

# SIEMENS

SIMATIC

PROFIBUS  
PROFIBUS with STEP 7 V13

Function Manual

Preface

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## Legal information

### Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

 <b>DANGER</b>
indicates that death or severe personal injury <b>will</b> result if proper precautions are not taken.
 <b>WARNING</b>
indicates that death or severe personal injury <b>may</b> result if proper precautions are not taken.
 <b>CAUTION</b>
indicates that minor personal injury can result if proper precautions are not taken.
<b>NOTICE</b>
indicates that property damage can result if proper precautions are not taken.


If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

### Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

### Proper use of Siemens products

Note the following:

 <b>WARNING</b>
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

### Trademarks

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### Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

# Preface

## Purpose of the manual

This function manual provides an overview of the PROFIBUS communication system with SIMATIC STEP 7 V13.

STEP 7 V13 is integrated into the powerful graphic Totally Integrated Automation Portal (TIA Portal), the new integration platform for all automation software tools.

This function manual supports you in planning a PROFIBUS system. The manual is structured into the following subject areas:

- PROFIBUS basics
- PROFIBUS diagnostics
- PROFIBUS functions

## Basic knowledge required

The following knowledge is required in order to understand the manual:

- General knowledge of automation technology
- Knowledge of the industrial automation system SIMATIC
- Knowledge about the use of Windows-based computers
- Proficiency with STEP 7

## Scope

This function manual is the basic documentation for all SIMATIC products from the PROFIBUS environment. The product documentation is based on this documentation.

The examples are based on the functionality of the S7-1500 automation system.

## Changes compared to previous version

As compared to the previous version (version 07/2014), this manual contains the following amendments/changes:

- Extension of the documentation to STEP 7 (TIA Portal) V13 SP1
- Addition of the function Intelligent DP slaves (I-slaves)
- New guide

## Conventions

**STEP 7:** We refer to "STEP 7" in this documentation as a synonym for the configuration and programming software "STEP 7 as of V12 (TIA Portal)" and subsequent versions.

This documentation contains figures of the devices described. The figures may differ slightly from the device supplied.

You should also pay particular attention to notes such as the one shown below:

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### Note

A note contains important information on the product described in the documentation, on the handling of the product or on the section of the documentation to which particular attention should be paid.

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## Additional support

You will find information about available technical support in the appendix Service & Support (Page 91).

The technical documentation for the individual SIMATIC products and systems is available on the Internet (<http://www.siemens.com/simatic-tech-doku-portal>).

The online catalog and the ordering system are available on the Internet (<http://mall.industry.siemens.com>).

## Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, solutions, machines, equipment and/or networks. They are important components in a holistic industrial security concept. With this in mind, Siemens' products and solutions undergo continuous development. Siemens recommends strongly that you regularly check for product updates.

For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action (e.g. cell protection concept) and integrate each component into a holistic, state-of-the-art industrial security concept. Third-party products that may be in use should also be considered. You can find more information about industrial security on the Internet (<http://www.siemens.com/industrialsecurity>).

To stay informed about product updates as they occur, sign up for a product-specific newsletter. You can find more information on the Internet (<http://support.automation.siemens.com>).

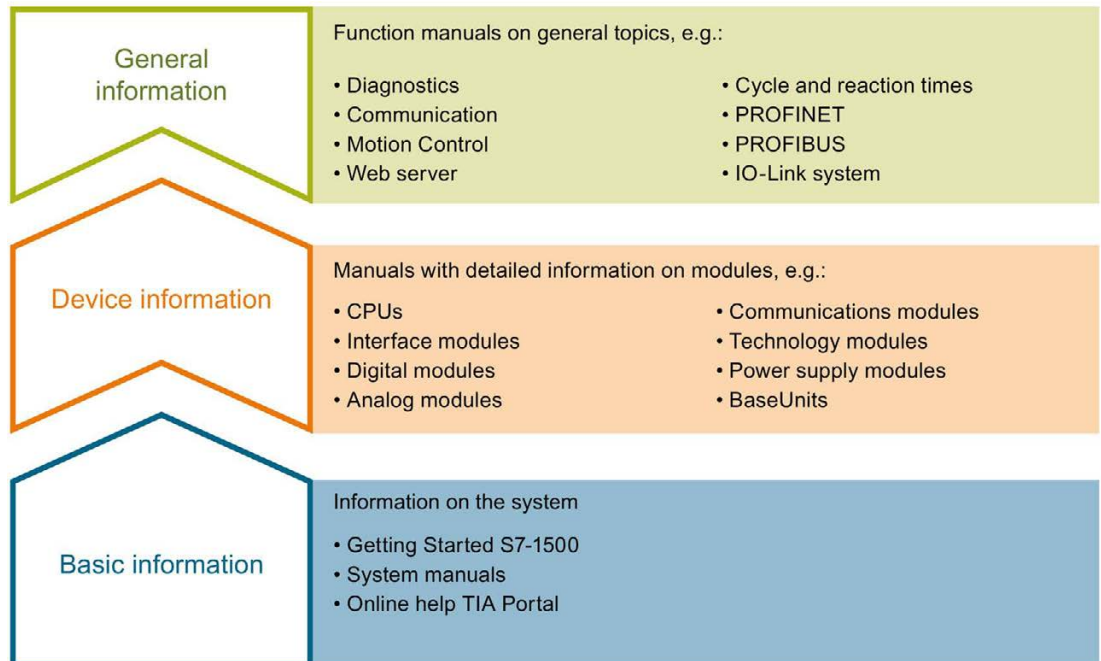
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# Documentation guide

The documentation for the SIMATIC S7-1500 automation system and the SIMATIC ET 200MP, ET 200SP and ET 200AL distributed I/O systems is divided into three areas. This division allows you easier access to the specific information you require.



## Basic information

System manuals and Getting Started describe in detail the configuration, installation, wiring and commissioning of the SIMATIC S7-1500, ET 200MP, ET 200SP and ET 200AL systems. The STEP 7 online help supports you in the configuration and programming.

## Device information

Product manuals contain a compact description of the module-specific information, such as properties, terminal diagrams, characteristics and technical specifications.

## General information

The function manuals contain detailed descriptions on general topics such as diagnostics, communication, Motion Control, Web server.

You can download the documentation free of charge from the Internet (<http://w3.siemens.com/mcms/industrial-automation-systems-simatic/en/manual-overview/Pages/Default.aspx>).

Changes and additions to the manuals are documented in product information sheets.

## Manual Collections

The Manual Collections contain the complete documentation of the systems put together in one file.

You will find the Manual Collections on the Internet:

- S7-1500/ET 200MP (<http://support.automation.siemens.com/WW/view/en/86140384>)
- ET 200SP (<http://support.automation.siemens.com/WW/view/en/84133942>)
- ET 200AL (<http://support.automation.siemens.com/WW/view/en/95242965>)

## My Documentation Manager

The My Documentation Manager is used to combine entire manuals or only parts of these to your own manual.

You can export the manual as PDF file or in a format that can be edited later.

You can find the My Documentation Manager on the Internet (<http://support.automation.siemens.com/WW/view/en/38715968>).

## Applications & Tools

Applications & Tools supports you with various tools and examples for solving your automation tasks. Solutions are shown in interplay with multiple components in the system - separated from the focus in individual products.

You can find Applications & Tools on the Internet (<http://support.automation.siemens.com/WW/view/en/20208582>).

## CAX Download Manager

The CAX Download Manager is used to access the current product data for your CAX or CAE systems.

You configure your own download package with a few clicks.

In doing so you can select:

- Product images, 2D dimension drawings, 3D models, internal circuit diagrams, EPLAN macro files
- Manuals, characteristics, operating manuals, certificates
- Product master data

You can find the CAX Download Manager on the Internet (<http://support.automation.siemens.com/WW/view/en/42455541>).



## **TIA Selection Tool**

With the TIA Selection Tool, you can select, configure and order devices for Totally Integrated Automation (TIA).

This tool is the successor of the SIMATIC Selection Tool and combines the known configurators for automation technology into one tool.

With the TIA Selection Tool, you can generate a complete order list from your product selection or product configuration.

You can find the TIA Selection Tool on the Internet

(<http://w3.siemens.com/mcms/topics/en/simatic/tia-selection-tool>).

## Description

### 2.1 Introduction to PROFIBUS

#### What is PROFIBUS?

PROFIBUS is a bus system that networks automation systems and field devices that are compatible with PROFIBUS. As communication medium for the field level, PROFIBUS is an important part of Totally Integrated Automation (TIA).

The different communication networks can be used independent of one another or they can be combined with each other.

#### PROFIBUS protocols

**PROFIBUS DP** (distributed I/O) is a communication network for the field level according to IEC 61158-2 / EN 61158-2 with the hybrid access protocols token bus and master-slave. The networking takes place by means of two-wire lines or fiber-optic cables. Data transmission rates of 9.6 kbps to 12 Mbps are possible.

**PROFIBUS PA** is the PROFIBUS for process automation (PA). It connects the PROFIBUS DP communication protocol with the MBP (Manchester Bus Powered) transmission technology to IEC 61158-2.

PROFIBUS PA networks can be designed based on shielded, twisted two-wire lines intrinsically safe and are therefore suitable for hazardous areas (Ex zones 0 and 1). The data transmission rate is 31.25 kbps.

## 2.1.1 Applications of PROFIBUS DP

### Introduction

The efficiency of control systems is not determined by automation devices alone, but depends to a large extent on the overall configuration of an automation solution. This includes a powerful communication system in addition to plant visualization and operator control and monitoring.

The STEP 7 engineering tool supports you during the engineering and configuration of an automation solution.

### Applications of PROFIBUS DP

The PROFIBUS network offers wireless connection of several controllers, components and subnets as electrical network, optical network or by using links. Sensors and actuators are controlled centrally by means of PROFIBUS DP.

The following figure shows connection options to PROFIBUS DP:

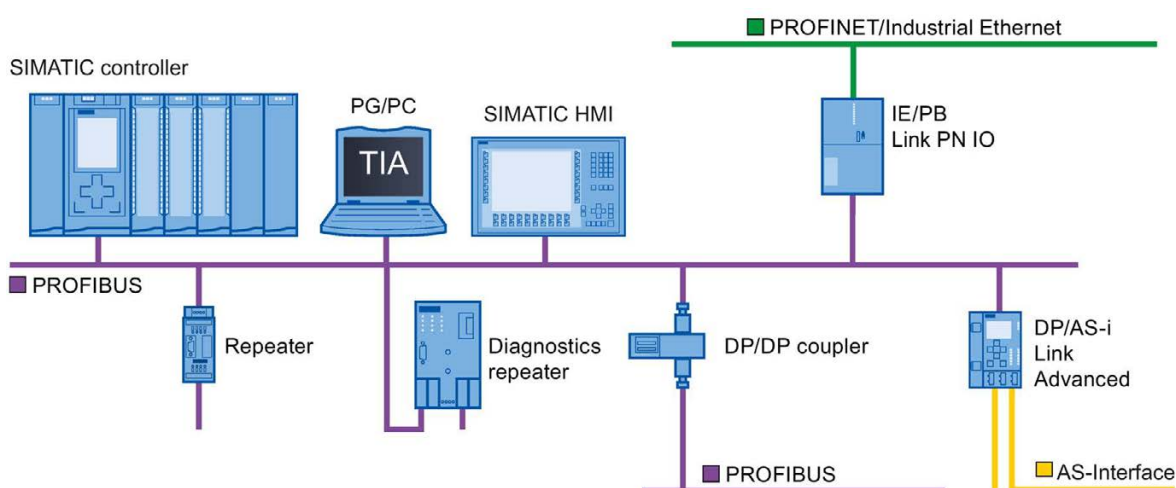


Figure 2-1 Connection options to PROFIBUS DP

## Objectives of PROFIBUS DP

Distributed automation systems are increasingly used in production and process automation. This means a complex control task is divided up into smaller, more transparent subtasks with distributed control systems. This creates a high demand for communication between the distributed systems.

Distributed systems offer the following benefits:

- Independent and simultaneous commissioning of individual devices is possible
- Small, manageable programs
- Parallel processing due to distributed automation systems
- Reduced response times
- Higher-level structures can take on additional diagnostics and logging functions.
- Increased plant availability because the rest of the overall system can continue to work when a subordinate station fails.

### 2.1.2 PROFIBUS terminology

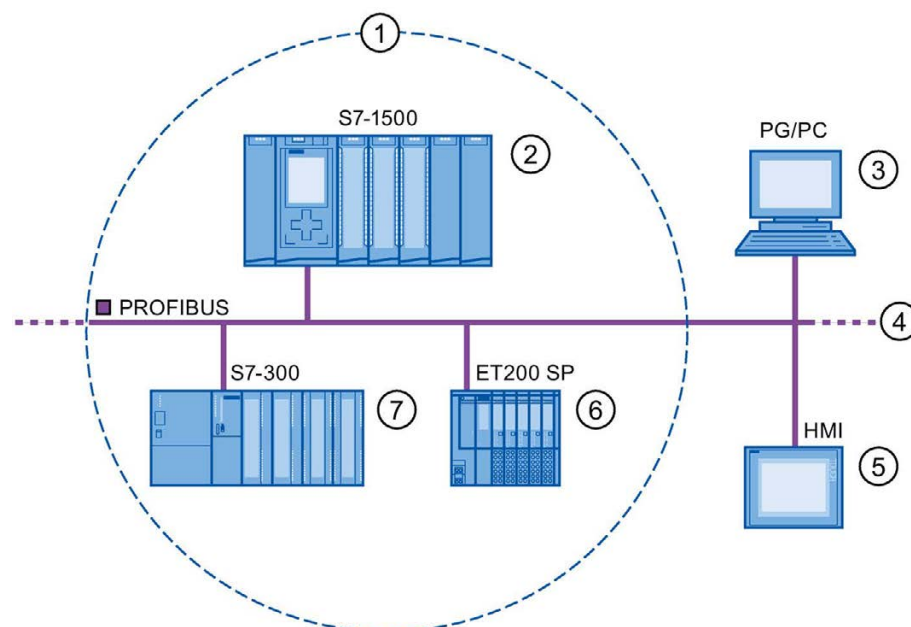
#### Definition: Devices in the PROFIBUS environment

In the PROFIBUS environment, "device" is the generic term for:

- Automation systems (for example, PLC, PC)
- Distributed I/O systems
- Field devices (for example, hydraulic devices, pneumatic devices)
- Active network components (e.g., diagnostic repeater, optical link module)
- Gateways to AS interface or other fieldbus systems

## Devices with PROFIBUS DP

The figure below shows the most important components with PROFIBUS DP. The table below lists the designations of the individual components.



Number	PROFIBUS	Note
①	DP master system	
②	DP master	Device used to address the connected DP slaves. The DP master exchanges input and output signals with field devices. The DP master is often the controller on which the automation program runs.
③	PG/PC	PG/PC/HMI device for commissioning and diagnostics DP master of class 2
④	PROFIBUS	Network infrastructure
⑤	HMI	Device for operating and monitoring functions
⑥	DP slave	Distributed field device assigned to the DP master, e.g., valve terminals, frequency converters.
⑦	I-slave	Intelligent DP slave

Figure 2-2 Devices with PROFIBUS

### Overview of I/O communication

I/O communication is the reading or writing of inputs/outputs of the distributed I/O. The figure below gives you an overview of I/O communication using PROFIBUS DP:

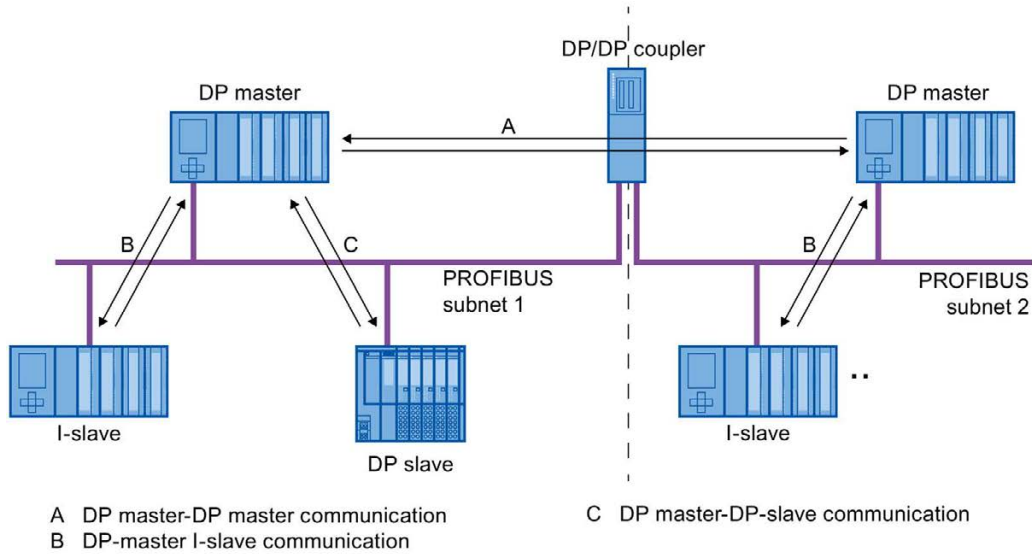


Figure 2-3 I/O communication using PROFIBUS DP

I/O communication is also available with the communication module (CM) or the interface module (IM) with integrated DP interface. These DP interfaces behave like integrated DP interfaces of the CPU.

## I/O communication using PROFIBUS DP

Table 2- 1 I/O communication using PROFIBUS DP

Communication between ...	Explanation
DP master and DP slave	The data exchange between a DP master and DP slaves with I/O modules takes place as follows: The DP master queries the DP slaves of its master system one after the other, receives input values from the DP slaves, and transmits output data to the DP slaves (master-slave principle).
DP master and I-slave	<p>A fixed amount of data is transmitted cyclically between the user programs in CPUs of DP masters and I-slaves.</p> <p>The DP master does not access the I/O modules of the I-slave, but instead accesses configured address areas, called transfer areas, that can be inside or outside the process image of the I-slave CPU. If parts of the process image are used as transfer areas, these may not be used for actual I/O modules.</p> <p>Data transmission takes place with load and transfer operations using the process image or by direct access.</p>
DP master and DP master	<p>A fixed amount of data is transmitted cyclically between the user programs in CPUs of DP masters. A DP/DP coupler is required as additional hardware.</p> <p>The DP masters mutually access configured address areas, called transfer areas, inside or outside the process image of the CPUs. If parts of the process image are used as transfer areas, these may not be used for actual I/O modules.</p> <p>Data transmission takes place with load and transfer operations using the process image or by direct access.</p>

### Additional information

You can find additional information on the hardware configuration in the STEP 7 online help.

### 2.1.3 PROFIBUS DP interface

#### Properties

A PROFIBUS device has at least one PROFIBUS interface with an electrical (RS 485) interface or optical (Polymer Optical Fiber, POF) interface.

Table 2- 2 Properties of the PROFIBUS DP interface

Standard	PROFIBUS: IEC 61158/61784
Physical bus/media	PROFIBUS cables (twisted two-wire lines RS 485 or fiber-optic cables)
Transmission rate	9.6 kbps to 12 Mbps

#### Representation of the PROFIBUS DP interface in STEP 7

In the device view of STEP 7, the PROFIBUS DP interfaces for a DP master and a DP slave are highlighted by a purple rectangle:

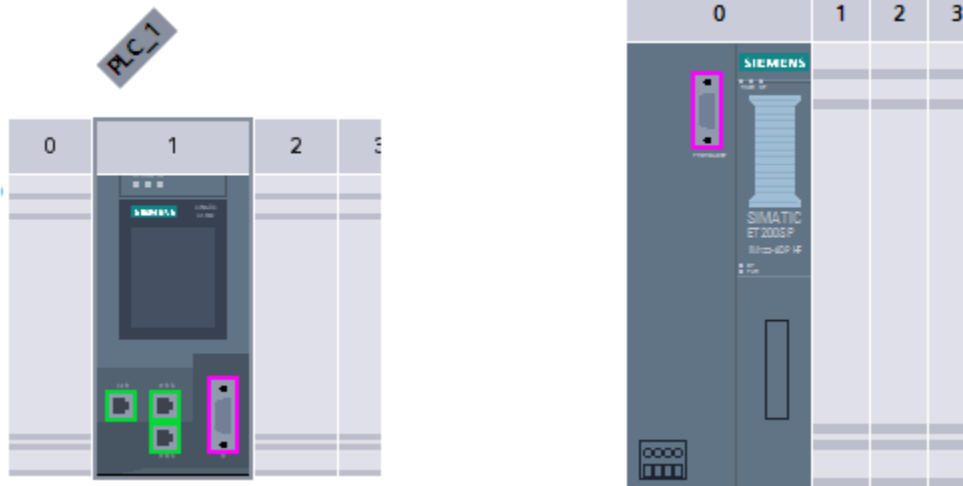


Figure 2-4 PROFIBUS DP interfaces



## 2.2 Structure of PROFIBUS networks

### Contents of this chapter

The following chapter provides background information on building your communication network.

- Overview of the most important passive network components: These are network components that forward a signal without the possibility of actively influencing it, for example, cables, connectors.
- Overview of the most important active network components: These are network components that actively affect a signal, for example, repeaters, diagnostic repeaters.
- Overview of the most common network structures (topologies)

### Physical connections of industrial networks

PROFIBUS devices can be networked in industrial plants in two different physical ways:

- By means of electrical signals via copper cables
- By means of optical signals via fiber-optic cables

## Selection criteria for networking

The table below includes selection criteria for electrical and optical networking of PROFIBUS devices:

Table 2- 3 Selection criteria for electrical and optical networking

Criteria		Electrical PROFIBUS	Optical network with OLM	Optical network with OBT
Transmission medium	Shielded two-wire line	•	–	–
	POF	–	•	•
	PCF	–	•	•
	Glass	–	•	–
Distances	Max. network span	PROFIBUS DP: 9.6 km PROFIBUS PA: 1.9 km	90 km	9.6 km
	Between two devices	up to 1 km <sup>1)</sup>	up to 15 km <sup>2)</sup>	up to 300 m <sup>2)</sup>
Topology	Bus	•	–	–
	Linear	–	•	•
	Tree	•	•	•
	Ring	–	•	•
Transmission protocols		DP, PA	DP, PA	DP
Connection of devices by means of	OLM	–	•	–
	Integrated interfaces	•	–	•
	Bus terminal	•	–	•
	Bus connector	•	–	–
Electrical network segments can be connected		•	•	–

• Suitable

– Not relevant for this application

1) Depending on data rate and type of service used

2) Depending on cable type used

## Installation guideline for PROFIBUS networks

A PROFIBUS segment must be terminated at the start and end; passively with a connector or actively with a bus terminating resistor.

The same principles apply to the installation of a PROFIBUS network as described in the SIMATIC NET PROFIBUS networks

(<http://support.automation.siemens.com/WW/view/en/35222591>) manual.

## 2.2.1 Passive network components for RS 485 networks

### 2.2.1.1 RS 485 cables

#### Introduction

The following applies to all RS 485 cables for PROFIBUS from Siemens:

- Their double shielding makes them especially suited for laying in industrial environments with electromagnetic interference.
- A continuous grounding concept can be implemented by means of the outer shield of the bus cable and the ground terminals of the bus terminals.
- The imprinted meter marking makes it easier to determine the length (accuracy  $\pm 5\%$ ).

#### RS 485 cables for PROFIBUS

SIMATIC NET PROFIBUS cables are available in different versions which allow optimum adaptation to different areas of application:

- FC Standard Cable GP (bus cable for fixed laying inside buildings)
- FC Standard Cable IS GP (bus cable for hazardous area)
- FC-FRNC Cable GP (bus cable with halogen-free protective jacket for use inside buildings)
- FC Food Cable (bus cable with PE jacket for use in the food and beverage industry)
- FC Robust Cable (bus cable with PUR jacket for environments subject to chemical and mechanical stress)
- FC Ground Cable (ground cable with PE jacket)
- PROFIBUS FC Trailing Cable (trailing cable for tow chains)
- PROFIBUS Festoon Cable (bus cable for festoon mounting)
- PROFIBUS Torsion Cable (torsion-free bus cable for networking movable plant parts, for example, robots)
- PROFIBUS FC Flexible Cable (bus cable for machine parts that are moved infrequently or cabinet doors)
- SIENOPYR-FR ship cable (for permanent laying on ships and off-shore units in all rooms and on open deck)
- PROFIBUS Hybrid Standard Cable (hybrid cable with 2 power wires (1.5 mm<sup>2</sup>) for data and power supply of the ET 200pro)
- PROFIBUS Hybrid Robust Cable (trailable hybrid cable with 2 power wires (1.5 mm<sup>2</sup>) for data and power supply of the ET 200pro)

### Maximum cable lengths

When using copper cables, the maximum size of a PROFIBUS segment depends on the transmission rate.

If these lengths are not sufficient for your application, you can expand the network by using repeaters. You can achieve a maximum size by cascading up to nine repeaters.

Table 2- 4 Maximum cable lengths

Transmission rate	Maximum cable length of a bus segment	Maximum distance between two stations
9.6 to 187.5 kbps	1000 m	10000 m
500 kbps	400 m	4000 m
1.5 Mbps	200 m	2000 m
3 to 12 Mbps	100 m	1000 m

#### 2.2.1.2 PROFIBUS FastConnect system

##### PROFIBUS FastConnect (FC)

PROFIBUS FastConnect is a system for fast and easy fabrication of PROFIBUS copper cables.

The system consists of three components:

- FastConnect bus cables for quick mounting
- FastConnect stripping tool
- FastConnect bus connector for PROFIBUS with insulation displacement method

##### FastConnect bus cables and stripping tool

The special design of the FastConnect bus cables allows for the use of the FastConnect stripping tool to accurately strip away the protective jacket and the braided shield in one step. The connection of the prepared cables takes place in the FastConnect bus connectors using the insulation displacement method.

All PROFIBUS FastConnect bus cables can also be connected to the conventional bus connectors with screw-type terminals.

## Area of application

You need FastConnect bus connectors for PROFIBUS for the following applications:

- Connect devices with an electrical 9-pin D-Sub interface to IEC 61158-2 directly with SIMATIC NET PROFIBUS cables.
- Connect electrical segments or individual devices to the Optical Link Module (OLM) and Optical Bus Terminal (OBT).
- Connect devices or programming devices to the repeater.

## Versions

The FastConnect bus connector in degree of protection IP20 is available in the following versions:

- with integrated terminating resistor and isolating function
- with or without PG socket
- with a cable outlet of 35°, 90° or 180°
- with device category 3G suitable for zone 2 hazardous area

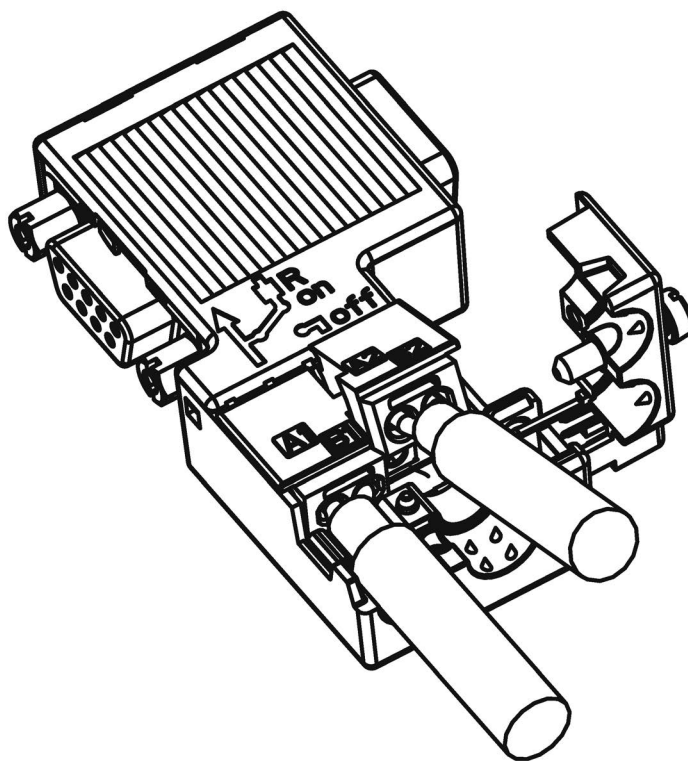


Figure 2-5 Example for PROFIBUS FastConnect bus connector with PG socket, cable outlet 90°

### **Additional information**

For additional information on the available components visit the Siemens Mall (<http://mall.industry.siemens.com>).

#### **2.2.1.3 PROFIBUS bus connector**

##### **Area of application**

You need PROFIBUS bus connectors for the following applications:

- Connect devices with a 9-pin D-Sub interface to IEC 61158-2 directly with the SIMATIC NET PROFIBUS cables.
- Connect electrical segments or individual devices to the Optical Link Module (OLM) and Optical Bus Terminal (OBT).
- Connect devices or programming devices to the repeater.

## Versions

The PROFIBUS bus connector in degree of protection IP20 is available in the following versions:

- with integrated terminating resistor and isolating function
- with or without PG socket
- with a cable outlet of 35°, 90° or 180°
- with device category 3G suitable for zone 2 hazardous area

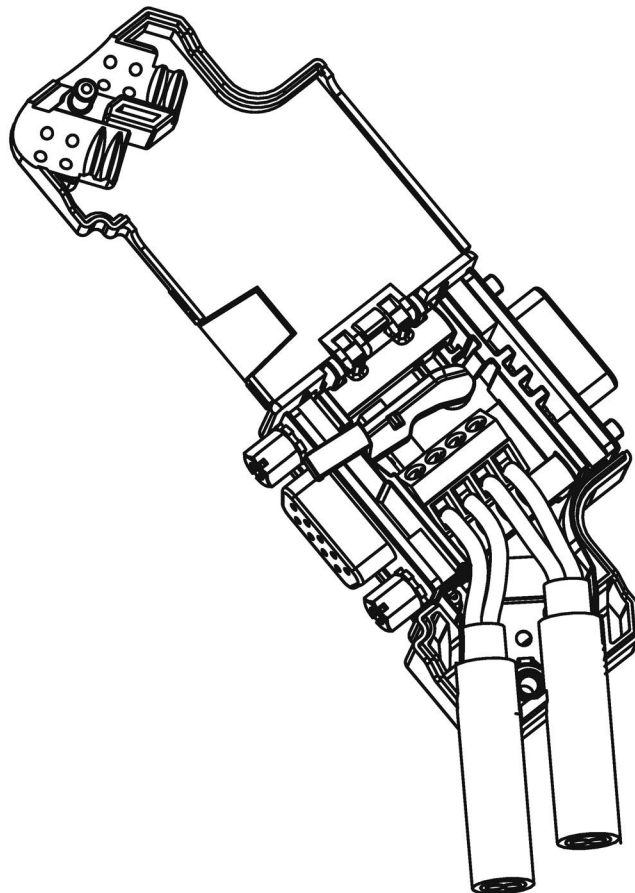


Figure 2-6 Example for PROFIBUS bus connector with PG socket, cable outlet 35°

## Additional information

For additional information on the available components visit the Siemens Mall (<http://mall.industry.siemens.com>).

#### 2.2.1.4 M12 bus connector

##### Area of application

Devices with an electrical M12 interface can use the M12 bus connector for SIMATIC NET PROFIBUS for direct connection with the SIMATIC NET PROFIBUS cables.

The M12 bus connector in degree of protection IP65 is available in the following versions:

- with screw-type terminals
- with insulation displacement termination
- with a cable outlet of 180°

#### 2.2.1.5 Bus terminals for RS 485 networks

##### Bus terminal RS 485 and bus terminal M12

A bus terminal is used for the connection of an individual PROFIBUS station with RS485 interface to the PROFIBUS bus cable.

Bus terminals in degree of protection IP20 are available in the following versions:

- Bus terminal RS 485 with or without PG interface, transmission rate 9.6 kbps to 1.5 Mbps, integrated terminating resistor combination (connectible), with 1.5 m and 3 m connecting cable
- Bus terminal M12, transmission rate 9.6 kbps to 12 Mbps, integrated terminating resistor combination with isolating function, with 1.5 m connecting cable

#### 2.2.1.6 M12 bus terminating resistor

##### Terminating segment with terminating resistor

If there is a station with M12 connection system at the beginning or end of a PROFIBUS segment, you need an M12 bus terminating resistor.

The M12 PROFIBUS connection of a device consists of an M12 socket for the infeed and an M12 male connector to loop-through the bus signal.

This means you need one bus terminating resistor with male contacts (6GK1905-0EC00) and with female contacts (6GK1905-0ED00) for each M12 bus cable.



## 2.2.2 Passive components for optical networks

### 2.2.2.1 Fiber-optic cables

#### Types of fiber-optic cables

Data transmission with fiber-optic cables takes place through modulation of electromagnetic waves in the range of visible and invisible light. These cables are made of high-quality plastic fibers and glass fibers:

- Plastic and PCF fiber-optic cables (Page 26)
- Glass fiber-optic cables (Page 27)

The different types of fiber-optic cables provide solutions matched to the operating and environmental conditions for the connection of components with each other.

#### Benefits

Fiber-optic cables offer the following benefits when compared with electrical cables:

- Galvanic isolation of the devices and segments
- No potential equalization currents
- No impact on transmission path through external electromagnetic interference
- No lightning protection elements required
- No noise radiation along the transmission route
- Low weight
- Depending on the type of fiber you can implement cable lengths up to few kilometers at even higher transmission rates.
- No dependency of the maximum permitted distances on the transmission rate

#### Additional information

Additional information of the properties and technical specifications of the passive components and connectors for fiber-optic cables is available in the PROFIBUS network manual (<http://support.automation.siemens.com/WW/view/en/35222591>).

### 2.2.2.2 Plastic and PCF fiber-optic cables

#### Plastic and PCF fiber-optic cables

Plastic (POF) and PCF fiber-optic cables are used for the connection of Optical Link modules with connections for plastic fiber-optic cables (OLM/P), Optical Bus Terminal (OBT) and devices with integrated optical interfaces. Under certain conditions, they are an inexpensive alternative to conventional glass fiber-optic cables.

#### Plastic Fiber Optic duplex core

The plastic fiber-optic duplex core is a flat dual core with PVC inner jacket without protective jacket. The cable can be easily assembled on-site.

The cable is intended for indoor applications with low mechanical loads or inside cabinets. For OLM connections and with integrated optical interfaces you cover a length of up to 50 m between two devices with this cable.

#### Plastic Fiber Optic standard cable

The plastic fiber optic standard cable consists of two plastic fibers with robust polyamide inner jacket surrounded by Kevlar tensile elements and a purple PVC protective jacket. The cable can be easily assembled on-site.

The robust round cable is suited for indoor applications. The maximum distance that can be covered is 80 m for OLM/P connections and 50 m with integrated optical interfaces and OBT.

#### PCF Standard Cable

The pre-assembled PCF Standard Cable consists of two PCF fibers surrounded by Kevlar tensile elements and a purple PVC protective jacket. It is always supplied with a pulling aid installed on one end to pull in the cable channels.

The robust round cable is suited for indoor applications with cable lengths up to 400 m (OLM) or 300 m (integrated optical interfaces, OBT) between two devices.

#### PCF Standard Cable GP

The PCF Standard Cable GP consists of two PCF fibers surrounded by Aramid tensile elements and a green PVC protective jacket. The cable is pre-assembled and can be ordered by the meter. It is supplied with a pulling aid installed on one end to pull in the cable channels.

The robust round cable is suited for indoor and outdoor applications with cable lengths up to 400 m (OLM) or 300 m (integrated optical interfaces, OBT) between two devices.

### PCF Trailing Cable

The PCF Trailing Cable consists of two PCF fibers surrounded by Aramid tensile elements and a green PUR protective jacket. The cable is pre-assembled and can be ordered by the meter. It is supplied with a pulling aid installed on one end to pull in the cable channels.

The robust round cable is suited for moving indoor and outdoor applications with cable lengths up to 400 m (OLM) or 300 m (integrated optical interfaces, OBT) between two devices.

### PCF Trailing Cable GP

The PCF Trailing Cable GP consists of two PCF fibers surrounded by Aramid tensile elements and a green PVC protective jacket. The cable is pre-assembled and can be ordered by the meter. It is supplied with a pulling aid installed on one end to pull in the cable channels.

The robust round cable is suited for moving indoor and outdoor applications with cable lengths up to 400 m (OLM) or 300 m (integrated optical interfaces, OBT) between two devices.

## 2.2.2.3 Glass fiber-optic cables

### Glass fiber-optic cables

Glass fiber-optic cables are suitable for connection of optical interfaces that work in the wavelength range around 850 nm and around 1300 nm. They include two graded-index multimode fibers of the type 62.5/125  $\mu\text{m}$ .

The glass fiber-optic cables are available in different versions which makes for an optimum adaptation to different areas of application:

- Fiber Optic standard cable
- INDOOR Fiber Optic indoor cable
- Flexible Fiber Optic trailing cable

### Fiber Optic standard cable

The standard cable is the universal cable for indoor and outdoor use.

### INDOOR Fiber Optic indoor cable

The indoor cable is intended for weather-proof indoor use. It is halogen-free, non-crush and flame-retardant.

### Flexible Fiber Optic trailing cable

The trailing cable was designed for the special application of forced movement, for example, for constantly moved machine parts such as trailing chains. It is mechanically designed for 100,000 bending cycles by  $\pm 90^\circ$  (with the specified minimum radius). Integrated dummy elements ensure a round cross-section of the cable. The trailing cable can be used indoors and outdoors.

### Maximum distances between two optical link modules

The following distances may not be exceeded between two OLMs regardless of the optical power budget:

- OLM/P11, OLM/P12: 400 m
- OLM/G11, OLM/G12, OLM/G12-EEC: 3 km
- OLM/G11-1300, OLM/G12-1300: 15 km

### Additional information

All operating instructions (<http://support.automation.siemens.com/WW/view/en/10805951/133300>) of the SIMATIC NET bus components include information on distances that can be covered with the SIMATIC NET glass fiber-optic cables. You can configure your optical network without any calculations using simple limits.

## 2.2.3 Active network components

### 2.2.3.1 Network components in electrical networks

#### Active network components

The following active network components are available for PROFIBUS in electrical networks:

- Repeater RS485
- Diagnostics repeater
- PROFIBUS Terminator
- DP/DP coupler
- IE/PB Link PN IO
- IWLAN/PB Link PN IO
- Active components for the connection of CAN
- Active components for the gateway between PROFIBUS and AS-Interface
  - DP/AS-i LINK Advanced
  - DP/AS-Interface Link 20E
  - DP/AS-i F-Link

#### RS485 repeater

The RS485 IP20 repeater connects two PROFIBUS bus segments in RS485 technology with up to 32 devices. It provides transmission rates from 9.6 kbps to 12 Mbps.

The RS485 repeater refreshes a signal regarding amplitude, signal width and edge steepness between two segments. It is used when more than 32 stations are connected to the bus or the maximum cable length of a segment is exceeded.

Bus segments can be operated ungrounded (galvanic isolation of segments) with an RS485 repeater.

#### Diagnostics repeater

The diagnostic repeater connects three PROFIBUS segments in RS485 technology, two of which are diagnostics-capable segments with 31 devices each. It is designed as DP slave to send diagnostics alarms to the DP master.

The diagnostic function provides the location and the cause of cable faults, such as wire break or missing terminating resistors. The fault location is indicated relative to the existing devices.

The diagnostics repeater refreshes a signal regarding amplitude, signal width and edge steepness between the segments. The cascading depth between any two PROFIBUS devices is limited to nine diagnostics repeaters.

## PROFIBUS Terminator

The PROFIBUS Terminator forms an active bus termination. Bus devices can be switched off, removed or replaced without affecting data transmission. This is particularly true for bus devices on both ends of the bus cable at which terminating resistors must be connected or supplied. The PROFIBUS Terminator can be mounted on a standard mounting rail.

## IE/PB Link PN for the connection of a PROFIBUS segment to an Industrial Ethernet network

The IE/PB Link PN IO as independent component provides the seamless transition between Industrial Ethernet and PROFIBUS. Through the use of IE/PB Link PN IO as substitute on the Ethernet, the existing PROFIBUS devices can continue to be used and can be integrated into a PROFINET application.

A PROFINET IO controller is required for this configuration. The IE/PB Link PN acts as master on the PROFIBUS end.

## IWLAN/PB Link PN IO as gateway between LAN and PROFIBUS

PROFIBUS devices can be coupled to PROFINET IO by means of IWLAN/PB Link PN IO. This means you can integrate existing PROFIBUS configurations into PROFINET.

The IWLAN/PB Link PN IO supports the use of IWLAN and WLAN antennas for wireless data transmission, for example, in suspended monorail systems or conveyor systems. Because of the PROFINET support, the numerous PROFIBUS system services, for example, diagnostics by bus, can continue to be used.

A PROFINET IO controller is required for this configuration. The IWLAN/PB Link PN IO acts as master on the PROFIBUS end.

## CANopen module for connection to CAN

You can use the CANopen module to easily connect CANopen applications to PROFIBUS.

Typical areas of application:

- Control of hydraulic valves/hydraulic axes in vehicles
- Control of motors in packaging machines and on conveyor belts
- Use in wind turbines for detection of angular encoders
- Detection of HMI devices on machines, e.g., joysticks
- Detection of measured data from displacement transducers, inclination sensors or angle encoders on tower cranes or gantry cranes

## DP/DP coupler for connection of two PROFIBUS networks

The PROFIBUS DP/DP coupler is used to connect two PROFIBUS DP networks. Data (0 to 244 bytes) is transmitted from the DP master of the first network to the DP master of another network and vice versa.

The DP/DP coupler comes equipped with two independent DP interfaces that establish the connection to the two DP networks. There is one slave at each DP network. The data exchange between the two DP networks takes place by internal copying in the coupler.

## DP/PA bus link for connection of PROFIBUS PA

The DP/PA bus link is the connection between PROFIBUS DP and PROFIBUS PA. This means it connects the process control systems with the field devices of the process automation.

The following components are available for a DP/PA bus link:

- DP/PA coupler Ex [ia]
- DP/PA coupler FDC 157-0
- Interface module IM 153-2 for establishing a DP/PA link.
- Active field distributor AFDiS for hazardous areas

## Active components for the gateway between PROFIBUS and AS-Interface

- **DP/AS-i LINK Advanced:**

The **DP/AS-i LINK Advanced** is PROFIBUS DPV1 slave (according to IEC 61158-2/EN 61158-2) and AS-Interface master (according to AS-Interface specification V3.0 according to EN 50295) and provides transparent data access to AS-Interface from PROFIBUS DP.

PROFIBUS DP masters can cyclically exchange I/O data with the AS-Interface; DP masters with acyclic services can also make AS-Interface master calls. The **DP/AS-i LINK Advanced** is particularly suited for distributed configurations and for the connection of a subordinate AS-Interface network.

The DP/AS-i LINK Advanced in the version as AS-Interface single master is completely sufficient for applications with typical configuration limits.

For applications with high configuration limits, the DP/AS-i LINK Advanced is used as AS-Interface double master. In this case, the duplicate configuration limits can be used on two independently running AS-Interface strands.

- **DP/AS-Interface Link 20E:**

The DP/AS-Interface Link 20E is PROFIBUS DP slave (in accordance with EN 61158) and AS-Interface master (in accordance with AS-Interface specification V3.0 according to EN 50295) and supports operation of the AS-Interface on PROFIBUS DP.

Single PROFIBUS masters can cyclically exchange I/O data with the AS-Interface; masters with acyclic services can exchange I/O data and make master calls.

- **DP/AS-i F-Link:**

The DP/AS-i F-Link is PROFIBUS DP-V1 slave (according to EN 61158) and AS-i master (according to AS-Interface specification V3.0 to EN 50295) and provides transparent data access to AS-Interface from PROFIBUS DP. The DP/AS-i F-Link is also the only AS-i master that can forward safety-oriented input data of ASIsafe slaves to a fail-safe CPU with PROFIBUS DP master by means of the PROFIsafe protocol. Additional safety cabling or monitoring is not required (in particular, no AS-Interface safety monitor). Depending on the slave type, you can transmit binary values or analog values. All slaves according to AS-Interface specification V2.0, V2.1 or V3.0 can be operated as AS-i slaves.

As fully-featured AS-i master according to specification V3.0, you can use higher configuration limits on the AS-i network (496 inputs and outputs each, up to 62 digital or analog slaves).

### Additional information

Information on the components is available in the Siemens Mall (<http://mall.industry.siemens.com>).

Additional information is available in these manuals:

- PROFIBUS Network Manual (<http://support.automation.siemens.com/WW/view/en/35222591>)
- Diagnostic repeater (<http://support.automation.siemens.com/WW/view/en/7915183>)
- DP/DP Coupler (<http://support.automation.siemens.com/WW/view/en/1179382>)
- SIMATIC NET Twisted-Pair and Fiber-Optic Networks (<http://support.automation.siemens.com/WW/view/en/8763736>)
- Basics on Setting up an Industrial Wireless LAN (<http://support.automation.siemens.com/WW/view/en/9975764>)
- SIMATIC bus links, DP/PA coupler, active field distributors, DP/PA Link and Y Link (<http://support.automation.siemens.com/WW/view/en/1142696>)
- Information on the CANopen module is available on the Internet (<http://www.hms-networks.com/can-for-et200s>).
- DP/AS-interface LINK Advanced (<http://support.automation.siemens.com/WW/view/en/22502958/133300>) manual
- DP/AS-i F-Link (<http://support.automation.siemens.com/WW/view/en/24196041>) manual

### See also

Topology with RS485 repeater (Page 35)

OLM topology (Page 40)

WLAN topology (Page 40)

Connecting PROFIBUS to PROFINET (Page 41)



### 2.2.3.2 Network components in optical networks

#### Active network components

The following active network components are available for PROFIBUS in optical networks:

- Optical Link Module OLM
- Optical Bus Terminal OBT

#### Optical Link Module OLM

You can use the PROFIBUS Optical Link Modul OLM to install PROFIBUS networks in line, star structure and redundant ring structure.

The transmission rate of a fiber-optic cable line does not depend on the distance and can be 9.6 kbps to 12 Mbps.

Applications for OLM include, for example, plant buses on PROFIBUS base, networking across buildings using glass fiber-optic cables, mixed networks with electrical and optical segments, large networks (road tunnels, traffic guidance systems) and networks with high demands on availability (redundant ring networks).

Optical Link modules can be combined by means of an RS485 interface and individual devices or entire electrical segments can be integrated into the optical PROFIBUS network.

The following distances may not be exceeded between two OLMs regardless of the optical power budget:

- OLM/P11, OLM/P12: 400 m
- OLM/G11, OLM/G12, OLM/G12-EEC: 3 km
- OLM/G11-1300, OLM/G12-1300: 15 km

#### Optical Bus Terminal OBT (optical bus terminal)

The Optical Bus Terminal connects an individual PROFIBUS device without integrated optical interface or a PROFIBUS RS 485 segment with up to 31 devices to an optical PROFIBUS.

An individual PROFIBUS DP device is connected with its RS 485 interface by means of a PROFIBUS cable with integrated terminating resistor, for example, connecting cable 830-1T, to the RS 485 interface of the OBT. The OBT is integrated into the optical line by means of two optical interfaces.

The following optical transmission media can be connected to the OBT:

- Plastic fiber-optic cable up to 50 m single distance length. They can be assembled on-site with two 2x2 Simplex connectors.
- PCF fiber-optic cable up to 300 m single distance length. The cables are delivered pre-assembled.

### **Additional information**

Information on the components is available in the Siemens Mall (<http://mall.industry.siemens.com>).

Additional information is available in these manuals:

- PROFIBUS network manual (<http://support.automation.siemens.com/WW/view/en/35222591>)
- SIMATIC NET PROFIBUS, Optical Link Module (<http://support.automation.siemens.com/WW/view/de/56606534/0/en>)
- SIMATC NET Twisted-Pair and Fiber-Optic Networks (<http://support.automation.siemens.com/WW/view/en/8763736>)

## 2.2.4 Examples for topology

### 2.2.4.1 Topology with RS485 repeater

#### Configuration options with the RS485 repeater

You can operate the RS485 repeater in the following configurations:

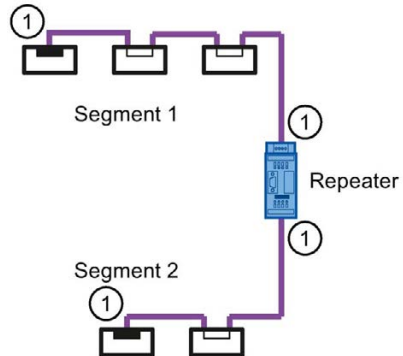


Figure 2-7 Segment 1 and segment 2 connected to RS485 repeater

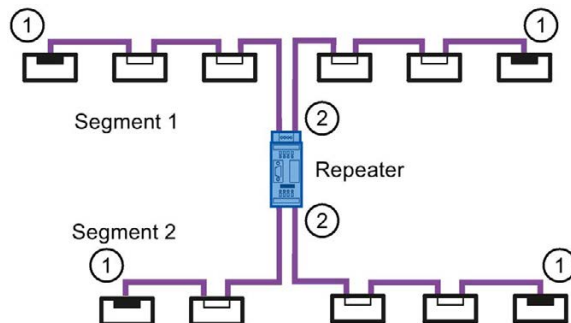


Figure 2-8 Segment 1 and segment 2 looped-through to RS485 repeater

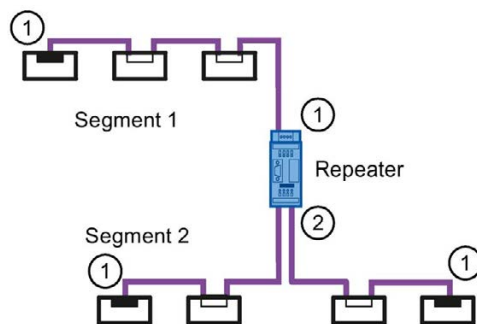


Figure 2-9 Segment 1 connected to RS485 repeater and segment 2 looped-through to RS485 repeater

- ① Connect terminating resistor
- ② Do not connect terminating resistor

### Configuration example

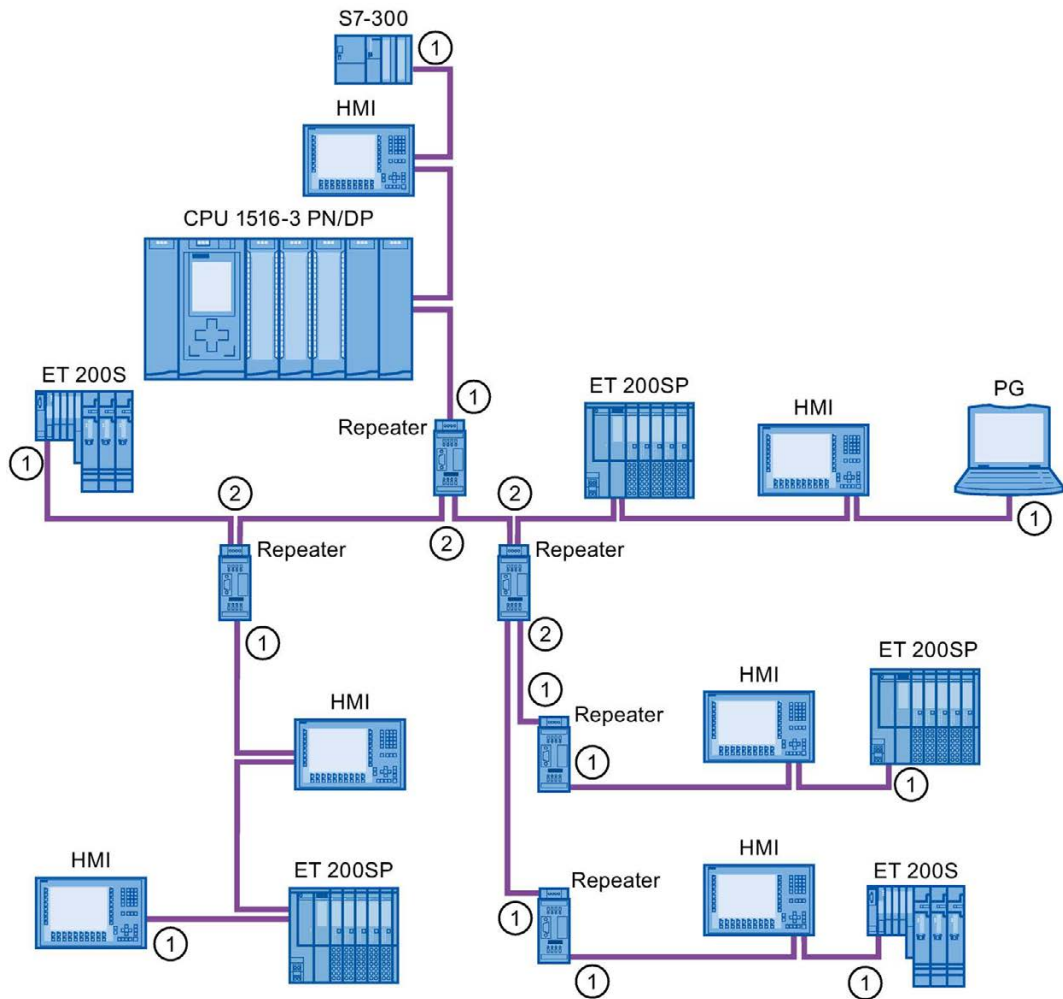


Figure 2-10 Configuration example with five RS485 repeaters

- ① Connect terminating resistor
- ② Do not connect terminating resistor

### Maximum configuration

If you install a PROFIBUS network with RS485 repeaters, you may not connect more than nine RS485 repeaters in series.

### 2.2.4.2 Topology with diagnostic repeater

#### Diagnostic repeater with three segments

You may not exceed the maximum permitted cable length of 100 m per segment that can be monitored for the diagnostic repeater. The segments connected to DP2 and DP3 are diagnostics-capable. The cable length that can be monitored is limited for some cable types.

#### Maximum cascade depth

You can connect up to nine diagnostic repeaters in series between any two PROFIBUS stations.

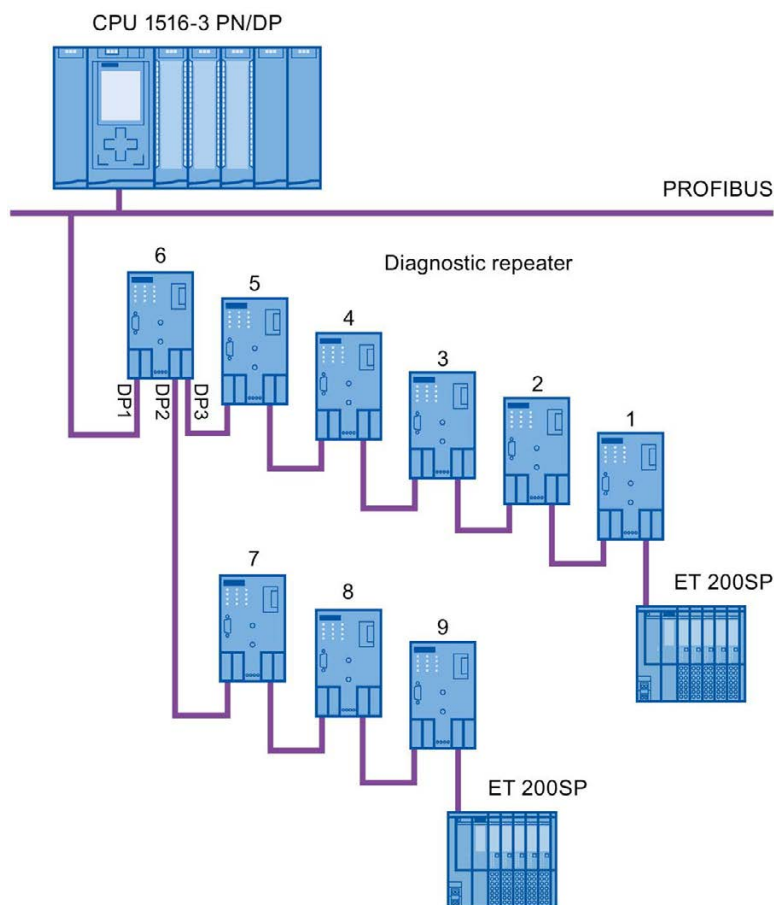


Figure 2-11 Schematic layout of a PROFIBUS network with maximum possible cascade depth at diagnostic repeaters

Example: Maximum cascade depth exceeded

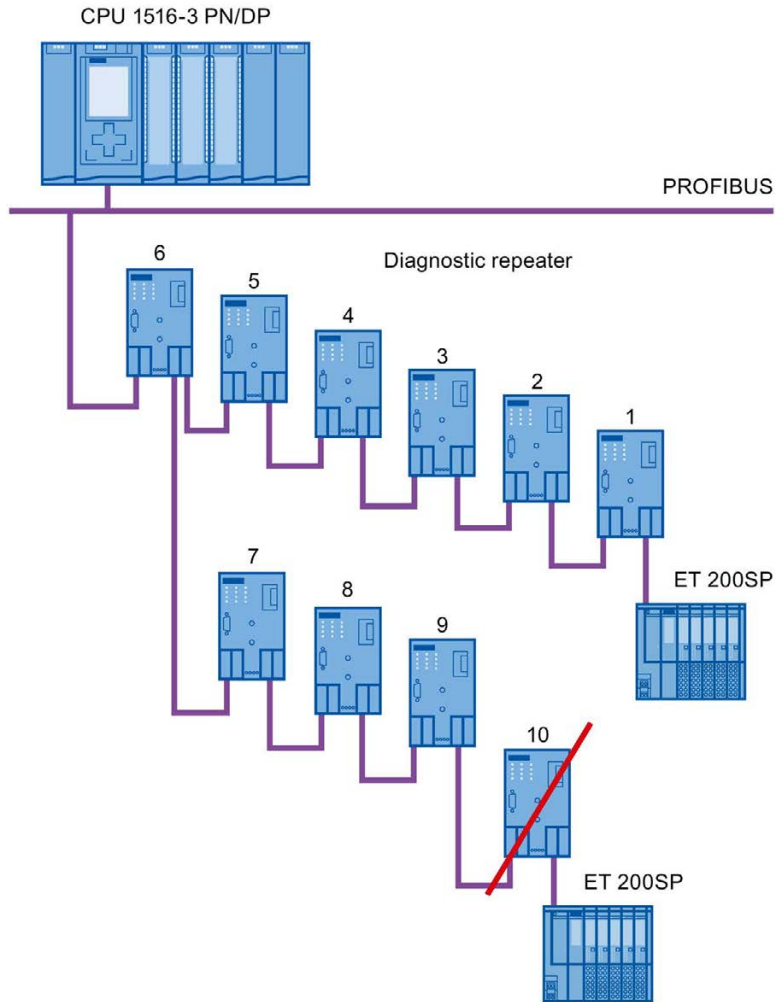


Figure 2-12 Maximum cascade depth exceeded

### Layout with several segments

You can increase the number of used diagnostic repeaters by using several segments. The example shows a layout in which the maximum cascade depth is exceeded at two segments.

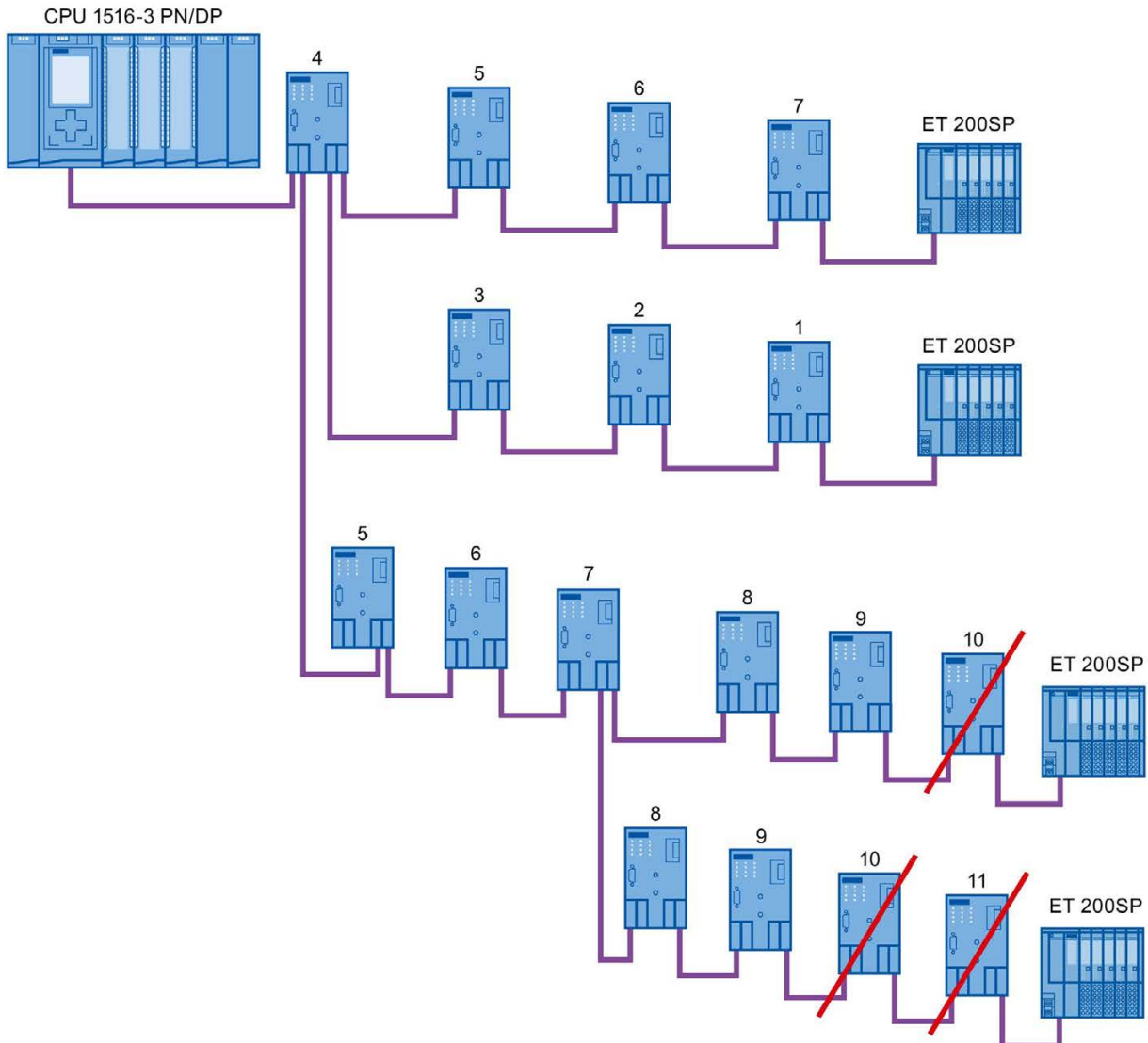


Figure 2-13 Layout with several segments, maximum cascade depth exceeded

### Additional information

Additional information is available in the Diagnostic Repeater (<http://support.automation.siemens.com/WW/view/en/7915183>) manual.

### 2.2.4.3 OLM topology

#### Combination of electrical and optical networks with OLM

Additional distances can be covered by means of the Optical Link Module.

Because bus cables across several buildings are particularly vulnerable to damage caused by overvoltage (effect of lightning), the devices in the connected bus segment must be protected against overvoltage.

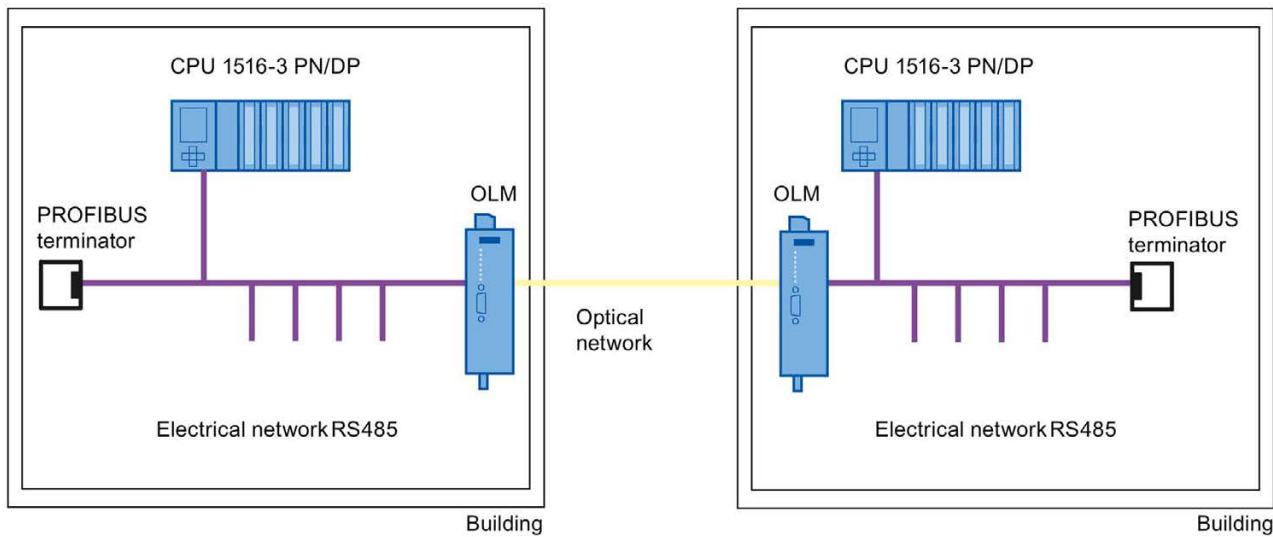


Figure 2-14 Combination of electrical and optical networks

### 2.2.4.4 WLAN topology

#### IWLAN/PB Link PN IO as gateway between Industrial Wireless LAN and PROFIBUS

The IWLAN/PB Link PN IO supports the use of IWLAN and WLAN antennas for wireless data transmission. This means the numerous PROFIBUS system services, for example, diagnostic by bus, can be used throughout.

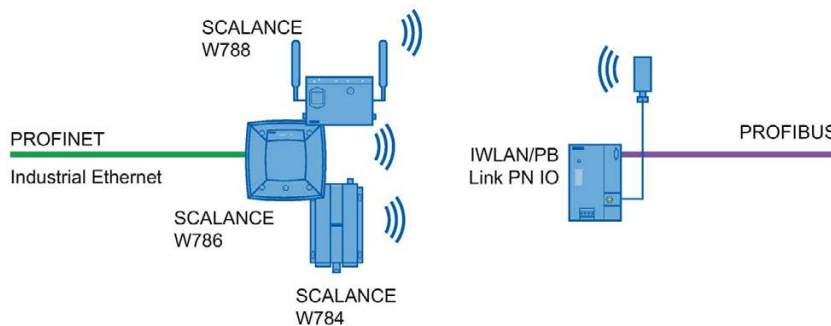


Figure 2-15 PROFIBUS and WLAN



### 2.2.4.5 Connecting PROFIBUS to PROFINET

PROFIBUS can be integrated in PROFINET. In this way, you can set up any hybrid systems consisting of fieldbus and Ethernet-based subsystems. This provides a continuous data exchange.

#### Coupling of PROFIBUS and PROFINET

With a proxy-capable PROFINET device that is equipped with a PROFIBUS interface in addition to a PROFINET interface, you can integrate existing PROFIBUS configurations into the PROFINET configuration.

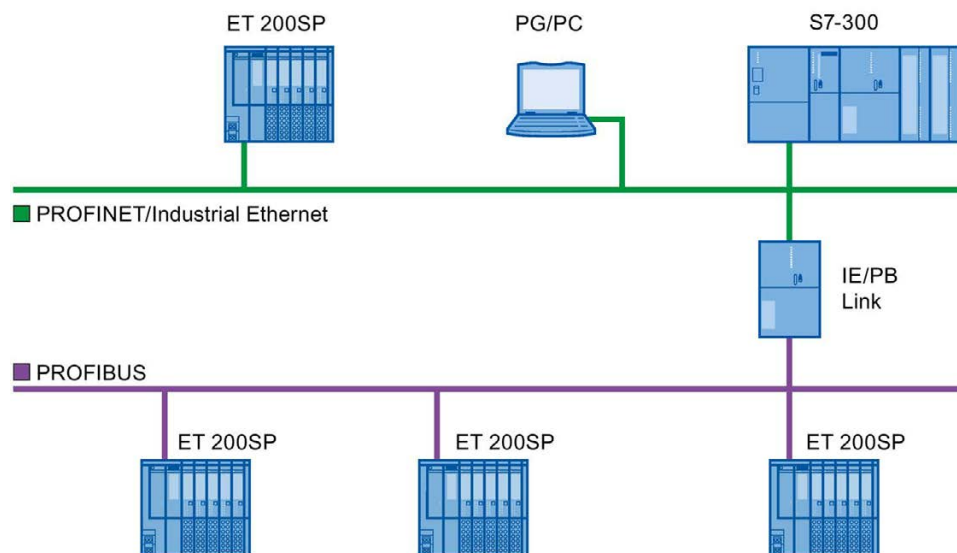


Figure 2-16 Connection of PROFIBUS and PROFINET with IE/PB link

#### PROFINET device with proxy functionality

The PROFINET device with proxy functionality is the substitute for a PROFIBUS device on Ethernet. The proxy functionality allows a PROFIBUS device to communicate not only with its master but also with all devices on PROFINET.

With PROFINET, existing PROFIBUS systems can be integrated into the PROFINET communication with the aid of an IE/PB link. The IE/PB link PN IO then handles communication via PROFINET on behalf of the PROFIBUS components.

## Parameter assignment/addressing

To set up an automation system, you will need to configure, assign parameters and link the individual hardware components. The work needed for this is undertaken in the STEP 7 device, topology and network view.

### Configuration

"Configuring" is understood to mean arranging, setting and networking devices and modules within the device or network view.

A PROFIBUS address is automatically assigned to each module. The addresses can be subsequently modified.

The CPU compares the preset configuration created in STEP 7 with the actual configuration of the plant. Errors can be detected and signaled immediately this way.

The exact procedure for configuring devices is described in detail in the STEP 7 online help.

### Parameter assignment

"Parameter assignment" is understood to mean setting the properties of the components used. The settings for the hardware components and for data exchange are assigned, for example, activating diagnostics, input delay with DI.

The parameters are downloaded into the CPU and transferred to the corresponding modules when the CPU starts up. Modules can be replaced with ease because with SIMATIC CPUs the set parameters are automatically downloaded into the new module during each startup.

### Adjusting the hardware to the project requirements

You need to adapt the hardware if you want to set up, expand or change an automation project. To do this, add hardware components to your layout, link them with existing components, and adapt the hardware properties to the tasks.

The properties of the automation systems and modules are preset so that in many cases you do not have to assign parameters again.

But parameter assignment is required in the following cases:

- You want to change the preset parameters of a module.
- You want to use special functions.
- You want to configure communication connections.

## Basic procedure for creating a PROFIBUS DP system

- Configuration
  - Creating PROFIBUS devices and modules in STEP 7
  - Assigning the DP slave to a DP master (Page 43)
- Optional: Parameter assignment
  - Assigning the PROFIBUS address (Page 45)
  - Making network settings (Page 46)
  - Considering cable configuration (Page 49)
  - Considering additional network devices (Page 51)
  - Bus parameters – creating a user-defined profile (Page 52)
  - Configuring constant bus cycle time (Page 55)

## 3.1 Assigning the DP slave to a DP master

### PROFIBUS DP system

A PROFIBUS DP system consists of a PROFIBUS DP master and its assigned PROFIBUS DP slaves. Once the devices have been placed in the network view or device view, STEP 7 assigns default parameter values to them. Initially, you only have to assign the DP slaves to one DP master.

### Requirement

- The network view of STEP 7 is open.
- A CPU has been placed (e.g., CPU 1516-3 PN/DP).
- A DP slave has been placed (e.g., IM151-1 HF).

**Procedure**

To assign DP slaves to a DP master, follow these steps:

1. On the DP slave, use the left mouse button to click on the "Not assigned" link. The "Select DP master" menu opens.
2. Select the DP master in the menu to which you want to assign the DP slave.

**Result:** A subnet with a DP system is created on the CPU. The CPU is now the PROFIBUS DP master. The DP slave is assigned to the DP master.

3. Repeat steps 1 and 2 for all other DP slaves that you want to assign to the DP master.

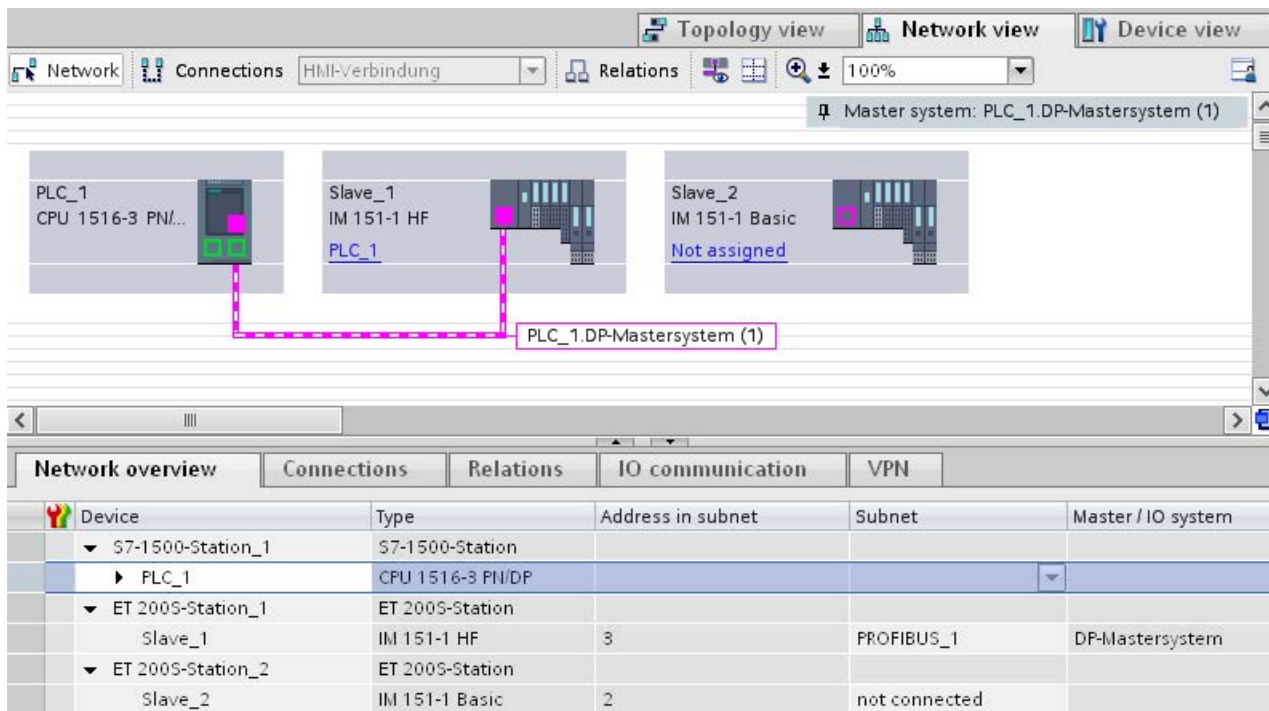


Figure 3-1 Assigning the DP slave to a DP master

**Network overview**

You can check the communication relationships of the activated interface in the network overview. The network overview is context-sensitive for selection in the network view:

- The selection of the CPU shows the DP communication of the CPU.
- The selection of the station shows the communication of the entire station.
- The selection of the interface shows the DP communication of the interface.

## 3.2 PROFIBUS address

Devices can be connected to the PROFIBUS subnet that communicate by means of configured connections or that are part of a PROFIBUS DP master system.

If the DP slave has already been assigned to a DP master, the PROFIBUS subnet to which the device is connected is automatically displayed under "Interface linked with".

In the Inspector window under "PROFIBUS", select the subnet to which the interface is linked or add a new subnet.

All devices of a subnet must have different PROFIBUS addresses.

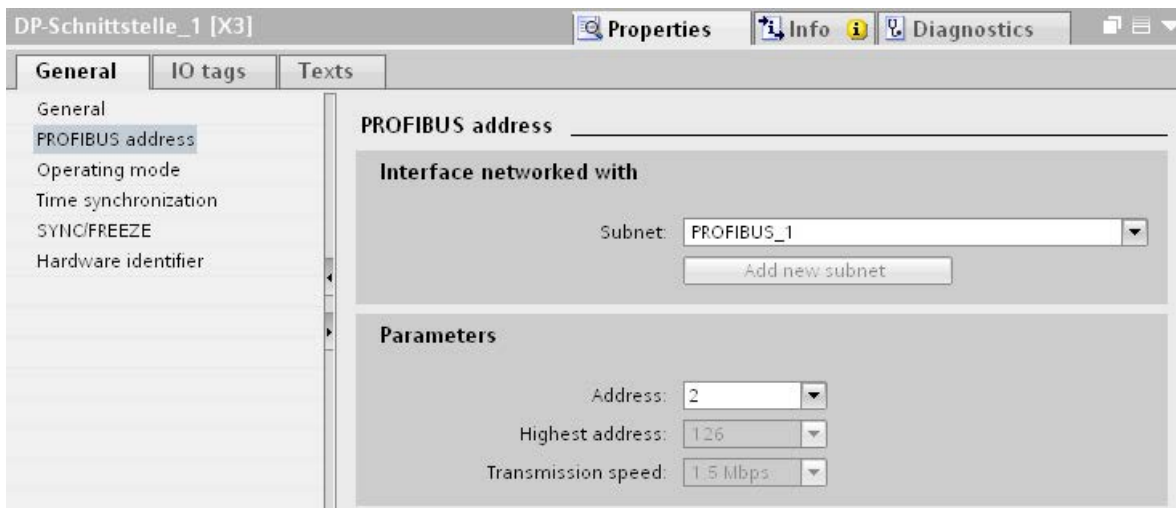


Figure 3-2 PROFIBUS address

### Rules for address assignment

STEP 7 automatically assigns device addresses.

You can change the addresses if you observe the following points:

- Assign a unique PROFIBUS address to each device in the PROFIBUS network, each DP master and each DP slave in the PROFIBUS network.
- Depending on the DP slave, not all permitted PROFIBUS addresses are supported. For devices with BCD switches, it is often the case that only the PROFIBUS addresses 1 to 99 are supported.

### Changing the PROFIBUS address

You change the PROFIBUS address under "Parameter".

### 3.3 Network settings

#### Highest PROFIBUS address (HSA)

Outputs the highest PROFIBUS address of an active device. PROFIBUS addresses greater than HSA are permitted for passive devices, but only up to 126.

#### Profile

Depending on the connected device types and the protocols used, different profiles are available on the PROFIBUS. The profiles differ with respect to their setting options and calculation of the bus parameters.

The PROFIBUS subnet will only work properly if the bus parameters of all devices have the same values.

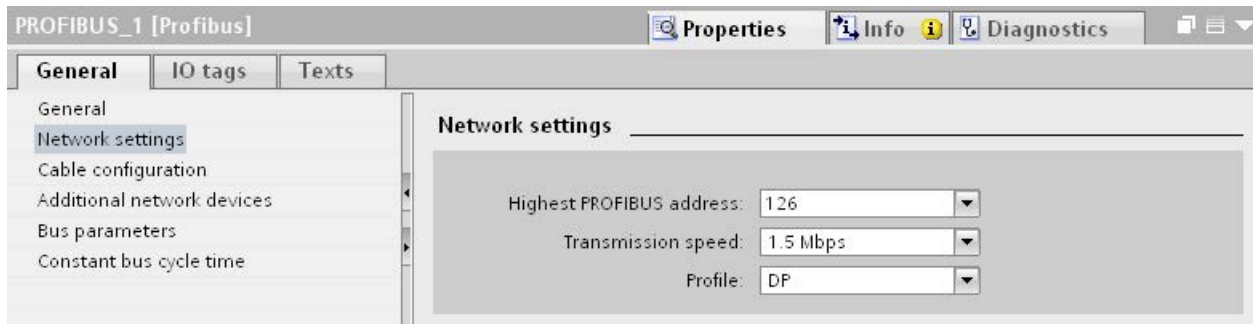


Figure 3-3 Network settings

#### Profiles and transmission rates

Table 3- 1 Profiles and transmission rates

Profiles	Supported transmission rates
DP	9.6 kbps to 12 Mbps
Standard	9.6 kbps to 12 Mbps
Universal (DP/FMS) (FMS is not supported)	9.6 kbps to 1.5 Mbps
User-defined	9.6 kbps to 12 Mbps

### DP (recommended profile)

Select the "DP" profile if only devices meeting the requirements of the standard EN 61158-6-3 are connected to the PROFIBUS subnet. The setting of the bus parameters has been optimized for these devices. These include devices with DP master and DP slave interfaces of SIMATIC S7 as well as distributed I/O devices from third parties.

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#### Note

##### Profile for constant bus cycle time and isochronous mode

DP is the recommended profile for the configuration of constant bus cycle time and isochronous mode.

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### Standard

Compared with the "DP" profile, the "Standard" profile gives you the option to take into consideration devices of another project or devices that have not been configured here for calculation of the bus parameters. The bus parameters are then calculated with a simple algorithm that was not optimized.

### Universal (DP/FMS) (FMS is not supported)

Select the "Universal (DP/FMS)" profile if individual devices in the PROFIBUS subnet use the FMS service (e.g., CP 343-5, PROFIBUS FMS devices).

As with the "Standard" profile, here, too, you have the option to take additional devices into consideration for calculation of the bus parameters.

## User-defined

The PROFIBUS subnet will only work properly if the parameters for the profile have been synchronized. Select the "User-defined" profile if none of the other profiles "match" for operation of a PROFIBUS device and if you have to adapt the bus parameters for your special layout.

You cannot configure all theoretically possible combinations with the user-defined profile either. The PROFIBUS standard prescribes some parameter limits depending on other parameters. It is, for example, not permitted that a responder responds (Min Tsdr) before the initiator is able to receive the frame (Trdy). These standard specifications are also checked in the "User-defined" profile.

---

### Note

#### User-defined settings

Use user-defined settings only if you are familiar with the PROFIBUS parameters. It is usually better to work with the "DP" profile.

Contact Customer Support (Page 91) if you have any questions.

The bus parameters that were last valid on the PROFIBUS subnet are automatically set as user-defined. If the "DP" bus profile was valid for the subnet, for example, the bus parameters for "DP" are set in the "User-defined" bus profile. You can modify the parameters based on these settings.

---

The monitoring times are not automatically recalculated in the "User-defined settings" setting so that the uniformity of the set values is not changed without your knowledge, for example, to configure other configuration tools.

You can calculate the monitoring times Ttr and watchdog based on the parameters you have set. To do so, click on the "Recalculate" button.

## See also

Additional network stations (Page 51)



## 3.4 Cable configuration

### Considering cable configuration

Information on the cable configuration can be taken into consideration for calculation of the bus parameters. To do so, select the check box "Take into account the following cable configuration" in the properties of the PROFIBUS subnet.

The other information depends on the type of cable used.

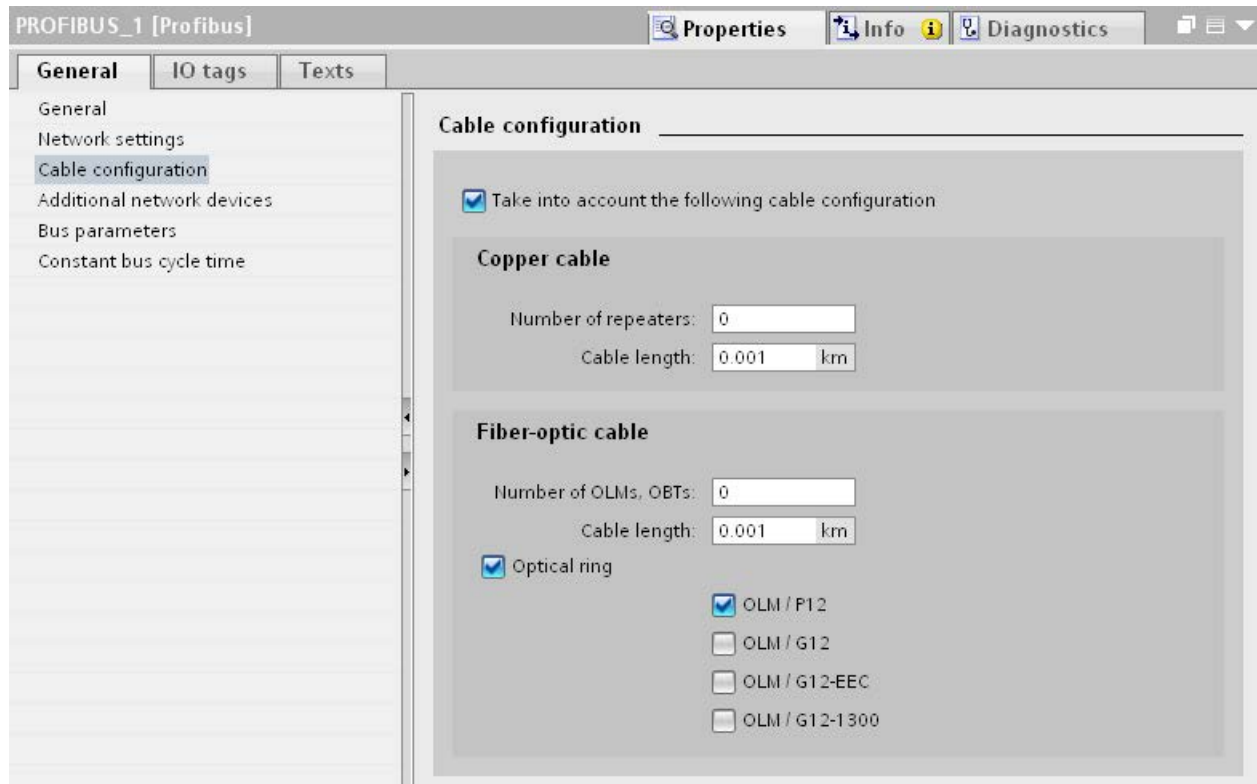


Figure 3-4 Cable configuration

### Cable configuration: Fiber-optic cables/optical ring

The calculation depends on the used OLM types. Select the corresponding check box. Multiple selections are possible.

### Adapting bus parameters in the optical ring

With the layout as ring, there is a kind of redundancy because you have the option to address all devices using the ring structure even if the connection between two devices is interrupted.

The following configuration conditions must be met in the optical ring:

- A free address below HSA (Highest Station Address)

- Increase of the retry value to at least 3

(Network settings: user-defined profile)

- Checking and adapting of the slot time

(Network settings: user-defined profile; bus parameters: Tslot parameter:

You need short slot time values for OLM / P12, medium slot time values for OLM / G12 and OLM / G12-EEC and high slot time values for OLM / G12-1300. This results in a high performance for small networks and a medium to low performance with medium to large networks.

### Additional information

Additional information on adaptation of the retry value and the slot time is available in the PROFIBUS Network Manual

(<http://support.automation.siemens.com/WW/view/en/35222591>).

## 3.5 Additional network stations

### Communication load - considering additional network stations

The bus parameters depend on the communication volume of the active network stations. There are differences between cyclical communication (DP) and connection-oriented, acyclical communication (S7 communication, Send/Receive (FDL)). Contrary to DP, the number and size of the communication jobs (communication load) depends on the user program. This means the communication load cannot always be determined automatically.

If you select the check box "Consider the following network stations", you can consider network stations in the calculation of the bus times that were not configured in the project.

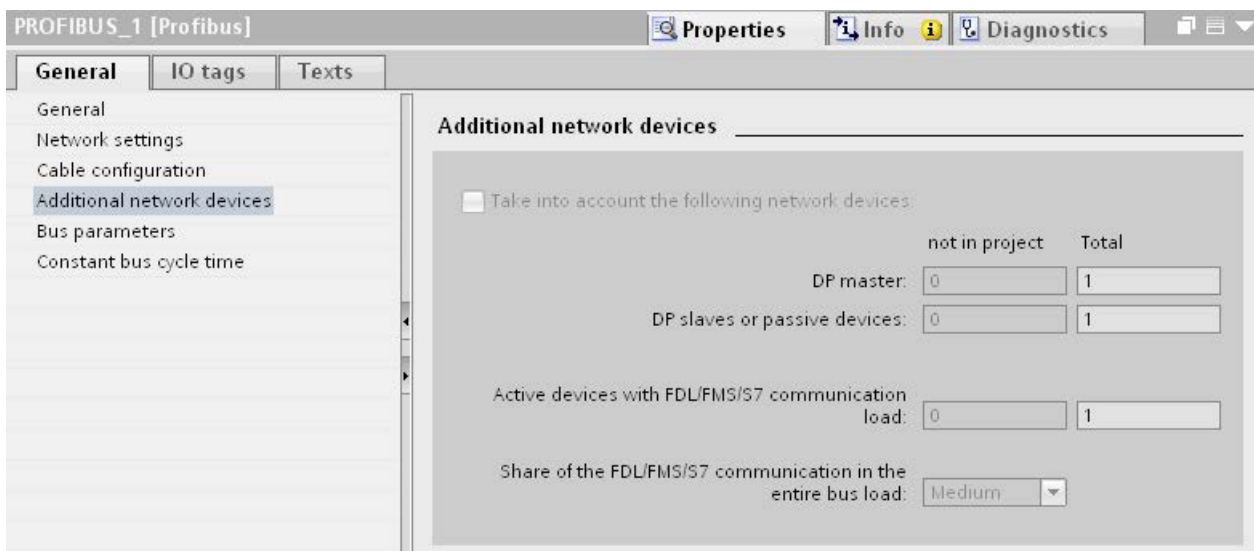


Figure 3-5 Additional network stations

### Calculating the bus times

You can specify a network configuration in the parameter group "Additional network stations" for calculation of the bus times that deviates from the configured network configuration.

The network configuration is available for the following profiles:

- Standard
- Universal (DP/FMS)
- User-defined

### Quantification of the communication load

The following settings are possible to take the communication load into consideration:

- Number of network stations that are not configured
- Information on the communication load from the user programs for FDL or S7 communication. You can choose from the following levels:
  - Low: Typical for DP, no larger data communication except DP.
  - Medium: Typical for mixed operation of DP and other communication services (e.g., S7 communication), if DP has high time requirements and with medium, acyclical communication volume.
  - High: For mixed operation of DP and other communication services (e.g., S7 communication), if DP has low time requirements and with high, acyclical communication volume.

## 3.6 Bus parameters

### Introduction

Bus parameters control the transmission behavior on the bus. Each device on the bus must correspond with the bus parameters of other devices.

---

#### Note

The PROFIBUS subnet will only work properly if the parameters for the bus profile have been synchronized. Change the preset values only if you are familiar with the parameter assignment of the bus profile for PROFIBUS.

---

## Cyclical distribution of the bus parameters

If the check box "Activate cyclical distribution of bus parameters" is selected under "Bus parameters" with the selected PROFIBUS subnet in the Inspector window, the bus parameters are sent cyclically during operation by the modules that support this function. This way you can, for example, connect a programming device to the PROFIBUS during operation.

Disable this function in the following cases:

- In constant bus cycle time mode to minimize the bus cycle.
- If third-party devices are connected in the PROFIBUS subnet whose protocol uses the DSAP 63 (Destination Service Access Point) for multicast.

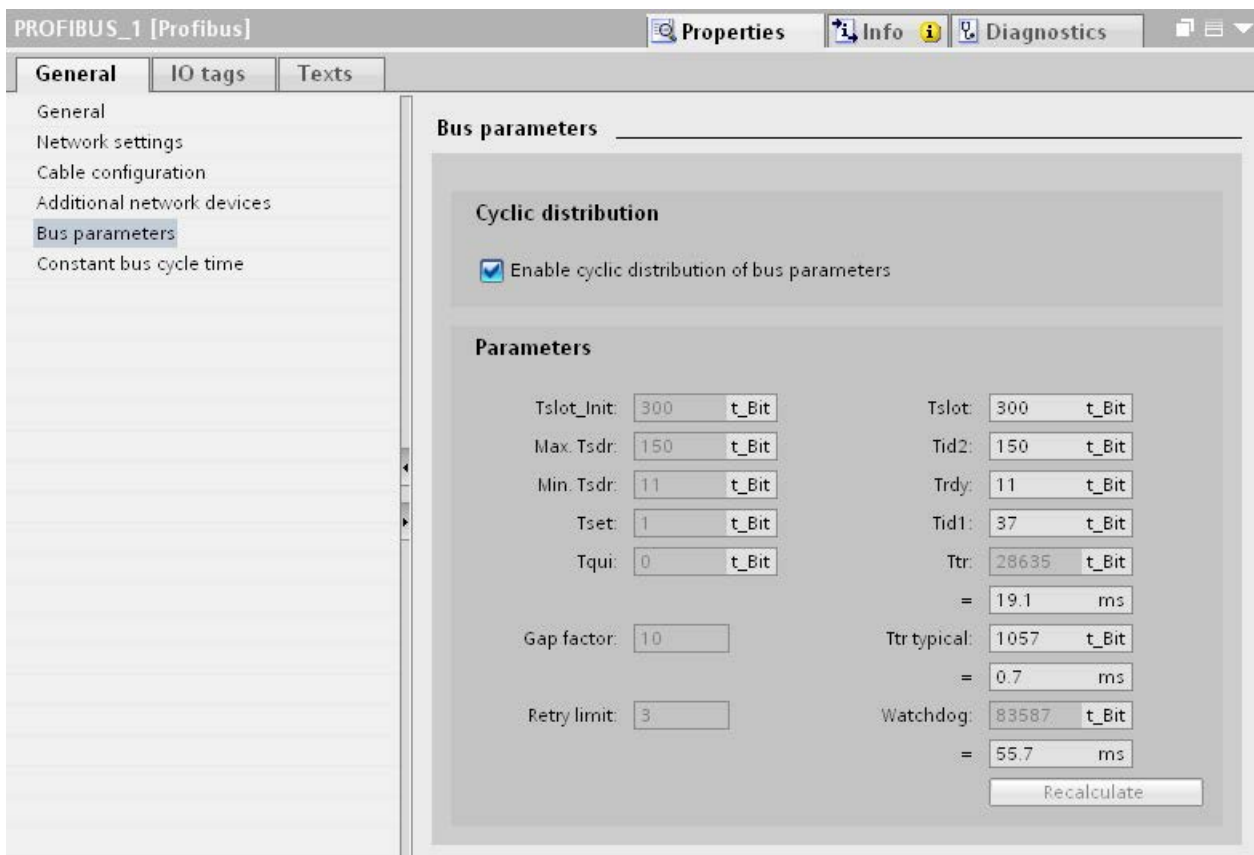


Figure 3-6 Bus parameters

**Bus parameters for the bus profile of PROFIBUS subnets**

**Note**

**Display of offline values**

The offline values of the bus parameters are always displayed even if they are connected online with the target system.

Table 3-2 Bus parameters - value ranges

Bus parameters	Adjustable <sup>1</sup>	Limit values
Tslot_Init	Yes	Max. Tsdr + 15 <= Tslot_Init <= 16.383 t_Bit
Max. Tsdr	Yes	35 + 2*Tset + Tqui <= Max. Tsdr <= 1,023 t_Bit
Min. Tsdr	Yes	11 t_Bit <= Min. Tsdr <= MIN(255 t_Bit, ... ... Max. Tsdr - 1, 34 + 2*Tset + Tqui)
Tset	Yes	1 t_bit <= Tset <= 494 t_bit
Tqui	Yes	0 t_bit <= Tqui <= MIN(31 t_bit, Min. Tsdr - 1)
GAP factor	Yes	1 <= GAP factor <= 100
Retry limit	Yes	1 <= Retry limit <= 15
Tslot ( slot time)	No	-
Tid2	No	Tid2 = Max. Tsdr
Trdy	No	Trdy = Min. Tsdr
Tid1	No	Tid1 = 35 + 2*Tset + Tqui
Ttr (Target Rotation Time)	Yes	256 t_Bit <= Ttr <= 16,777,960 t_bit
Ttr typical	No	This time is for information only and is not transmitted to the devices.
Watchdog		10 ms <= Watchdog <= 650 s

<sup>1</sup> depending on bus profile

**User-defined bus profile**

Use the following settings to create a user-defined bus profile:

- minimum Target Rotation Time (Ttr) = 5000x HSA (highest PROFIBUS address of an active device)
- minimum watchdog (Watchdog) = 6250x HSA

**Recalculate**

Use the button "Recalculate" to recalculate the parameters.

## 3.7 Constant bus cycle time

### Constant bus cycle time

The DP master addresses its assigned DP slaves cyclically. S7 communication may cause the intervals to vary. You can enable a "bus cycle with constant bus cycle time" to achieve identical intervals. This ensures data transmission at the same (constant bus cycle time) intervals.

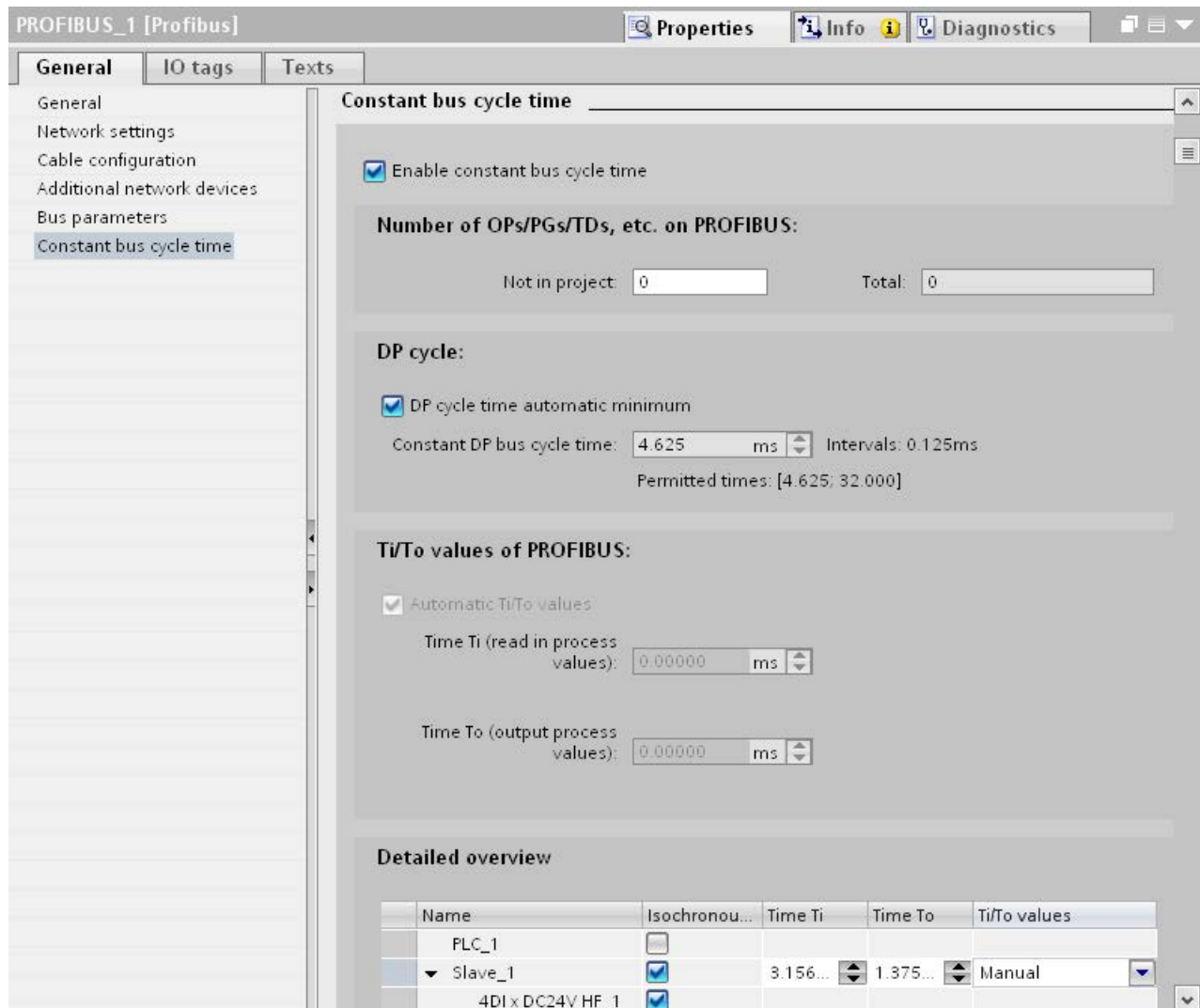


Figure 3-7 Enabling a bus cycle with constant bus cycle time

### Number of OPs/PGs/TDs at the PROFIBUS

Here you enter the number of devices that are not configured.

### **Increasing DP cycle time manually**

The following situation can occur especially with very short DP cycle times:  
The runtime of the user program is greater than the shortest cycle (see Technical specifications of the CPU, section "Isochronous mode"). You have to manually increase the automatically calculated DP cycle time in this case.

### **See also**

Configuring isochronous mode (Page 67)



# Diagnostics

## 4.1 Overview

### Diagnostics options

In case of an error you can determine the current status of your automation system and react specifically by using the event-related diagnostics and the evaluation of interrupts.

You can use the following options for diagnostics of the PROFIBUS components:

- Determine the status of the system using the Lifelist in STEP 7.
- Evaluate the module status, error and message texts by using the display of the S7-1500 CPU.
- Run cable diagnostics during operation by means of the diagnostics repeater.
- Evaluate the diagnostics and interrupt behavior in isochronous mode. (Page 70)
- Determine status information for fault localization and fault rectification by using the DP/PA coupler FDC 157-0 configured as PROFIBUS diagnostics slave.

### Additional information

Additional information on diagnostics is available in these manuals:

- In the Diagnostics repeater for PROFIBUS-DP (<http://support.automation.siemens.com/WW/view/en/7915183>) manual for diagnostics with STEP 7, diagnostics in the user program, monitoring function isochronous PROFIBUS, topology display in STEP 7.
- In the Diagnostics (<http://support.automation.siemens.com/WW/view/en/59192926>) function manual for diagnostics options that are available for the SIMATIC systems S7-1500, ET 200MP, ET 200SP and ET 200AL.
- In the PROFIBUS Network Manual (<http://support.automation.siemens.com/WW/view/en/35222591>) system manual for diagnostics of fiber-optic cables.
- In the DP/PA Coupler, Active Field Distributors, DP/PA Link and Y Link (<http://support.automation.siemens.com/WW/view/en/1142696>) operating instructions.
- In the Web Server (<http://support.automation.siemens.com/WW/view/en/59193560>) function manual for diagnostics options (based on the functionality of the CPU).

## 4.2 Diagnostics using the display of the S7-1500

### Displays

Each CPU in the S7-1500 automation system has a front cover with a display and operating buttons. Control and status information is displayed in different menus on the display. You use the operating buttons to navigate through the menus.

The following states can be evaluated on the display:

- Module status for central and distributed modules
- Error and alarm texts (system diagnostics, user-defined alarms)

### Module status

From the station overview you go to the module status for a distributed module via the module overview.

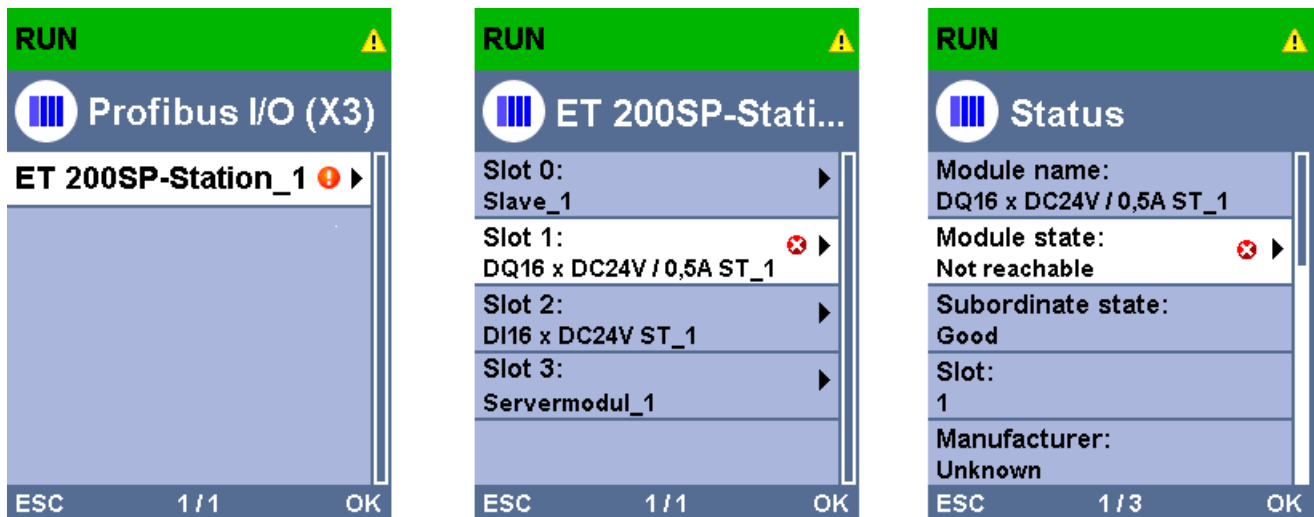


Figure 4-1 Example: Station overview, module overview, module status

## Error and alarm texts

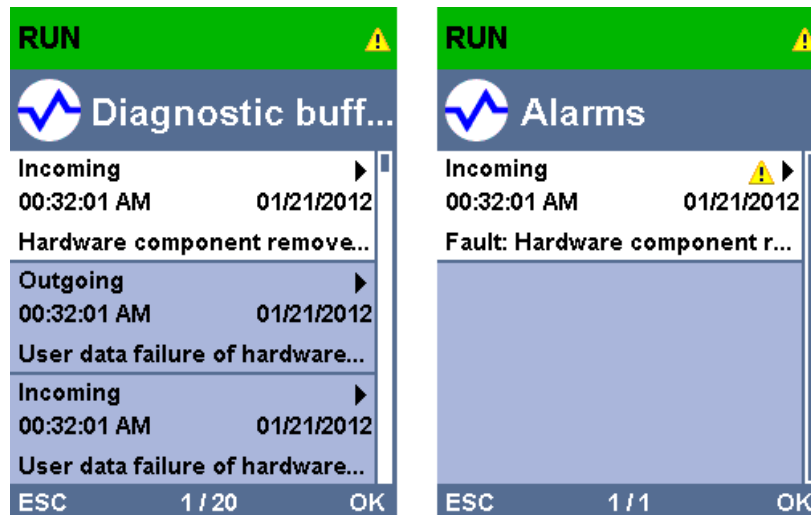


Figure 4-2 Example: Diagnostic buffer, alarms

## Additional information

Additional information on the topic "Functions and operation of the display" is available in the documentation for the S7-1500 automation system on the Internet (<http://support.automation.siemens.com/WW/view/en/59191792>).

## 4.3 Diagnostics with the diagnostic repeater

### Introduction

The diagnostic repeater is a repeater that can monitor two segments of a RS485-PROFIBUS subnet (copper cable) during operation and signal cable faults to the DP master by sending a diagnostic frame. Fault location and the cause of the fault can be displayed in plain text by means of STEP 7 as well as operator control and monitoring devices (SIMATIC HMI).

With its cable diagnostics during operation, the diagnostic repeater allows you to detect and localize cable faults early on. This means plant faults are detected early and plant downtimes can be prevented.

### Diagnostic functions

- The diagnostic function provides the location and the cause of cable faults, such as wire break or missing terminating resistors. The fault location is specified relative to the devices present, for example "Break on signal line A and/or B".
- Reading out the saved diagnostic and statistical information.
- Monitoring of the isochronous PROFIBUS, e.g., violation of cycle time.
- Providing identification data.

### Additional information

Additional information on diagnostics with STEP 7 and for reading out the diagnostics with the user program is available in the Diagnostic repeater for PROFIBUS DP (<http://support.automation.siemens.com/WW/view/en/7915183>) manual.

## 4.4 I&M data (Identification and Maintenance)

### Definition and properties

Identification and maintenance data (I&M) is information saved in a module to provide support when:

- Checking the plant configuration
- Locating hardware changes in a plant

Identification data (I data) is module information (some of which may be printed on the module housing) such as the order and serial number. I data is read-only, vendor-specific module information.

Maintenance data (M data) is system-specific information such as the installation location and date. M data is generated in the course of configuration and is written to the module memory.

The modules can be uniquely identified in online mode by means of the I&M data.

### Additional information

Information if and to what extent a DP device supports I&M data is available in the respective device manual of the device.

## Functions

### 5.1 Isochronous mode

#### 5.1.1 What is isochronous mode?

##### Why isochronous mode?

Assuming public transport were to operate at maximum speed while reducing stop times at the passenger terminals to absolute minimum, the last thing many potential passengers would notice of the departing contraption are its red tail lights. The overall travel time is, however, decided by the train, bus or underground clock, because well adjusted timing is essential to a good service. This also applies to distributed automation engineering. Not only fast cycles but also the adaptation and synchronization of the individual cycles result in optimum throughput.

##### Just-In-Time

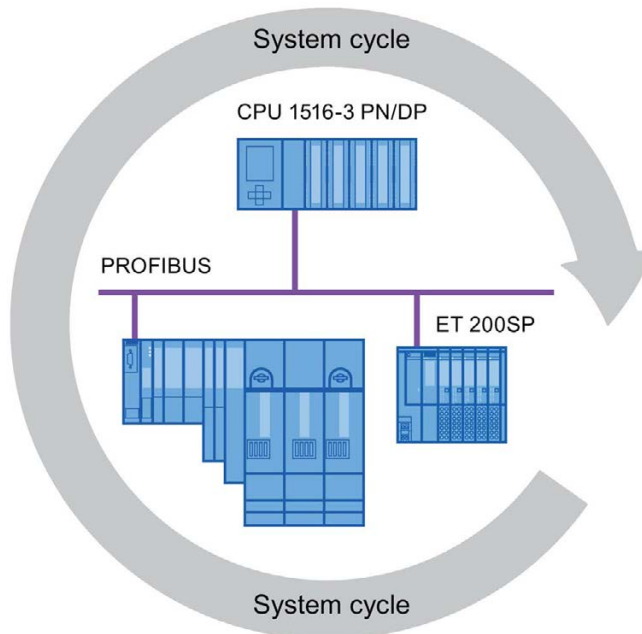


Figure 5-1 System cycle

The high speed and reliable reaction time of a system operating in isochronous mode is based on the fact that all data is provided just-in-time. The constant bus cycle time PROFIBUS DP cycle beats the time here.

### Advantages of isochronous mode

The use of isochronous mode provides:

- Optimized controls
- Determinism
- Consistent (simultaneous) reading of input data
- Consistent (simultaneous) output of output data

### 5.1.2 Use of isochronous mode

The system property "isochronous mode" enables recording of measured values and process data in a defined system cycle. Signal processing takes place in the same system cycle all the way to switching to the "output terminal". This means isochronous mode improves the control quality and provides greater manufacturing precision. Isochronous mode drastically reduces the possible fluctuations of process response times. The time-assured processing can be used for a higher machine cycle.

Isochronous mode is basically always the choice when acquisition of measured values needs to be synchronized, movements need to be coordinated and process reactions need to be defined and take place simultaneously. This means the areas of applications for isochronous mode are manifold.

### 5.1.3 Isochronous applications

#### Example: Isochronous measurement at several measuring points

QC requires precise measurement of dimensions within a camshaft production process.

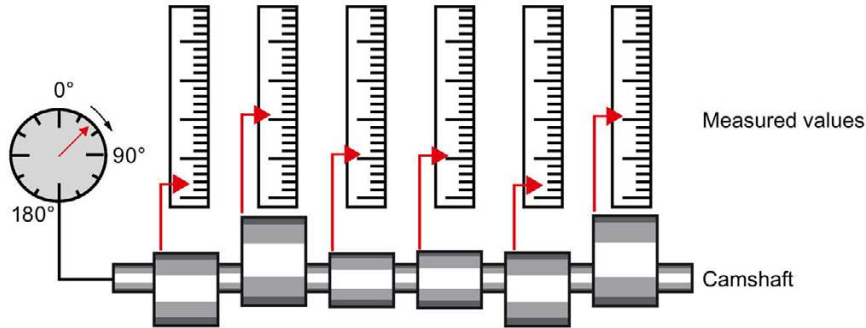


Figure 5-2 Measuring of camshafts

#### Isochronous workflow

By using the system property "isochronous mode" and the associated simultaneous measured value acquisition, measurement can be performed continuously and the time required for measurement is reduced. Resultant workflow:

- Continuous turning of the camshaft.
- During the continuous turning, measure the positions and cam excursion synchronously.
- Process the next camshaft.

All camshaft positions and the corresponding measured values (red) are measured synchronously within a single rotation of the camshaft. This increases machine output and maintains or enhances precision of the measurement.

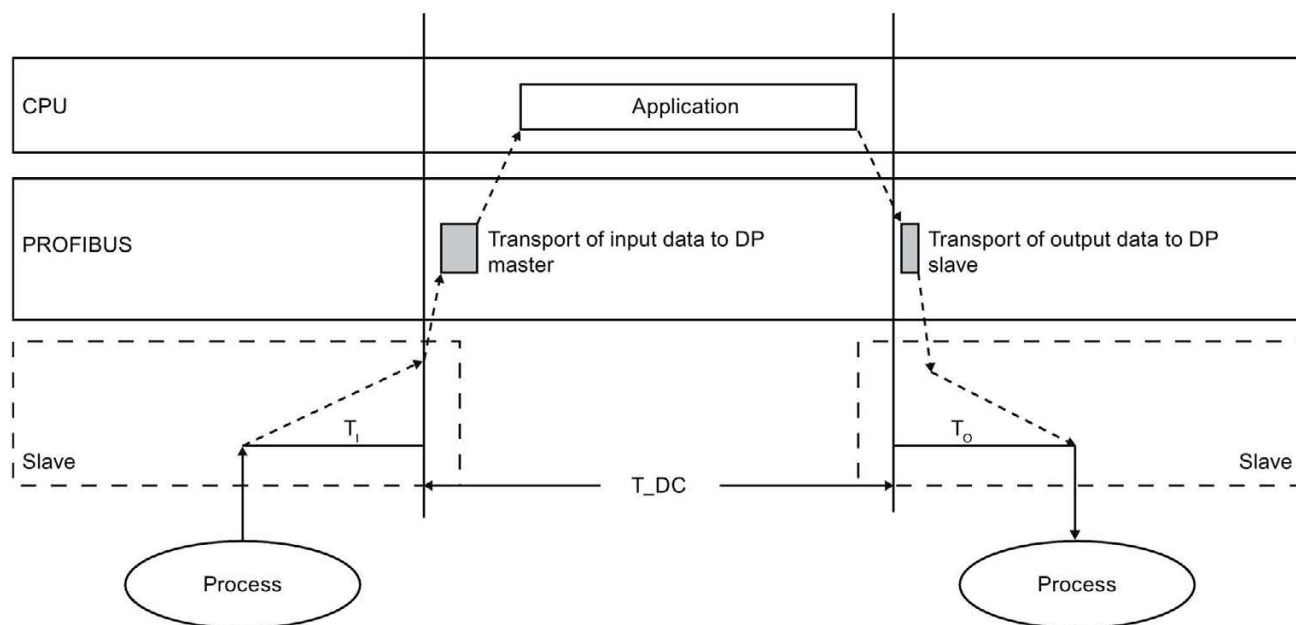


### 5.1.4 Sequence of synchronization

#### From reading of input data to output of output data

The sequence of all components involved in the synchronization is explained in the paragraphs below:

- Isochronous reading of input data
- Transport of input data by means of the PROFIBUS subnet to the DP master (CPU)
- Further processing in the isochronous application of the CPU
- Transport of output data by means of the PROFIBUS subnet to the output DP slave
- Isochronous output of output data



- $T_{DC}$  Date cycle
- $T_I$  Time for reading the input data
- $T_O$  Time for output of output data

Figure 5-3 Time sequence of synchronization

To ensure that all input data is ready for transportation via the PROFIBUS DP line when the next PROFIBUS DP cycle begins, the I/O read cycle has a lead time  $T_I$  so that it starts earlier. The  $T_I$  is the "flash gun" for all inputs. This  $T_I$  is necessary to compensate for analog to digital conversion, backplane bus times, etc. The lead time  $T_I$  can be configured by STEP 7 or by the user. We recommend that you have  $T_I$  assigned automatically by STEP 7.

The PROFIBUS DP line transports the input data to the DP master. The synchronous cycle interrupt OB SynchronousCycle is called. The user program in the synchronous cycle interrupt OB decides the process reaction and provides the output data in time for the start of the next data cycle. The length of the data cycle is always configured by the user.

$T_0$  is the compensation from the backplane bus and the digital to analog conversion within the slave. The  $T_0$  is the "flash gun" for all outputs. The time  $T_0$  can be configured by STEP 7 or by the user. We recommend that you have  $T_0$  assigned automatically by STEP 7.

Without isochronous mode, application, data transmission and field devices have their own, unsynchronized processing cycles; these result in a higher total cycle time with high jitter. With isochronous mode, application, data transmission and field device are synchronized resulting in a minimum total cycle with minimum jitter.

### **Isochronous mode and non isochronous mode distributed I/O**

It is possible to combine isochronous mode distributed I/O with non isochronous mode distributed I/O on one DP master.

#### **5.1.5 Requirements for configuration**

Note the following requirements for configuration of isochronous mode:

- Isochronous mode cannot be used in optical PROFIBUS networks.
- Constant bus cycle time and isochronous mode are only possible with the bus profiles "DP" and "User-defined".
- Isochronous mode is only possible with the DP interfaces integrated in the CPU. Isochronous mode with CPs for PROFIBUS is not possible.
- Only the constant bus cycle time master is permitted as active station on the isochronous PROFIBUS DP. OPs and PGs (for example, PCs with PG functionality) influence the time behavior of the isochronous DP cycle and are therefore not permitted.
- Isochronous mode is not permitted across lines.
- Isochronous I/O can only be processed in process image partitions. Isochronous consistent data transmission is not possible without the use of process image partitions. The adherence to quantity structures is monitored because the number of slaves and bytes on the DP master system is limited for each process image partition.
- The addresses of isochronous modules must be located in a process image partition.
- Full isochronous mode from "terminal" to "terminal" is only possible if all components involved in the chain support the system property "isochronous mode".

Make sure you look for the entry "Isochronous mode" or "Isochronous processing" in the information box of the module when you select it in the catalog.

- When you configure isochronous mode, you may not assign a SYNC/FREEZE group to the slave.

## 5.1.6 Configuring isochronous mode

### Introduction

A SIMATIC automation solution can be connected to the isochronous PROFIBUS with the isochronous mode function. Isochronous mode guarantees the synchronous reading of input data, the processing and output of output data at the same (isochronous) intervals.

### Basic procedure for configuration of isochronous mode

1. Setting the properties for isochronous mode on the DP slave:
  - Isochronous DP cycle
  - Isochronous mode of the modules
2. Setting the properties for isochronous mode on the modules:
  - Synchronous cycle interrupt (SynchronousCycle)
  - Process image partition
  - Input delay
3. Create user program with access to isochronous I/O

### Requirement

- The network view in STEP 7 is open.
- A CPU has been placed (e.g., CPU 1516-3 PN/DP).
- An interface module has been placed and networked with the CPU (e.g., IM 151-1 HF).
- I/O modules have been placed (e.g., 2DI x DC24V HF and 2DO x DC24V/0,5A HF).

### Configuring isochronous mode on the DP slave

1. Select the DP slave in the network view and navigate to the "isochronous mode" area in the Inspector window.
2. Enable the option for synchronization to the DP cycle for the DP slave.  
Default: The DP slaves get the Ti/To values from the subnet which means the values are automatically the same for all DP slaves of the DP master system.
3. Enable the "Isochronous mode" option the the "Detail view" for all I/O modules you want to operate in isochronous mode.
4. Repeat steps 1 and 3 for all DP slaves that you want to operate in isochronous mode.

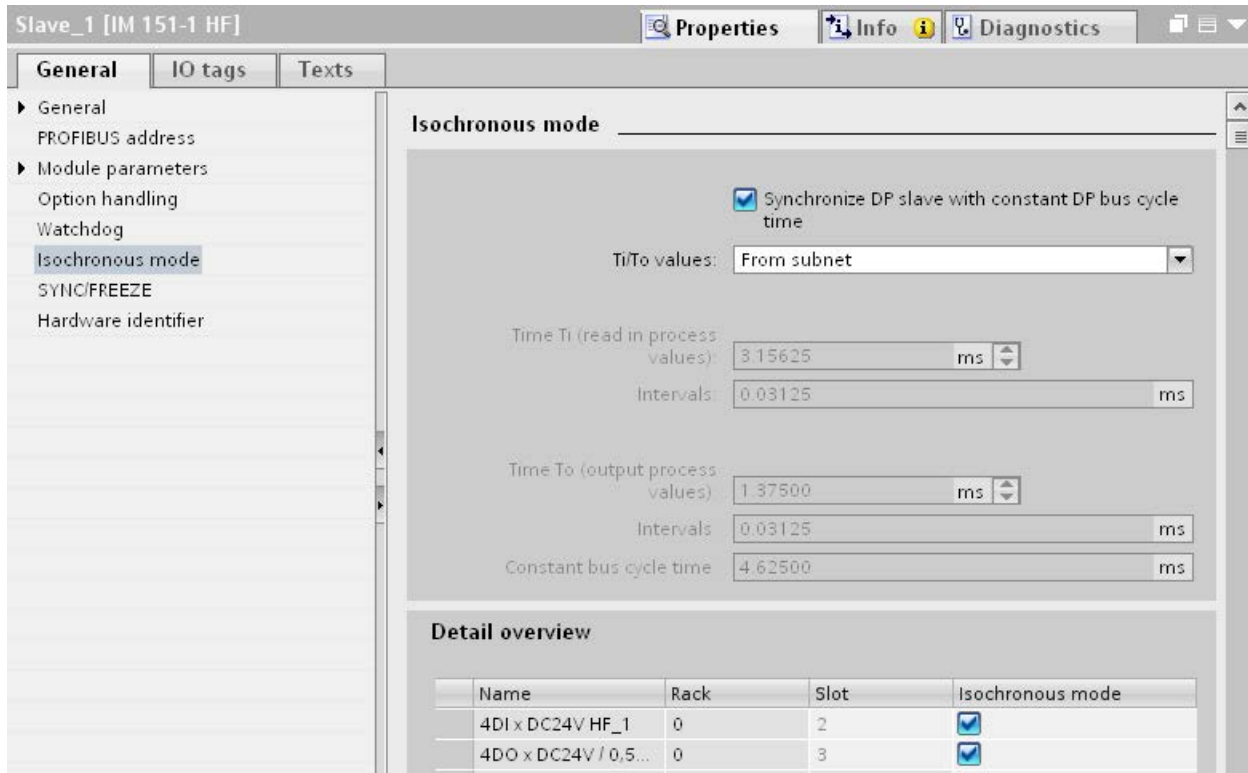


Figure 5-4 Configuring isochronous mode on the DP slave

### Configuring synchronous cycle interrupt on the I/O module

1. Select an I/O module in the device view and navigate to the "I/O addresses" area in the Inspector window.
  - The option for isochronous mode is selected.
2. Select the synchronous cycle interrupt in the drop-down list.

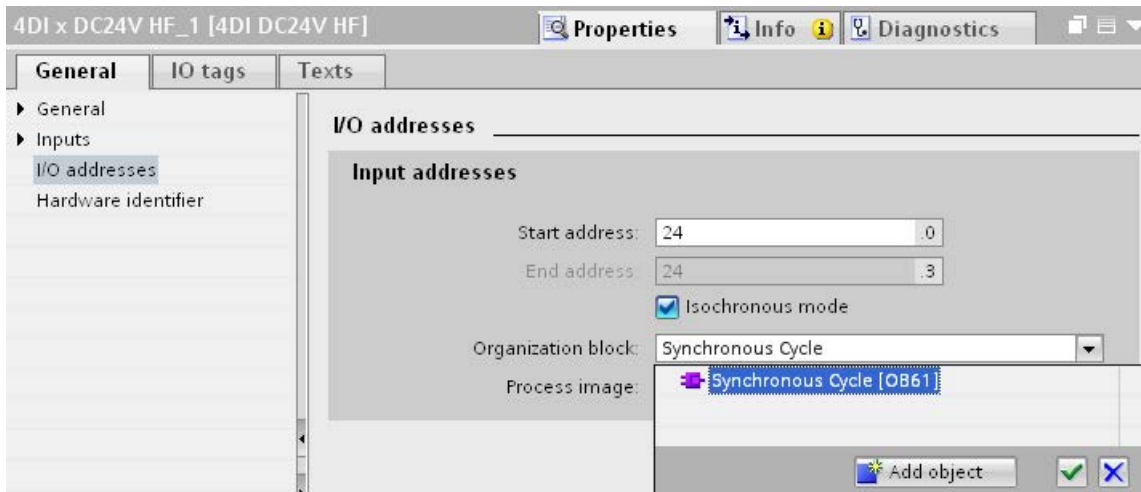


Figure 5-5 I/O addresses - creating the synchronous cycle interrupt OB

3. Assign the process image partition configured in the CPU.

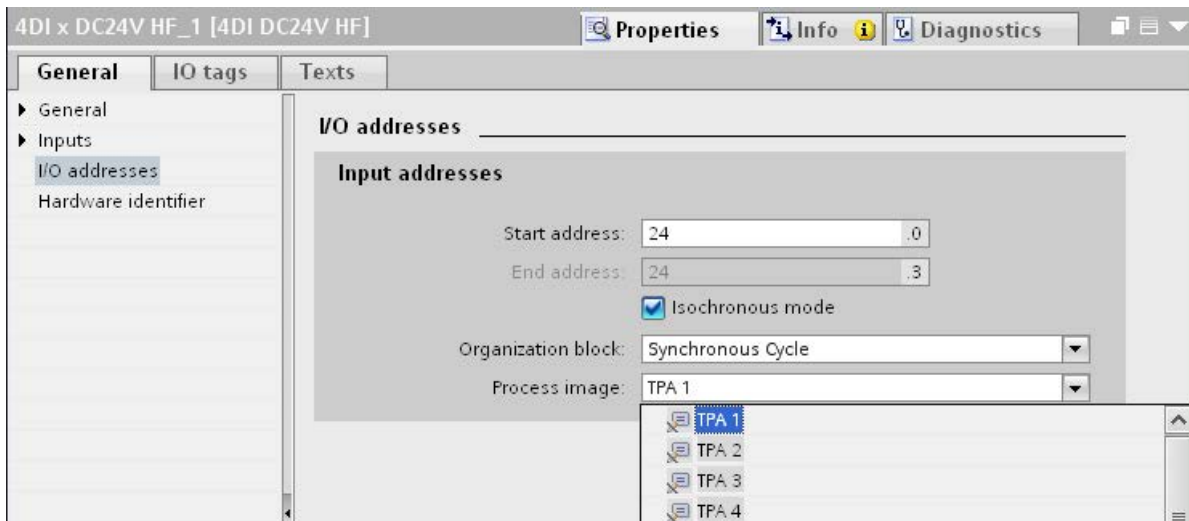


Figure 5-6 I/O addresses - assigning process image partitions

4. Repeat steps 1 and 3 for all I/O modules that you want to operate in isochronous mode.

**Programming isochronous mode**

To operate your plant in isochronous mode, the user program must be structured accordingly. This means you have to add a synchronous cycle interrupt in the STEP 7 project tree.

You access the isochronous I/O by means of a process image partition, which means the addresses of the isochronous modules must be located in a process image partition. You program access to isochronous I/O with the "SYNC\_PI" instructions (updating the process image partitions of the inputs) and "SYNC\_PO" (updating the process image partition of the outputs) in the synchronous cycle interrupt OB.

You call the "SYNC\_PI" instruction at the start of the synchronous cycle interrupt OB, provided you have selected the automatic setting for the delay time. You call the "SYNC\_PO" instruction at the end of the synchronous cycle interrupt OB.

**5.1.7 Diagnostics and interrupt functions**

The diagnostic and interrupt functions of STEP 7 are available for isochronous mode. These reduce downtimes and simplify localization and elimination of faults.

**Events, causes of errors and remedies**

Below, you will find the events for diagnostic and interrupt functions and remedies for the problem.

Table 5- 1 Events, causes of errors and remedies

Event	Cause of the error	Remedy
<ul style="list-style-type: none"> <li>Synchronous cycle interrupt OB is started with the input parameter EventCount &gt; 0 (number of lost OB calls since last OB call)</li> </ul> If configured: <ul style="list-style-type: none"> <li>Call of the time error OB</li> <li>Diagnostic buffer entry "Buffer overflow for OB6x events"</li> </ul>	The synchronous cycle interrupt OB takes too long.	<ul style="list-style-type: none"> <li>Shorten the synchronous cycle interrupt OB.</li> <li>Increase the DP cycle.</li> <li>Reduce the delay time setting (setting with isochronous mode at synchronous cycle interrupt OB).</li> </ul>
Error (negative RetVals) when updating the isochronous process image partition with SYNC_PI / SYNC_PO: <ul style="list-style-type: none"> <li>Consistency warning</li> <li>Update time is after / before the permitted access window.</li> </ul>	SYNC_PI / SYNC_PO are not called in the permitted access window in the synchronous cycle interrupt OB, which means they are called or processed during the I/O data transfer on PROFIBUS.	<ul style="list-style-type: none"> <li>Increase the delay time.</li> <li>Increase the DP cycle.</li> <li>Adapt the program.</li> </ul>
Error when updating the isochronous process image partition with SYNC_PI / SYNC_PO: <ul style="list-style-type: none"> <li>Access error</li> </ul>	DP slave / module does not respond / is not available.	

## 5.1.8 Parameter settings for isochronous mode

### Parameter changes as task of the field service technician

The task of a field service technician is to maintain the production process.

In this context the technician has to detect, localize and eliminate errors and performance losses of isochronous mode.

All parameters which influence isochronous mode can be checked and configured using the "Isochronous mode" dialog box.

Parameters should only be changed by experienced users or service technicians.

### 5.1.8.1 Viewing isochronous mode parameters

#### "Isochronous mode" dialog box

1. Select "Properties > Isochronous mode" in the Inspector window.

The "isochronous mode" dialog box opens with an overview of parameters which influence isochronous mode.

Information on the individual parameters is available under "Detail overview".

2. Compare the values shown with the values in the documentation, or with the value specified by a technician.

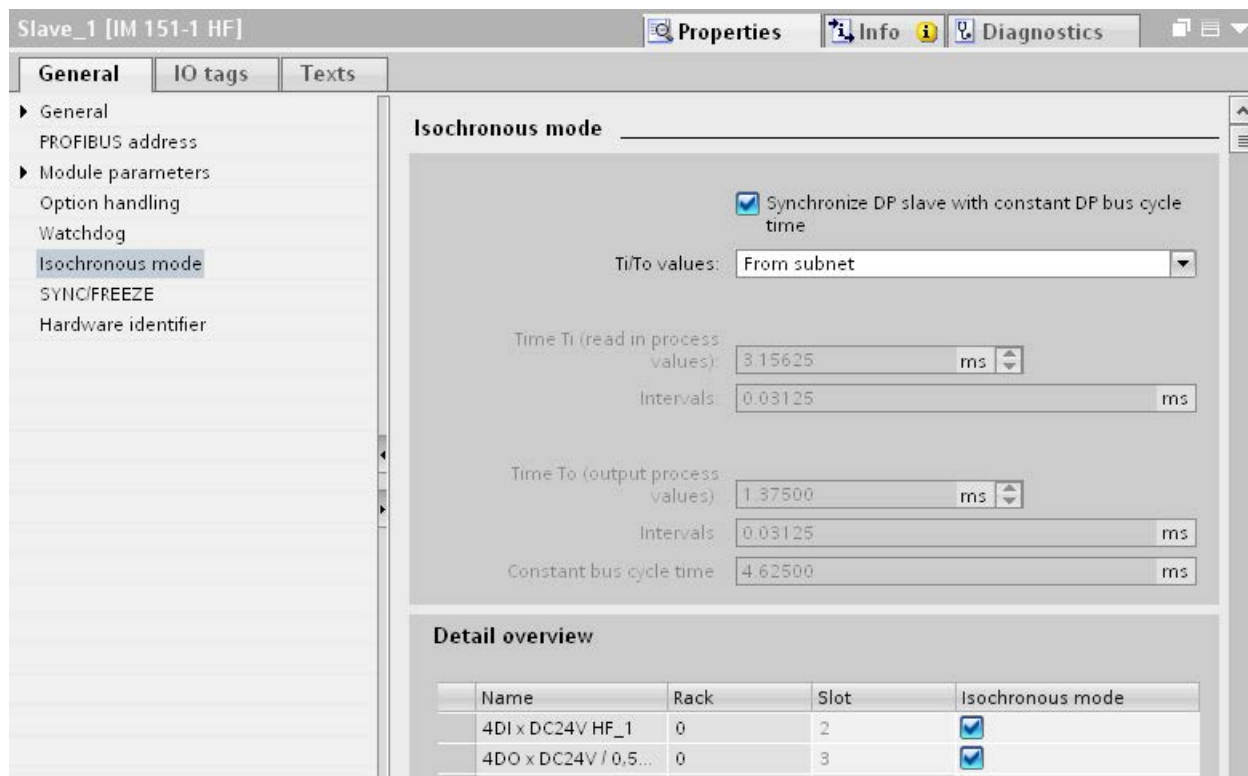


Figure 5-7 Viewing parameters for isochronous mode

5.1.8.2 Change parameters

Changing parameters for the DP master system

You can change the parameters for isochronous mode in the "Constant bus cycle time" dialog box.

1. Select the DP master system in the network view.
2. Select the section "Constant bus cycle time" in the Inspector window.
3. Change the parameters according to the received instructions.

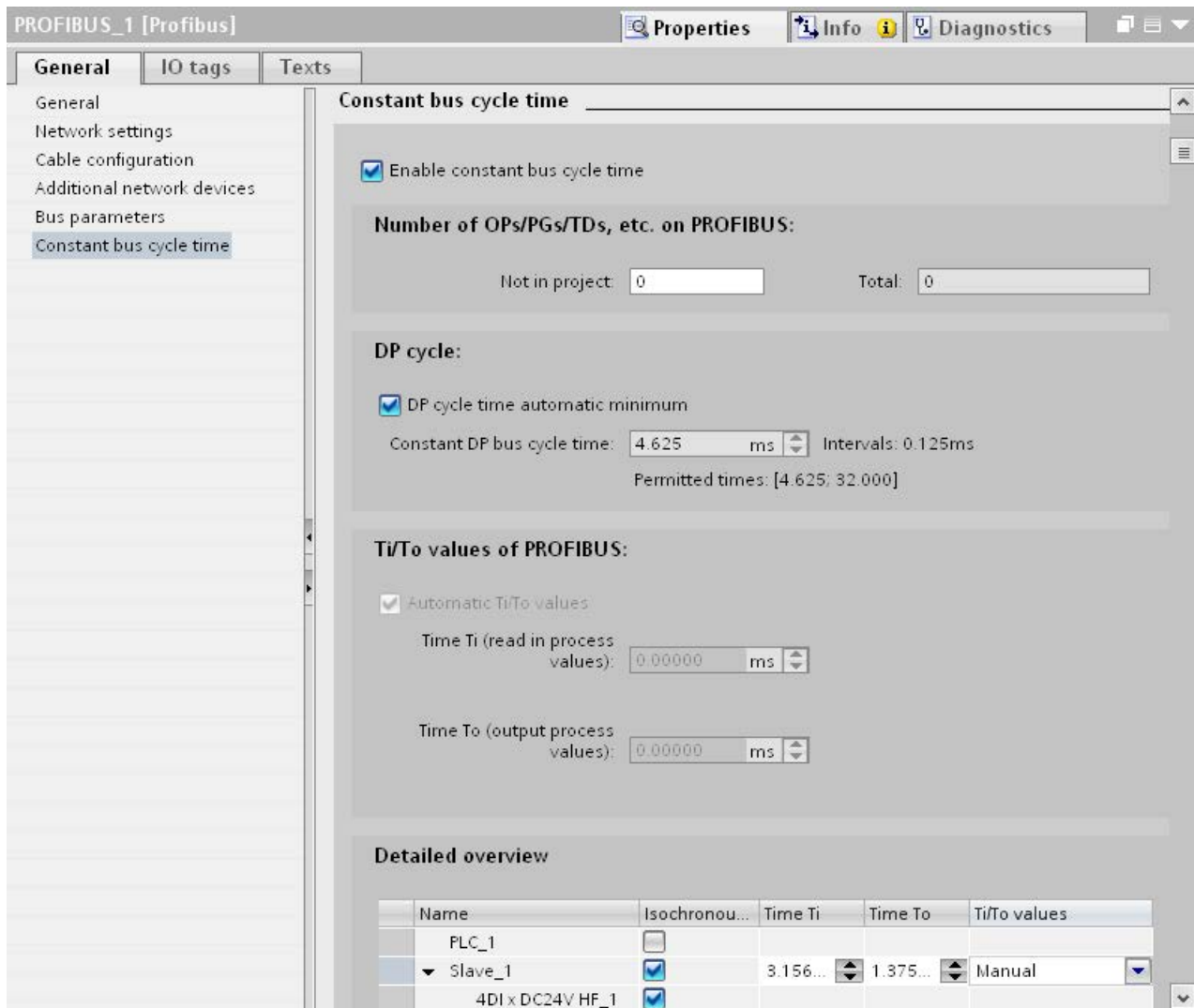


Figure 5-8 Changing parameters for the DP master system



## Adapting the input delay

1. Select the input module in the device view.
2. Select the section "Inputs" in the Inspector window.
3. Adapt the input delay.

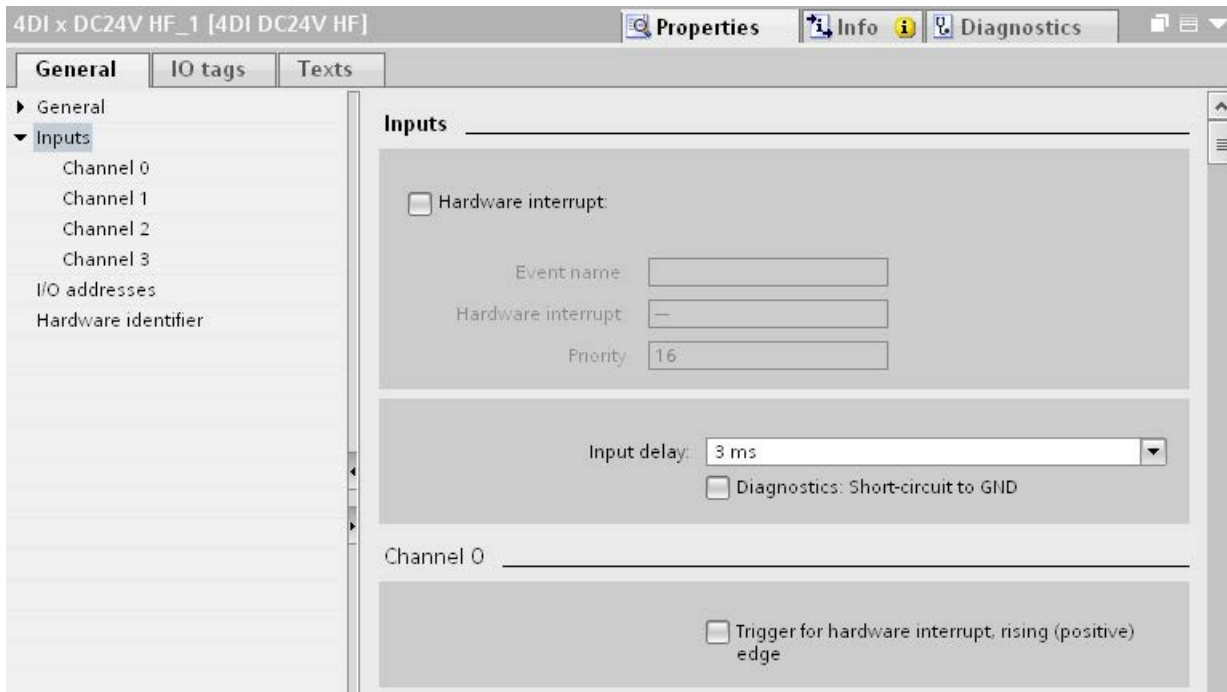


Figure 5-9 Adapting the input delay

## Compile, load and save the changed configuration

1. Put the plant out of operation.
2. Select the CPU in the project navigator.
3. Select "Compile > Hardware" in the shortcut menu.
4. Select "Download to device" in the shortcut menu.
5. Save the project.

## 5.2 Acyclical data exchange

### Additional functionality with DPV1 devices (DP master/DP slaves)

DP masters and DP slaves that support DPV1 have the following additional functions compared to the devices that support only DPV0:

- The acyclic data exchange between master and slave is supported.
- Interrupts can be set by a DPV1 slave which ensure handling of the interrupt-triggering event in the master CPU.

### Acyclic data exchange

Read/write data record, for example, to change the parameters of a slave during operation. The data records of a module and the structure of these data records is available in the documentation for the respective module.

The table below contains the instructions with their functions for access to DPV1 slaves. Detailed information is available in the STEP 7 online help.

Table 5- 2 Instructions for access to DPV1 slaves

Instructions	Function (DPV1)
RDREC	Read data record
WRREC	Write data record
RALRM	Receive interrupt from a DP slave. (The instruction must be called in the OB that triggers the interrupt.)

## 5.3 SYNC/FREEZE groups

### Assigning the SYNC/FREEZE group to the DP slave

A DP master with the corresponding functionality can send the control commands SYNC and/or FREEZE for synchronization of the DP slaves simultaneously to a group of DP slaves. You must assign SYNC/FREEZE groups to the DP slaves for this purpose.

Requirement: A DP master system has been created in the project.

### Procedure

To assign a DP slave to a SYNC/FREEZE group, follow these steps:

1. Select the DP interface of the DP slave you want to assign to a group in the device view or network view.
2. Select the check boxes for the required SYNC/FREEZE groups under the group "SYNC/FREEZE" in the Inspector window.

You can assign each DP slave to only one SYNC/FREEZE group.

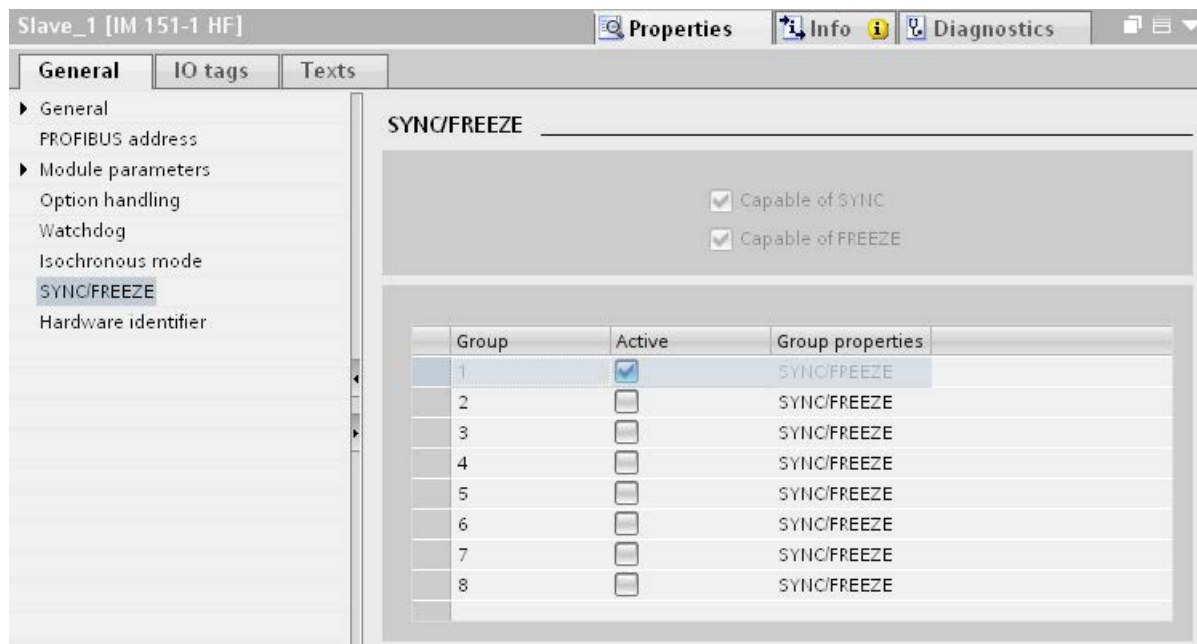


Figure 5-10 Assigning the DP slave to a SYNC/FREEZE group

### Important information on the control commands SYNC and FREEZE

You can use the control commands SYNC and FREEZE in the DP master to synchronize the DP slaves event-controlled. The DP master sends the control commands simultaneously to a group of DP slaves in its master system. It does not take into consideration DP slaves that have failed or are currently sending diagnostic information.

Requirement for synchronization using control commands is that you have assigned the DP slaves to SYNC/FREEZE groups.

For a S7 CPU use the instruction DPSYC\_FR (SFC 11) to synchronize the DP slaves.

When you select the DP master, you see a list of the eight SYNC/FREEZE groups under "Properties > DP interface > SYNC/FREEZE" in the Inspector window.

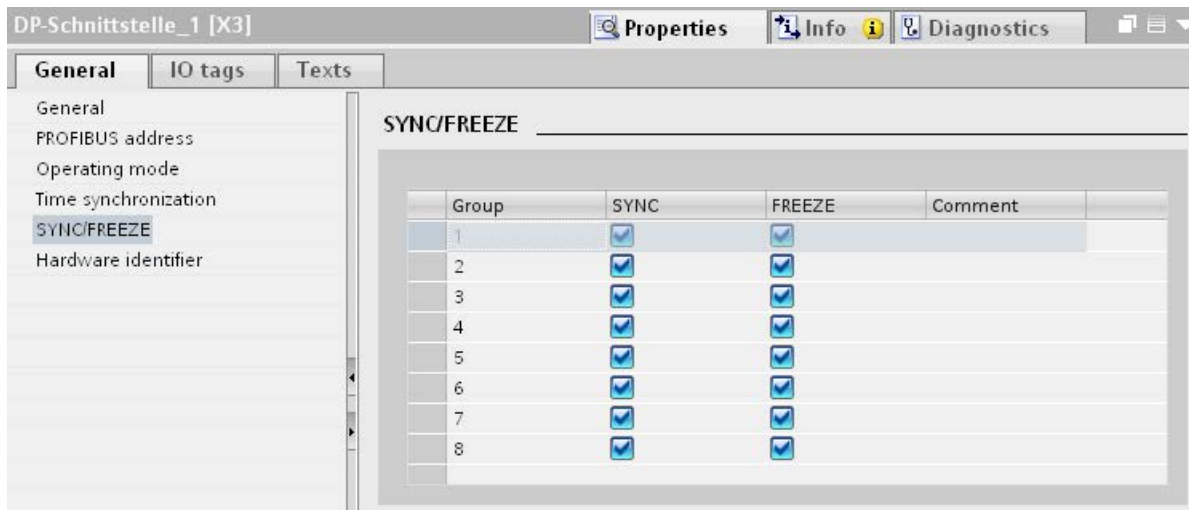


Figure 5-11 SYNC/FREEZE groups on DP master

### SYNC control command

The DP master uses the SYNC control command to cause a group of DP slaves to freeze the states of their outputs to the current value.

The DP slaves save the output data of the DP master for the following frames. But the states of the DP slave outputs remain unchanged.

Only after each new SYNC control command does the DP slave set its outputs to the values that it has saved as the output data of the DP master.

The outputs are not updated cyclically again until the DP master has sent a UNSYNC control command.

## FREEZE control command

After receiving the FREEZE control command from the DP master, the DP slaves of a group freeze the current status of their inputs. The DP slaves send these frozen input data to the DP master with the following cyclical frames.

The DP slaves freeze the current state of their inputs again after each new FREEZE control command.

The state of the DP slave inputs is only send to the DP master cyclically again when the DP master sends the UNFREEZE control command.

## 5.4 Interrupts

### Interrupts and interrupt OBs for DPV1

Interrupts can be set by a DPV1 slave which ensure handling of the interrupt-triggering event in the master CPU. The interrupt data is evaluated in the CPU and the diagnostics buffer and the module state are updated even in the "STOP" operating mode. The OB is not processed in STOP.

The following DPV1 interrupts are supported:

- Status interrupt
- Update interrupt
- Vendor-specific interrupt

Detailed information is available in the descriptions on the OBs. You can use the corresponding OBs that are provided by the operating system of the S7 CPUs for diagnostic interrupts, hardware interrupts, and pull/plug interrupts.

### OB 55 interrupt - Status interrupt

The status interrupt can be triggered when the operating mode of a device or module changes, for example, from RUN to STOP.

### OB 56 interrupt - Update interrupt

An update interrupt can be triggered if the parameters of a slot were changed. This may be caused by local access or partner access to the parameters.

### OB 57 interrupt - Vendor-specific interrupt

The event that triggers the vendor-specific interrupt can be specified by the manufacturer of a DPV1 slave.

**Additional information**

A detailed description of the events at which interrupts are triggered is available in the documentation of the respective manufacturer of the DPV1 slave.

## 5.5 Intelligent DP slaves (I-slaves)

### 5.5.1 I-slave functionality

#### I-slave functionality

The "I-slave" (intelligent DP slave) functionality of a CPU supports the exchange of data with a DP master and thus allows the CPU to be used, for example, as intelligent preprocessing unit of subprocesses. The I-slave is connected in its role as DP slave to a "higher-level" DP master.

The preprocessing is handled by the user program in the I-slave. The process values acquired by the I/O modules are preprocessed by the user program and made available to the DP master.

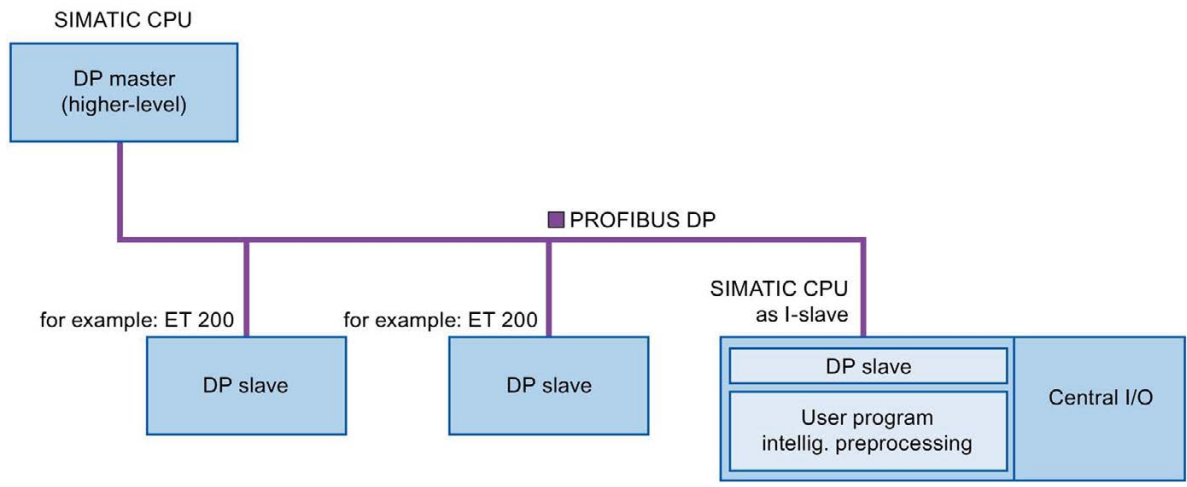


Figure 5-12 I-slave functionality

#### "I-slave" naming convention

In the remainder of this description, a CPU or a CP with I-slave functionality is simply called an "I-slave".

## Advantages of configurations with I-slaves

The I-slave offers the following advantages:

- Simple coupling of CPUs with PROFIBUS interface
- Real-time communication between CPUs and PROFIBUS interface
- Distributed processing

A complex automation task can be divided into smaller units/subprocesses. This results in manageable processes which lead to simplified subtasks.

- Relieving the DP master by distributing the computing capacity to I-devices
- Lower communication load by processing process data locally
- Separating subprocesses

Complicated, widely distributed and extensive processes can be subdivided into several subprocesses with manageable interfaces by using I-slaves. These subprocesses can be stored in individual STEP 7 projects if necessary, which can later be merged to form one master project.

- Separating STEP 7 projects

Creators and users of an I-device can have completely separated STEP 7 projects. The GSD file together with the configuration of the transfer areas of the I-slave form the interface between the STEP 7 projects. This allows coupling to standard DP masters via a standardized interface.

- Know-how protection

Plant units can now only be delivered with a GSD file and the configuration of the transfer areas instead of with a STEP 7 project for the I-slave interface description. This means that you no longer have to disclose the user program know-how.

**Difference: DP slave - I-slave**

In the case of a DP slave, the DP master accesses the distributed inputs/outputs directly.

In the case of an I-slave, the DP master accesses a transfer area in the I/O address space of the preprocessing CPU instead of accessing the connected inputs/outputs of the I-slave. The user program running on the preprocessing CPU is responsible for ensuring data exchange between the operand area and inputs/outputs.

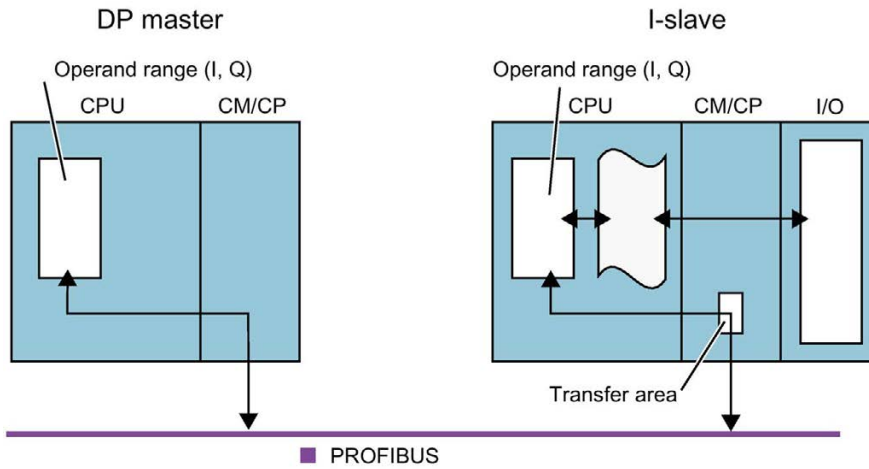


Figure 5-13 Data access to an I-slave

**Note**

**DP master or DP slave**

Note: The communication modules of the S7-1500 CPUs/ET 200SP CPUs, for example the CP 1542-5, support the operation as DP master or DP slave only as alternative.

**Note**

The I/O areas configured for data exchange between the DP master and DP slaves must not be used by I/O modules.



## 5.5.2 Data exchange with higher-level DP master

### Introduction

The following section describes the data exchange between the I-slave and the higher-level DP master.

### Transfer areas

Transfer areas are an interface to the user program of the I-slave CPU. Inputs are processed in the user program and outputs are the result of the processing in the user program.

The data for communication between DP master and I-slave is made available in the transfer areas. A transfer area contains an information unit that is exchanged consistently, in terms of bytes, words or overall, between DP master and I-slave. You can find more information on configuration and use of transfer areas in the section Configuring transfer areas (Page 84).

The following figure shows the data exchange between the I-slave and the higher-level DP master. The individual communication relations are explained below based on the numbers.

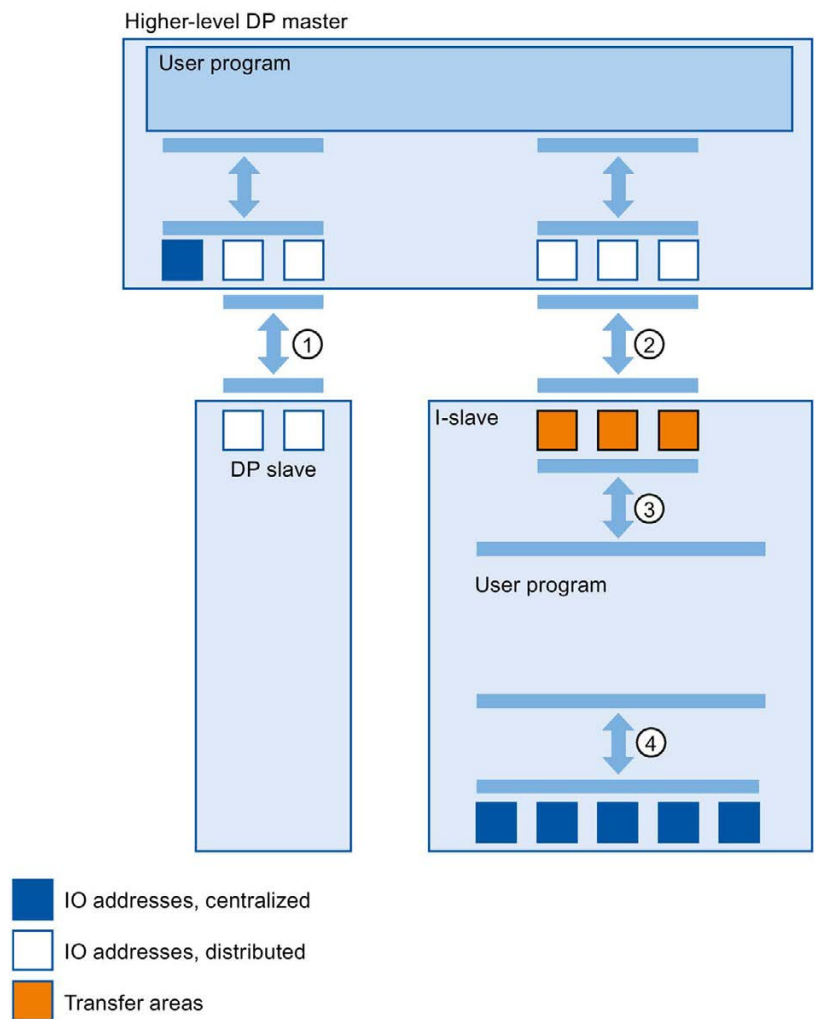


Figure 5-14 Data exchange with the DP master

**① Data exchange between higher-level DP master and normal DP slave**

In this way, the DP master and the DP slave exchange data through PROFIBUS.

**② Data exchange between higher-level DP master and I-slave**

In this way, the DP master and the slave exchange data through PROFIBUS.

The data exchange between a higher-level DP master and an I-slave is based on the conventional DP master/DP slave relationship.

For the higher-level DP master, the transfer areas of the I-slave represent submodules of a DP slave.

The output data of the DP master is the input data of the I-slave. Analogously, the input data of the DP master is the output data of the I-slave.

**③ Transfer relationship between the user program and the transfer area**

In this way, the user program and the transfer area exchange input and output data.

**④ Data exchange between the user program and the I/O of the I-slave**

In this way, the user program and the centralized I/O of the I-slave exchange input and output data.

### 5.5.3 Configuring an I-slave

#### Requirements for configuring an I-slave

The I-slave consists of:

- A CPU from S7-1500 and a communications module CM 1542-5/CP 1542-5 (STEP 7 as of V12)
- A CPU from ET 200SP and a communications module CM DP (STEP 7 as of V13 SP1)

## Procedure for configuring an I-slave

This section shows how to configure an I-slave in STEP 7 based on the example of a CPU 1512SP-1 PN. The procedure for the CPUs from S7-1500 with CM 1542-5/CP 1542-5 and for the CPU 1510SP-1 PN with CM DP is the same.

To configure an I-slave, follow these steps:

1. Drag a CPU 1512SP-1 PN from the hardware catalog to the network view.
2. Open the device view of the CPU.
3. Double-click on the CM DP communications module in the hardware catalog. STEP 7 creates the CM DP in the device view.
4. Select the PROFIBUS interface of the CM DP communications module.
5. In the Inspector window in the area navigation, select the "Operating mode" entry and enable the "DP slave" check box.
6. Now you can select the DP master in the "Assigned DP Master" drop-down list.

Once you have selected the DP master, the networking and the DP master system between both devices are displayed in the network view.

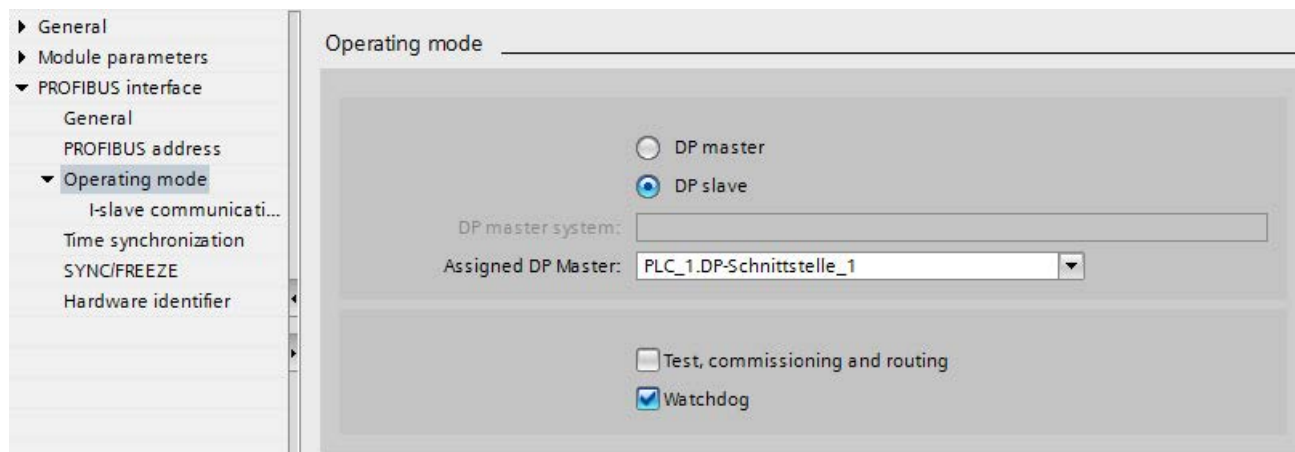


Figure 5-15 Configuring an I-slave

---

### Note

#### Operation using a GSD file

If you operate an I-slave using a GSD file, you should not select the "Test, commissioning and routing" check box.

Create a DP subnet on the PROFIBUS interface of the I-slave.

---

## Result

You have configured an I-slave.

### 5.5.4 Configuring transfer areas

#### Requirements for configuring transfer areas

- You have configured an I-slave in STEP 7.
- You are in the device view of the I-device and have selected the PROFIBUS interface of the communications module.

#### Procedure for configuring transfer areas

To configure transfer areas for an I-slave in STEP 7, follow these steps:

1. In the area navigation, go to the section "Operating mode" > "I-slave communication" > "Transfer areas".
2. Create transfer areas. Set the properties of the created transfer areas.

	①	②	③		④	⑤
...	Transfer area	Type	Master address	↔ Slave address	Length	Consistency
1	Transferbereich_1	MS	Q 0	→ I 0	1 byte	Unit
2	<Add new>					

- ① Click in the first cell of the "Transfer area" column. STEP 7 assigns a default name that you can change.
- ② Select the type of communication relation: Currently, you can only select MS for "master-slave communication relation".
- ③ STEP 7 assigns the addresses for the transfer area automatically. Correct the addresses if necessary.
- ④ Set the length of the transfer area. Specify the length of the transfer area in the cell in the following format: [1...64] Byte/Word.  
Examples: "32 Byte", "64 Word"
- ⑤ Specify whether the transfer area is exchanged in units of bytes or words or consistently over the entire length between the DP master and I-slave.

Figure 5-16 Configuring transfer areas

A separate entry is created in the area navigation for each transfer area. If you select one of these entries, you can adjust the details of the transfer area, or correct them and comment on them.

## 5.5.5 Sample program

### Introduction

This simple sample program shows how you use the transfer areas of an I-slave.

### Requirement

You have configured an I-slave.

### Task

The result of an "AND logic operation" of two inputs (preprocessing) in the I-slave is to be provided to the higher-level DP master. This result is to be assigned to a local output in the DP master (further processing).

Use a transfer area with the following addresses for this purpose:

- Address in the I-slave: Q568
- Address in the DP master: I68

### Required steps

The following steps are necessary to solve the task:

1. Configuring the transfer area
2. Programming the I-slave
3. Programming the DP master


### Configuring the transfer area


Configure a transfer area with the following properties in the I-slave:

**Details of the transfer area**

Transfer area:

Type of transfer area:

Partner: 

Local: 

Data exchange between:  and

Slot:

Address type:

Start address:

Organization block:

Process image:

Length:

Unit:

Consistency:

Comment:

Figure 5-17 Transfer area, I-slave sample program

### Programming the I-slave

To program the sample program for the I-slave, follow these steps:

1. Using the SCL programming language, create a new function with the name "preprocessing" in the project tree under "Program blocks" > "Add new block". Open the function.
2. In the interface of the function "preprocessing", create the following tags:

Name	Data type	Input/output type
input 1	bool	Input
input 2	bool	Input
result	bool	Output

3. In the instruction window of the function "preprocessing", write the following program code:  
`#result:=#input 1&#input 2;`
4. Call the function "preprocessing" in a cycle OB, for example, in OB1.
5. Wire the function "preprocessing" in the cycle OB as follows:

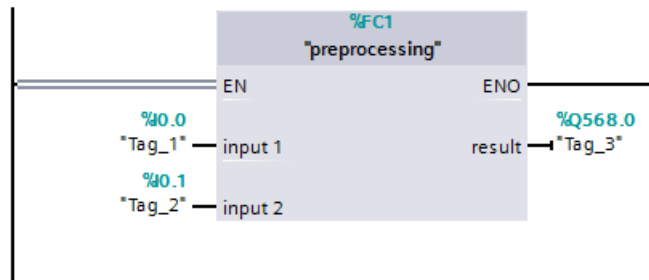


Figure 5-18 I-slave sample program

### Programming the DP master

To program the sample program for the DP master, follow these steps:

1. Using the SCL programming language, create a new function with the name "further processing" in the project tree under "Program blocks" > "Add new block". Open the function.
2. In the interface of the function "further processing", create the following tags:

Name	Data type	Input/output type
result	bool	Input
output	bool	Output

3. In the instruction window of the function "further processing", write the following program code:  
`#output:=#result;`
4. Call the function "further processing" in a cycle OB, for example, in OB1.
5. Wire the function "further processing" in the cycle OB as follows:

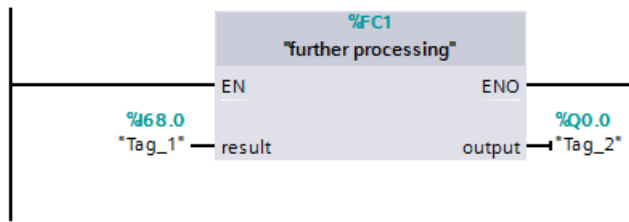


Figure 5-19 DP master sample program

### Result

You mastered the task successfully.



## 5.5.6 Diagnostics and interrupt behavior

### Diagnostics and interrupt behavior

S7 CPUs have numerous diagnostics and interrupt functions that can, for example, report errors/faults or failures of underlying DP systems. These diagnostics alarms reduce downtimes and simplify localization and elimination of problems.

### Diagnostics options in the higher-level DP master and in the I-slave

The following diagnostics mechanisms are available to the higher-level DP master and the I-slave:

- OB 82 (diagnostic interrupt)

When the I-slave changes mode, the DP master calls OB 82 (diagnostic interrupt).

When the DP master changes mode, the I-slave calls OB 82 (diagnostic interrupt).

- OB 86 (rack failure)

If the bus connection to the I-slave is interrupted, the DP master calls OB 86 (rack failure).

If the bus connection to the DP master is interrupted, the I-slave calls OB 86 (rack failure).

- OB 122 (I/O access error)

If you have not set the attribute "Handle errors within block" for OB 122, the following applies:

- If the bus connection to the I-slave is interrupted, the DP master calls OB 122 (I/O access error) if there is direct access to the relevant transfer areas.
- If the bus connection to the DP master is interrupted, the I-slave calls OB 122 (I/O access error) if there is direct access to the relevant transfer areas.

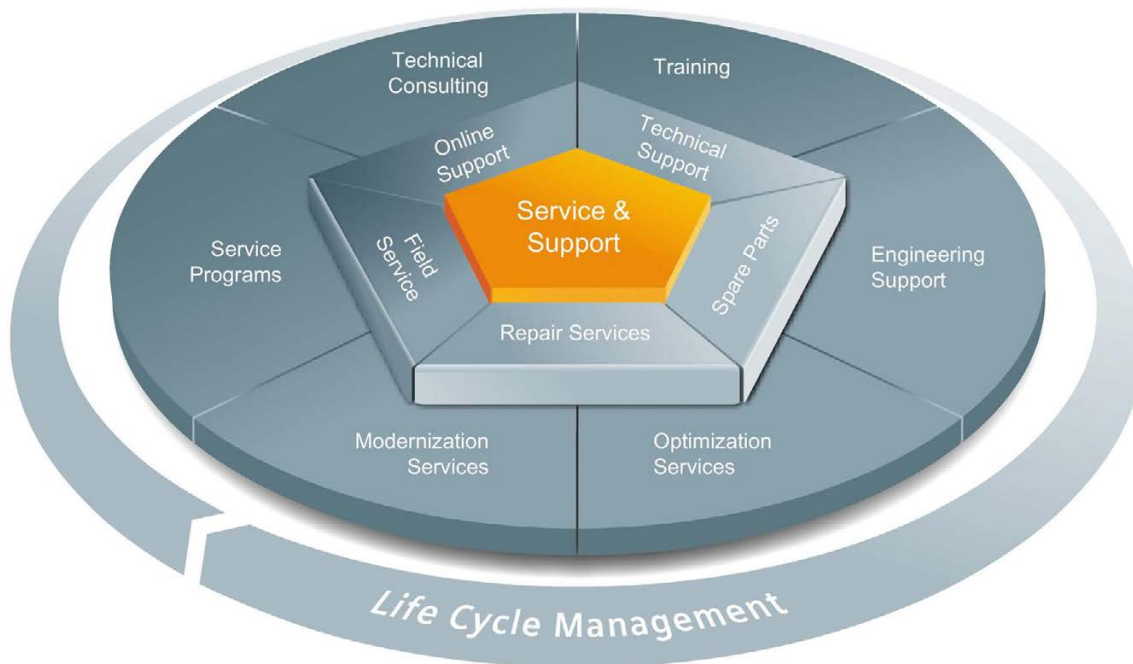
**Reaction of the transfer areas to mode changes**

Table 5- 3 Reaction of the transfer areas to mode changes

DP master	I-slave	Reaction of DP master input transfer areas	Reaction of I-slave input transfer areas
RUN→STOP	RUN	No updating of the process image	The input transfer areas retain their current values. (no access error)
STOP→RUN	RUN	The input transfer areas are updated by the cyclic user program via the process image.	The input transfer areas are updated via the process image.
RUN	RUN→STOP	The I-slave sets the input transfer areas on the DP master to "0".	No updating of the process image
RUN	STOP→RUN	The I-slave sets the input transfer areas on the DP master to "0". After the startup program of the I-slave, the input transfer areas of the DP master are updated via the process image.	Prior to processing of the startup program, the input transfer areas are updated via the process image.

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# A



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# Glossary

## Automation system

Programmable logic controller for the open-loop and closed-loop control of process chains of the process engineering industry and manufacturing technology. The automation system consists of different components and integrated system functions according to the automation task.

## Bus

A common transfer route to which all nodes are connected; it has two defined ends. In the case of PROFIBUS, the bus is a two-wire line or a fiber-optic cable.

## Bus connector

Physical connection between the node and bus cable.

## Bus system

All stations physically connected to a bus cable form a bus system.

## Device

In the PROFIBUS environment, "device" is the generic term for:

- Automation systems (for example, PLC, PC)
- Distributed I/O systems
- Field devices (for example, hydraulic devices, pneumatic devices)
- Active network components
- Gateways to AS interface or other fieldbus systems

Device that can send, receive or amplify data via the bus, for example, a DP slave by means of PROFIBUS DP.

## Device

In the PROFIBUS environment, "device" is the generic term for:

- Automation systems (for example, PLC, PC)
- Distributed I/O systems
- Field devices (for example, hydraulic devices, pneumatic devices)
- Active network components
- Gateways to AS interface or other fieldbus systems

Device that can send, receive or amplify data via the bus, for example, a DP slave by means of PROFIBUS DP.

## Diagnostics

Monitoring functions for the recognition, localization, classification, display and further evaluation of errors, faults and alarms. They run automatically during plant operation. This increases the availability of systems/plants by reducing commissioning times and downtimes.

## DP master

CPU or device that conducts the communication with the DP slaves according to a defined algorithm. To do this, the DP master uses the functions for communication with the DP slaves which are defined by PROFIBUS DP. It acts according to standard EN 50170, Part 3.

→ *Master*

## DP slave

Slave in the distributed I/O that is operated on the PROFIBUS with PROFIBUS DP protocol and acts according to standard EN 50170, Part 3. The DP slave is addressed by the DP master and provides it with specified functions (I/O data, diagnostics, etc.).

→ *Slave*

## DPV1

The designation DPV1 refers to the functional extension of acyclic services (to include new interrupts, for example) provided by the DP protocol. The DPV1 functionality is integrated in IEC 61158/EN 50170, Volume 2, PROFIBUS.

## FDL

Fieldbus Data Link (bus access protocol). Step 2 with PROFIBUS.

## HMI device

Human Machine Interface, device for visualization and control of automation processes.

## HSA

Highest Station Address. A bus parameter for PROFIBUS. Outputs the highest PROFIBUS address of an active device. PROFIBUS addresses greater than HSA are permitted for passive devices, up to 126.

## Industrial Ethernet

Guideline for setting up Ethernet in an industrial environment. The main difference to the standard Ethernet is the mechanical current carrying capacity and interference immunity of the individual components.

## I-slave

The "I-slave" functionality of a CPU supports the exchange of data with a DP master and can thus be used, for example, as intelligent preprocessing unit of partial processes. The I-slave is connected in its role as DP slave to a "higher-level" DP master.

## Master

A master device that is in possession of the token can send data to other devices and request data from them (= active device).

## PCF

Polymer Cladded Fiber (plastic-covered glass fiber)

## POF

Polymer Optical Fiber (plastic fiber-optic cable made of light-conducting plastics)

## Process image

Address area in the system memory of the DP master. At the start of the cyclic program the signal states of the input modules are transmitted to the process image of the inputs. And the end of cyclic program execution, the process image of the outputs is transmitted to the DP slave as signal state.

## PROFIBUS

PROcess Field BUS, in IEC 61158-2 as "Type 3" standardized, bit-serial fieldbus system. The standard specifies functional, electrical and mechanical properties.

PROFIBUS is a bus system that networks automation systems and field devices compatible with PROFIBUS at the cell and field level. PROFIBUS is available with the protocols DP (= distributed I/O), FMS (= fieldbus message specification) or PA (process automation).



**PROFIBUS address**

Unique identification of a device connected to PROFIBUS. The PROFIBUS address is transmitted in the frame for addressing a device. A PC or programming device has the PROFIBUS address "0". DP masters and DP slaves have a PROFIBUS address in the range from 1 to 125.

**PROFIBUS device**

A PROFIBUS device has at least one PROFIBUS interface with an electrical (RS 485) or optical (Polymer Optical Fiber, POF) interface.

**PROFIBUS DP**

A PROFIBUS with DP protocol that complies with EN 50170. DP stands for distributed I/O (fast, real-time capable, cyclic data exchange). From the perspective of the user program, the distributed I/Os are addressed in exactly the same way as the centralized I/Os.

**PROFINET**

Open component-based industrial communication system based on Ethernet for distributed automation systems. Communication technology promoted by the PROFIBUS Users Organization.

**RS 485**

Asynchronous data transmission process for PROFIBUS DP to ANSI TIA/EIA-RS485-A.

**RS 485 repeater**

Equipment for amplifying bus signals and for coupling segments over long distances.

**Segment**

The bus line between two terminating resistors forms a bus segment.

A bus segment can contain up to 32 bus nodes. Segments can be coupled, for example, by means of RS 485 repeaters or diagnostics repeaters.

**Slave**

Distributed device in a fieldbus system that may exchange data with a master after being requested to do so by the master. Slaves are all DP slaves, for example, such as ET 200SP, ET 200MP, ET 200AL.

### **Standard mounting rail**

Standardized metal profile to EN 50022.

The standard mounting rail is used for quick snap-on installation of network components, such as OLM, repeaters, etc.

### **Subnet**

Part of a network whose parameters must be synchronized with the devices (e.g., with PROFIBUS). A subnet includes the bus components and all connected stations.

### **SynchronousCycle**

Name for synchronous cycle interrupt OB in STEP 7.

### **Target-Rotation-Time (Ttr)**

Bus parameter for PROFIBUS. The token is the send permission for a device on PROFIBUS. A device compares a token rotation time it has measured with the Target-Rotation-Time and controls the sending of frames with high priority or low priority based on this comparison.

### **Terminating resistor**

Component that terminates the ends of a data transmission line to prevent reflections in the transmission medium.

### **Terminator**

Terminating resistor of bus segments with transmission rates of 9.6 kbps to 12 Mbps. The power supply is separate from the bus nodes.

### **TIA Portal**

Totally Integrated Automation Portal

### **Topology**

Structure of a network. Common structures are line topology, ring topology, star topology and tree topology.

### **Transmission rate**

Specifies the number of bits transmitted per second.

### **Watchdog**

Mechanism for monitoring the readiness for operation.

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