NET PROFIBUS cables can be used. The clearances described in Section D2.1.2 must be maintained.

If the conduits are reinforced with iron and the reinforcement sections are connected together in the form of a Faraday cage, additional equipotential bonding is unnecessary.

Only the SIMATIC NET PROFIBUS underground cable is suitable for installation directly underground.

If the LAN cables are to be installed directly in the earth, the following measures are recommended:

> Lay the LAN cable in a trench.
> The LAN cable should be approximately 60 cm below the surface of the earth.
> If LAN cables are laid along with other cables, the clearances as shown in Figure C. 4 must be maintained (for example using bricks as spacers).
> The LAN cable must be mechanically protected and a cable warning line should be laid along with the cable.
> Approximately 20 cm above the LAN cables, the equipotential bonding bar between the buildings to be connected must be laid (for example a galvanized earth strip). The earth strip also serves as protection against direct lightning strikes.
> The clearance to power cables should be $\geq 100$ cm, unless other regulations require a greater clearance.
D.3 Installing Fiber-Optic Cables

When installing fiber-optic cables, the measures described in Section D1.2 relating to mechanical protection must be adhered to. All the technical data (for example permitted tensile stress and permitted bending radii) must be adhered to during storage, installation and operation.
Appendix

Plastic Fiber-Optic Accessories and Assembling Cables
E Plastic Fiber-Optic Accessories and Assembling Cables

E.1 Fitting HP Simplex Connectors to Plastic Fiber-Optic Cables

The simplex connector can only be used with plastic fiber-optic cords with a diameter of 2.2 mm. The following tools are required or recommended:

➢ Stripping pliers for inner conductors with 1 mm Ø
➢ A sharp knife
➢ A smooth flat working surface (approximately 10 cm x 10 cm)
➢ Clean, 600 grit abrasive paper

Make sure that when you are removing the PVC jacket from the fiber-optic cord, neither the PMMA fiber nor the cladding are damaged.

The procedure is shown in detail on the following page.
Fitting HP Simplex Connectors to Plastic Fiber-Optic Cable

Remove at least 3 mm of the core jacket of the simplex cord using stripping pliers. **Caution: The fiber must not be scratched.**

Insert the fiber-optic cable as far as possible into the HP simplex connector.

Make sure that the fiber extends beyond the tip of the connector.

By closing and locking the rear part of the connector fix the simplex cord in the connector (press the two halves of the connector together until the upper section locks into the lower section).

The length of the fiber extending beyond the tip of the connector should not be more than 1 mm to 1.5 mm (if necessary cut off excess fiber with scissors or a sharp knife).

Place the tip of the connector vertically above the 600 grit abrasive paper and rub the tip over the paper describing a figure of 8 until the tip is flush with the connector. The abrasive paper must lie on an even solid surface.

Grinding is completed as soon as the fiber no longer extends beyond the tip of the connector.

The connector and particularly the tip of the connector should then be cleaned with a cloth and a little alcohol. The job is done!

The HP simplex connectors are supplied along with the OLP.

**Caution:**
If the fiber extends beyond the tip of the connector and the connector is inserted into the OLP, the transmit and receive elements in the OLP may be damaged.
E.1.1 Fitting BFOC Connectors to Plastic Fiber-Optic Cables

E.1.1.1 Fitting Connectors to Simplex and Duplex Cords with 2.2 mm Ø

Fitting Connectors to Simplex and Duplex Cords with 2.2 mm Ø

1. Split one fiber from the other (only with the duplex cord)
2. Remove 10 mm of the fiber jacket with the stripping tool
3. Push on the black anti-kink sleeve
4. Push on the short crimping sleeve
5. Push on the body of the connector
6. Push the crimping sleeve over the body of the connector
7. Crimp the connector body with the cord and crimping sleeve (crimp with hexagonal, 3.25 mm setting)
8. Push on the black anti-kink sleeve
9. Prepare the end of the connector as described in the following sections
**E.1.1.2 Fitting Connectors to the Simplex and Twin Cables with 3.6 mm Ø**

1. **Split the cable** (only with the twin cable)
2. **Remove 25 mm of the outer jacket** with the cable stripper
3. **Reduce 10 mm of the fiber jacket** with the jacket stripping tool
4. **Shorten the Kevlar fibers by approximately 7 mm using scissors**
5. **Push on the red anti-kink sleeve**
6. **Push on the long crimping sleeve**
7. **Push in the body of the connector under the Kevlar fibers and outer jacket**
8. **Caution:** The outer jacket and strain relief must be pushed at least 4 mm onto the body of the connector
9. **Push the crimping sleeve over the outer jacket and body of the connector**
10. **Crimp the body of the connector with the cable and crimping sleeve (hexagonal, 4.52 mm setting)**
11. **Push on the red anti-kink sleeve**
12. **Prepare the end of the connector as described in the following sections**

![Dimensions for Preparing the Cable](image)

**Figure D. 1:** Dimensions for Preparing the Cable
E.1.1.3 Preparing the End of the Connector

Cutting

Cut excessive fiber with a knife or scissors leaving approximately 0.5 mm

Remove remnants of the fiber leaving it flush with the face of the connector

Clean away fiber remnants from the tip of the fiber and connector using a cloth dipped in alcohol

Polishing

Cut off excessive fiber with scissors or a knife leaving approximately 0.5 mm

Insert the connector into the black polishing disc

Using the coarser dark gray polishing paper, polish the tip until the fiber no longer extends beyond the connector. During polishing, push down on the connector.

Then fit the connector into the white polishing disc

Using the finer light gray polishing paper, repeat the polishing procedure

Clean the tip of the fiber and connector with a cloth dipped in alcohol.
Hot Plate

Cut off the tip of the fiber with the cutting gauge (integrated in the connector holder) and a knife.

Connect the hot plate to the power supply. Insert the connector into the holder and position the connector against the hot plate when the red LED lights up (heating phase). Press the connector in against the hot plate but do not move it.

After a short time the red LED goes off and the green LED is lit (cooling phase). Do not move the connector during the cooling phase. When the green LED goes off (end of the cooling phase) the finished connector can be removed from the hot plate.
### E.1.1.4 Connectors and Cables

<table>
<thead>
<tr>
<th>Connector/Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BFoC connector for plastic fiber-optic cable, 1000 µm</strong></td>
<td>Set comprising one connector housing, short crimping sleeve, long crimping sleeve, black anti-kink sleeve and red anti-kink sleeve, for use with CUPOFLEX cables and CUPOFLEX cords, packed in sets of two</td>
</tr>
<tr>
<td><strong>CUPOFLEX simplex PVC UL 3.6 mm twin cable I-VYY1P 980/1000 200A</strong></td>
<td>According to UL 1581 VW1 Without connectors, to be ordered in meters, for OLM/P single-fiber ring</td>
</tr>
<tr>
<td><strong>CUPOFLEX twin cable PVC UL 3.6 mm I-VYY2P 980/1000 200A</strong></td>
<td>According to UL 1581 VW1 Without connectors, to be ordered in meters, for OLM/P networks with a bus, star and redundant ring structure</td>
</tr>
<tr>
<td><strong>CUPOFLEX simplex cord PVC UL 2.2 mm I-VY1P 980/1000 150A</strong></td>
<td>According to UL 1581 VW1 Suitable when there is no mechanical stress, no strain relief, without connectors, ordered in meters, for OLM/P single-fiber ring</td>
</tr>
<tr>
<td><strong>CUPOFLEX duplex cord PVC UL 2.2 mm I-VY2P 980/1000 150A</strong></td>
<td>According to UL 1581 VW1 Must not be subjected to external mechanical strain, without strain relief, without connectors, ordered in meters, for OLM/P networks with bus, star and redundant ring structures</td>
</tr>
</tbody>
</table>
### E.1.1.5 Tools

<table>
<thead>
<tr>
<th>Tool Description</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cable stripper 3.6 mm ∅</strong> for cables with strain relief</td>
<td><img src="image1.jpg" alt="Image" /></td>
</tr>
<tr>
<td>➢ For removing the outer jacket</td>
<td></td>
</tr>
<tr>
<td><strong>Commercially available scissors</strong></td>
<td><img src="image2.jpg" alt="Image" /></td>
</tr>
<tr>
<td>➢ For cutting off excess fiber</td>
<td></td>
</tr>
<tr>
<td>➢ For cutting Kevlar fibers from cables with strain relief</td>
<td></td>
</tr>
<tr>
<td>➢ For shortening the fiber</td>
<td></td>
</tr>
<tr>
<td><strong>Jacket stripping tool 2.2 mm ∅</strong> for plastic fiber-optic cords with 1 mm fiber ∅</td>
<td><img src="image3.jpg" alt="Image" /></td>
</tr>
<tr>
<td>➢ For removing the cord jacket</td>
<td></td>
</tr>
<tr>
<td><strong>Crimping tool for BFOC connectors</strong></td>
<td><img src="image4.jpg" alt="Image" /></td>
</tr>
<tr>
<td>crimping caliber 4.52 mm and 3.25 mm</td>
<td></td>
</tr>
<tr>
<td>➢ For crimping connectors, strain relief, outer jacket and crimping sleeve</td>
<td></td>
</tr>
<tr>
<td>➢ Crimping with 4.52 mm for cables with strain relief</td>
<td></td>
</tr>
<tr>
<td>➢ Crimping width 3.25 mm for cords (without strain relief)</td>
<td></td>
</tr>
<tr>
<td><strong>Knife</strong></td>
<td><img src="image5.jpg" alt="Image" /></td>
</tr>
<tr>
<td>➢ For cutting plastic fiber-optic cables</td>
<td></td>
</tr>
<tr>
<td><strong>BFOC polishing set for plastic fiber-optic connectors</strong></td>
<td><img src="image6.jpg" alt="Image" /></td>
</tr>
<tr>
<td>➢ For polishing the end surface of the fiber</td>
<td></td>
</tr>
<tr>
<td>Set consisting of instructions, coarse polishing paper, fine polishing paper,</td>
<td></td>
</tr>
<tr>
<td>coarse polishing disc (black) and find polishing disc (white).</td>
<td></td>
</tr>
<tr>
<td><strong>Hot plate including power supply unit and socket for the connector with integrated cutting gauge</strong></td>
<td></td>
</tr>
</tbody>
</table>
| > For polishing the surface of the fiber  
  (lower attenuation and good reproducibility) |

| **Cutting gauge** |
| > For holding the connector when shortening fibers  
  > For precise cutting of fibers  
    (with guide for the blade) |