SIEMENS

SIMATIC

S7-300, CPU 31xC and CPU 31x: Installation

Operating Instructions

This manual is part of the documentation package with the order number: 6ES7398-8FA10-8BA0

Edition 08/2004

A5E00105492-05

Safety Guidelines

This manual contains notices which you should observe to ensure your own personal safety as well as to avoid property damage. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring to property damage only have no safety alert symbol.

Danger

indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

Warning

indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

Caution

used with the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Caution

used without safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.

Notice

used without the safety alert symbol indicates a potential situation which, if not avoided, may result in an undesirable result or state.

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 device/system may only be set up and operated in conjunction with this documentation. Only qualified personnel should be allowed to install and work on the equipment. Qualified persons are defined as persons who are authorized to commission, to earth, and to tag circuits, equipment and systems in accordance with established safety practices and standards.

Intended Use

Please note the following:

Warning

This device and its components may only be used for the applications described in the catalog or technical description, and only in connection with devices or components from other manufacturers approved or recommended by Siemens.

This product can only function correctly and safely if it is transported, stored, set up and installed correctly, and operated and maintained as recommended.

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

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Siemens AG 2004
Technical data subject to change

Siemens Aktiengesellschaft

Order No. A5E00105492-05

Preface

Purpose of the manual

This manual contains all the information you need to configure, install, wire, address and commission an S7-300.

In addition, you will become familiar with the tools you can use to diagnose and eliminate errors in hardware and software.

Basic knowledge

To understand this manual, you require a general knowledge of automation engineering. You should also be accustomed to working with STEP 7 basic software. For further information, refer to the Programming with STEP 7 V5.3 manual.

Area of application

CPU	Convention: CPU designation	Order number	as of version	
			Firmware	Hardware
CPU 312C	CPU 31xC	6ES7312-5BD01-0AB0	V2.0.0	01
CPU 313C		6ES7313-5BE01-0AB0	V2.0.0	01
CPU 313C-2 PtP		6ES7313-6BE01-0AB0	V2.0.0	01
CPU 313C-2 DP		6ES7313-6CE01-0AB0	V2.0.0	01
CPU 314C-2 PtP		6ES7314-6BF01-0AB0	V2.0.0	01
CPU 314C-2 DP		6ES7314-6CF01-0AB0	V2.0.0	01
CPU 312	CPU 31x	6ES7312-1AD10-0AB0	V2.0.0	01
CPU 314		6ES7314-1AF10-0AB0	V2.0.0	01
CPU 315-2 DP		6ES7315-2AG10-0AB0	V2.0.0	01
CPU 315-2-PN/DP		6ES7315-2EG10-0AB0	V2.3.0	01
CPU 317-2 DP		6ES7317-2AJ10-0AB0	V2.1.0	01
CPU 317-2 PN/DP		6ES7317-2EJ10-0AB0	V2.3.0	01

Note

The special features of the 315F-2 DP and CPU 317F-2 DP CPUs are described in their Product Information, available on the Internet at http://www.siemens.com/automation/service&support, article ID 17015818.

Note

There you can obtain the descriptions of all current modules.

For new modules, or modules of a more recent version, we reserve the right to include a Product Information containing latest information.

Approvals

The SIMATIC S7-300 product series has the following approvals:

- Underwriters Laboratories, Inc.: UL 508 (Industrial Control Equipment)
- Canadian Standards Association: CSA C22.2 No. 142, (Process Control Equipment)
- Factory Mutual Research: Approval Standard Class Number 3611

CE label

The SIMATIC S7-300 product series satisfies the requirements and safety specifications of the following EU Directives:

- EU Directive 73/23/EC "Low-voltage directive"
- EU Directive 89/336/EWE "EMC directive"

C tick mark

The SIMATIC S7-300 product series is compliant with AS/NZS 2064 (Australia).

Standards

The SIMATIC S7-300 product series is compliant with IEC 61131-2.

Documentation classification

This manual is part of the S7-300 documentation package.

Name of the manual	Description
Manual • 31xC and 31x CPUs, technical data	Control and display elements, communication, memory concept, cycle and response times, technical data
Reference Manual • CPU data: CPU 312 IFM – 318-2 DP	Control and display elements, communication, memory concept, cycle and response times, technical data
YOU ARE READING the Manual • S7-300, CPU 31xC and CPU 31x: Installation	Configuration, installation, wiring, addressing, commissioning, maintenance and the test functions, diagnostics and troubleshooting.
Installation Manual • S7-300 Automation System: Installation: CPU 312 IFM – 318-2 DP	Configuration, installation, wiring, addressing, commissioning, maintenance and the test functions, diagnostics and troubleshooting.
System Manual PROFINET System Overview	Basic information on PROFINET: Network components, data exchange and communication, PROFINET I/O, Component based Automation, application example of PROFINET I/O and Component based Automation
Programming Manual From PROFIBUS DP to PROFINET I/O	Guideline for the migration from PROFIBUS DP to PROFINET I/O.
Manual • CPU 31xC: Technological functions • Examples	Description of the various technological functions of positioning and counting. PtP communication, rules The CD contains examples of the technological functions
Reference Manual • S7-300 Automation System: Module data	Descriptions of the functions and technical data of signal modules, power supply modules and interface modules.
Instruction List • CPU 312 IFM – 318-2 DP • CPU 31xC and CPU 31x	List of CPU instruction resources and the relevant execution times. List of executable blocks.
Getting Started The following Getting Started editions are available as a collective volume: • CPU 31x: Commissioning • CPU 31xC: Commissioning • CPU 31xC: Positioning with analog output • CPU 31xC: Positioning with digital output • CPU 31xC: Counting • CPU 31xC: Rules • CPU 31xC: PtP communication • CPU 31x-2 PN/DP: Commissioning a PROFINET I/O subnet	The example used in this Getting Started guides you through the various steps in commissioning required to obtain a fully functional application.

Additional information required:

Name of the manual	Description
Reference Manual System software for S7-300/400 system and standard functions	Description of the SFCs, SFBs and OBs. This manual is part of the STEP 7 documentation package. For further information, refer to the STEP 7 Online Help.
Manual SIMATIC NET: Twisted Pair and Fiber-Optic Networks	Description of Industrial Ethernet networks, network configuration, components, installation guidelines for networked automation systems in buildings, etc.
Manual Component-based Automation: Configuring systems with SIMATIC iMap	Description of the engineering software iMAP
Manual Programming with STEP 7 V5.3	Programming with STEP 7
Manual SIMATIC communication	Basics, services, networks, communication functions, connecting PGs/OPs, engineering and configuring in STEP 7.

S7-300 documentation package: Additional documentation

Recycling and Disposal

The devices described in this manual can be recycled, because their components contain a minimum of harmful substances. For environment-friendly recycling and disposal of your old equipment, contact a certified disposal facility for electronic scrap.

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Tables

Guide to the S7-300 documentation

1

Overview

This guide leads you through the S7-300 documentation.

Selecting and configuring

Table 1-1 Ambient influence on the PLC

Information on..	is available in ...
What provisions do I have to make for PLC installation space?	S7-300, CPU 31xC and CPU 31x Manual: Installation: Configuring - Component dimensions S7-300, CPU 31xC and CPU 31x Manual: Installation: Mounting - Installing the mounting rail
How do environmental conditions influence the PLC?	S7-300, CPU 31xC and CPU 31x Manual: Installation: Appendix

Table 1-2 Galvanic isolation

Information on..	is available in ...
Which modules can I use if electrical isolation is required between sensors/actuators?	S7-300, CPU 31xC and CPU 31x Operating Instructions: Installation: Configuring – Electrical assembly, protective measures and grounding Module data Manual
Under what conditions do I have to isolate the modules electrically? How do I wire it?	S7-300, CPU 31xC and CPU 31x operating instructions: Installation: Configuring – Electrical assembly, protective measures and grounding CPU 31xC and CPU 31x operating instructions: Installation: Wiring
Under which conditions do I have to isolate stations electrically? How do I wire it?	S7-300, CPU 31xC and CPU 31x operating instructions: Installation – Configuring – Configuring subnets

Table 1-3 Communication between sensors/actuators and the PLC

Information on..	is available in ...
Which module is suitable for my sensor/actuator?	For CPU: CPU 31xC and CPU 31x Manual, Technical Data For signal modules: Reference manual of your signal module
How many sensors/actuators can I connect to the module?	For CPU: CPU 31xC and CPU 31x Manual, technical data of signal modules: Reference manual of your signal module
To connect my sensors/actuators to the PLC, how do I wire the front connector?	S7-300, CPU 31xC and CPU 31x operating instructions: Installation: Wiring – Wiring the front connector
When do I need expansion modules (EM) and how do I connect them?	S7-300, CPU 31xC and CPU 31x operating instructions: Installation: Configuring – Distribution of modules to several racks
How to mount modules on racks / mounting rails	S7-300, CPU 31xC and CPU 31x operating instructions: Installation: Assembly – Installing modules on the mounting rail

Table 1-4 The use of local and distributed I/O

Information on..	is available in ...
Which range of modules do I want to use?	For local I/O and expansion devices: Module Data reference manual For distributed I/O and PROFIBUS DP: Manual of the relevant I/O device

Table 1-5 Configuration consisting of the Central Unit (CU) and Expansion Modules (EMs)

Information on..	is available in ...
Which rack / mounting rail is most suitable for my application?	S7-300, CPU 31xC and CPU 31x operating instructions: Installation: Configuring
Which interface modules (IM) do I need to connect the EMs to the CU?	S7-300, CPU 31xC and CPU 31x operating instructions: Installation: Configuring – Distribution of modules to several racks
What is the right power supply (PS) for my application?	S7-300, CPU 31xC and CPU 31x operating instructions: Installation: Configuring

Table 1-6 CPU performance

Information on..	is available in ...
Which memory concept is best suited to my application?	CPU 31xC and CPU 31x Manual, Technical Data
How do I insert and remove Micro Memory Cards?	S7-300, CPU 31xC and CPU 31x operating instructions: Installation: Commissioning – Commissioning modules – Removing / inserting a Micro Memory Card (MMC)
Which CPU meets my demands on performance?	S7-300 instruction list: CPU 31xC and CPU 31x
Length of the CPU response / execution times	CPU 31xC and CPU 31x Manual, Technical Data
Which technological functions are implemented?	Technological Functions Manual
How can I use these technological functions?	Technological Functions Manual

Table 1-7 Communication

Information on..	is available in ...
Which principles do I have to take into account?	Communication with SIMATIC Manual PROFINET System Manual, System Description
Options and resources of the CPU	CPU 31xC and CPU 31x Manual, Technical Data
How to use communication processors (CPs) to optimize communication	CP Manual
Which type of communication network is best suited to my application?	S7-300, CPU 31xC and CPU 31x operating instructions: Installation: Configuring – Configuring subnets
How to network the various components	S7-300, CPU 31xC and CPU 31x operating instructions: Installation: Configuring – Configuring subnets
What to take into account when configuring PROFInet networks	SIMATIC NET Manual, Twisted-Pair and Fiber Optic Networks (6GK1970-1BA10-0AA0) – Network Configuration PROFINET System Manual, System Description – Installation and Commissioning

Table 1-8 Software

Information on..	is available in ...
Software requirements of my S7-300 system	CPU 31xC and CPU 31x Manual, Technical Data – Technical Data

Table 1-9 Supplementary features

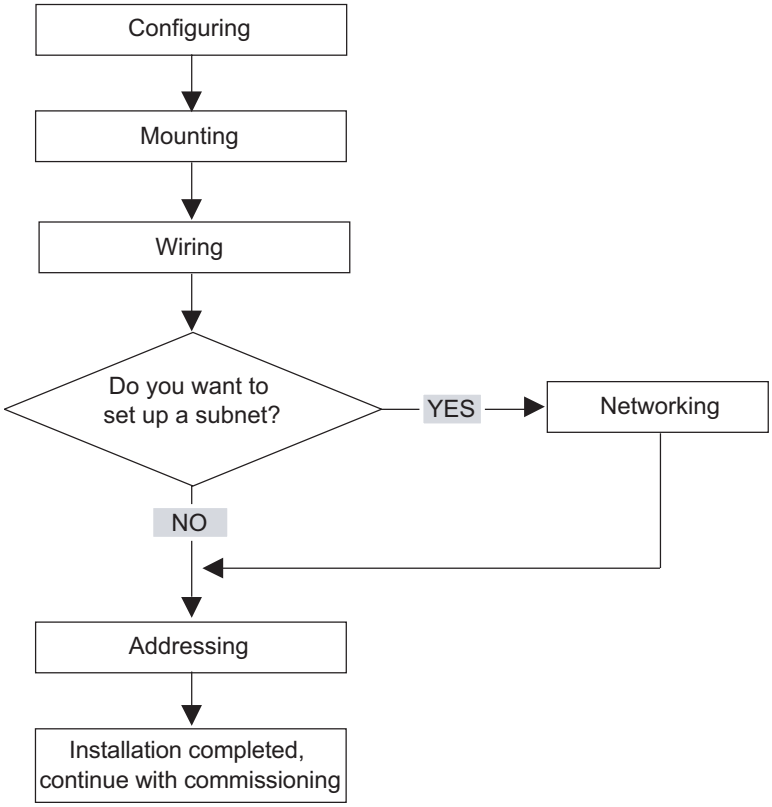
Information on..	is available in ...
How to implement operating and monitoring functions (Human Machine Interface)	For text-based displays: The relevant Manual For Operator Panels: The relevant Manual For WinCC: The relevant Manual
How to integrate process control modules	For PCS7: The relevant Manual
Options of redundant and fail-safe systems	S7-400H Manual – Redundant Systems Fail-Safe Systems Manual
Information to be observed when migrating from PROFIBUS DP to PROFINET IO	Programming Manual: From PROFIBUS DP to PROFINET IO

Installation Order

2

We will start by showing you the sequence of steps you have to follow to install your system. Then we will go on to explain the basic rules that you should follow, and how you can modify an existing system.

Installation procedure



Basic rules for trouble-free operation of the S7 system

In view of the many and versatile applications, we can only provide basic rules for the electrical and mechanical installation in this section.

You have to at least keep to these basic rules in order to obtain a fully functional SIMATIC-S7 system.

Modifying the existing S7 system structure

To modify the configuration of an existing system, proceed as described earlier.

Note

When adding a new signal module, always refer to the relevant module information.

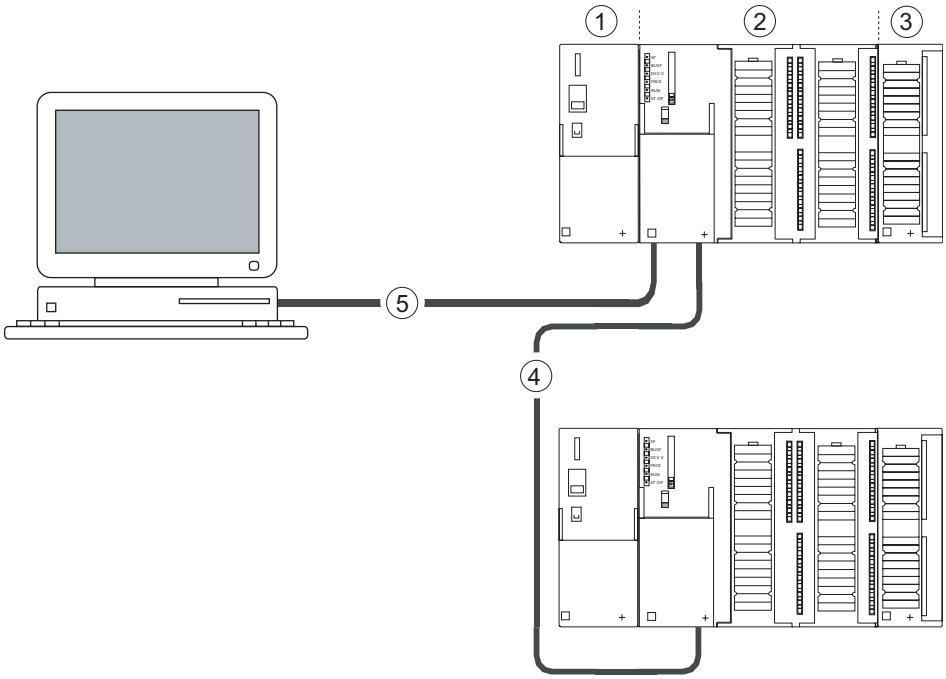
Reference

Also refer to the description of the various modules in the manual: *SIMATIC S7-300 Automation Systems, Module Data Reference Manual*.

S7-300 components

3

3.1 Example of an S7-300 configuration



The figure illustrates the following	the following S7-300 components
(1)	Power supply (PS) module
(2)	Central processing unit (CPU) The example in the figure shows a CPU 31xC with integrated I/O.
(3)	Signal module (SM)
(4)	PROFIBUS bus cable
(5)	Cable for connecting a programming device (PG)

You use a programming device (PG) to program the S7-300 PLC. Use the PG cable to interconnect the PG with the CPU.

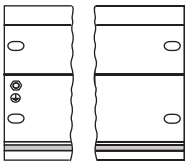
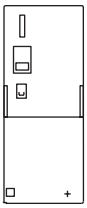
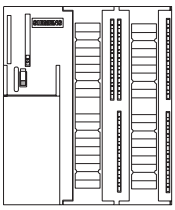
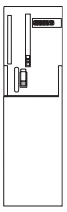
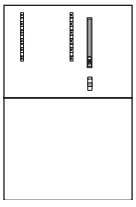
To commission or program a CPU with PROFINET interface, you may also use an Ethernet cable to interconnect the PG with the PROFINET connector of the CPU. Please note that you need to adjust the Ethernet interface on your PG.

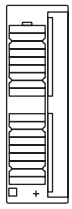
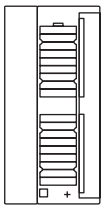
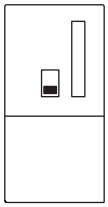
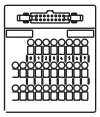
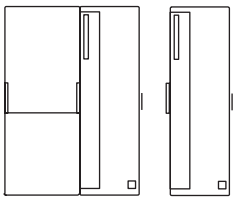
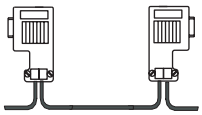
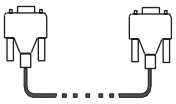
Several S7-300 CPUs communicate with one another and with other SIMATIC S7 PLCs via the PROFIBUS cable. Several S7-300 are connected via the PROFIBUS bus cable.

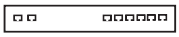
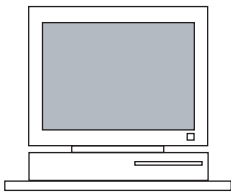
3.2 Overview of the vital modules of an S7-300

You can choose from a number of modules for installing and commissioning the S7-300. The most important modules and their functions are shown below.

Table 3-1 S7-300 components:

Component	Function	Illustration
Mounting rail Accessories: • Shielding terminal	S7-300 racks	
Power supply (PS) module	The PS converts the line voltage (120/230 VAC) into a 24 VDC operating voltage, and supplies the S7-300 and its 24 VDC load circuits.	
CPU Accessories: • Front connectors (CPU 31xC only)	The CPU executes the user program, supplies 5 V to the S7-300 backplane bus, and communicates with other nodes of an MPI network via the MPI interface. Additional features of specific CPUs: • DP master or DP slave on a PROFIBUS subnet • Technological functions • PtP communication • Ethernet communication via integrated PROFINET interface	 A CPU 31xC, for example
		 A CPU 312, 314, or 315-2 DP, for example
		 A CPU 317, for example

Component	Function	Illustration
Signal modules (SM) • Digital input modules • Digital output modules • Digital I/O modules, • Analog input modules • Analog output modules • Analog I/O modules Accessories: • Front connectors	The SM matches different process signal levels to the S7-300.	
Function modules (FM) Accessories: • Front connectors	The FM performs time-critical and memory-intensive process signal processing tasks. Positioning or controlling, for example	
Communication processor (CP) Accessories: Connecting cable	The CP relieves the CPU of communication tasks. Example: CP 342-5 DP for connecting to PROFIBUS DP	
SIMATIC TOP connect Accessories: • Front connector module with ribbon cable terminals	Wiring of digital modules	
Interface module (IM) Accessories: • Connecting cable	The IM interconnects the various rows in an S7-300	
PROFIBUS cable with bus connector	Interconnect the nodes of an MPI or PROFIBUS subnet	
PG cable	Connects a PG/PC to a CPU	

Component	Function	Illustration
RS 485 repeater	The repeater is used to amplify the signals and to couple segments of an MPI or PROFIBUS subnet.	
Switch	A switch is used to interconnect the Ethernet nodes.	
Twisted-pair cables with RJ45 connectors.	Interconects devices with Ethernet interface (a switch with a CPU 317-2 PN/DP, for example)	
Programming device (PG) or PC with the STEP 7 software package	You need a PG to configure, set parameters, program and test your S7-300	

Configuring

4

4.1 Overview

There, you can find all the necessary information

- for the mechanical configuration of an S7-300,
- for the electrical configuration of an S7-300,
- that has to be observed in networking.

Reference

- For further information, refer to the *Communication with SIMATIC* manual (6ES7398-8EA00-8AA0), or
- the *SIMATIC NET Twisted-Pair and Fiber-Optic Networks* Manual (6GK1970-1BA10-0AA0)

4.2 Basic engineering principles

Important information for engineering

Warning

Open equipment
S7-300 modules are open equipment. That is, the S7-300 must be installed in a cubicle, cabinet or electrical control room which can only be accessed using a key or tool. Only trained or authorized personnel are allowed access to such cubicles, cabinets or electrical operating rooms.

Caution

Operation of an S7-300 in plants or systems is defined by special set of rules and regulations, based on the relevant field of application. Observe the safety and accident prevention regulations for specific applications, for example, the machine protection directives. This chapter and the appendix *General rules and regulations on S7-300 operation* provide an overview of the most important rules you need to observe when integrating an S7-300 into a plant or a system.

Central unit (CU) and expansion module (EM)

An S7-300 PLC consists of a central unit (CU) and of one or multiple expansion modules.

The rack containing the CPU is the central unit (CU). Racks equipped with modules and connected to the CU form the expansion modules (EMs) of the system.

Use of an expansion module (EM)

You can use EMs if the CU runs out of slots for your application.

When using EMs, you might require further power supply modules in addition to the extra racks and interface modules (IM). When using interface modules you must ensure compatibility of the partner stations.

Racks

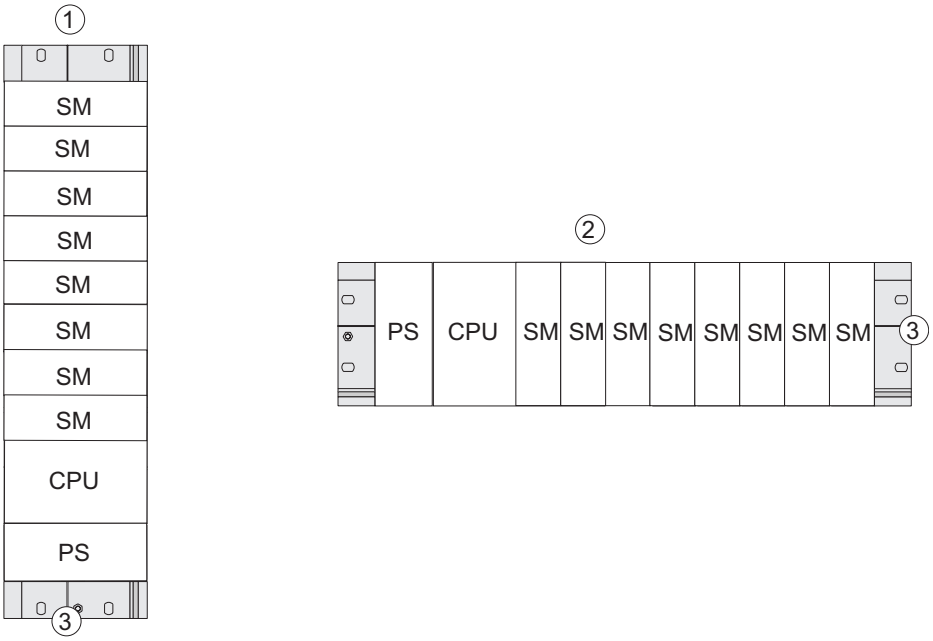
The rack for your S7-300 is a mounting rail. You can use this rail to mount all modules of your S7-300 system.

Horizontal and vertical installation

You can mount an S7-300 either vertically or horizontally. The following ambient air temperatures are permitted:

- Vertical assembly: 0 °C to 40 °C
- Horizontal assembly: 0 °C to 60 °C

Always install the CPU and power supply modules on the left or at the bottom.



The figure illustrates the following	
(1)	the vertical installation of an S7-300
(2)	the horizontal installation of an S7-300
(3)	the mounting rail

4.3 Component dimensions

Length of the mounting rails

Table 4-1 Mounting rails - Overview

Mounting rail length	Usable length for modules	Order number
160 mm	120 mm	6ES7 390-1AB60-0AA0
482.6 mm	450 mm	6ES7 390-1AE80-0AA0
530 mm	480 mm	6ES7 390-1AF30-0AA0
830 mm	780 mm	6ES7 390-1AJ30-0AA0
2000 mm	cut to length as required	6ES7 390-1BC00-0AA0

In contrast to other rails, the 2 m mounting rail is not equipped with any fixing holes. These must be drilled, allowing optimal adaptation of the 2 m rail to your application.

Dimensions of modules

Table 4-2 Module width

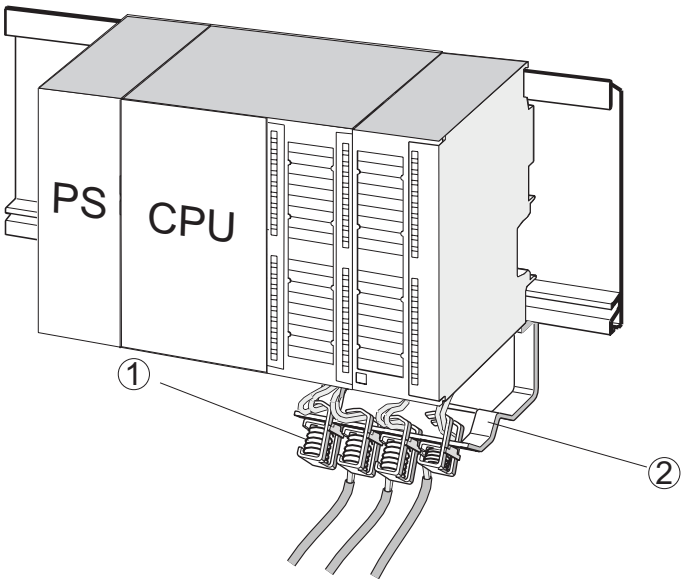
Module	Width
Power supply module PS 307, 2 A	50 mm
Power supply module PS 307, 5 A	80 mm
Power supply module PS 307, 10 A	200 mm
CPU	For information on assembly dimensions, refer to the Technical Data in *CPU 31xC and CPU 31x Manual, Technical Data*.
Analog I/O modules	40 mm
Digital I/O modules	40 mm
Simulator module SM 374	40 mm
Interface modules IM 360 and IM 365	40 mm
Interface module IM 361	80 mm

- Module height: 125 mm
- Module height with shielding contact element: 185 mm
- Maximum assembly depth: 130 mm
- Maximum assembly depth of a CPU with an inserted DP connector with angled cable feed: 140 mm
- Maximum assembly depth with open front panel (CPU): 180 mm

Dimensions of other modules such as CPs, FMs etc. are found in the relevant manuals.

Shielding contact element

The direct contact between the shielding contact element and the mounting rail makes it easy for you to connect all shielded cables of your S7 modules to ground.



The figure illustrates the following	
(1)	Shielding terminals
(2)	The bracket.

Mount the bracket (order no. 6ES5 390-5AA0-0AA0) to the rail using the two screw bolts. If you use a shielding contact element, the specified dimensions are measured from the base of the element.

- Width of the shielding contact element: 80 mm
- Mountable shielding terminals per shielding contact element max. 4

Table 4-3 Shielding terminals - Overview

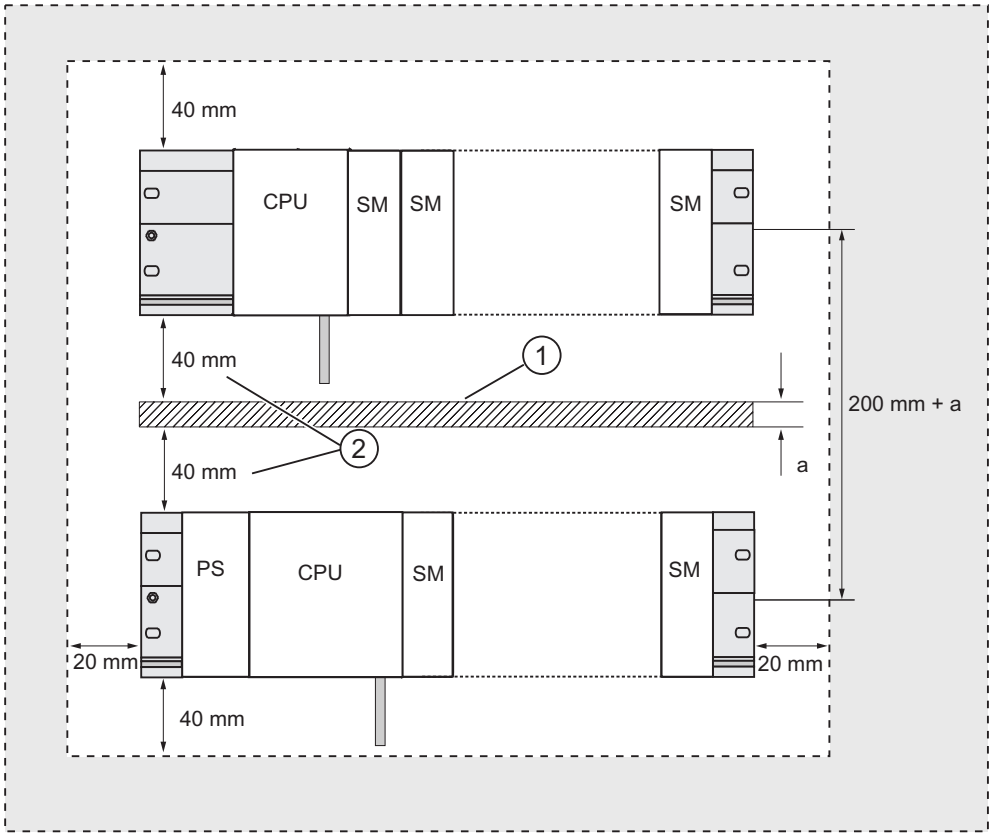
Cable with shielding diameter	Shielding terminal order no.
Cable with 2 mm to 6 mm shielding diameter	6ES7 390–5AB00–0AA0
Cable with 3 mm to 8 mm shielding diameter	6ES7 390–5BA00–0AA0
Cable with 4 mm to 13 mm shielding diameter	6ES7 390–5CA00–0AA0

4.4 Required clearances

You must maintain the clearance shown in the figure in order to provide sufficient space for installing the modules, and to allow the dissipation of heat generated by the modules.

The S7-300 assembly on multiple racks shown in the figure below shows the clearance between racks and adjacent components, cable ducts, cabinet walls etc.

For example, when routing your module wiring through cable duct, the minimum clearance between the bottom of the shielding contact element and the cable duct is 40 mm.



The figure illustrates the following	
(1)	Wiring with cable duct
(2)	Minimum clearance between the cable duct and the bottom edge of the shielding contact element is 40 mm

4.5 Arrangement of modules on a single rack

Reasons for using one or multiple racks

The number of racks you need will depend on your application.

Reasons for using a single rack:	Reasons for distributing modules between several racks
• Compact, space-saving use of all your modules • Local use of all modules • Fewer signals to be processed	• More signals to be processed • Insufficient number of slots

Note

If you opt for the installation on a single rack, insert a dummy module to the right of the CPU (order no.: 6ES7 370-0AA01-0AA0). This gives you the option of adding a second rack for your application, simply by replacing the dummy module with an interface module, and without having to reinstall and rewire the first rack.

Rules: Layout of modules on a single module rack

The following rules apply to module installations on a single rack:

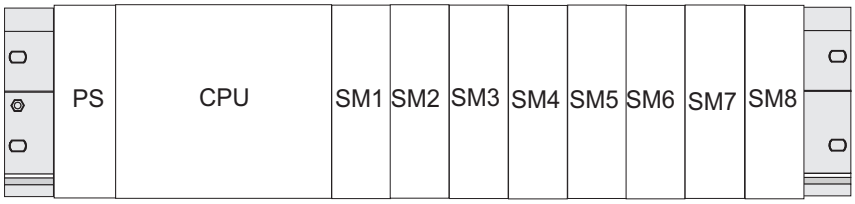
- No more than eight modules (SM, FM, CP) may be installed to the right of the CPU.
- The accumulated power consumption of modules mounted on a rack may not exceed 1.2 A on the S7-300 backplane bus.

Reference

For further information, refer to the technical data, for example, in the *S7-300 Module Specifications Reference Manual* or in the *Reference Manual* for your CPU.

Example

The figure below shows a layout with eight signal modules in an S7-300 assembly.



4.6 Distribution of modules to several racks

Exceptions

With CPU 312 and CPU 312C, only a single-row configuration on a rack is possible.

Using interface modules

If you are planning an assembly in multiple racks, then you will need interface modules (IM). Interface modules route the backplane bus of an S7-300 to the next rack.

The CPU is always located on rack 0.

Table 4-4 Interface modules - Overview

Properties	Two or more rows	Cost-effective 2-row configuration
Send IM in rack 0	IM 360 order no..: 6ES7 360-3AA01-0AA0	IM 365 order no..: 6ES7 365-0AB00-0AA0
Receiver IM in racks 1 to 3	IM 361 order no..: 6ES7 361-3CA01-0AA0	IM 365 (hard-wired to send IM 365)
Maximum number of expansion modules	3	1
Length of connecting cables	1 m (6ES7 368-3BB01-0AA0) 2.5 m (6ES7 368-3BC51-0AA0) 5 m (6ES7 368-3BF01-0AA0) 10 m (6ES7 368-3CB01-0AA0)	1 m (hard-wired)
Remarks	-	Rack 1 can only receive signal modules; the accumulated current load is limited to 1.2 A, whereby the maximum for rack 1 is 0.8 A These restrictions do not apply to operation with interface modules IM 360/IM 361

Rules: arrangement of the modules on several racks

Please note the following points if you wish to arrange your modules on multiple racks:

- The IM always uses slot 3 (slot 1: power supply module; slot 2: CPU, slot 3: Interface module)
- It is always on the left before the first signal module.
- No more than 8 modules (SM, FM, CP) are permitted per rack.
- The number of modules (SM, FM, CP) is limited by the permitted current consumption on the S7-300 backplane bus. The accumulated power consumption may not exceed 1.2 A per row.

Note

For information on the power consumption of the various modules, refer to the *Module Specifications Reference Manual.*

Rules: Interference-proof interfacing

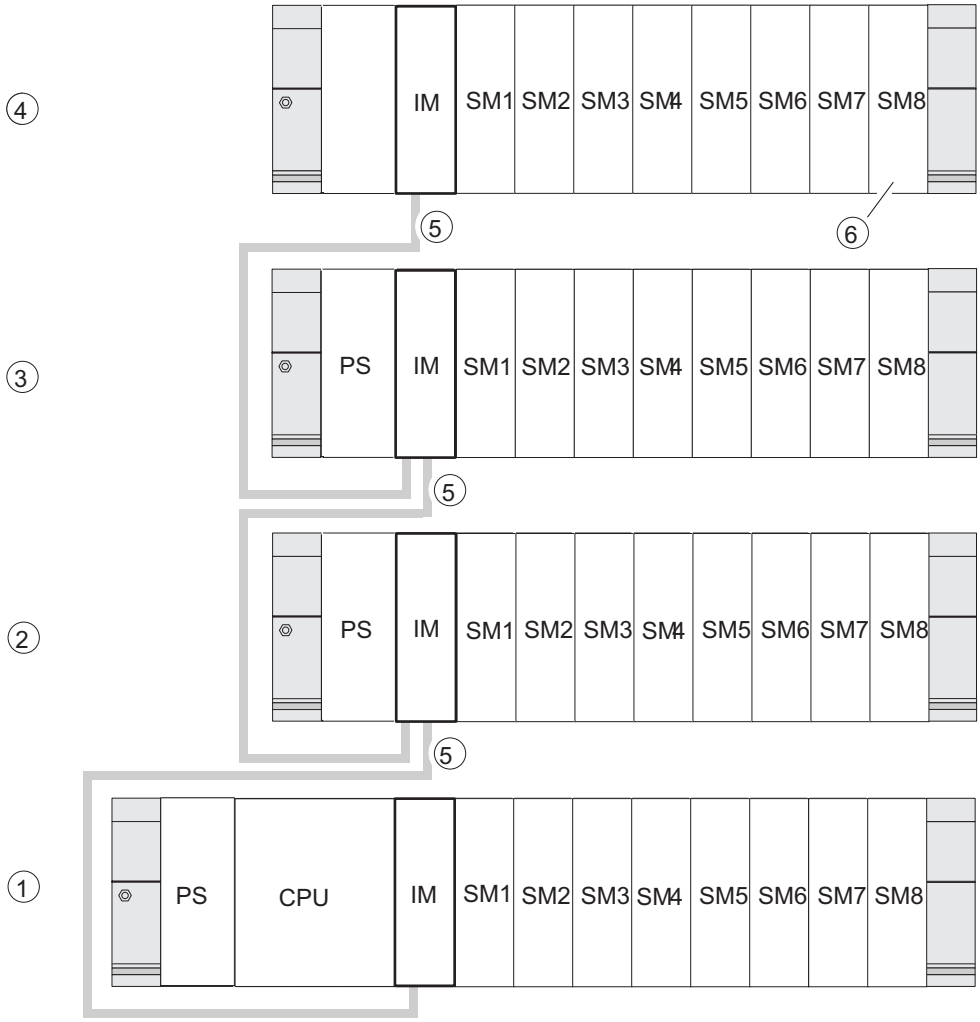
Special shielding and grounding measures are not required if you interconnect the CU and EM using suitable interface modules (Send IM and Receive IM).

However, you must ensure

- a low impedance interconnection of all racks,
- that the racks of a grounded assembly are grounded in a star pattern,
- that the contact springs on the racks are clean and not bent, thus ensuring that interference currents are properly discharged to ground.

Example: Full assembly using four racks

The figure shows the arrangement of modules in an S7-300 assembly on 4 racks.



The figure illustrates the following	
(1)	Rack 0 (central unit)
(2)	Rack 1 (expansion module)
(3)	Rack 2 (expansion module)
(4)	Rack 3 (expansion module)
(5)	The connecting cable 368
(6)	Restriction for CPU 31xC. When this CPU is used, do not insert SM 8 into Rack 4.

4.7 Selection and installation of cabinets

Reasons for installing an S7-300 in a cabinet

Your S7-300 should be installed in a cabinet,

- if you plan a larger system,
- if you are using your S7-300 systems in an environment subject to interference or contamination, and
- to meet UL/CSA requirements for cabinet installation.

Selecting and dimensioning cabinets

Take the following criteria into account:

- ambient conditions at the cabinet's place of installation
- the specified mounting clearance for racks (mounting rails)
- accumulated power loss of all components in the cabinet.

The ambient conditions (temperature, humidity, dust, chemical influence, explosion hazard) at the cabinet's place of installation determine the degree of protection (IP xx) required for the cabinet.

Reference for degrees of protection

For further information on the degrees of protection, refer to IEC 529 and DIN 40050.

The power dissipation capability of cabinets

The power dissipation capability of a cabinet depends on its type, ambient temperature and on the internal arrangement of devices.

Reference for power loss

For detailed information on power dissipation, refer to the Siemens catalogs NV21 and ET1.

Specification of cabinet dimensions

Note the following specifications when you determine the dimensions of a cabinet for your S7-300 installation:

- Space required for racks (mounting rails)
- Minimum clearance between the racks and cabinet walls
- Minimum clearance between the racks
- Space required for cable ducts or fan assemblies
- Position of the stays

Warning

Modules may get damaged if exposed to excess ambient temperatures.

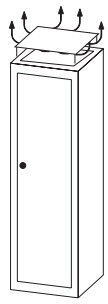
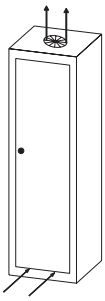
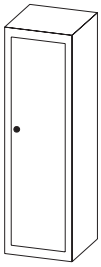
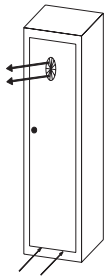
Reference for ambient temperatures

For information on permitted ambient temperatures, refer to the *S7-300 Automation System, Module data* Reference Manual.

Overview of typical cabinet types

The table below gives you an overview of commonly used cabinet types. It shows you the applied principle of heat dissipation, the calculated maximum power loss and the degree of protection.

Table 4-5 Cabinet types

Open cabinets		**Closed cabinets**		
Enclosed ventilation by means of natural convection	Increased enclosed ventilation	Natural convection	Forced convection with rack fan, improvement of natural convection	Forced convection with heat exchanger, internal and external auxiliary ventilation
				
Mainly inherent heat dissipation, with a small portion across the cabinet wall.	Higher heat dissipation with increased air movement.	Heat dissipation only across the cabinet wall; only low power losses permitted. In most cases, the heat accumulates at the top of the cabinet interior.	Heat dissipation only across the cabinet wall. Forced convection of the interior air improves heat dissipation and prevents heat accumulation.	Heat dissipation by heat exchange between heated internal air and cool external air. The increased surface of the pleated profile of the heat exchanger wall and forced convection of internal and external air provide good heat dissipation.
Degree of protection IP 20	Degree of protection IP 20	Degree of protection IP 54	Degree of protection IP 54	Degree of protection IP 54
Typical power dissipation under following marginal conditions: • Cabinet size: 600 mm x 600 mm x 2,200 mm • Difference between the outer and inner temperature of the cabinet is 20 °C (for other temperature differences refer to the temperature charts of the cabinet manufacturer)				
up to 700 W	up to 2,700 W (with fine filter up to 1,400 W)	up to 260 W	up to 360 W	up to 1,700 W

4.8 Example: Selecting a cabinet

Introduction

The sample below clearly shows the maximum permitted ambient temperature at a specific power loss for different cabinet designs.

Installation

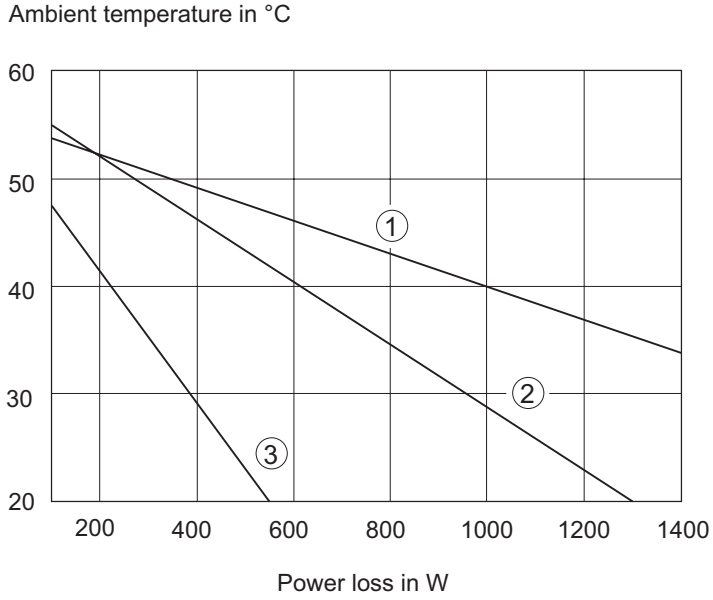
The following device configuration should be installed in a cabinet:

- Central unit, 150 W
- Expansion modules, each with 150 W
- Load power supply under full load, 200 W

This results in an accumulated power loss of 650 W.

Power loss dissipated

The diagram in the figure below shows guide values for the permitted ambient temperature of a cabinet with the dimensions 600 mm x 600 mm x 2,000 mm, based on the accumulated power loss. These values only apply if you maintain the specified assembly and clearance dimensions for racks (rails).



Trend	shows you the following cabinet type
(1)	Closed cabinet with heat exchanger (heat exchanger size 11/6 (920 mm x 460 mm x 111 mm)
(2)	Cabinet with through-ventilation by natural convection
(3)	Closed cabinet with natural convection and forced convection by equipment fans

Result

The figure below shows the resultant ambient temperatures, based on an accumulated power loss of 650 W:

Table 4-6 Cabinet selection

Cabinet design	Maximum permitted ambient temperature
Closed with natural convection and forced convection (trend 3)	Operation not possible
Open with through-ventilation (trend 2)	approx. 38 °C
Closed with heat exchanger (trend 1)	approx. 45 °C

Cabinet types suitable for horizontal installation of the S7-300:

- open, with closed ventilation
- closed, with heat exchanger

4.9 Electrical assembly, protective measures and grounding

4.9.1 Grounding concept and overall structure

This section contains information about the overall configuration of an S7-300 connected to a grounded TN-S network:

- Circuit-breaking devices, short-circuit and overload protection to VDE 0100 and VDE 0113
- Load power supplies and load circuits
- Grounding concept

Note

An S7-300 can be used in many different ways, so we can only describe the basic rules for the electrical installation in this document. Those basic rules are a must in order to achieve a fully functional S7-300 system.

Definition: Grounded mains

In a grounded mains network, the neutral conductor is always bonded to ground. A short-circuit to ground of a live conductor, or of a grounded part of the system, trips the protective devices.

Specified components and protective measures

A number of components and protective measures are prescribed for plant installations. The type of components and the degree of compulsion pertaining to the protective measures will depend on the VDE specification applicable to your particular plant.

The table below shows components and protective measures.

Table 4-7 VDE specifications for the installation of a PLC system

Compare ...	1)	VDE 0100	VDE 0113
Disconnect devices for control systems, signal generators and final control elements	(1)	...Part 460: Master switch	... Part 1: Load disconnect switch
Short-circuit / overload protection: In groups for signal generators and final control elements	(2)	...Part 725: Single-pole fusing of circuits	... Part 1: • With grounded secondary power circuit: single-pole fusing • Otherwise: fusing of all poles
Load power supply for AC load circuits with more than five electromagnetic devices	(3)	Galvanic isolation by transformer recommended	Electrical isolation by transformer mandatory

1) This column refers to the indexes of the figure in the chapter Overview: Grounding.

Reference

For further information on protective measures, refer to the Appendix.

4.9.2 Installing an S7-300 with grounded reference potential

Introduction

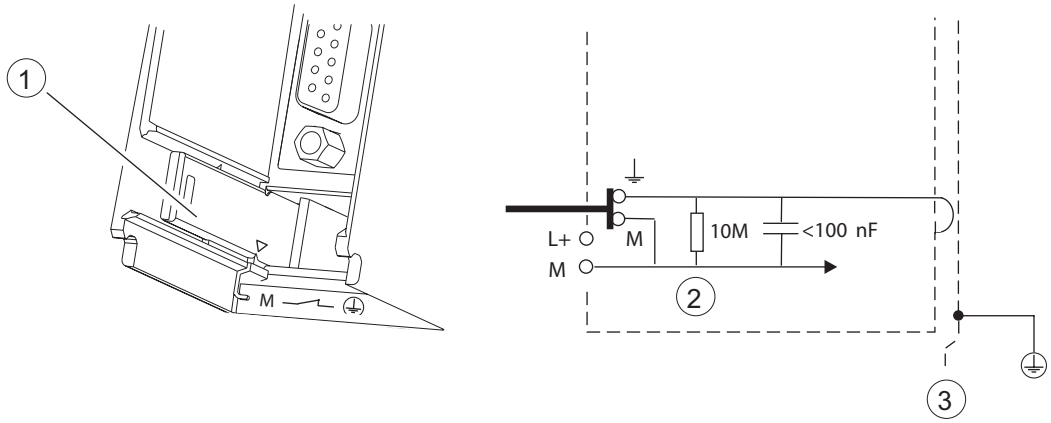
During installation of an S7-300 with grounded reference potential interference current is discharged to the ground conductor / to earth. A grounding slide contact is used for this except with CPU 31xC.

Note

Your CPU is supplied with grounded reference potential. Therefore, if you wish to install an S7-300 with grounded reference potential, you do not need to modify your CPU!

Grounded reference potential of the CPU 31x

The figure shows an S7-300 configuration with grounded reference potential (factory state.)



The figure illustrates the following	
(1)	Grounding slide contact in grounded state
(2)	Ground of the internal CPU circuitry
(3)	The mounting rail

Note

Do not pull out the grounding slide contact when you install an S7-300 with grounded reference potential.

4.9.3 Configuring an S7-300 with ungrounded reference potential (not CPU 31xC)

Introduction

During installation of an S7-300 with ungrounded reference potential interference currents are discharged to the ground conductor / to ground via an RC combination integrated in the CPU.

Note

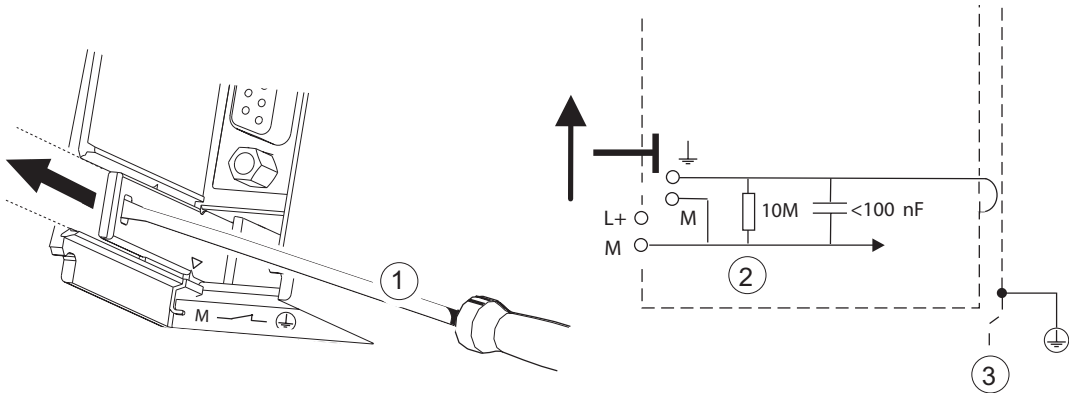
An S7-300 with a CPU 31xC cannot be configured ungrounded.

Application

In large systems, the S7-300 may require a configuration with grounded reference potential due to ground-fault monitoring. This is the case, for example, in chemical industry and power stations.

Ungrounded reference potential of the CPU 31x

The figure shows an S7-300 configuration with floating potential



The figure illustrates the following	
(1)	How to implement an ungrounded reference potential in your CPU: Use a screwdriver with 3.5 mm blade width to push the grounding slide contact forwards in the direction of the arrow until it snaps into place.
(2)	Ground of the internal CPU circuitry
(3)	The mounting rail.

Note

You should set up the ungrounded reference potential before you mount the device on the rail. If you have already installed and wired up the CPU, you may have to disconnect the MPI interface before you pull out the grounding slide contact.

4.9.4 Modules with isolated or common potential?

Isolated modules

Isolated modules are installed with galvanic isolation between the reference potentials of the control circuit ($M_{internal}$) and load circuit ($M_{external}$.)

Field of application

Use isolated modules for:

- All AC load circuits
- DC load circuits with separate reference potential

  Examples:

  – DC load circuits containing sensors which are connected to different reference potentials (for example, if grounded sensors are located at a considerable distance from the control system and equipotential bonding is not possible)

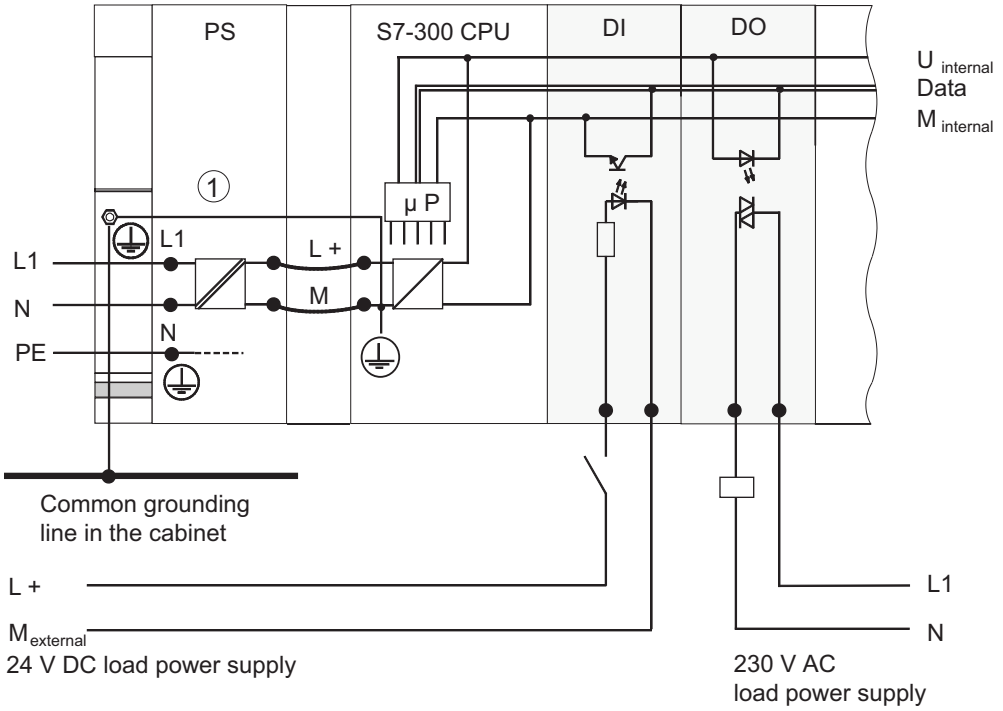
  – DC load circuits with grounded positive pole (L+) (battery circuits.)

Isolated modules and grounding concept

You can always use isolated modules, irrespective of the grounding state of the control system's reference potential.

Example: Assembly with CPU 31xC and isolated modules

The figure below shows an example of such a configuration: A CPU 31xC with isolated modules. The CPU 31xC (1) is automatically grounded.



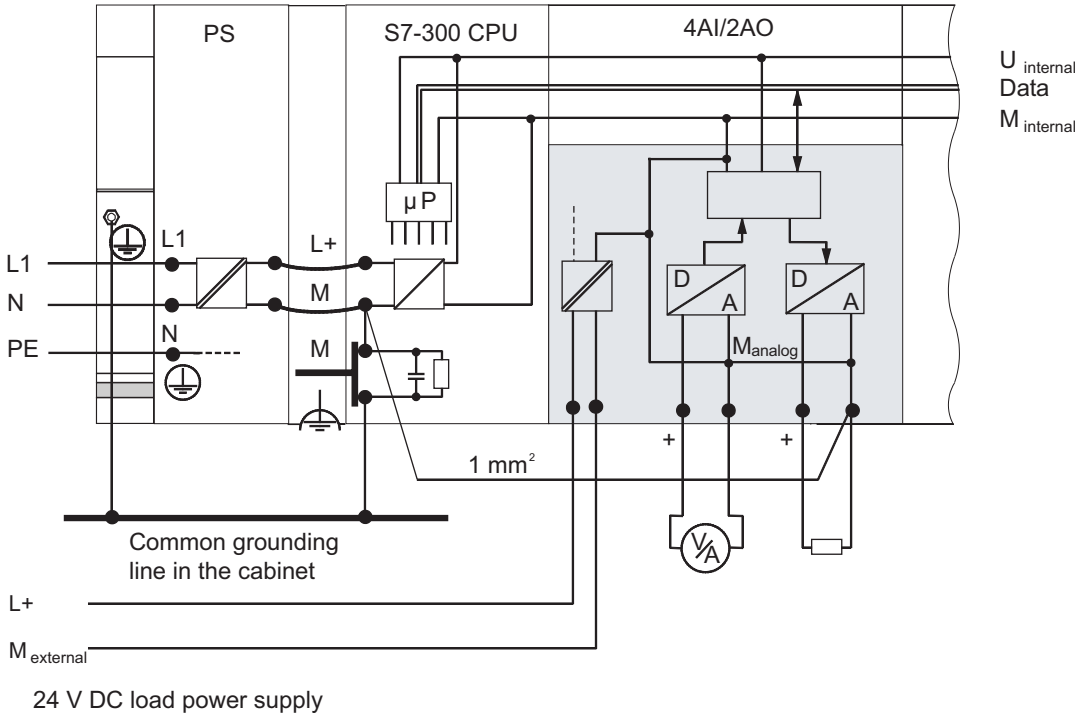
Common potential modules

In a configuration containing modules with common potential, the reference potentials of the control circuit ($M_{internal}$) and analog circuit (M_{analog}) are not galvanically isolated.

Example: Installing an S7-300 with common potential modules

When using an SM 334 AI 4/AO 2 analog I/O module, connect one of the grounding terminals M_{analog} to the CPU's chassis ground.

The figure below shows an example of such a configuration: An S7-300 with common potential modules



4.9.5 Grounding measures

Bonding to ground

Low-impedance connections to ground reduce the risk of electric shock as a result of a short-circuit or system fault. Low-impedance connections (large surface, large-surface contact) reduce the effects of interference on the system or the emission of interference signals. An effective shielding of cables and devices is also a significant contribution.

Warning

All protection class 1 devices, and all larger metal parts, must be bonded to protective ground. That is the only way to safely protect operators from electrical shock. This also discharges any interference transmitted from external power supply cables, signal cables or cables to the I/O devices.

Measures for protective grounding

The table below shows an overview of the most important measures for protective grounding.

Table 4-8 Measures for protective grounding

Device	Measures
Cabinet / mounting frame	Connection to central ground (equipotential busbar, for example) using cables with protective conductor quality
Rack / mounting rail	Connection to central ground, using cables with a minimum cross-section of 10 mm^2, if the rails are not installed in the cabinet and not interconnected with larger metallic parts.
Module	None
I/O Device	Grounding via grounding-type plug
Sensors and final control elements	Grounding in accordance with regulations applying to the system

Rule: Connect the cable shielding to ground

You should always connect both ends of the cable shielding to ground / system ground. This is the only way to achieve an effective interference suppression in the higher frequency range.

Attenuation is restricted to the lower frequency range if you connect only one end of the shielding (that is, at the start or end of the cable) to ground. One-sided shielding connections could be more favorable in situations

- not allowing the installation of an equipotential bonding conductor,
- where analog signals (some mA or A) are transferred,
- or if foil shielding is used (static shielding).

Note

Potential differences between two grounding points might cause an equipotential current flow across shielding connected at both ends. In this case, you should install an additional equipotential bonding conductor.

Caution

Always avoid the flow of operating current to ground.

Rule: Load circuit grounding

You should always ground the load circuits. This common reference potential (ground) ensures proper functioning.

Note

(not valid for CPU 31xC):

If you want to locate a fault to ground, provide your load power supply (terminal L or M) or the isolating transformer with a removable connection to the protective conductor (see *Overview: Grounding* section 4).

Connecting the load voltage reference potential

A complex system containing many output modules requires an additional load voltage for switching the final control elements.

The table below shows how to connect the load voltage reference potential $M_{external}$ for the various configurations.

Table 4-9 Connecting the load voltage reference potential

Installation	common potential modules	isolated modules	Note
grounded	Connect $M_{external}$ with M on the CPU	Connect or do not connect $M_{external}$ to the grounding busbar	-
ungrounded	Connect $M_{external}$ with M on the CPU	Connect or do not connect $M_{external}$ to the grounding busbar	Ungrounded installation with CPU 31xC is not possible

4.9.6 Overview: Grounding

CPU 31xC

The figure below shows you the complete assembly of an S7-300 with CPU 31xC with a power supply from TN-S mains. Apart from powering the CPU, the PS 307 also supplies the load current for the 24 VDC modules. Note: The layout of the power connections does not correspond with their physical arrangement; it was merely selected to give you a clear overview.

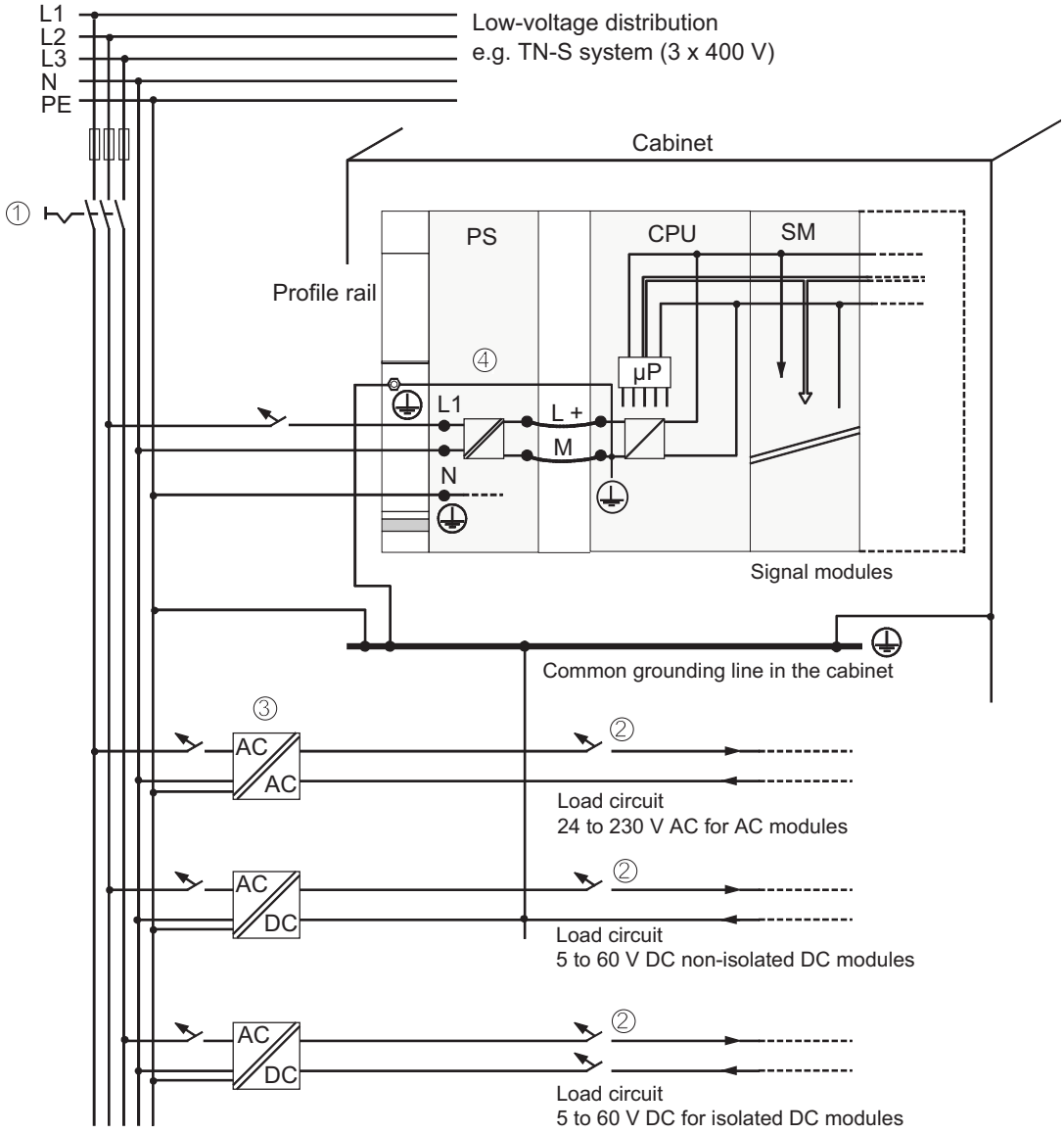


Table 4-10 Connecting the load voltage reference potential

The figure illustrates the following	
(1)	The main switch
(2)	The short-circuit / overload protection
(3)	The load current supply (galvanic isolation)
(4)	This connection is made automatically for the CPU 31xC

All CPUs except CPU 31xC

The figure below shows you the complete assembly of an S7-300 with TN-S mains supply (does not apply to CPU 31xC). Apart from powering the CPU, the PS 307 also supplies the load current for the 24 VDC modules.

Note: The layout of the power connections does not correspond with their physical arrangement; it was merely selected to give you a clear overview.

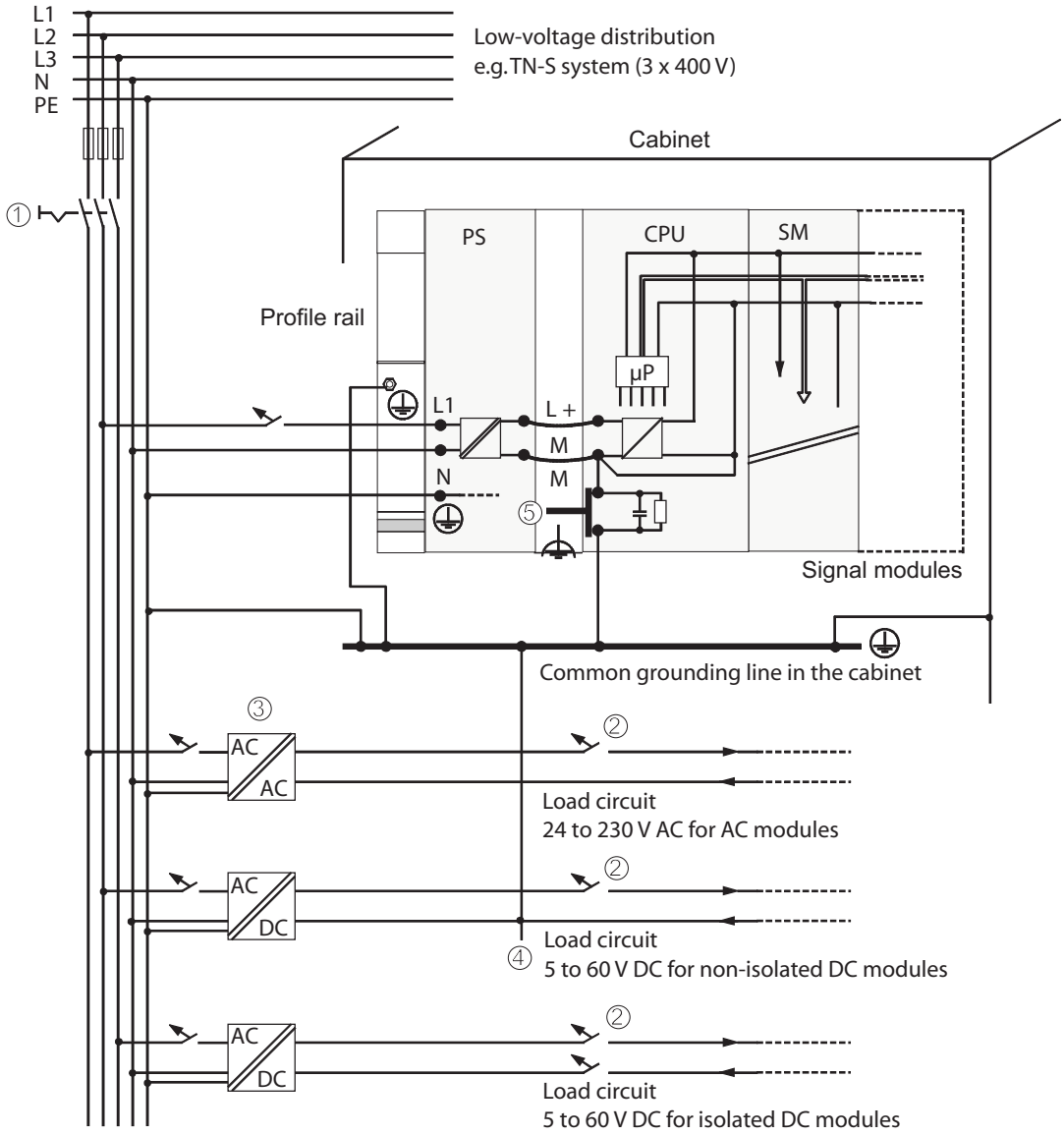


Table 4-11 Connecting the load voltage reference potential

The figure illustrates the following	
(1)	The main switch
(2)	The short-circuit / overload protection
(3)	The load current supply (galvanic isolation)
(4)	The removable connection to the grounding conductor, for ground fault localization
(5)	The grounding slide contact of the CPU (not CPU 31xC)

4.10 Selecting the load power supply

Task of the load power supply

The load power supply feeds the input and output circuits (load circuits), and the sensors and actuators.

Features of load power supply units

You will have to adapt the load power supply unit to your specific application. The table below shows a comparison of the various load power supply units and their features to help you make your choice:

Table 4-12 Features of load power supply units

Necessary for ...	Feature of the load power supply	Remarks
Modules requiring voltage supplies ≤ 60 VDC or ≤ 25 VAC. 24 VDC load circuits	Safety isolation	This is a common feature of the Siemens power supply series PS 307 and SITOP power series 6EP1.
24 VDC load circuits 48 VDC load circuits 60 VDC load circuits	Output voltage tolerances: 20.4 V to 28.8 V 40.8 V to 57.6 V 51 V to 72 V	-

Load power supply requirements

Only an extra-low voltage of ≤ 60 VDC which is safely isolated from mains may be used as load voltage. Safe isolation from mains can be achieved, for example, in accordance with VDE 0100 Part 410 / HD 384-4-41 / IEC 364-4-41 (as functional extra-low voltage with safe isolation) or VDE 0805 / EN 60950 / IEC 950 (as safety extra-low voltage SELV) or VDE 0106 Part 101.

Load current determination

The required load current is determined by the accumulated load current of all sensors and actuators connected to the outputs.

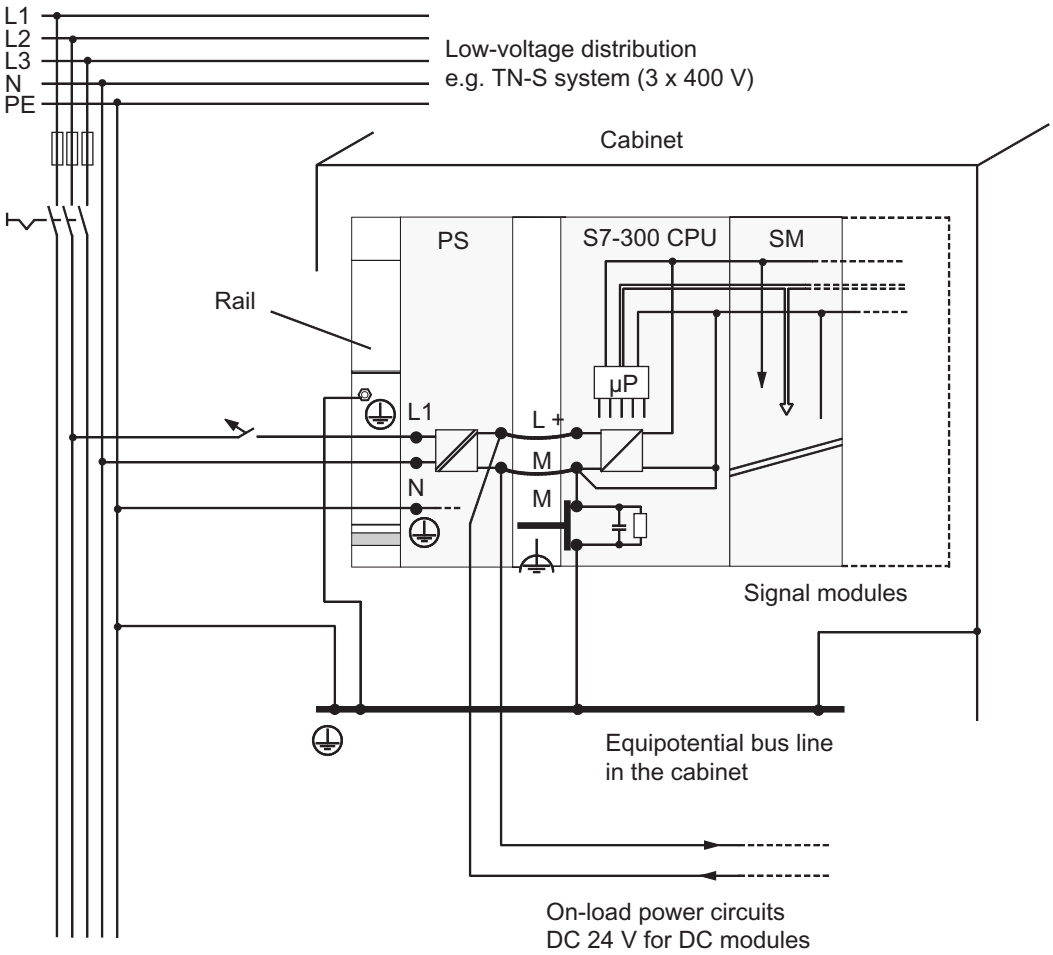
A short-circuit induces a surge current at the DC outputs which is 2 to 3 times higher than the rated output current, until the clocked electronic short-circuit protection comes into effect. Make allowances for this increased short-circuit current when selecting your load power supply unit. Uncontrolled load power supplies usually provide this excess current. With controlled load power supplies, and particularly for low output power up to 20 A, always ensure that the supply can handle this excess current.

Example: S7-300 with load power supply from PS 307

The figure below shows the overall S7-300 configuration (load power supply unit and grounding concept), with TN-S mains supply. The PS 307 supplies the CPU and the load current circuit of the 24 VDC modules.

Note

The layout of the power connections does not correspond with their physical arrangement; it was merely selected to give you a clear overview.



Example: S7-300 with load power supply from PS 307

4.11 Planning subnets

4.11.1 Overview

Subnets

Subnets available in SIMATIC for the various automation levels (process, cell, field and actuator/sensor level):

- Multi-Point Interface (MPI)
- PROFIBUS
- PROFINET (Industrial Ethernet)
- Point-to-point communication (PtP)
- Actuator/Sensor Interface (ASI)

Multi Point Interface (MPI)

Availability: For all CPUs described in this document.

MPI is a small area subnet containing a small number of nodes at the field/cell level. It is a multipoint-capable interface in SIMATIC S7/M7 and C7, designed as PG interface, for networking a small number of CPUs, or for low volume data exchange with PGs.

MPI always retains the last configuration of the transmission rate, node number and highest MPI address, even after CPU memory reset, power failure or deletion of the CPU parameter configuration.

It is advisable to use the PROFIBUS DP network components for your MPI network configuration. The same configuration rules apply in this case. Exception: OWG modules are not allowed in the MPI network.

PROFIBUS

Availability: CPUs with the "DP" name suffix are equipped with a PROFIBUS interface (CPU 315-2 DP, for example).

PROFIBUS represents the network at the cell and field level in the SIMATIC open, multivendor communication system.

PROFIBUS is available in two versions:

1. PROFIBUS DP field bus for high-speed cyclic data exchange, and PROFIBUS-PA for intrinsically safe applications (requires DP/PA coupler).
2. The cell level as PROFIBUS (FDL or PROFIBUS FMS) for high-speed data exchange with communication partners at the same authorization level (can only be implemented via CP).

PROFINET (Industrial Ethernet)

Availability: CPUs with a "PN" name suffix are equipped a second interface, namely the PROFINET interface (CPU 317-2 PN/DP, for example) A PROFINET interface, or communication processors, can be used to implement Industrial Ethernet in an S7-300 CPU system.

Industrial Ethernet, in an open multivendor communication system, represents the SIMATIC network at the process and cell level. PROFINET CPUs, however, also support real-time communication at the field level. This structure also supports S7 communication. Industrial Ethernet is suitable for high-speed and high-volume data exchange, and for remote network operations via gateway.

PROFINET is available in two versions:

- PROFINET IO and
- PROFINET CBA.

PROFINET IO is a communications concept for the implementation of modular distributed applications. PROFINET IO allows you to create automation solutions you are familiar with from PROFIBUS.

PROFINET CBA Component-Based automation) is an automation concept for the implementation of applications with distributed intelligence. PROFINET CBA lets you create distributed automation solutions, based on default components and partial solutions. This concept satisfies demands for a higher degree of modularity in the field of mechanical and systems engineering by extensive distribution of intelligent processes.

Component-Based automation is designed for the integration of complete technological modules as standardized components into large systems.

PtP communication (PtP)

Availability: CPUs with "PtP" name suffix are equipped with a second interface, namely the PtP interface (CPU 314C-2 PtP, for example)

PtP does not represent a subnet in the common sense, because it is used to interconnect only two stations.

If a PtP interface is not available, you require PtP Communication Processors (CP).

Actuator/Sensor Interface (ASI)

Implementation by means of communication processors (CP).

The ASI, or actuator/sensor interface, represents a subnet system on the lowest process level for automation systems. It is designed especially for networking digital sensors and actuators. The maximum data volume is 4 bits per slave station.

S7-300 CPUs require communication processor for the ASI connection.

Reference

For further information on communication, refer to the *Communication with SIMATIC* manual.

4.11.2 Configuring MPI and PROFIBUS subnets

4.11.2.1 Overview

The next section contains all the information you require to configure MPI, PtP and PROFIBUS subnets:

Contents

- MPI, PtP and PROFIBUS subnets
- Multi-Point Interface
- PROFIBUS DP
- MPI and PROFIBUS network components
- Example of networks - MPI

4.11.2.2 Basic principles of MPI and PROFIBUS subnets

Convention: device = node

All devices you interconnect on the MPI or PROFIBUS network are referred to as nodes.

Segment

A segment is a bus line between two terminating resistors. A segment may contain up to 32 nodes. It is also limited with respect to the permitted line length, which is determined by the transmission rate.

Transmission rate

Maximum transmission rates:

- MPI:
  - CPU 315-2 PN/DP and CPU 317: 12 Mbps
  - All other CPUs: 187.5 kbps
- PROFIBUS DP: 12 Mbps

Number of nodes

Maximum number of nodes per subnet:

Table 4-13 Subnet nodes

Parameters	MPI	PROFIBUS DP
Number	127	126 [1]
Addresses	0 to 126	0 to 125
Note	Default: 32 addresses Reserved addresses: • Address 0 for PG • Address 1 for OP	of those: • 1 master (reserved) • 1 PG connection (address 0 reserved) • 124 slaves or other masters

[1] Note the CPU-specific maximum specifications in the relevant CPU manual.

MPI/PROFIBUS DP addresses

You need to assign an address to all nodes in order to enable intercommunication:

- On the MPI network: an MPI address
- On the PROFIBUS DP network: a PROFIBUS DP address

You can use the PG to set the MPI/PROFIBUS addresses for each one of the nodes (some of the PROFIBUS DP slaves are equipped with a selector switch for this purpose).

Default MPI/PROFIBUS DP addresses

The table below shows you the default setting of the MPI/PROFIBUS DP addresses, and the factory setting of the highest MPI/PROFIBUS DP addresses for the nodes.

Table 4-14 MPI/PROFIBUS DP addresses

Node (device)	Default MPI/PROFIBUS DP address	Default highest MPI address	Default highest PROFIBUS DP address
PG	0	32	126
OP	1	32	126
CPU	2	32	126

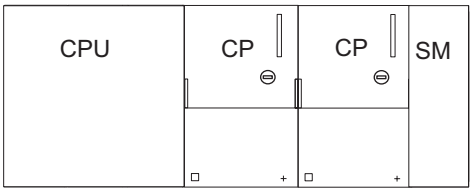
Rules: Assignment of MPI /PROFIBUS DP addresses

Note the following rules before assigning MPI/PROFIBUS addresses:

- All MPI/PROFIBUS subnet addresses must be unique.
- Highest MPI/PROFIBUS address ≥ physical MPI/PROFIBUS address, and must be identical for each node. (Exception: connecting a PG to multiple nodes; refer to the next chapter).

Differences in the MPI addresses of CPs/FMs in an S7-300 system

Table 4-15 MPI addresses of CPs/FMs in an S7-300 system

Options	Example			
Example: A system containing an S7-300 CPU and 2 CPs. You have two options of assigning MPI addresses to CPs/FMs installed in a system:				
	CPU	CP	CP	
1st option: The CPU accepts the MPI addresses you set for the CPs in STEP 7.	MPI addr.	MPI addr.+x	MPI add.+y	
2nd option: The CPU automatically assigns MPI addresses to the CPs in its system, based on the following syntax: MPI addr. CPU; MPI addr.+1; MPI addr.+2. (Default)	MPI addr.	MPI addr.+1	MPI addr.+2	
Special feature: CPU 315-2 PN/DP and CPU 317	When the central rack of an S7-300 contains FM/CPs with their own MPI address, the CPU forms its own communication bus via the backplane bus for these FM/CPs and separates it from the other subnets. The MPI address of those FM/CPs is thus no longer relevant for the nodes on other subnets. The MPI address of the CPU is used to communicate with these FMs/CPs.			

Recommended MPI address settings

Reserve MPI address "0" for a service PG, or "1" for a service OP, for temporary connections of these devices to the subnet. You should therefore assign different MPI addresses to PGs/OPs operating on the MPI subnet.

Recommended MPI address of the CPU for replacement or service operations:

Reserve MPI address "2" for the CPU. This prevents duplication of MPI addresses after you connect a CPU with default settings to the MPI subnet (for example, when replacing a CPU). That is, you should assign an MPI address > "2" to CPUs on the MPI subnet.

Recommended PROFIBUS address settings

Reserve PROFIBUS address "0" for a service PG that you can subsequently connect briefly to the PROFIBUS subnet as required. You should therefore assign unique PROFIBUS addresses to PGs integrated in the PROFIBUS subnet.

PROFIBUS DP: Electrical cables or fiber-optic cables?

Use fiber optic cables on a field bus with greater length, rather than copper conductors, in order to be independent on the transmission rate, and to exclude external interference.

Equipotential bonding

For information on what to take into account with respect to equipotential bonding in your network configuration, refer to the corresponding chapter in the appendix.

Reference

For further information, refer to the Communication section in *CPU 31xC and CPU 31x Manual, Technical Data*.

4.11.2.3 Multi-Point Interface (MPI)

Availability

All CPUs described in this manual are equipped with an MPI interface X1.

A CPU equipped with an MPI/DP interface is configured and supplied as MPI. To use the DP interface, set DP interface mode in STEP 7.

Properties

The MPI (Multi-Point Interface) represents the CPU interface for PG/OP connections, or for communication in an MPI subnet.

The typical (default) transmission rate for all CPUs is 187.5 kbps. You can also set 19.2 kbps for communication with an S7-200. The 315-2 PN/DP and 317 CPUs support transmission rates up to 12 Mbps.

The CPU automatically broadcasts its bus configuration via the MPI interface (the transmission rate, for example). A PG, for example, can thus receive the correct parameters and automatically connect to a MPI subnet.

Note

You may only connect PGs to an MPI subnet which is in RUN.
Other stations (for example, OP, TP, ...) should not be connected to the MPI subnet while the system is in RUN. Otherwise, transferred data might be corrupted as a result of interference, or global data packages may be lost.

Devices capable of MPI communication

- PG/PC
- OP/TP
- S7-300 / S7-400 with MPI
- S7-200 (19.2 kbps only)

4.11.2.4 PROFIBUS DP interface

Availability

CPUs with “DP“ name suffix are equipped at least with a DP X2 interface.

The 315-2 PN/DP and 317 CPUs are equipped with an MPI/DP X1 interface. A CPU with MPI/DP interface is supplied with default MPI configuration. You need to set DP mode in STEP 7 if you want to use the DP interface.

Operating modes for CPUs with two DP interfaces

Table 4-16 Operating modes for CPUs with two DP interfaces

MPI/DP interface (X1)	PROFIBUS DP interface (X2)
• MPI	• not configured
• DP master	• DP master
• DP slave [1]	• DP slave [1]

[1] simultaneous operation of the DP slave on both interfaces is excluded

Properties

The PROFIBUS DP interface is mainly used to connect distributed I/O. PROFIBUS DP allows you to create large subnets, for example.

The PROFIBUS DP interface can be set for operation in master or slave mode, and supports transmission rates up to 12 Mbps.

The CPU broadcasts its bus parameters (transmission rate, for example) via the PROFIBUS DP interface when master mode is set. A PG, for example, can thus receive the correct parameters and automatically connect to a PROFIBUS subnet. You can disable this bus parameter broadcast in you configuration.

Note

(for DP interface in slave mode only)

When you disable the Commissioning / Debug mode / Routing check box in the DP interface properties dialog in STEP 7, all user-specific transmission rate settings will be ignored, and the transmission rate of the master is automatically set instead. This disables the routing function at this interface.

Devices capable of PROFIBUS DP communication

- PG/PC
- OP/TP
- DP slaves
- DP master
- Actuators/Sensors
- S7-300/S7-400 with PROFIBUS DP interface

Reference

Further information on PROFIBUS: http://www.profibus.com

4.11.2.5 Network components of MPI/DP and cable lengths

MPI subnet segment

You can install cables with a length of up to 50 m in an MPI subnet segment. This length of 50 m is the distance between the first and the last node of the segment.

Table 4-17 Permissible cable length of a segment on the MPI subnet

Transmission rate	S7-300 CPUs (common potential MPI) without CPU 317	CPU 317
19.2 kbps	50 m	1000 m
187.5 kbps		
1.5 Mbps	-	200 m
3.0 Mbps		100 m
6.0 Mbps		
12.0 Mbps		

Segment on the PROFIBUS subnet

The maximum cable length of a a segment on the PROFIBUS subnet is determined by the set transmission rate.

Table 4-18 Permissible cable length of a segment on the PROFIBUS subnet

Transmission rate	Maximum cable length of a segment
9.6 kbps to 187.5 kbps	1000 m
500 kbps	400 m
1.5 Mbps	200 m
3 Mbps to 12 Mbps	100 m

Longer cable lengths via RS 485 repeater

You need to install RS485 repeaters for segments requiring cable lengths longer than the allowed length. For further information, refer to the RS485 Repeater Product Information.

Stub cables

Make allowances for the maximum stub cable length when you connect bus nodes to a bus segment by means of stub cables, for example, a PG via standard PG cable.

For transmission rates up to 3 Mbps, you can use a PROFIBUS bus cable with bus connector as stub cable. For transmission rates higher than 3 Mbps, use the patch cord to connect the PG or PC. You can connect several PG patch cords to the the bus (for order numbers see table 4-20). Other types of stub cables are not permitted.

Length of stub cables

The table below shows the maximum permitted lengths of stub cables per segment:

Table 4-19 Lengths of stub cables per segment

Transmission rate	Max. length of stub cables per segment	Number of nodes with stub cable length of ...	
		1.5 m or 1.6 m	3 m
9.6 kbps to 93.75 kbps	96 m	32	32
187.5 kbps	75 m	32	25
500 kbps	30 m	20	10
1.5 Mbps	10 m	6	3
3 Mbps to 12 Mbps	[1]	[1]	[1]

[1] To connect PGs or PCs when operating at rates higher than 3 Mbps, use patch cords with the order no. 6ES7 901-4BD00-0XA0. In your bus configuration, you can use multiple PG patch cords with this order number. Other types of stub cables are not permitted.

PG patch cord

Table 4-20 PG patch cord

Type	Order number
PG patch cord	6ES7 901-4BD00-0XA0

PROFIBUS cables

For PROFIBUS DP or MPI networking we offer you the following bus cables for diverse fields of application:

Table 4-21 Available bus cables

Bus cable	Order number
PROFIBUS cable	6XV1 830-0AH10
PROFIBUS cable, halogen-free	6XV1 830-0CH10
PROFIBUS underground cable	6XV1 830-3AH10
PROFIBUS trailing cable	6XV1 830-3BH10
PROFIBUS cable with PUR sheath for environments subject to chemical and mechanical stress	6XV1 830-0DH10
PROFIBUS cable with PE sheath for the food and beverages industry	6XV1 830-0BH10
PROFIBUS cable for festooning	6XV1 830-3CH10

Properties of PROFIBUS cables

The PROFIBUS cable is a 2-wire, shielded twisted-pair cable with copper conductors. It is used for hardwired transmission in accordance with US Standard EIA RS485.

The table below lists the characteristics of these bus cables.

Table 4-22 Properties of PROFIBUS cables

Properties	Values
Wave impedance	approx. 135 Ω to 160 Ω (f = 3 MHz to 20 MHz)
Loop resistance	≤ 115 Ω/km
Effective capacitance	30 nF/km
Attenuation	0.9 dB/100 m (f = 200 kHz)
Permitted conductor cross-sections	0.3 mm^2 to 0.5 mm^2
Permitted cable diameter	8 mm ± 0.5 mm

Installation of bus cables

When you install PROFIBUS cables, you must not

- twist,
- stretch
- or compress them.

When wiring indoor bus cables, also maintain the following marginal conditions (d_A = outer cable diameter):

Table 4-23 Marginal conditions for wiring interior bus cables

Characteristics	Condition
Bending radius (one-off)	≥ 80 mm (10 x d_A)
Bending radius (multiple times)	≥ 160 mm (20 x d_A)
Permitted temperature range during installation	–5 °C to +50 °C
Shelf and static operating temperature range	–22 °F to +149 °F

Reference

For information on the use of fiber-optic cables for PROFIBUS, refer to the SIMATIC NET, PROFIBUS Networks Manual.

Bus connector RS 485

Table 4-24 Bus connector

Type	Order number
RS485 bus connector, up to 12 Mbps, with 90° cable exit, without PG interface, with PG interface	 6ES7 972-0BA11-0XA0 6ES7 972-0BB11-0XA0
Fast Connect RS485 bus connector, up to 12 Mbps, with 90° cable exit, with insulation displacement technology, without PG interface, with PG interface	 6ES7 972-0BA50-0XA0 6ES7 972-0BB50-0XA0
RS485 bus connector up to 12 Mbps with 35° cable exit (not for CPU 31xC, 312, 314, and 315-2 DP without PG interface with PG interface	 6ES7 972-0BA40-0XA0 6ES7 972-0BB40-0XA0

Fields of application

You need bus connectors to connect the PROFIBUS cable to an MPI or PROFIBUS-DP interface

You do not require a bus connector for:

- DP slaves with degree of protection IP 65 (ET 200X, for example)
- RS 485 repeater.

RS 485 repeater

Type	Order number
RS 485 repeater	6ES7 972-0AA00-0XA0

Purpose

RS485 repeaters are used to amplify data signals on bus lines and to couple bus segments.

You require this RS 485 Repeater in the following situations:

- more than 32 network nodes
- when interconnecting a grounded with an ungrounded segment
- when exceeding the maximum line length in a segment

Longer cable lengths

If you want to implement cable lengths above those permitted in a segment, you must use RS485 repeaters. The maximum cable length possible between two RS 485 repeaters corresponds to the cable length of a segment. Please note that these maximum cable lengths only apply if there is no further node interconnected between the two RS 485 repeaters. You can connect up to nine RS 485 repeaters in series. Please note that you have to add the RS 485 repeater when you determine the number of nodes in your subnet, even if it is not assigned its own MPI/PROFIBUS address.

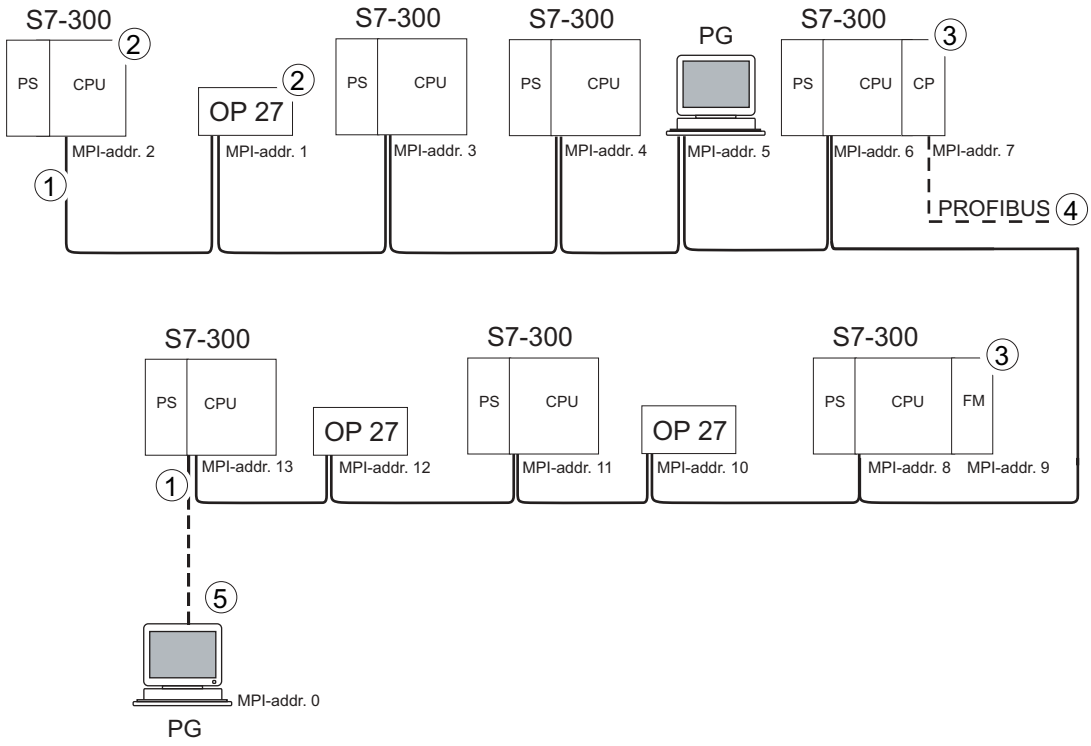
Reference

- Technical data about the RS 485 repeater can be found in the product information.

4.11.2.6 Cable lengths of MPI and PROFIBUS subnets

Example: Installation of an MPI subnet

The figure below shows you the block diagram of a MPI subnet.

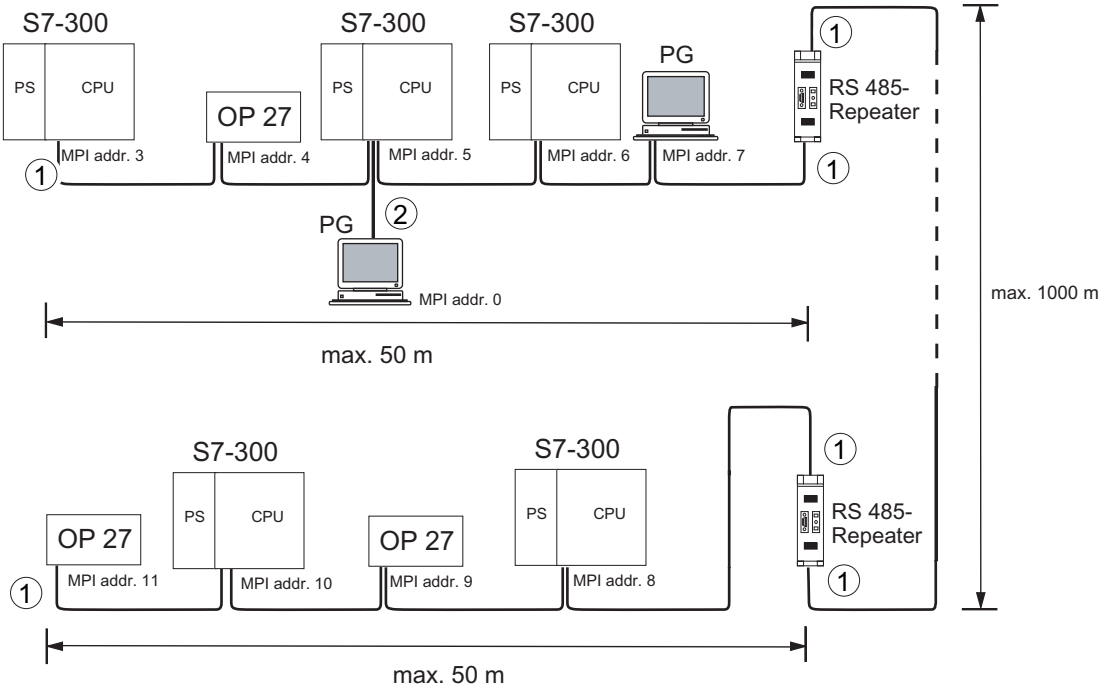


Key to numbers in the figure	
(1)	Terminating resistor enabled.
(2)	S7-300 and OP 27 have subsequently been connected to the MPI subnet using their default MPI address.
(3)	CPU 31xC, 312, 314, 315-2 DP You can also assign user-specific MPI addresses to the CPs/FMs at these CPUs. CPU 317-2 DP CPs and FMs do not have their own MPI address in this CPU.
(4)	In addition to the MPI address, the CP also has a PROFIBUS address (7 in this case).
(5)	Connected via a stub cable using the default MPI address for commissioning/maintenance only

Example: Maximum distances in the MPI subnet

The figure below shows you:

- a possible MPI subnet configuration
- maximum distances possible in an MPI subnet
- the principle of "Line extension" using RS 485 repeaters

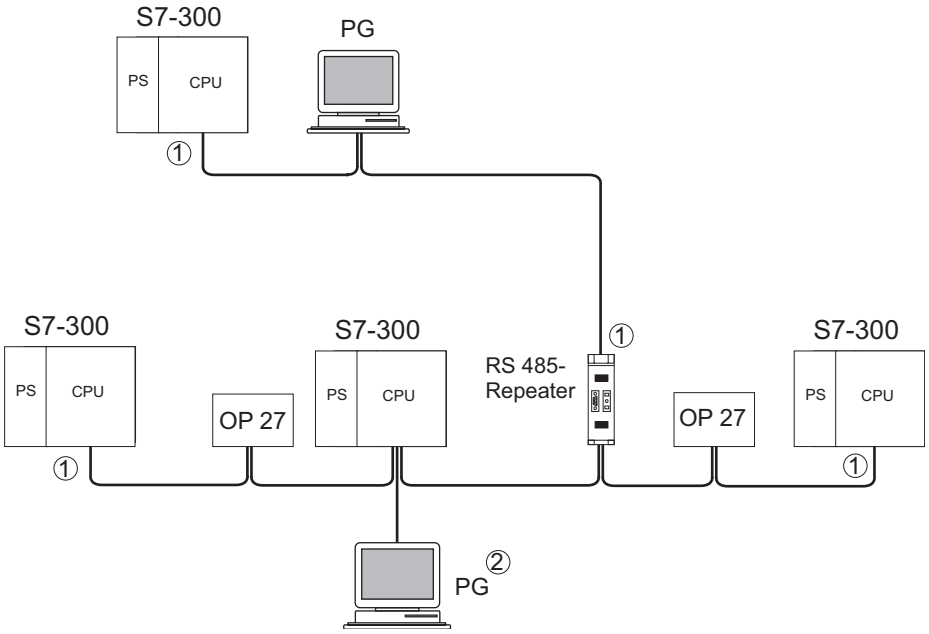


Key to numbers in the figure	
(1)	Terminating resistor enabled.
(2)	PG connected by means of a stub cable for maintenance purposes

Example: Terminating resistor in the MPI subnet

The figure below shows you an example of an MPI subnet and where to enable the terminating resistor.

The figure below illustrates where the terminating resistors must be enabled in an MPI subnet. In this example, the programming device is connected via a stub cable only for the duration of commissioning or maintenance.



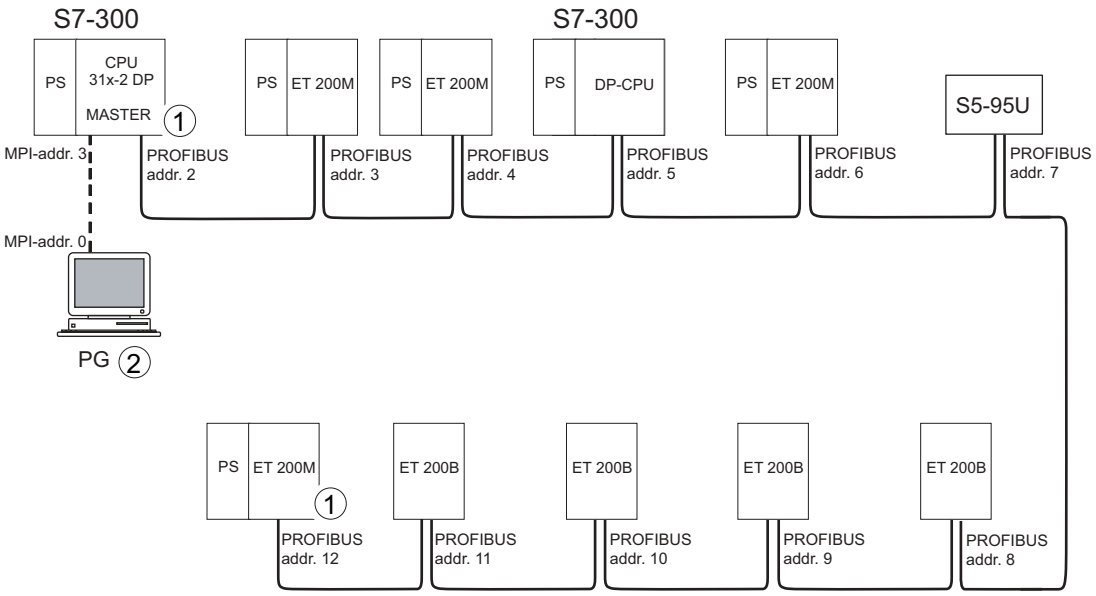
Key to numbers in the figure	
(1)	Terminating resistor enabled.
(2)	PG connected by means of a stub cable for maintenance purposes

Warning

Disturbance of data traffic might occur on the bus. A bus segment must always be terminated at both ends with the terminating resistor. This, for example, is not the case if the last slave with bus connector is off power. The bus connector draws its power from the station, and the terminating resistor is thus disabled. Please make sure that power is always supplied to stations on which the terminating resistor is active. Alternatively, you can also use the PROFIBUS terminator as active bus termination.

Example: Installation of a PROFIBUS subnet

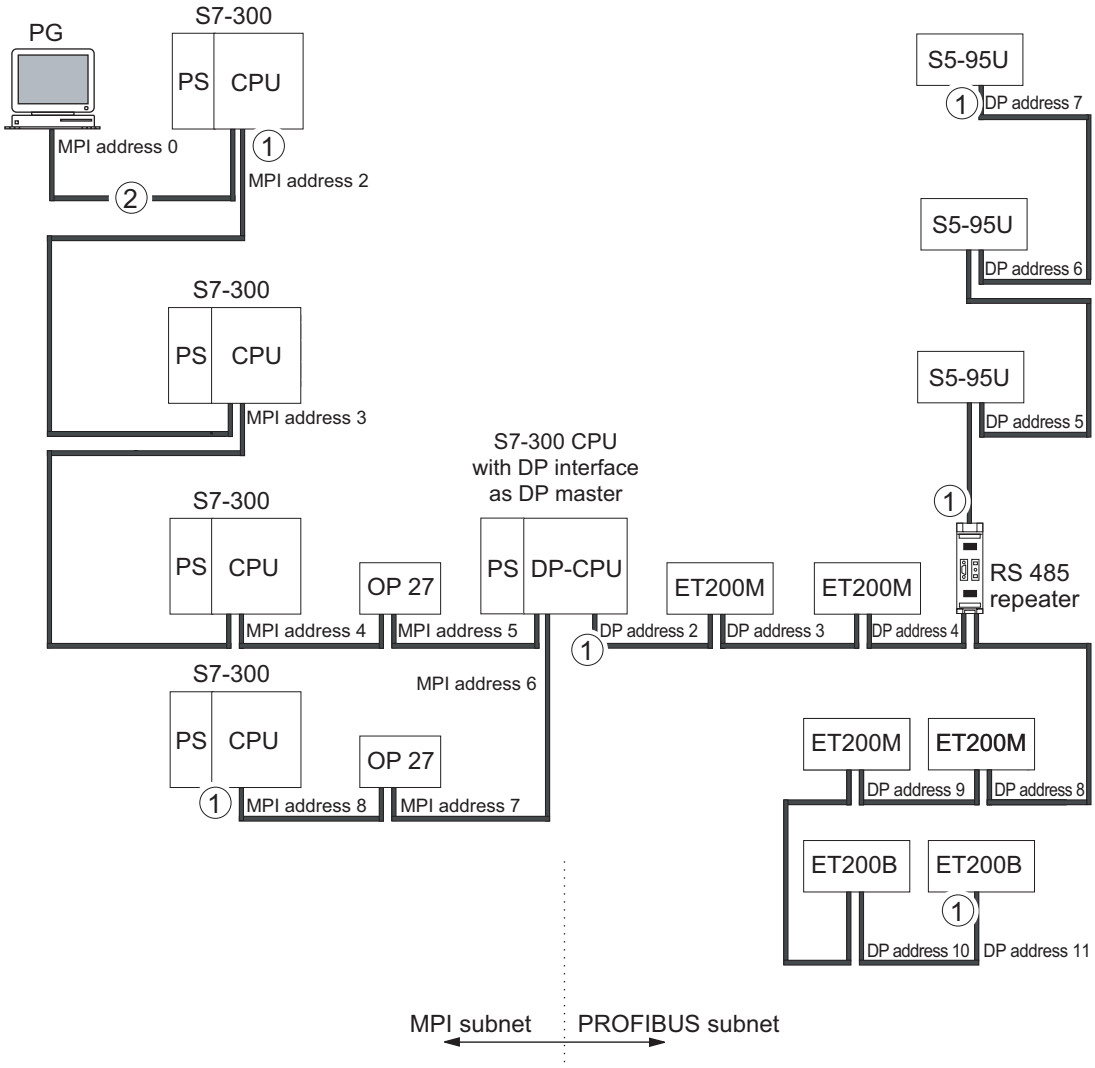
The figure below shows you the basic principles of a PROFIBUS subnet installation.



Key to numbers in the figure	
(1)	Terminating resistor enabled.
(2)	PG connected by means of a stub cable for maintenance purposes

Example: CPU 314C-2 DP as MPI and PROFIBUSnode

The figure below shows you an assembly with a CPU 314C-2 DP integrated in an MPI subnet and also operated as DP master in a PROFIBUS subnet.



Key to numbers in the figure	
(1)	Terminating resistor enabled.
(2)	PG connected via a stub cable for maintenance or commissioning purposes

4.11.3 Configuring PROFINET subnets

4.11.3.1 Overview

The next section contains all the information you require to configure PROFINET subnets:

Contents

- PROFINET nodes
- Integration of field bus system into PROFINET
- PROFINET IO and PROFINET CBA (Component-Based Automation)
- PROFINET cable lengths
- Ethernet bus cable and connector
- Example of a PROFINET subnet
- Example of a PROFINET IO system

4.11.3.2 PROFINET nodes

Definition: Nodes in the PROFINET environment

Within the context of PROFINET, "node" is the generic term for:

- Automation systems
- Field devices (for example, PLC, PC, hydraulic devices, pneumatic devices)
- Active network components (for example, distributed I/O, valve blocks, drives)

The main characteristics of a node is its integration into PROFINET communication by means of Ethernet or PROFIBUS.

The following device types are distinguished based on their attachment to the bus:

- PROFINET nodes
- PROFIBUS nodes

Definition: PROFINET nodes

A PROFINET node always has at least one Industrial Ethernet port. A PROFINET node can also have a PROFIBUS port, that is, as master with proxy functionality. In exceptional circumstances, a PROFINET node can also have more than one PROFIBUS port (for example the CP 5614).

Definition: PROFIBUS nodes

A PROFIBUS node has at least one or more ports.

A PROFIBUS node cannot take part directly in PROFINET communication, but must be implemented by means of PROFIBUS master with PROFINET port or Industrial Ethernet/PROFIBUS link (IE/PB Link) with proxy functionality.

Comparison of the terminology in PROFIBUS DP and PROFINET IO

The following schematic shows you the general names of the most important devices in PROFINET IO and PROFIBUS DP. The table below shows the designation of the various components in the PROFINET IO and PROFIBUS DP context.

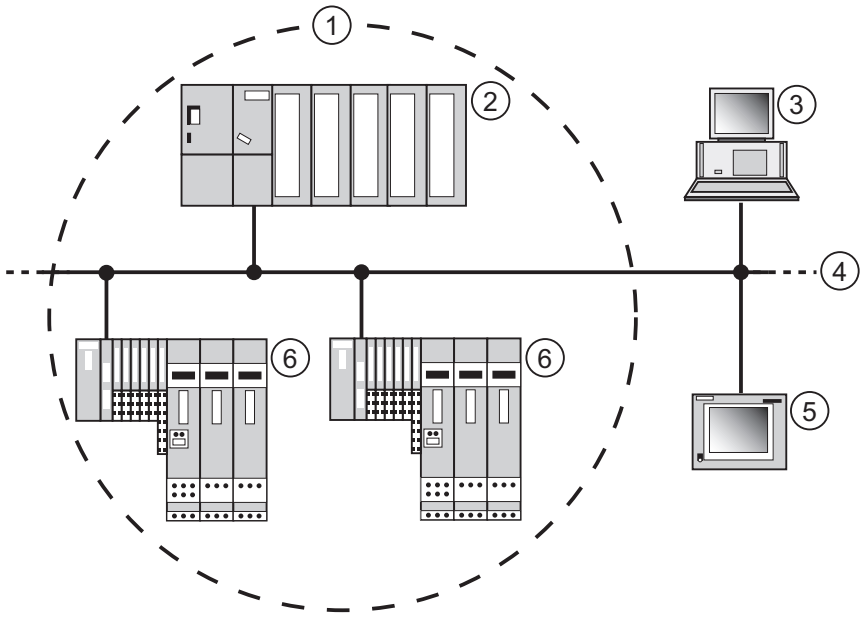


Figure 4-1 PROFINET and PROFIBUS nodes

Number	PROFINET	PROFIBUS	Comment
1	IO system	DP master system	
2	IO controller	DP master	Node used to address the connected IO devices/DP slaves. That is: the IO controller/DP master exchanges input and output signals with field devices. The IO controller/DP master is often the controller on which the automation program runs.
3	IO supervisor	PG/PC Class 2 DP master	PG/PC HMI device for commissioning and diagnostics
4	Industrial Ethernet	PROFIBUS	Network infrastructure
5	HMI (Human Machine Interface)	HMI	Device for operating and monitoring functions.
6	IO device	DP slave	Distributed field device assigned to one of the IO controllers/DP masters (for example, remote I/O, valve terminal, frequency converter, switches)

Slots and Submodules

A PROFINET node can have a modular structure similar to a DP slave. A PROFINET node consists of slots in which the modules/submodules are inserted. The modules/submodules have channels over which the process signals are read in or output.

The following graphic illustrates the situation.

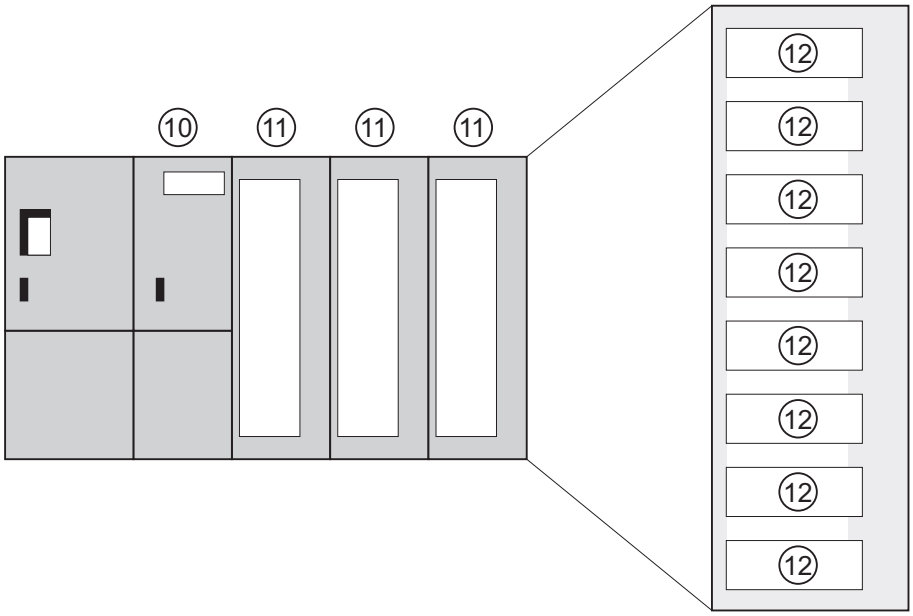


Figure 4-2 Module, Submodule, Slot, and Channel

Number	Description
10	Interface module
11	Slot with module/submodule
12	Channel

It is always possible for a slot to be divided into subslots that contain submodules.

4.11.3.3 Integration of field bus systems in PROFINET

Field bus Integration

PROFINET allows you to integrate existing field bus systems (for example, PROFIBUS, ASI, etc.) into PROFINET via proxy. This allows you to set up mixed systems consisting of field bus and Ethernet based subsystems. This makes a continuous technological transition to PROFINET possible.

Interconnection of PROFINET and PROFIBUS

You can connect PROFIBUS devices to the local PROFIBUS interface of a PROFINET device. This allows you to integrate existing PROFIBUS configurations in PROFINET.

The following figure shows the supported network types for PROFINET:

- Industrial Ethernet and
- PROFIBUS.

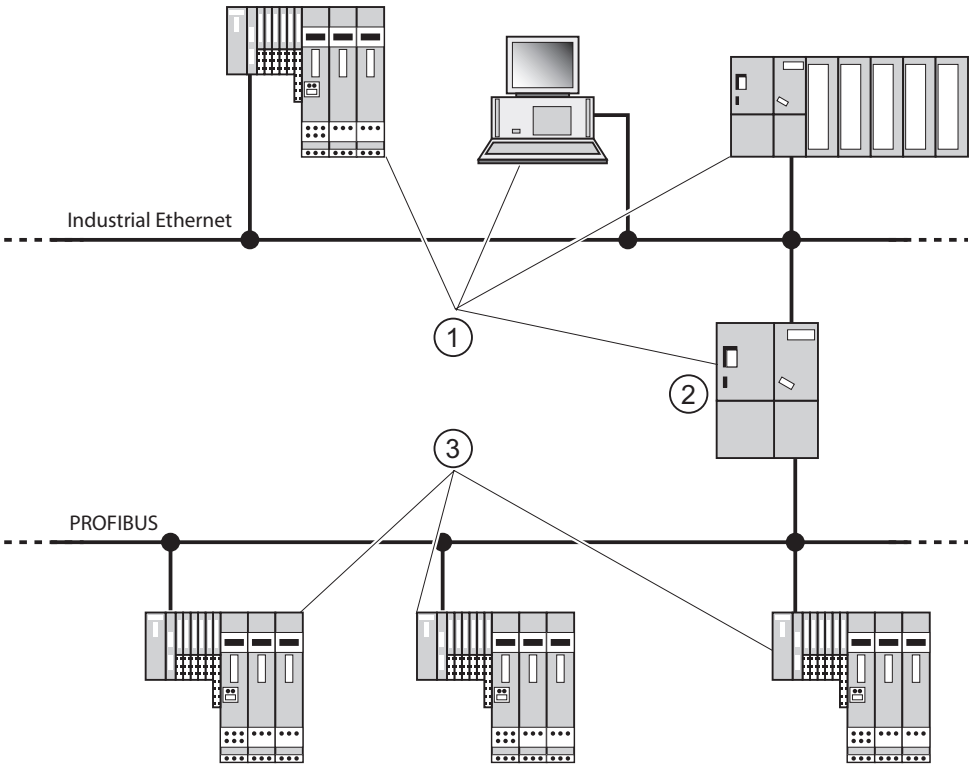


Figure 4-3 PROFINET Devices, PROFIBUS Devices, and Proxy

Number	Description
1	PROFINET devices
2	PROFINET device with proxy functionality (for more detailed information, see below)
3	PROFIBUS devices

PROFINET device with proxy functionality = Substitute

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 nodes on PROFINET.

You can integrate existing PROFIBUS systems in PROFINET communication, for example with the help of an IE/PB Link or a CPU 31x-2 PN/DP. The IE/PB Link then handles communication over PROFINET as a substitute for the PROFIBUS components.

Currently, you can include DPV0 slaves in PROFINET in this way.

Further Information

For information on the differences and common features of PROFINET IO and PROFIBUS DP and for information on migrating from PROFIBUS DP to PROFIBUS I/O, refer to the *From PROFIBUS DP to PROFINET IO* programming manual.

4.11.3.4 PROFINET IO and PROFINET CBA

What is PROFINET IO?

Within the framework of PROFINET, PROFINET IO is a communication concept for the implementation of modular, distributed applications.

PROFINET IO allows you to create automation solutions familiar from PROFIBUS.

PROFINET IO is implemented by the PROFINET standard for the programmable controllers on the one hand, and on the other hand by the engineering tool STEP 7.

This means that you have the same application view in STEP 7 regardless of whether you configure PROFINET devices or PROFIBUS devices. Programming your user program is essentially the same for PROFINET IO and PROFIBUS DP if you use the expanded blocks and system status lists for PROFINET IO.

Reference

For more detailed information on new and modified blocks, refer to the *From PROFIBUS DP to PROFINET IO* programming manual.

User Programs in PROFINET IO and PROFIBUS DP

A comparison of the most important differences and common features in PROFINET IO and PROFIBUS DP that are relevant for the creation of user programs can be found in the programming manual *From PROFIBUS DP to PROFINET IO.*

What is PROFINET CBA? (Component based Automation)?

Within the framework of PROFINET, PROFINET CBA is an automation concept for the implementation of applications with distributed intelligence.

PROFINET CBA lets you create distributed automation solutions, based on default components and partial solutions. This concept satisfies demands for a higher degree of modularity in the field of mechanical and systems engineering by extensive distribution of intelligent processes.

Component based Automation allows you to use complete technological modules as standardized components in large systems.

PROFINET CBA is implemented by:

- the PROFINET standard for programmable controllers and
- the SIMATIC iMAP engineering tool.

The components are also created in an engineering tool that can differ from vendor to vendor. Components of SIMATIC devices are generated, for example, with STEP 7.

The following figures illustrate how automation solutions are being transformed as a result of PROFINET CBA.

Conventional Automation Solutions without PROFINET CBA

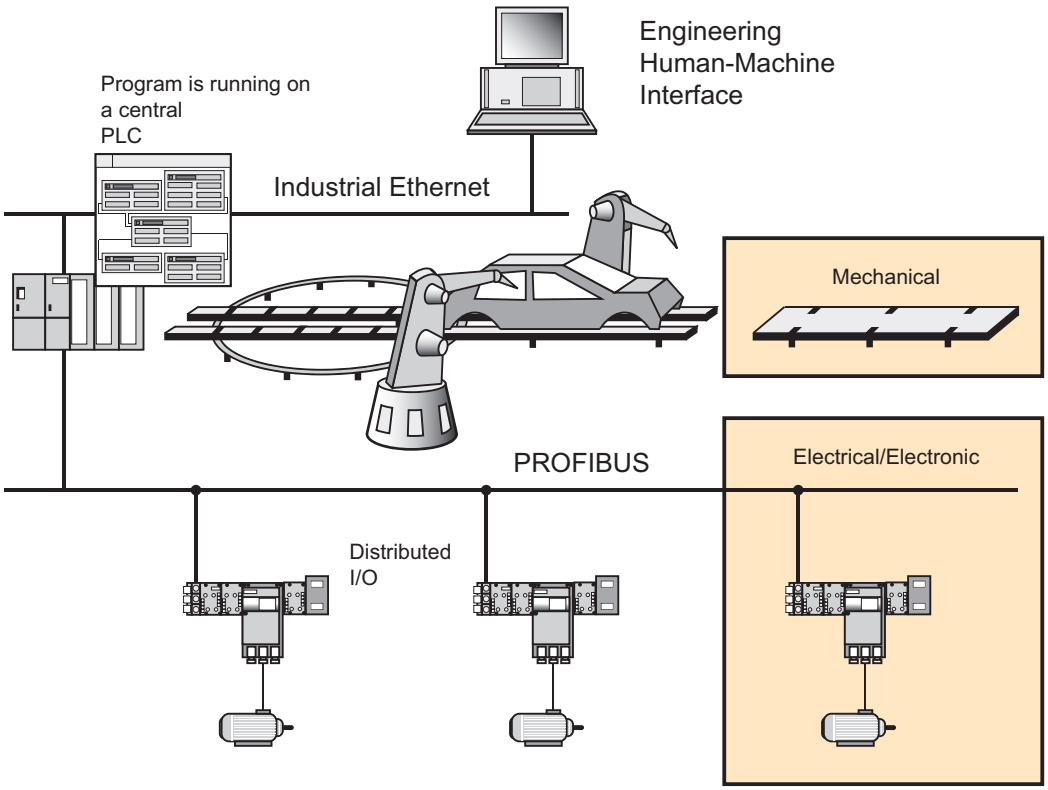


Figure 4-4 Existing automation concept with modular plant engineering

Automation Solution with PROFINET CBA

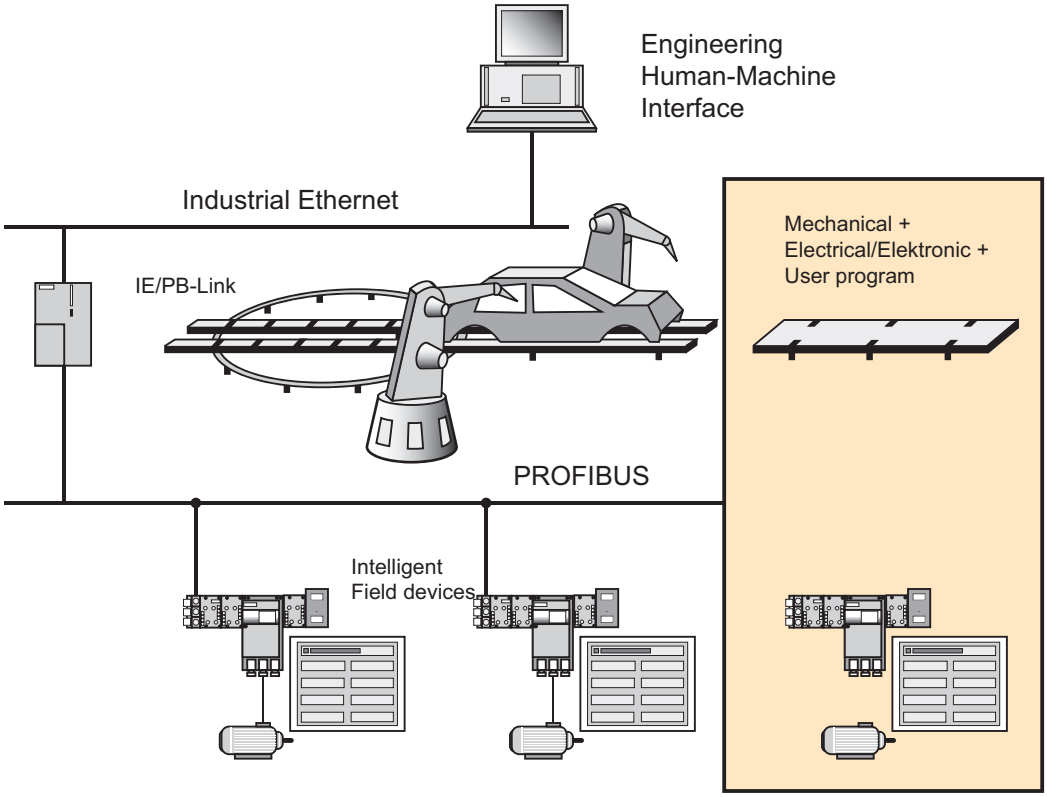


Figure 4-5 New: Modular Concept with Distributed Intelligence

Extent of PROFINET IO and PROFINET CBA

PROFINET IO and CBA are two different views of programmable controllers on Industrial Ethernet.

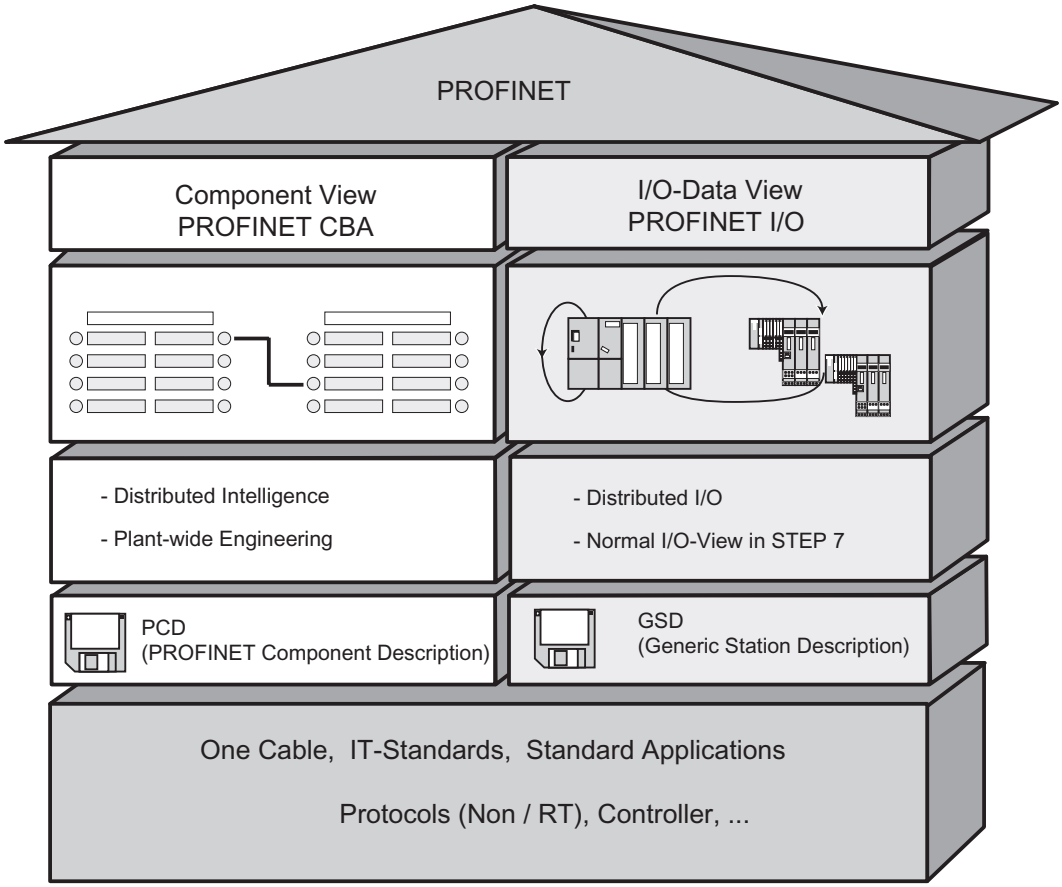


Figure 4-6 Extent of PROFINET IO and Component based Automation

Component based Automation divides the entire plant into various functions. These functions are configured and programmed.

PROFINET IO provides you with a picture of the plant that is very similar to the view obtained in PROFIBUS. You continue to configure and program the individual programmable controllers.

Controllers in PROFINET IO and PROFINET CBA

You can also use some PROFINET IO controllers for PROFINET CBA.

The following list illustrates which PROFINET devices can adopt the function of a **PROFINET CBA or IO controller**:

- Programmable controllers such as the S7-300 CPU 317-2 PN/DP
- CP 343-1 or CP 443-1 Advanced

The following list illustrates which PROFINET devices can only adopt the function of a **PROFINET IO controller**:

- PCs attached to PROFINET with a CP (for example CP 1616) and SOFTNET PROFINET (for example CP 1612). With the CP 1616, the user program executes on the CP, with SOFTNET PROFINET, it executes in the CPU of the PC.
- SIMOTION device for particularly strict real-time requirements.

PROFINET devices can only adopt the function of a **PROFINET CBA controller**, for example PCs with a standard Ethernet interface and the WinLC software.

Proxy in PROFINET IO and PROFINET CBA

Proxies for PROFINET IO and proxies for PROFINET CBA are different.

In PROFINET IO, the proxy for PROFINET IO represents each connected PROFIBUS DP slave as a PROFINET IO device on PROFINET.

In PROFINET CBA, the proxy for PROFINET CBA represents each connected PROFIBUS DP slave as a component on PROFINET.

As a result, there are, for example, different IE/PB Links for PROFINET IO and PROFINET CBA. Currently, you can only use a CPU 317-2 DP/PN as a proxy for PROFINET CBA.

Integrating Components and Devices

In Component based Automation, you integrate the components in an interconnection editor (for example SIMATIC iMap). The components are described in a PCD file.

In PROFINET IO, you integrate the devices in an engineering system (for example STEP 7). The components are described in a GSD file.

Connecting PROFIBUS Devices via an IE/PB Link

Remember that there is a separate proxy functionality for PROFINET I/O and PROFINET CBA. With the IE/PB Link, this means that you must use different devices depending on the system you are using.

Interaction of PROFINET CBA and PROFINET IO

PROFINET IO integrates field devices (IO devices) in PROFINET. The input and output data of the IO devices is processed in the user program. The IO devices with their IO controller themselves can, in turn, be part of a component in a distributed automation structure.

You configure communication between, for example, a CPU as IO controller and the IO devices assigned to it as PROFINET IO in much the same way as a PROFIBUS DP master system in STEP 7. You also create your user program in STEP 7. From this, you generate a component in STEP 7.

You then configure communication between the components conveniently in SIMATIC iMAP.

Note

Update Times for Cyclic Data Exchange

STEP 7 automatically calculates a time within which each PROFINET IO device completes exchange of its user data with the corresponding IO controller: the update time.

Based on the existing hardware configuration and the resulting cyclic data traffic, STEP 7 automatically calculates an update time that you can extend manually.

If other cyclic services (for example PROFINET CBA) need to be taken into account in addition to PROFINET IO: Set a percentage in STEP 7/HW Config that will be reserved for PROFINET IO.

For more detailed information, refer to the STEP 7 online help.

Details on the Possible Uses of the Individual Products

For more information, refer to the documentation of the particular product.

4.11.3.5 PROFINET cable lengths and network expansion

Network expansion options are based on various factors (hardware design used, signal propagation delay, minimum distance between data packets, etc.)

Prefabricated twisted-pair cord cables

Twisted-pair cables can be used in environments with low EMC loads and with transmission lines up to 10 m. They employ the TP cord that is designed significantly thinner and more flexible by using reduced shielding compared to industrial twisted-pair cables. The connectors used in connecting industrial twisted-pair components are standardized RJ45 connectors and sub-D connectors.

Product range for the RJ45 connection

The following prefabricated twisted-pair cables are available:

Table 4-25 Data for twisted-pair patch cables

Cable designation	Application	Available lengths	Order number
TP Cord RJ45/RJ45	TP connecting cable with two RJ45 connectors.	0.5 m	6XV1 850-2GE50
		1.0 m	6XV1 850-2GH10
		2.0 m	6XV1 850-2GH20
		6.0 m	6XV1 850-2GH60
		10.0 m	6XV1 850-2GN10
TP XP cord RJ45/RJ45	Crossed TP cable with two RJ45 connectors.	0.5 m	6XV1 850-2HE50
		1.0 m	6XV1 850-2HH10
		2.0 m	6XV1 850-2HH20
		6.0 m	6XV1 850-2HH60
		10.0 m	6XV1 850-2HN10
TP cord 9/RJ45	TP cable with a 9-pin Sub-D connector and an RJ45 connector.	0.5 m	6XV1 850-2JE50
		1.0 m	6XV1 850-2JH10
		2.0 m	6XV1 850-2JH20
		6.0 m	6XV1 850-2JH60
		10.0 m	6XV1 850-2JN10
TP XP cord 9/RJ45	Cross-over TP patch cable with 9-pin sub-D connector and RJ45 connector.	0.5 m	6XV1 850-2ME50
		1.0 m	6XV1 850-2MH10
		2.0 m	6XV1 850-2MH20
		6.0 m	6XV1 850-2MH60
		10.0 m	6XV1 850-2MN10
TP patch cable 9-45/RJ45	TP patch cable with RJ45 connector and sub-D connector, with 45° cable exit (for OSM/ESM only)	1.0 m	6XV1 850-2NH10
TP XP patch cable 9-45/RJ45	Cross-over TP patch cable with RJ45 connector and sub-D connector with 45° cable exit (for OSM/ESM only)	1.0 m	6XV1 850-2PH10
TP XP patch cable 9/9	Cross-over TP patch cable for direct connection of two industrial Ethernet network components with ITP interface, with two 9-pin sub-D connectors	1.0 m	6XV1 850-2RH10
TP patch cable RJ45/15	TP patch cable with 15-pin sub-D connector and RJ45 connector.	0.5 m	6XV1 850-2LE50
		1.0 m	6XV1 850-2LH10
		2.0 m	6XV1 850-2LH20
		6.0 m	6XV1 850-2LH60
		10.0 m	6XV1 850-2LNN10
TP XP patch cable RJ45/15	Cross-over TP patch cable with 15-pin sub-D connector and RJ45 connector	0.5 m	6XV1 850-2SE50
		1.0 m	6XV1 850-2SH10
		2.0 m	6XV1 850-2SH20
		6.0 m	6XV1 850-2SH60
		10.0 m	6XV1 850-2SN10

Reference

For detailed information on network configuration, refer to the Internet: SIMATIC NET: Twisted Pair and Fiber-Optic Networks (6GK1970-1BA10-0AA0) at http://www.siemens.com/automation/service&support.

See also

Connecting the PG to a node (Page 8-14)

Connecting the PG to several nodes (Page 8-15)

4.11.3.6 Connectors and other components for Ethernet

The selection of the bus cable, bus connector and other components for Ethernet (for example, switches, etc.) depends on the intended application.

We offer a range of products covering a variety of applications for the installation of an Ethernet connection.

Reference

- *SIMATIC NET: Twisted-Pair and Fiber-Optic Networks* (6GK1970-1BA10-0AA0)

4.11.3.7 Example of a PROFINET Subnet

Example: Installation of a PROFINET subnet

The graphic illustrates the combination of corporate level and process control level via industrial Ethernet. PCs in a classical office environment can be used to acquire data of the process automation system.

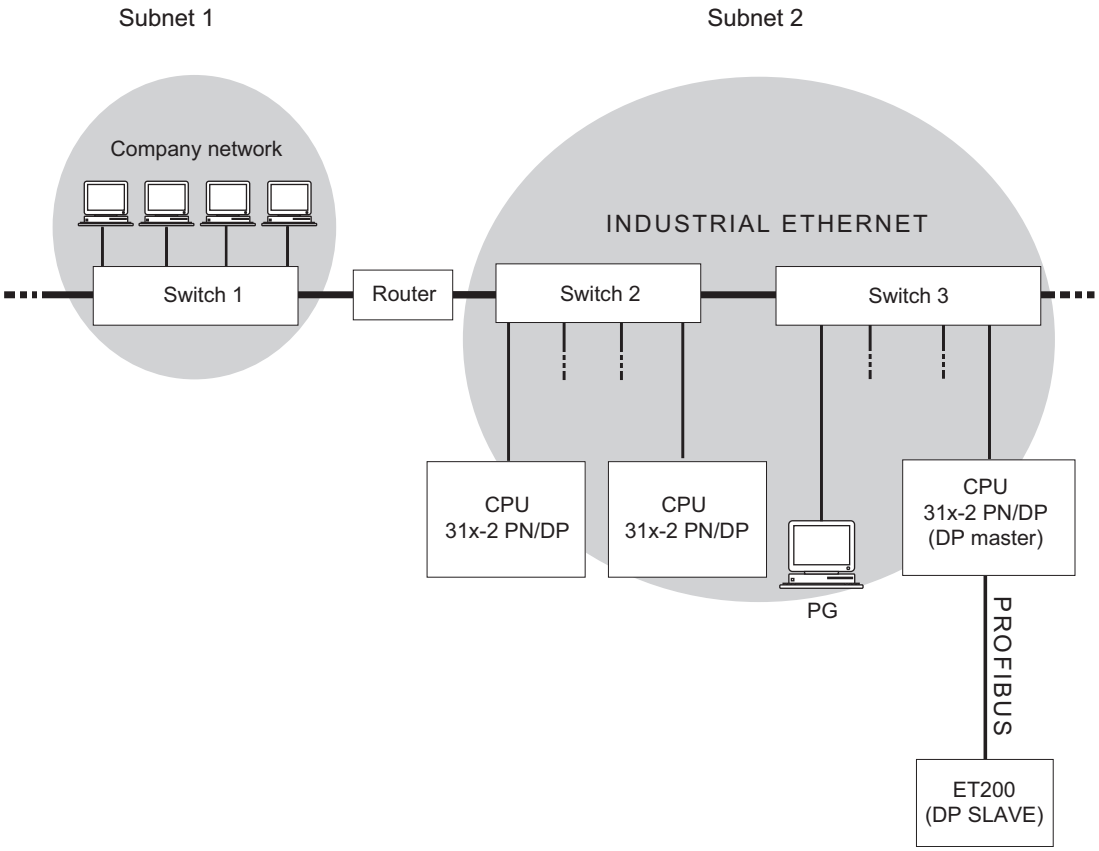


Figure 4-7 Example of a PROFINET Subnet

Installation guidelines

PROFINET allows you to set up a high-performance and continuous communication system. You can further increase performance by using the following installation guidelines.

- Interconnect a router between the office network and the PROFINET system. Use the router to define access privileges for your PROFINET system.
- Set up your PROFINET in a star architecture where this is useful (for example: in a switch cabinet).
- Keep the number of switches low. This increases clarity of your PROFINET system architecture.
- Connect your programming device (PG) close to the communication partner (for example: connect the PG and the communication partner to the same switch).
- Modules with PROFINET interfaces may only be operated in LANs where all nodes are equipped with SELV/PELV power supplies or protection systems of equal quality.
- A data transfer device that ensures this safety must be specified for the coupling to the WAN.

Reference

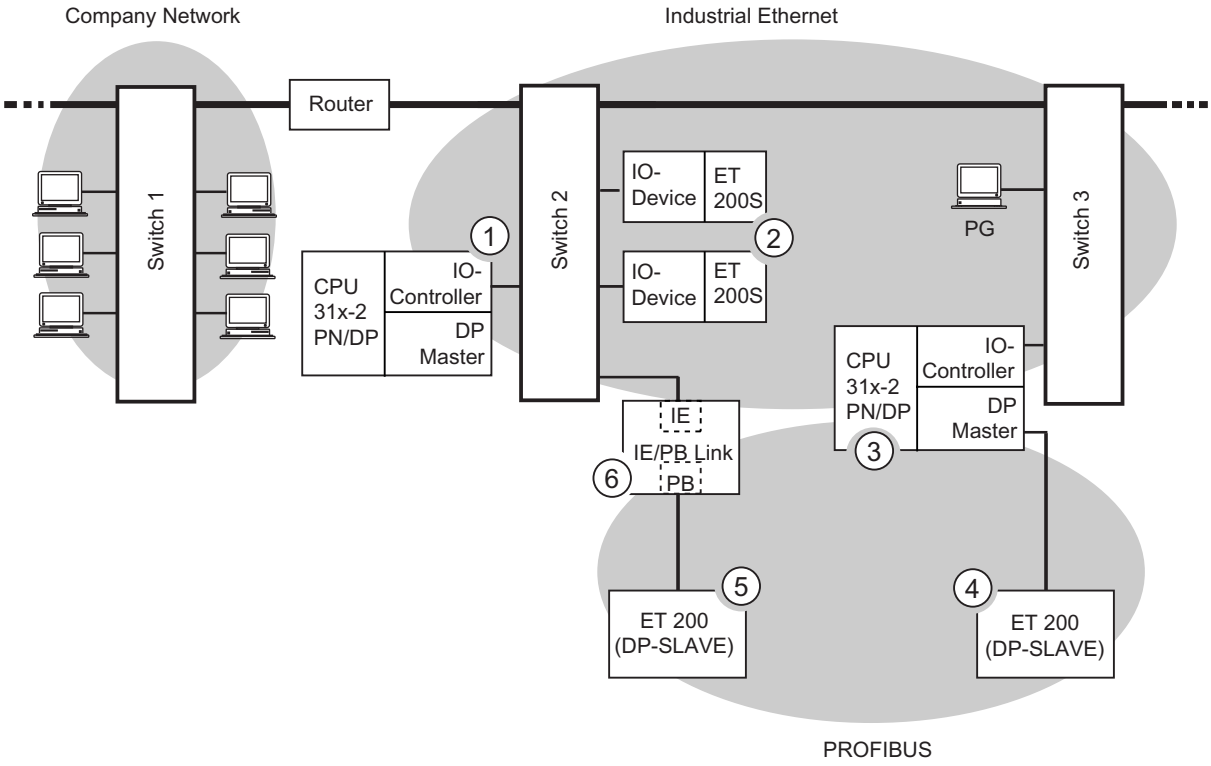
For detailed information on Industrial Ethernet networks or network components, refer to:

- the Internet URL http://www.siemens.com/automation/service&support.
- The STEP 7 Online Help. There you can also find further information on IP address assignment.
- The Communication with SIMATIC (EWA 4NEB 710 6075-01) manual
- The SIMATIC NET manual: Twisted-Pair and Fiber Optic Networks (6GK1970-1BA10-0AA0)

4.11.3.8 Example of a PROFINET IO system

Extended Functions of PROFINET IO

The figure below shows you the new functions of PROFINET IO



The figure shows	The figure shows the communication path
The interconnection of the company network with field level	From PCs in your company network, you can access devices at the field level Example: • PC — Switch 1 — Router — Switch 2 — CPU 31x-2 PN/DP (1).
The interconnection between the automation system and field level	You can, of course, also access other areas in Industrial Ethernet from a field PG. Example: • PG — Switch 3 — Switch 2 — to an IO device of ET 200S (2).
The IO controller of the CPU 31x-2 PN/DP (1) controls the nodes connected to the Industrial Ethernet and PROFIBUS **directly**	At this point, you see the enhanced IO feature between the IO controller and IO device(s) on Industrial Ethernet: • The CPU 31x-2 PN/DP (1) is the IO controller for one of the ET 200S (2) IO devices. • The CPU 31x-2 PN/DP (1) is also the IO controller for the ET 200 (DP slave) (5) via the IE/PB Link (6).
A CPU can be both IO controller and DP master	Here, you can see that a CPU can be both IO controller for an IO device as well as DP master for a DP slave: • The CPU 31x-2 PN/DP (3) is the IO controller for the other ET 200S (2) IO device. CPU 31x-2 PN/DP (3) — Switch 3 — Switch 2 — ET 200S (2) • The CPU 31x-2 PN/DP (3) is the DP master for a DP slave (4). The DP slave (4) is assigned locally to the CPU (3) and is not visible on the Industrial Ethernet.

Requirements

- CPUs as of Firmware 2.3.0 (for example CPU 315-2 PN/DP)
- STEP 7, as of Version 5.3 + Service Pack 1

Reference

For information on PROFINET, refer to:

- the *System Description PROFINET*
- in the programming manual *From PROFIBUS DP to PROFINET.* This manual also provides a comprehensive overview of the new PROFINET blocks and system status lists.

4.11.4 Routed network transitions

Example: PG access to remote networks (routing)

A CPU with several interfaces can also serve as a router for intercommunication with different subnets. With a PG you can access all modules on local and remote networks.

Requirements:

- STEP 7 Version 5.0 or higher.
  Note: For STEP 7 requirements with respect to the CPUs used, refer to the technical specifications.
- Assign the PG/PC to a network in your STEP 7 project (SIMATIC Manager, assigning a PG/PC).
- The various networks are interconnected using modules with routing functions.
- After you configured all networks in NETPRO, initiated a new compilation for all stations, and then download the configuration to all modules with routing function. This also applies to all changes made in the network.

  All routers therefore know all paths to a destination station.

Access to remote networks

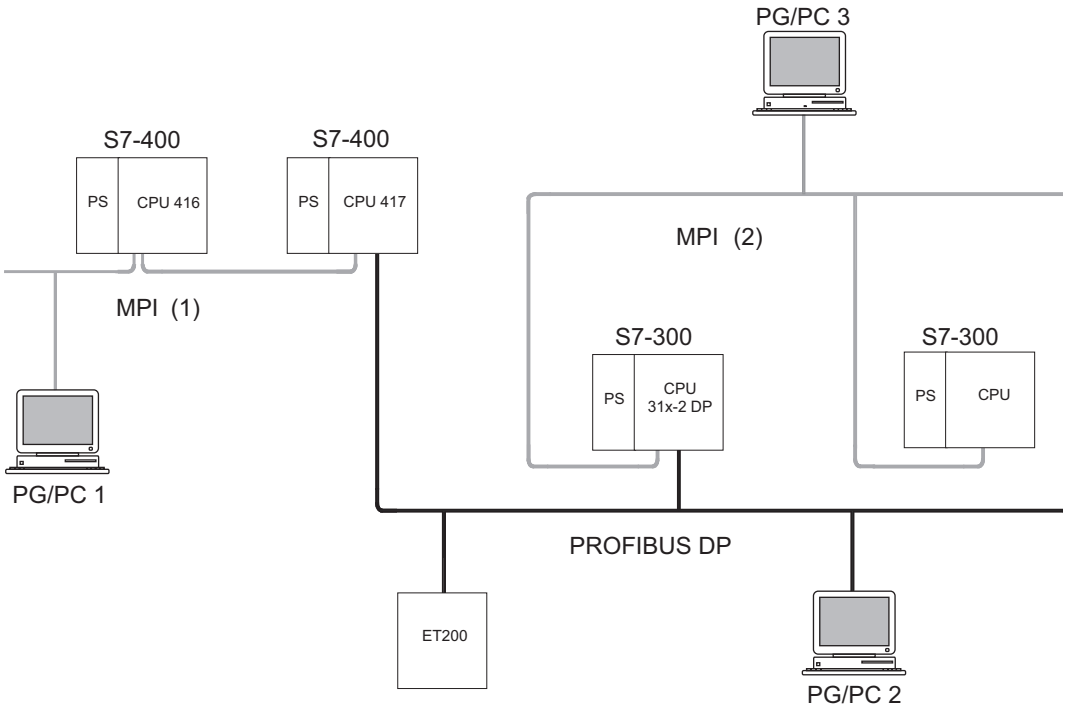


Figure 4-8 Access to remote networks

Example 1

To access the CPU 31x-2 DP using PG/PC 1:

PG/PC 1 - MPI network (1) - CPU 417 as router - PROFIBUS network (3) - CPU 31x-2 DP

Example 2

To access the the S7-300 CPU (on the right in the figure) using PG/PC 2:

PG/PC 2 - PROFIBUS network (3)- CPU 31x-2 DP as router - MPI network (2) - S7-300 CPU

Example 3

To access the 416 CPU using PG/PC 3:

PG/PC 3 - MPI network (2) - CPU 31x-2 DP as router - PROFIBUS network (3)- CPU 417 as router - MPI network (1) - CPU 416

Note

Only for CPUs with DP interface:

If these CPUs are operated as I-slaves and you want to use routing functionality, set the Commissioning / Debug Mode / Routing check box in the DP Interface for DP Slave dialog box in STEP 7.

Information on routing can be found ...

- *CPU Data Reference Manual* for your CPU
- In the *Communication with SIMATIC* manual.

4.11.5 Point-to-point (PtP)

Availability

CPUs with a “PtP“ name suffix are equipped with a PtP X2 interface.

Properties

Using the PtP interface of your CPU, you can connect external devices with serial interface. You can operate such a system at transmission rates up to 19.2 kbps in full duplex mode (RS 422), and up to 38.4 kbps in half duplex mode (RS 485).

Transmission rate

- Half duplex: 38.4 kbps
- Full duplex: 19.2 kbps

Driver

PtP communication drivers installed in those CPUs:

- ASCII drivers
- 3964(R) Protocol
- RK 512 (only CPU 314C-2 PtP)

Devices capable of PtP communication

Devices equipped with a serial port, for example, barcode readers, printers, etc.

Reference

CPU 31xC: Technological functions manual

4.11.6 Actuator/sensor interface (ASI)

Actuator/Sensor Interface (ASI)

Implementation using communication processors (CP).

The ASI, or Actuator/Sensor Interface, represents a subnet system on the lowest process level for automation systems. It is designed especially for networking digital sensors and actuators. The maximum data volume is 4 bits per slave station.

S7-300 CPUs require communication processor for the ASI connection.

Installing

5

5.1 Installing an S7-300

Here we will explain the steps required for the mechanical assembly of an S7-300.

Note

Note the installation guidelines and notes on safety in this manual when mounting, commissioning and operating S7-300 systems.

Open components

S7-300 modules are "Open Components" according to IEC 61131-2 and EC directive 73/23/EEC (Low-Voltage directive), and to UL/CSA Approval an "open type".

In order to conform with specifications on safe operation relating to mechanical strength, inflammability, stability and touch-protection, the following alternative installation modes are prescribed:

- Installation in a suitable cubicle
- Installation in a suitable cabinet
- Installation in an appropriately equipped and closed operating area

Access to these areas must only be possible with a key or tool. Only trained or authorized personnel is allowed access to these cubicles, cabinets or electrical operating rooms.

Accessories included

Installation accessories are included with the module package. The appendix contains a list of accessories and spare parts together with the corresponding order numbers.

Table 5-1 Module accessories

Module	Accessories included	Explanation
CPU	1 x Slot number label	For assigning slot numbers
	Inscription labels	for the MPI address and Firmware Version (all CPUs) for labeling of integrated inputs and outputs (CPU 31xC only) Tip: Templates for labeling strips are available on the Internet at http://www.ad.siemens.de/csinfo, under article ID 11978022.
Signal module (SM) Function Module (FM)	1 Bus connector	For electrical interconnection of modules
	1 Labeling strip	For labeling module I/O Tip: Templates for labeling strips are available on the Internet at http://www.ad.siemens.de/csinfo under article ID 11978022.
Communication module (CP)	1 Bus connector	For electrical interconnection of modules
	1 Inscription label (only CP 342-2)	For labeling the AS interface connector Tip: Templates for labeling strips are available on the Internet at http://www.ad.siemens.de/csinfo under article ID 11978022.
Interface module (IM)	1 x Slot number label (only IM 361 and IM 365)	For assigning slot numbers on racks 1 to 3

Tools required and material

To install the S7-300, you require the tools and materials listed in the table below.

Table 5-2 Installation tools and materials

You require ...	for ...
cutting the 2 m rail to length	commonly available tool
scribing and drilling holes on the 2 m rail	commonly available tool, 6.5 mm diameter drill bit
screw-mounting the rail	wrench or screwdriver, matching the selected fixing screws diverse M6 screws (length depends on the place of installation) with nuts and spring lock washers
screw-fastening the modules on the rail	screwdriver with 3.5 mm blade width (cylindrical design)
pulling out the grounding slide contact to achieve ungrounded state	screwdriver with 3.5 mm blade width (cylindrical design)

5.2 Installing the mounting rail

Mounting rail versions available

- Ready-to-use, four standard lengths (with 4 holes for fixing screws and 1 ground conductor bolt)
- One meter mounting rail
  May be shortened to any special length. Supplied without holes for fixing screws and without ground conductor bolt.

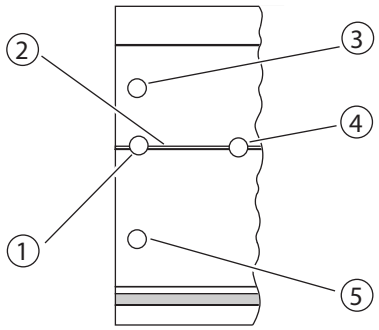
Requirements

Prepare the 2 m mounting rail for installation.

Preparing the 2 m mounting rail for installation

1. Cut the 2 m mounting rail to the required length.
2. Mark out:
   - four bores for the fixing screws (for dimensions, refer to "Dimensions for fixing holes")
   - one hole for the protective conductor bolt.
3. If the length of your rail exceeds 830 mm, you must stabilize it by providing additional holes for fixing it with more screws.

   Mark out these holes along the groove in the middle section of the rail (see the Figure below). The pitch should be approx. 500 mm.
4. Drill the marked holes, bore diameter = 6.5 $^{+0,2}$mm for M6 screws.
5. Mount an M6 bolt for fixing the ground conductor.

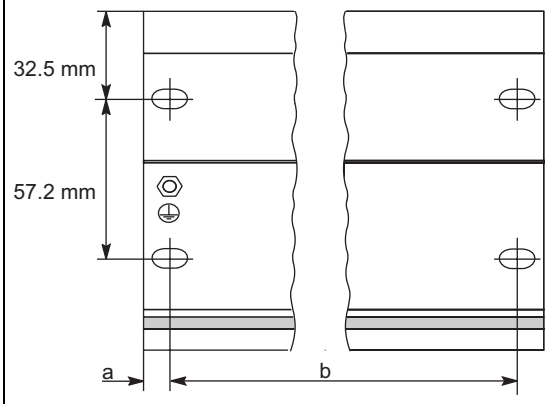
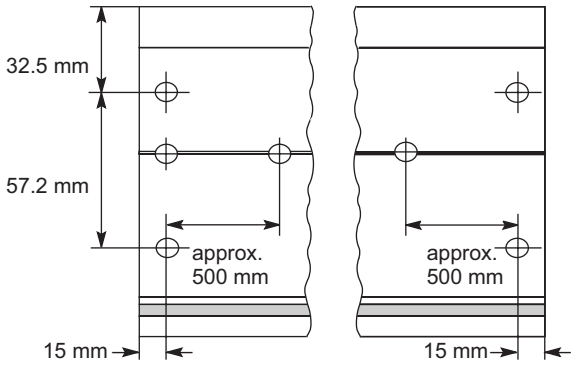


Key to numbers in the figure	
(1)	Hole for the ground conductor bolt
(2)	Groove for drilling additional holes for mounting screws
(3)	Hole for the mounting screw
(4)	Additional hole for mounting screw
(5)	Hole for the mounting screw

Dimension of the mounting holes

The fixing hole dimensions for the mounting rail are shown in the table below..

Table 5-3 Mounting holes for rails

"Standard" rail			2 m mounting rail
			
Length of rail	Dimension a	Dimension b	–
160 mm	10 mm	140 mm	
482.6 mm	8.3 mm	466 mm	
530 mm	15 mm	500 mm	
830 mm	15 mm	800 mm	

Fixing screws

To fix the mounting rails you can use the following types of screws:

For ...	you can use ...	description
outer fixing screws	cylindrical head screw M6 to ISO 1207/ISO 1580 (DIN 84/DIN 85)	Choose a suitable screw length for your assembly. You also need size 6.4 washers to ISO 7092 (DIN 433)
	M6 hexagonal head screw to ISO 4017 (DIN 4017)	
additional fixing screws (only 2 m mounting rail)	cylindrical head screw M6 to ISO 1207/ISO 1580 (DIN 84/DIN 85)	

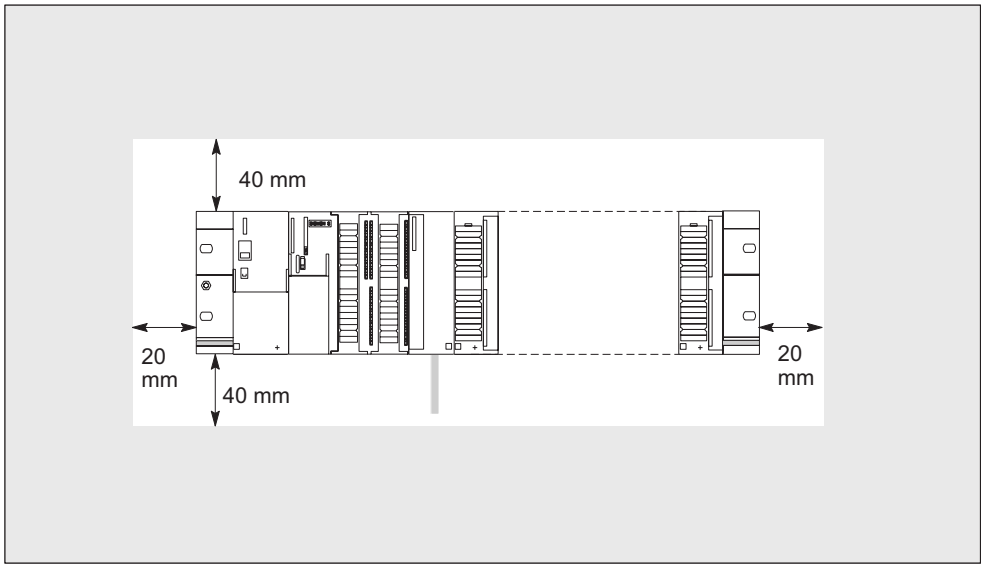
Installing the mounting rail

1. Install the mounting rails so that sufficient space is available for installing modules and to allow heat dissipation (clearance of at least 40 mm above and below the modules. See the figure below).
2. Mark up the mounting holes on the mounting surface. Drill the holes, diameter = 6.5 $^{+0.2}$ mm.
3. Screw the rail (M6 screws) onto the mounting surface.

Note

Always make sure of a low-impedance contact between the rail and a mounting surface, if the latter is a grounded metal panel or equipment mounting panel. On varnished or anodized metals, for instance, use a suitable contacting agent or contact washers.

The figure below shows the clearance required for the installation of an S7-300.



5.3 Mounting modules onto the rail

Requirements for module installation

- The configuration of the automation system is completed.
- The mounting rail is installed.

Mounting order of the modules

Hang the modules onto the rail, starting at the left and in the following order:

1. Power supply module
2. CPU
3. SMs, FMs, CPs, IMs

Note

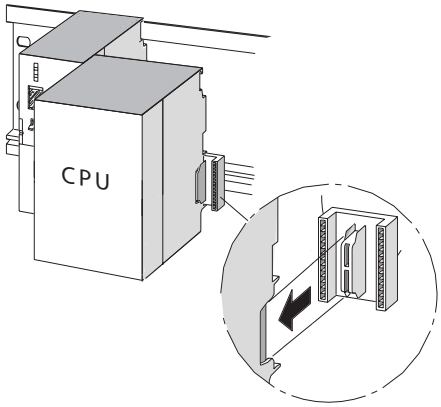
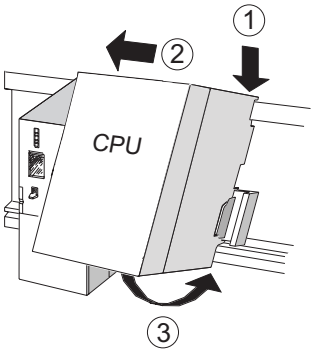
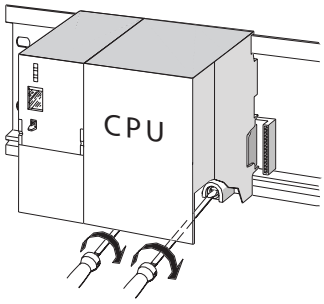
Please check **before** you insert any SM 331 analog input modules whether you have to reposition the measuring range submodules at the side of the module. For further information, refer to chapter 4, "Analog Modules" in your *Module Data* Reference Manual.

Note

When installing an S7-300 system with ungrounded reference potential, make the relevant settings on the CPU. You ideally do so before you mount any modules onto the rail.

Installation steps

The various steps in module installation are explained below.

1.	Plug the bus connectors into the CPU and SMs / FMs / CPs / IMs. Except for the CPU, each module is supplied with a bus connector. • Always start at the CPU when you plug in the bus connectors. Remove the bus connector from the "last" module of the assembly. • Plug the bus connectors into the other modules. The "last" module does not receive a bus connector.	
2.	Add all modules to the rail in the specified order **(1)**, slide them up to the module on the left **(2)**, then swing them down **(3)**.	
3.	Screw-tighten the modules.	

See also

Configuring an S7-300 with ungrounded reference potential (not CPU 31xC) (Page 4-17)

5.4 Labeling the modules

Slot numbers Assignment

You should assign a slot number to each one of the mounted modules, thus making it easier to assign the modules in the configuration table in STEP 7. The table below shows the slot number assignment.

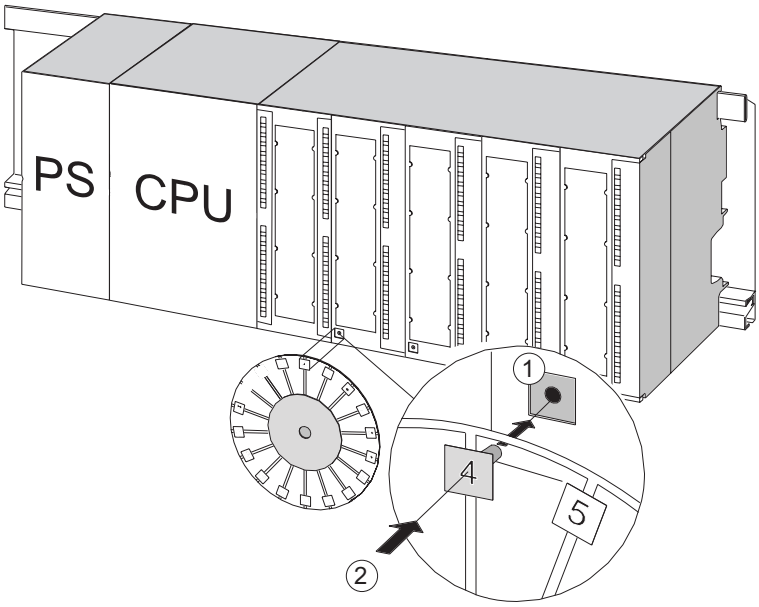
Table 5-4 Slot numbers for S7 modules

Slot number	Module	Comment
1	Power supply (PS)	–
2	CPU	–
3	Interface module (IM)	to the right of the CPU
4	1. Signal module (SM)	to the right of the CPU or IM
5	2. Signal module (SM)	–
6	3. Signal module (SM)	–
7	4. Signal module (SM)	–
8	5. Signal module (SM)	–
9	6. Signal module (SM)	–
10	7. Signal module (SM)	–
11	8. Signal module (SM)	–

Slot numbers Clipping the slot numbers onto the modules

1. Hold the corresponding slot number in front of the relevant module.
2. Insert the pin into the opening on the module (1).
3. Press the slot number into the module (2). The slot number breaks off from the wheel.

The figure below illustrates this procedure. The slot number labels are included with the CPU.



Wiring

6

6.1 Requirements for wiring the S7-300

This chapter

Describes the requirements for wiring the PS, CPU and front connectors.

Accessories required

The following accessories are required for wiring the S7-300.

Table 6-1 Wiring accessories

Accessories	Description
Front connectors	for connecting the sensors / actuators of the system to the S7-300
Labeling strips	for labeling the module I/Os
Shielding contact element, shielding terminals (matching the shielding diameter)	for connecting cable shielding

Tools and material required

Tools and materials required for wiring the S7-300.

Table 6-2 Tools and material for wiring

To ...	you need ...
Connect the protective conductor to the rail	Wrench (size 10) Protective conductor cable (cross-section $\geq$ 10 mm^2) with M6 cable lug M6 nut, washer, spring lock washer
Adjust the power supply module to mains voltage	Screwdriver with a blade width of 4.5 mm
Wire the power supply module and the CPU	Screwdriver with a 3.5-mm blade, side-cutters, stripping tool Flexible cable, for example, sheathed flexible cable 3 x 1.5 mm^2 Wire end ferrules to DIN 46228

To ...	you need ...
Wire the front connector	Screwdriver with a 3.5-mm blade, side-cutters, stripping tool Flexible cables, 0.25 mm^2 to 0.75/1.5 mm^2 Shielded cables as required Wire end ferrules to DIN 46228

Wiring conditions for PS and CPU

Table 6-3 Wiring conditions for PS and CPU

Connectable cables	to PS and CPU
Solid conductors	No
Flexible conductors • without wire end ferrule • With wire end ferrule	 0.25 mm^2 to 2.5 mm^2 0.25 mm^2 to 1.5 mm^2
Number of conductors per terminal	1 or 2, up to 1.5 mm^2 (total) in a common wire end ferrule
Diameter of the conductor insulation	max. 3.8 mm
Stripped length	11 mm
Wire end ferrules to DIN 46228 • without insulating collar • with insulating collar	 Design A, 10 mm to 12 mm length Design E, up to 12 mm length

Wiring conditions for front connectors

Table 6-4 Wiring conditions for front connectors

Connectable cables	Front connectors	
	20-pole	40-pole
Solid conductors	No	No
Flexible conductors • without wire end ferrule • with wire end ferrule	 0.25 mm^2 to 1.5 mm^2 0.25 mm^2 to 1.5 mm^2	 0.25 mm^2 to 0.75 mm^2 0.25 mm^2 to 0.75 mm^2 • Mains feed 1.5 mm^2
Number of conductors per terminal	1 or 2, up to 1.5 mm^2 (total) in a common wire end ferrule	1 or 2, up to 0.75 mm^2 (total) in a common wire end ferrule
Diameter of the conductor insulation	max. 3.1 mm	• max. 2.0 mm for 40-pole cables • max. 3.1 mm for 20-pole cables
Stripped length	6 mm	6 mm
Wire end ferrules to DIN 46228 • without insulating collar • with insulating collar	 Design A, 5 mm to 7 mm length Design E, up to 6 mm length	 Design A, 5 mm to 7 mm length Design E, up to 6 mm length

6.2 Bonding the protective conductor to the mounting rail

Requirements

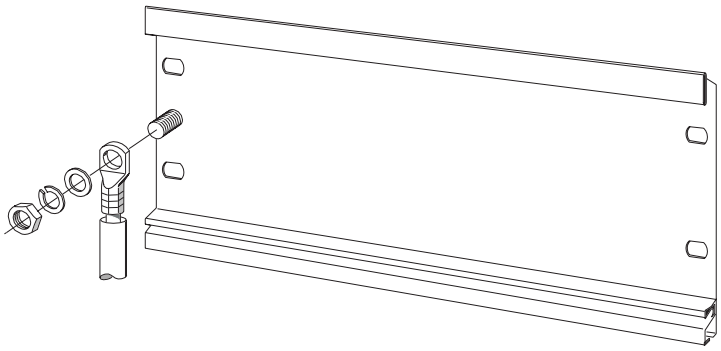
The mounting rail is fixed onto the mounting surface.

Protective conductor Connecting

Connect the rail with the protective conductor
using the M6 protective conductor bolt.

Minimum cross-section of the protective conductor: 10 mm^2

The figure below shows how the protective conductor has to be bonded to the rail.



Note

Always make sure of a low-impedance contact between the protective conductor and the rail. You can achieve this by using a low-impedance cable, keeping it as short as possible and contacting it to a large surface.
For example, an S7-300 mounted on a hinged frame must be connected to ground using a flexible grounding strap.

6.3 Adjusting the power supply module to local mains voltage

Introduction

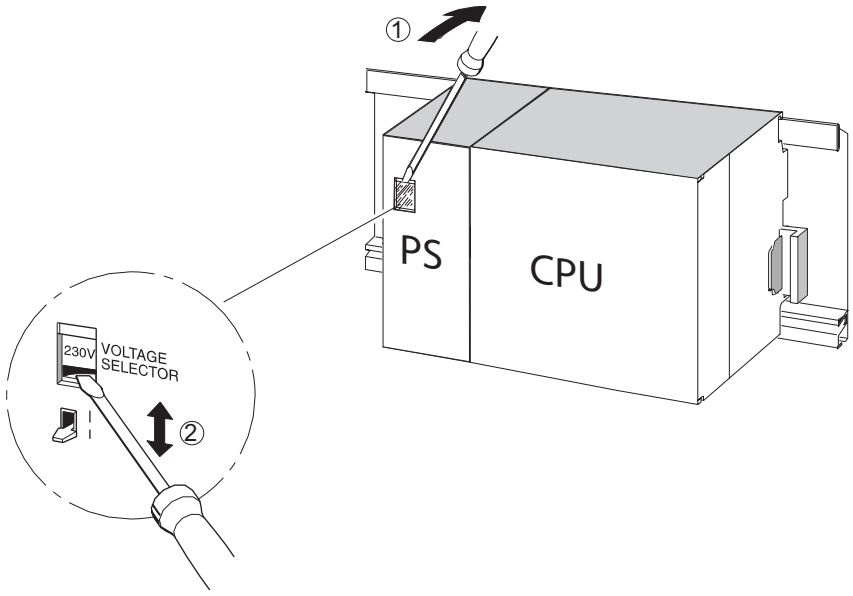
You can operate the S7-300 power supply module on 120 VAC or 230 VAC. The default setting for the PS 307 is 230 VAC.

Mains voltage selector switch adjusting

Verify that the setting of the voltage selector switch matches your local mains voltage.

To set the selector switch:

1. Remove the protective cap with a screwdriver.
2. Set the selector switch to match the local line voltage.
3. Reinsert the protective cap.



Key to numbers in the figure	
(1)	Remove the protective cap with a screwdriver
(2)	Set selector switch to mains voltage

6.4 Wiring the power supply module and the CPU

Requirements

All modules are mounted onto the rail.

Wiring the PS and CPU

Note

The PS 307 power supply module is equipped with two additional 24 VDC terminals L+ and M for the supply to I/O modules.

Note

The power supply connector of your CPU is a plug-in device and can be removed.

Warning

There is a risk of contact to live wires if the power supply module, or any additional load power supply units, are connected to the mains.

You should therefore isolate the S7-300 from power before you start wiring. Always use crimp ferrules with insulating collars for the conductors. Close all front panels of the modules when you completed the wiring. This is conditional before you reconnect the S7-300 to power.

1. Open the PS 307 power supply module and CPU front panels.
2. Open the strain relief on the PS 307.
3. Strip the power cable to a length of 11 mm and connect it to L1, N and to the protective earth (PE) terminal of the PS 307.
4. Screw-tighten the strain relief again.
5. Next, wire the PS and CPU

   The power supply connector of the CPUs is a removable plug-in device.

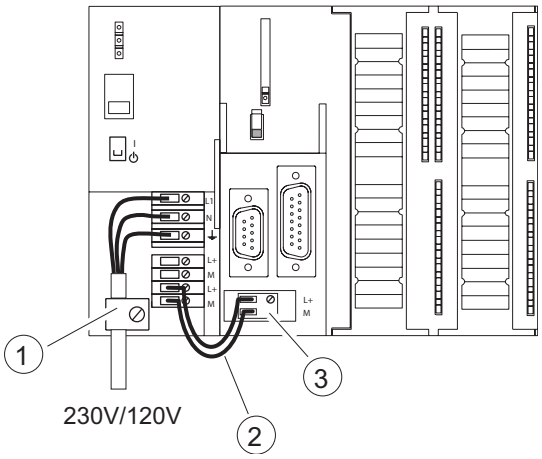
   Strip the connecting cables for the CPU power supply to a length of 11 mm. Wire the lower terminals M and L+ on the PS 307 to terminals M and L+ of the CPU.

Warning

Reversing the polarity of the M and L+ terminals trips the internal fuse on your CPU. Always interconnect the M and L+ terminals of the power supply module and of the CPU.

6. Close the front panels.

The figure below illustrates the procedures described earlier.



Key to numbers in the figure	
(1)	Strain relief of the power supply cable
(2)	Connection cables between the PS and CPU
(3)	Removable power supply connector

Note

The PS 307 power supply module is equipped with two additional 24 VDC terminals L+ and M for the supply to I/O modules.

6.5 Wiring front connectors

Introduction

The sensors and actuators of your system are connected to the S7-300 AS by means of front connectors. Wire the sensors and actuators to the relevant front connector and then plug it into the module.

Front connector versions

Front connectors come in 20-pin and 40-pin versions with screw contacts or spring terminals. You require 40-pin front connectors for the CPUs 31xC and 32-channel SMs.

Use the following front connectors as required for the module:

Table 6-5 Assignment of front connectors to modules

Module	Front connector with screw terminals, order no.:	Front connector with spring terminals, order no.:
SMs (not 32-channel), FMs, Communication module CP 342-2	6ES7 392-1AJ00-0AA0	6ES7 392-1BJ00-0AA0
SMs (32-channel) and CPU 31xC	6ES7 392-1AM00-0AA0	6ES7 392-1BM01-0AA0

Termination on spring terminals

It is quite easy to wire a front connector with spring terminals: Simply insert the screwdriver vertically into the opening with the red opening mechanism, insert the wire into the terminal and remove the screwdriver.

Warning

You might damage the spring clamp mechanism of the front connector if you turn the screwdriver sideways or use the wrong size of screwdriver. Always slide a matching screwdriver vertically into the desired opening until it reaches the mechanical stop. This ensures that the spring terminal is fully open.

Tip:

There is a separate opening for test probes up to 2 mm in diameter to the left of the opening for the screwdriver.

Requirements

The modules (SM, FM, CP 342-2) are mounted on the rail.

Preparing the front connectors and cables

Warning

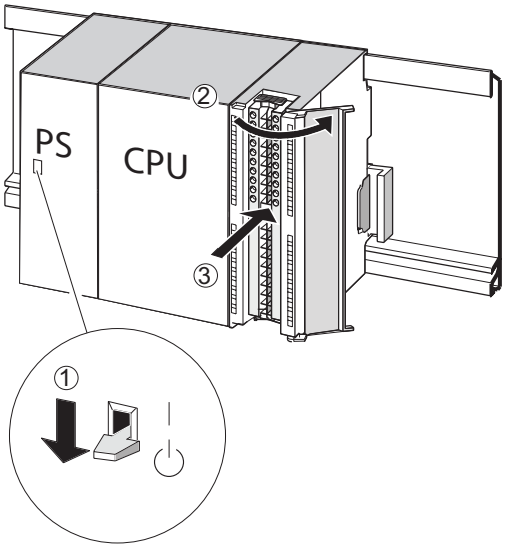
There is a risk of contact to live wires if the power supply module, or any additional load power supply units, are connected to the mains.

You should therefore isolate the S7-300 from power before you start wiring it. Close all front panels of the modules when you completed the wiring. This is conditional before you reconnect the S7-300 to power.

1. Switch off the power supply.
2. Open the front panel.
3. Place the front connector into wiring position.

   Push the front connector into the signal module until it latches. In this position, the front connector still protrudes from the module.

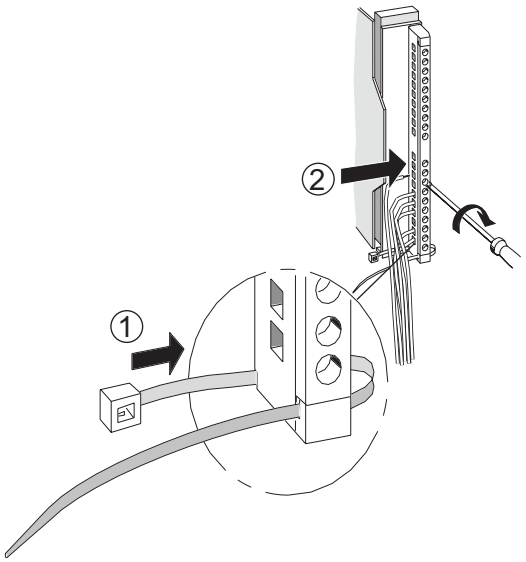
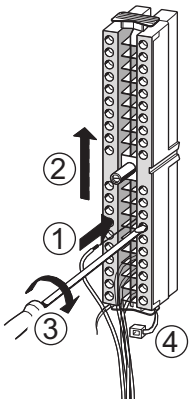
   Advantage of this wiring position: Comfortable wiring.
   The front connector pins do not contact the module in this wiring position.
4. Strip the conductors to a length of 6 mm.
5. Crimp the wire end ferrules, for example, to terminate two conductors at one terminal.



The figure illustrates the following	
(1)	The switched off power supply module (PS)
(2)	The opened module
(3)	The front connector in wiring position

Wiring front connectors

Table 6-6 Wiring front connectors

Step	20-pin front connector	40-pin front connector
1.	Place the included cable strain relief into the front connector.	–
2.	Cable exit at the bottom of the module?	
	If yes: Starting at terminal 20, work your way down to terminal 1.	Start wiring at terminal 40 or 20, and work in alternating passes from terminals 39, 19, 38, 18 etc. until you have reached terminals 21 and 1.
	If not: Start wiring at terminal 1, and work your way up to terminal 20.	Start wiring at terminal 1 or 21, and work in alternating passes from terminals 2, 22, 3, 23 etc. until you have reached terminals 20 and 40.
3.	**Front connectors with screw terminals:** Always screw-tighten the unused terminals.	
4.	–	Place the strain relief around the cable harness and the front connector.
5.	Tighten the strain relief for the cable harness. Push in the strain relief to the left to increase cable space.	
–		
	The work step numbers are shown in the figure above	
	(1) Insert the strain relief. **(2)** Wire the terminals.	**(1)** to **(3)** Wire the terminals. **(4)** Tighten the strain relief clamp.

Reference

For information on wiring the integrated I/O of 31xC CPUs, refer to the *CPU 31xC and CPU 31x, Technical Data* manual.

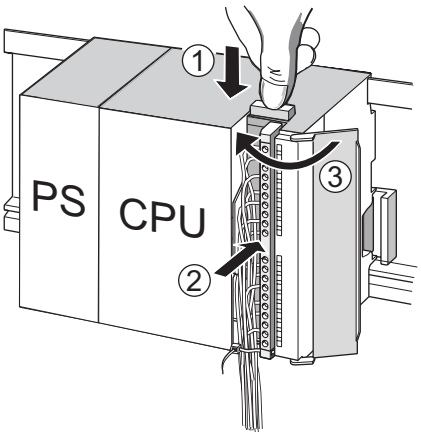
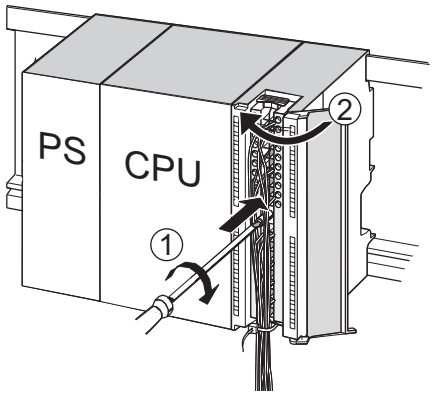
6.6 Plugging the front connectors into modules

Requirements

The front connectors are completely wired.

Front connectors plugging

Table 6-7 Inserting the front connector

Step	20-pin front connector	40-pin front connector
1.	Push in the unlocking mechanism on top of the module. Keeping the locking mechanism pressed, insert the front connector into the module. Provided the front connector is seated correctly in the module, the unlocking mechanism automatically returns to the initial position when you release it.	Tighten the mounting screw in the center of the connector. This pulls the front connector completely into contact with the module.
	Note When you insert the front connector into the module, an encoding mechanism engages in the front connector, thus ensuring that the connector can only be inserted into modules of the same type.	
2.	Close the front panel.	Close the front panel.
		
	The work step numbers are shown in the figure above	
	(1) Keep unlocking mechanism pressed. **(2)** Insert front connector. **(3)** You can now close the front panel	**(1)** Tighten mounting screw. **(2)** You can now close the front panel

6.7 Labeling the module I/O

Introduction

The labeling strips are used to document the assignment of module I/Os and the sensors / actuators of your system.

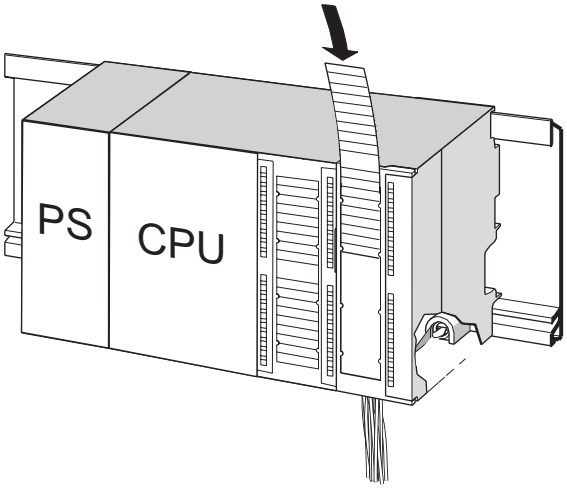
You have to use the following labeling strips, depending on the module:

Table 6-8 Labeling strip assignment to modules

Module	Labeling strip order no.:
SMs (not 32-channel), FMs, Communication module CP 342-2	6ES7 392-2XX00-0AA0
SMs (32-channel)	6ES7 392-2XX10-0AA0

Labeling strips Labeling and inserting

1. Label the strips with the addresses of the sensors / actuators.
2. Slide the labeled strips into the front panel.



Hint

Templates for labeling strips are available on the Internet at http://www.ad.siemens.de/csinfo article ID 11978022.

6.8 Connecting shielded cables to the shielding contact element

Application

The shielding contact element allows easy grounding of all shielded cables of S7 modules, due to its direct contact to the mounting rail.

Design of the shielding contact element

The shielding contact element consists of:

- a bracket with two screw bolts for rail mounting (order no.: 6ES5 390-5AA00-0AA0) and
- the shielding terminals.

You must use the following shielding terminals, based on the shielding diameter of your cables:

Table 6-9 Shielding diameter assignment to shielding terminals

Cable with shielding diameter	Shielding terminal order no.:
2 cables, each with shielding diameter of 2 mm to 6 mm	6ES7 390-5AB00-0AA0
1 cable, shielding diameter 3 mm to 8 mm	6ES7 390-5BA00-0AA0
1 cable, shielding diameter 4 mm to 13 mm	6ES7 390-5CA00-0AA0

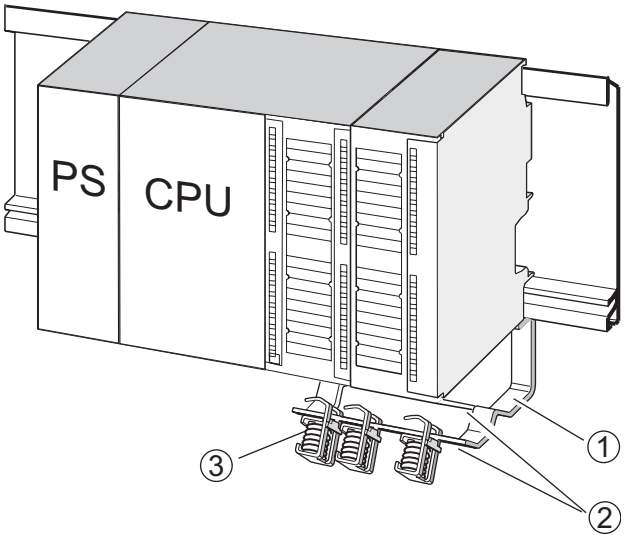
The shielding contact element width is 80 mm and provides two rows, each with 4 shielding terminals.

Shielding contact element Installation underneath two signal modules

1. Push the two screw bolts of the bracket into the guide on the underside of the mounting rail.
2. Place the bracket underneath the modules whose shielded cables are to be terminated.
3. Screw-tighten the bracket onto the rail.

4. The shielding terminal is equipped with a slotted web underneath. Place the shielding terminal at this position onto the edge of the bracket (see figure below). Push the shielding terminal down and pivot it into the desired position.

   You can install up to 4 shielding terminals on each of the two rows of the shielding contact element.



The figure illustrates the following	
(1)	Bracket of shielding contact element
(2)	Edge of the bracket where the shielding terminal(s) has to be placed.
(3)	Shielding terminals

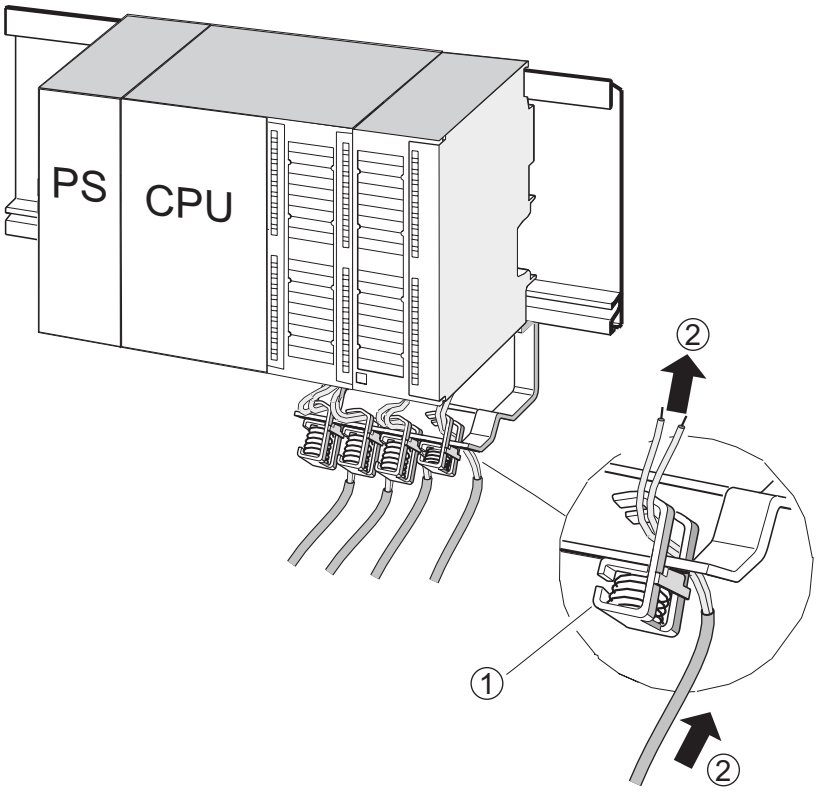
Terminating 2-wire cables on shielding contact elements

Only one or two shielded cables may be terminated per shielding terminal (see the figure below). The cable is clamped down at the stripped cable shielding.

1. Strip the cable shielding to a length of at least 20 mm.
2. Clamp in the stripped cable shielding underneath the shielding terminal.

   Push the shielding terminal towards the module (1) and feed the cable through the clamp opening (2).

   If you need more than four shielding terminals, start wiring at the rear row of the shielding contact element.



The figure illustrates the following	
(1)	Magnified view of the shielding terminal
(2)	Wiring of the shielding terminal

Hint

Provide a sufficient cable length between the shielding terminal and the front connector. This allows you to disconnect the front connector for repairs, without having to disconnect the shielding terminal also, for example.

6.9 Wiring the MPI / PROFIBUS DP bus connectors

6.9.1 Wiring the bus connector

Introduction

You need to network all the nodes you integrate into a subnet of your system. Information on how to wire the bus connector can be found in the article below.

Wiring a bus connector with screw terminals

1. Strip the bus cable.

   Details on stripped lengths are found in the product information supplied with the bus connector.
2. Open the bus connector housing.
3. Insert the green and the red wire into the screw-terminal block.

   Always connect the same wires to the same terminal (green wire to terminal A, red wire to terminal B, for example).
4. Press the cable sheath into the clamp. Make sure that the shielding directly contacts the shielding contact surfaces.
5. Screw-tighten the wire terminals.
6. Close the bus connector housing.

Wiring a Fast Connect bus connector

1. Strip the bus cable.

   Details on stripped lengths are found in the product information supplied with the bus connector.
2. Open the strain relief of the bus connector.
3. Insert the green and red wire into the open contacting covers.

   Always connect the same wires to the same terminal (green wire to terminal A, red wire to terminal B, for example).
4. Close the contacting cover.

   This presses the conductors into the insulation displacement terminals.
5. Screw-tighten the strain relief clamp. Make sure that the shielding directly contacts the shielding contact surfaces.

Note

Use a bus connector with 90° cable exit.

See also

Network components of MPI/DP and cable lengths (Page 4-35)

6.9.2 Setting the terminating resistor on the bus connector

Bus connector: Plugging it into module

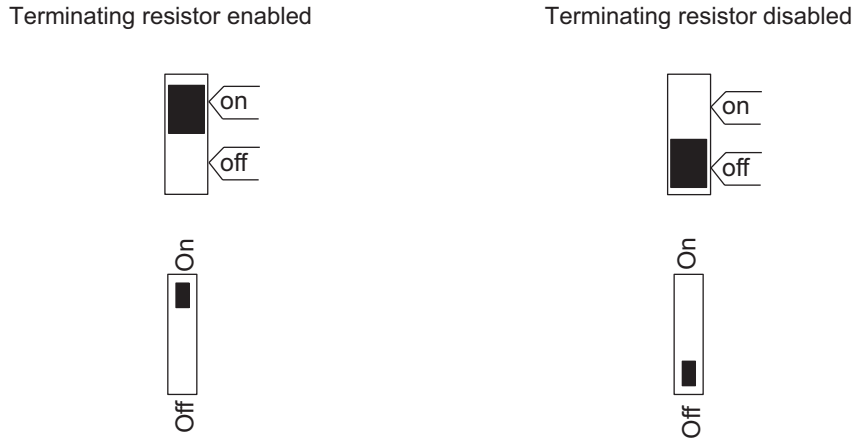
1. Plug the wired bus connector into the module.
2. Screw-tighten the bus connector on the module.
3. If the bus connector is located at the beginning or end of a segment, you must enable the terminating resistor (switch setting "ON"; see the following figure).

Note

6ES7 972-0BA30-0XA0 bus connectors are not equipped with a terminating resistor. You cannot insert this type of bus connector at the beginning or end of a segment.

Please make sure during startup and normal operation that power is always supplied to nodes where the terminating resistor is active.

The figure below shows the switch settings of a bus connector:



Removing the bus connectors

With a looped-through bus cable, you can always unplug the bus connector from the PROFIBUS-DP interface without interrupting data traffic on the bus.

Possible data traffic errors

Warning

Data traffic error might occur on the bus!
A bus segment always has to be terminated at both ends with a terminating resistor. This is not the case if the last slave with bus connector is off power, for example. The bus connector draws its power from the station, and the terminating resistor is thus disabled. Please make sure that power is always supplied to stations on which the terminating resistor is active.

6.10 RJ45 Ethernet connector

This is an 8-pin connector with a design in accordance with ISO/IEC 8877:1992. This connector type is recommended to IEEE 802.3 for 10BASE-T and 100BASE-TX interfaces.

The RJ45 connector is currently only available in standard patch cable lengths (TP cord).

Reference

For detailed information on RJ45 connectors, refer to the SIMATIC NET Twisted-Pair and Fiber Optic Networks (6GK1970-1BA10-0AA0) manual, available on the Internet at http://www.siemens.com/automation/service&support.

Addressing

7

7.1 Slot-specific addressing of modules

Introduction

In slot-specific addressing (default addressing if configuration data was not loaded to the CPU yet), each slot number is assigned a module start address. This is a digital or analog address, based on the type of module.

This section shows you which module start address is assigned to which slot number. You need this information to determine the start addresses of the installed modules.

Maximum assembly and the corresponding module start addresses

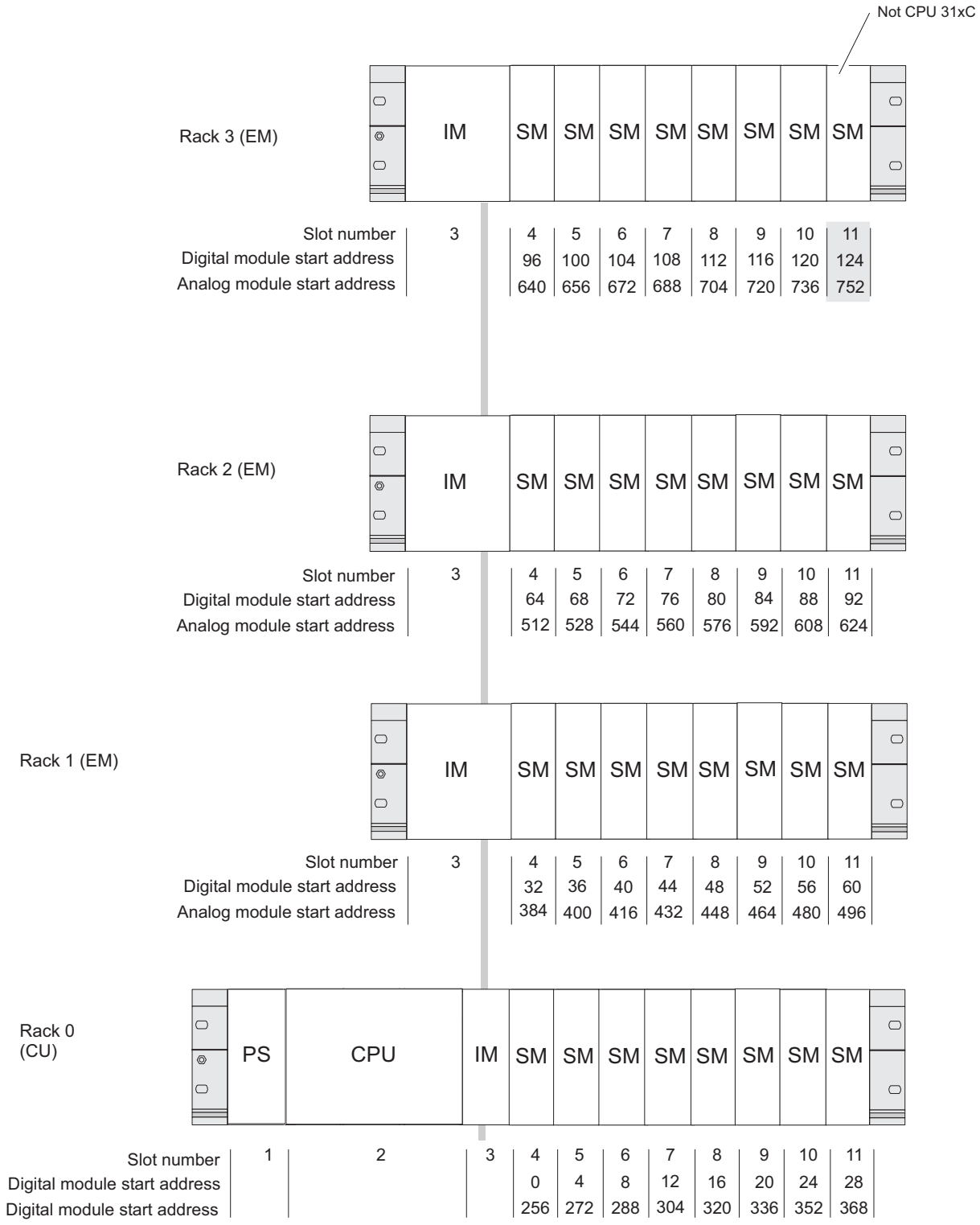
The figure below shows you an S7-300 assembly on four racks, and the optional slots with their modules.Start addresses

The input and output addresses for I/O modules begin at the same module start address.

Note

On a CPU 31xC system you cannot insert any modules into slot 11 of rack 3. The address area is reserved for the integrated I/O.

The figure below shows the slots of an S7-300 and the corresponding module start addresses:



7.2 User-specific addressing of modules

7.2.1 User-specific addressing of modules

User-specific addressing means that you can assign an address of your choice to any module (SM/FM/CP). The addresses are assigned in STEP 7. There you specify the module start address that forms the basis for all other addresses of the module.

Advantages in user-specific addressing:

- Optimization of address space, due to the exclusion of "address gaps" between the modules.
- In your standard software configuration, you can define addresses which are independent of the relevant S7-300 configuration.

Note

User-specific addressing of modules is always required when using PROFIBUS DP or PROFINET IO field devices. There is no fixed slot addressing for such a configuration.

7.2.2 Addressing digital modules

This section describes how to assign addresses to digital modules. You need this information in order to be able to address the channels of the digital module in the user program.

Addresses of digital modules

The address of an input or output of a digital module consists of a byte address plus a bit address.

Example: **I 1.2**

The example consists of:

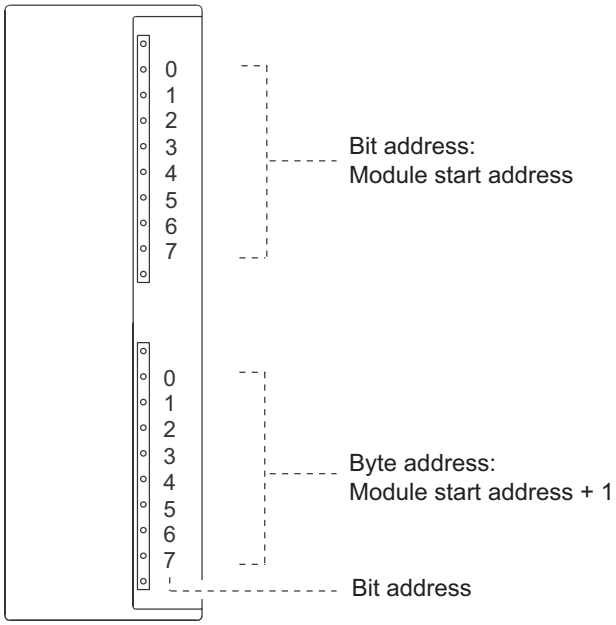
- input **I**,
- byte address **1** and
- bit address **2**

The byte address is based on the module start address.

The bit address is the number printed on the module.

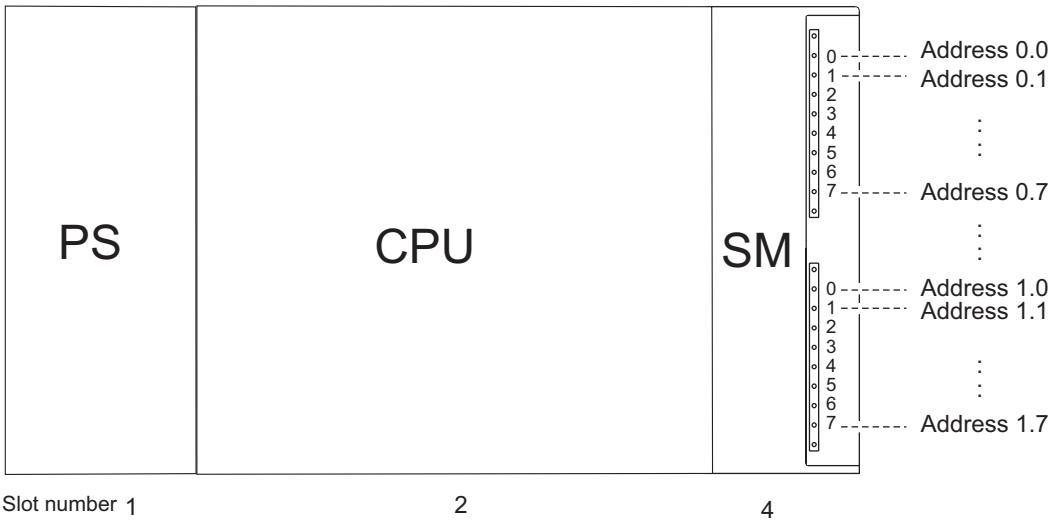
When the first digital module is located in slot 4, its default start address is 0. The start address of each further digital module increments by the count of 4.

The figure below shows you how the scheme by which the addresses of the various channels of a digital module are derived.



An example of digital modules

The example in the figure below shows which default addresses are derived when a digital module is located in slot 4 (that is, when the module start address is 0). Slot number 3 is not assigned, because the example does not contain an interface module.



See also

Slot-specific addressing of modules (Page 7-1)

7.2.3 Addressing analog modules

This section describes how to address analog modules. You need this information in order to be able to address the channels of the analog modules in your user program.

Addresses of analog modules

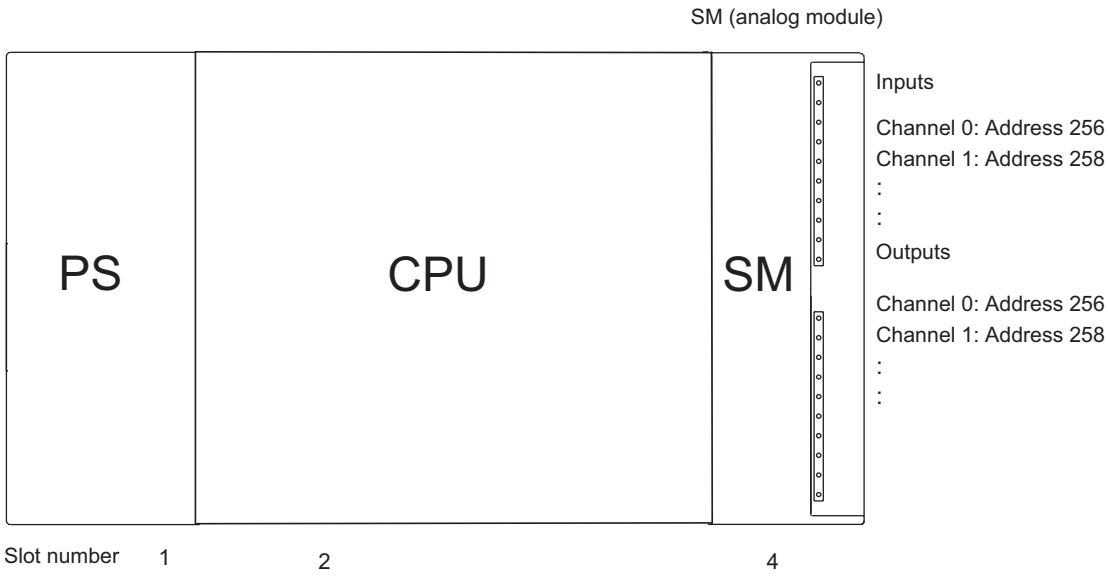
The analog input or output channel is always assigned a word address. The channel address is based on the module start address. When the first analog is located in slot 4, its default start address is 256. The start address of each further analog module increments by the count of 16.

An analog I/O module has the same start addresses for its input and output channels.

An example of analog modules

The example in the figure below shows you which default channel addresses are derived for an analog module located at slot 4. As you can see, the input and output channels of an analog I/O module are addressed starting at the same address, namely the module start address.

Slot number 3 is not assigned, because the example does not contain an interface module.



See also

Slot-specific addressing of modules (Page 7-1)

7.2.4 Addressing the integrated I/Os of CPU 31xC

CPU 312C

Addresses of the integrated I/Os of this CPU:

Table 7-1 Integrated I/Os of CPU 312C

Inputs / outputs	Default addresses	Remarks
10 digital inputs	124.0 to 125.1 of which 8 Inputs are for technological functions: 124.0 to 124.7	All digital inputs can be assigned an interrupt function. Optional technological functions: • Counting • Frequency measurement • Pulse width modulation
6 digital outputs	124.0 to 124.5 of which 2 inputs are for technological functions: 124.0 to 124.1	

CPU 313C

Addresses of the integrated I/Os of this CPU:

Table 7-2 Integrated I/Os of CPU 313C

Inputs / outputs	Default addresses	Comments
24 digital inputs	124.0 to 126.7 of which 12 inputs are for technological functions: 124.0 to 125.0 125.4 to 125.6	All digital inputs can be assigned an interrupt function. Optional technological functions: • Counting • Frequency measurement • Pulse width modulation
16 digital outputs	124.0 to 125.7 of which 3 inputs are for technological functions: 124.0 to 124.2	
4+1 analog inputs	752 to 761	
2 analog outputs	752 to 755	

CPU 313C-2 PtP and CPU 313C-2 DP

Addresses of the integrated I/Os of these CPUs:

Table 7-3 Integrated I/Os of CPU 313C-2 PtP/DP

Inputs / outputs	Default addresses	Comments
16 digital inputs	124.0 to 125.7 of which 12 inputs are for technological functions: 124.0 to 125.0 125.4 to 125.6	All digital inputs can be assigned an interrupt function. Optional technological functions: • Counting • Frequency measurement • Pulse width modulation
16 digital outputs	124.0 to 125.7 of which 3 inputs are for technological functions: 124.0 to 124.2	

CPU 314C-2 PtP and CPU 314C-2 DP

Addresses of the integrated I/Os of these CPUs:

Table 7-4 Integrated I/Os of CPU 314C-2 PtP/DP

Inputs / outputs	Default addresses	Comments
24 digital inputs	124.0 to 126.7 of which 16 inputs are for technological functions: 124.0 to 125.7	All digital inputs can be assigned an interrupt function. Optional technological functions: • Counting • Frequency measurement • Pulse width modulation • Positioning
16 digital outputs	124.0 to 125.7 of which 4 inputs are for technological functions: 124.0 to 124.3	
4+1 analog inputs	752 to 761	
2 analog outputs	752 to 755	

Special features

You cannot influence outputs with transfer instructions if they are assigned to technological functions.

I/Os not configured for technological functions can be used as standard I/Os.

7.3 Consistent data

Consistent data

The table below shows you which aspects to take into account for communication **in a PROFIBUS DP master system** and in a **PROFINET IO system**, when transferring I/O data areas with consistent "full length."

CPU 315, CPU 317, CPU 31xC
The address area of consistent data in the process image is automatically updated.
To read and write consistent data, you can also use SFC 14 and SFC 15. If the address area of consistent data is not in the process image, you must use SFC 14 and SFC 15 to read and write consistent data.
Direct access to consistent areas is also possible (L PEW or T PAW, for example).

In a PROFIBUS DP system you can transfer up to 32 bytes of consistent data.

In a PROFINET IO system you can transfer up to 256 bytes of consistent data.

Commissioning

8

8.1 Overview

This section contains important notes on commissioning which you should strictly observe in order to avoid injury or damage to machines.

Note

Your commissioning phase is determined primarily by your application, so we can only offer you general information, without claiming completeness of this topic.

Reference

Note the information about commissioning provided in the descriptions of your system components and devices.

8.2 Commissioning procedure

8.2.1 Procedure: Commissioning the hardware

Hardware requirements

- S7-300 is installed
- S7-300 is wired

With networked S7-300, the following applies to these interfaces:

- MPI/ PROFIBUS
  - MPI/PROFIBUS addresses are configured
  - segments are terminated with active terminating resistors
- PROFINET
  - integrated PROFINET interface of CPU 31x-2 PN/DP is configured with STEP 7 (IP address and transfer medium / duplex operation is set in HW Config) and
  - the CPU is connected to the subnet.

Recommended procedure: Hardware

With its modular structure and many different expansion options, the S7-300 can be very large and extremely complex. It is therefore inappropriate to initially start up an S7-300 with multiple racks and all inserted (installed) modules. Rather, we recommend a step-by-step commissioning procedure.

We recommend the following initial commissioning procedure for an S7-300:

Table 8-1 Recommended commissioning procedure: Hardware

Tasks	Comments	Information can be found
An installation and wiring check according to checklist	-	In the following chapter
Disconnecting drive aggregates and control elements	This prevents negative effects on your system as a result of program errors. Tip: By redirecting data from your outputs to a data block, you can always check the status at the outputs	-
Preparing the CPU	Connecting the PG	*Connecting the programming device (PG)*
Central unit (CU): commission the CPU and power supply, check the LEDs	Commission the CU with inserted power supply module and CPU. First, switch on the expansion devices (EMs) which are equipped with their own power supply module, and then switch on the power supply module of the CU.	*Initial power on*
	Check the LED displays on both modules.	*Debugging functions, diagnostics and troubleshooting*
Reset CPU memory and check the LEDs	-	*CPU memory reset by means of the mode selector switch*
CU: commission the remaining modules	Insert further modules into the CU and commission these, working successively.	*Module Data* Reference Manual
Expansion module (EM): Connecting	Interconnect the CU with EMs as required: Insert only one send IM into the CU, and insert the matching receive IM into into the EM.	*Installing*
EM: Commissioning	Insert further modules into the EMs and commission these, working in successively.	See above.

Danger

Proceed step-by-step. Do not go to the next step unless you have completed the previous one without error / error message.

Reference

Important notes can also be found in the section *Debugging Functions, Diagnostics and Troubleshooting.*

See also

Procedure: Software commissioning (Page 8-3)

8.2.2 Procedure: Software commissioning

Requirements

Your S7-300

- is installed and
- wired.

Software requirements to be satisfied in order to utilize the full functionality of your CPU:

For the CPUs	you require the following versions of STEP 7
31xC, 312, 314, 315-2 DP	V5.1 + Servicepack 4 or higher
317-2 DP	V5.2 + Servicepack 1 or higher
317-2 PN/DP with firmware version 2.2.0:	V5.3 or higher
315-2 PN/DP and 317-2 PN/DP with FW version 2.3.0	V5.3 + Servicepack 1 or higher

With networked S7-300, the following applies to the interfaces:

- MPI/ PROFIBUS
  - the MPI/PROFIBUS addresses are configured
  - the terminating resistors on the segments are enabled
- PROFINET
  - the integrated PROFINET interface of CPU 317-2 PN/DP is configured with STEP 7 (IP address and transfer medium / duplex operation is set in HW Config) and
  - the CPU is connected to the subnet.

Note

Please observe the procedure for commissioning the hardware.

Recommended procedure: Software

Table 8-2 Recommended commissioning procedure - Part II: Software

Tasks	Comments	Information can be found ...
• Switch on the PG and run SIMATIC Manager • Download the configuration and the program to the CPU	-	in the *STEP 7* Programming Manual
Debugging the I/Os	Helpful functions are here: • Monitoring and controlling tags • Testing with program status • Forcing • Controlling outputs in STOP mode (PO enable) **Tip:** Test the signals at the inputs and outputs using the simulation module SM 374, for example.	in the *STEP 7* Programming Manual in the section *Debugging functions, diagnostics and troubleshooting*
Commissioning PROFIBUS DP or Ethernet	-	in the section *Commissioning PROFIBUS DP* in the section *Configuring PROFINET interface X2*
Commissioning PROFINET IO		in the *System Description PROFINET*
Connect the outputs	Commissioning the outputs successively.	-

Danger

Proceed step-by-step. Do not go to the next step unless you have completed the previous one without error / error message.

Reaction to errors

React to errors as follows:

- Check the system with the help of the check list in the chapter below.
- Check the LED displays on all modules. For information on their meaning, refer to the chapters describing the relevant modules.
- If required, remove individual components to trace the error.

Reference

Important notes can also be found in the section *Debugging Functions, Diagnostics and Troubleshooting.*

See also

Procedure: Commissioning the hardware (Page 8-1)

8.3 Commissioning check list

Introduction

After you mounted and wired your S7-300, we advise you to check all previous steps once again.

The check list tables below are a guide for your examination of the S7-300. They also provide cross-references to chapters containing further information on the relevant topic.

Racks

Points to be examined are in the manual	S7-300: Installation in chapter
Are the rails mounted firmly to the wall, in the frame or in the cabinet?	Configuring, Installation
Have you maintained the free space required?	Configuring, Installation
Are the cable ducts installed properly?	Configuring
Is the air circulation OK?	Installing

Concept of grounding and chassis ground

Points to be examined are in the manual	S7-300: Installation in chapter
Have you established a low-impedance connection (large surface, large contact area) to local ground?	Configuring, Appendix
Are all racks (rails) properly connected to reference potential and local ground (direct electrical connection or ungrounded operation)?	Configuring, Wiring, Appendix
Are all grounding points of electrically connected modules and of the load power supply units connected to reference potential?	Configuring, Appendix

Module installation and wiring

Points to be examined are in the manual	S7-300: Installation in chapter
Are all modules properly inserted and screwed in?	Installing
Are all front connectors properly wired, plugged, screw-tightened or latched to the correct module?	Installation, Wiring

Mains voltage

Points to be examined	S7-300: Installation in chapter	See reference manual; Section ...
Is the correct mains voltage set for all components?	Wiring	Module Specifications

Power supply module

Points to be examined	S7-300: Installation in chapter	See reference manual; Section ...
Is the mains plug wired correctly?	Wiring	-
Is mains voltage connected?	-	-

8.4 Commissioning the Modules

8.4.1 Inserting/Replacing a Micro Memory Card (MMC)

SIMATIC Micro Memory Card (MMC) as memory module

Your CPU uses a SIMATIC Micro Memory Card (MMC) as a memory module. You can set up the MMC as a load memory or a portable data medium.

Note

An MMC must be plugged in before you can use the CPU.

Note

If the CPU is set to RUN and you remove the MMC, the CPU will STOP and request a memory reset.

Caution

Data on a SIMATIC Micro Memory Card can be corrupted if you remove the card while it is being accessed by a write operation. In this case, you may have to delete the MMC on your PG or format the card in the CPU.
Never remove an MMC in RUN mode. Always remove when power is off or when the CPU is in STOP state and when the PG is not a writing to the card. When the CPU is in STOP mode and you cannot not determine whether or not a PG is writing to the card (e.g. load/delete block), disconnect the communication lines.

Warning

Make sure that the MMC to be inserted contains the proper user program for the CPU (system). The wrong user program may have fatal processing effects.

Inserting/replacing the Micro Memory Card (MMC)

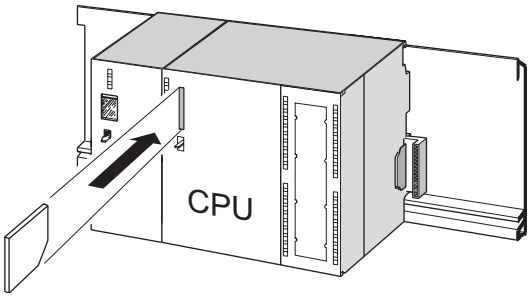
1. Switch the CPU to STOP mode.
2. Is an MMC already inserted?

   If yes, ensure that no write operations are running on the PG (such as loading a block). If you cannot ensure this state, disconnect all communication lines of the CPU.

   Now, press the ejector and remove the MMC.

   The module slot has an ejector device to enable you to remove the micro memory card (see CPU 31xC and CPU 31x Manual, Technical Data *Operator Control and Display Elements*).

   Use a small screwdriver or ball-point pen to remove the MMC.
3. Insert the ("new") MMC into the MMC slot with the beveled edge of the MMC pointing towards the ejector.
4. Gently insert the MMC into the CPU until the MMC clicks into place.
5. Reset CPU memory *(see Resetting CPU memory by means of mode selector switch)*



Inserting and removing an MMC when CPU power is switched off

If you replace MMCs while the power is switched off, the CPUs

- will recognize a physically identical MMC with changed content
- a new MMC with the same content as the old MMC

It automatically performs a CPU memory reset after POWER ON.

Reference

- *Properties of the Micro Memory Card (MMC)*, CPU 31xC and CPU 31x Manual, Technical data
- *Technical Data of the Micro Memory Card (MMC)*, CPU 31xC and CPU 31x Manual, Technical data

8.4.2 Initial power on

Requirements

- You must have installed and wired up the S7-300.
- The MMC is inserted in the CPU.
- Your CPU's mode selector switch must be set to STOP.

Initial power on of a CPU with Micro Memory Card (MMC)

Switch on the PS 307 power supply module.

Result:

- The 24 VDC LED on the power supply module is lit.
- The 5 VDC LED on the CPU
  - is lit.
  - The STOP LED flashes at 2 Hz when the CPU executes an automatic memory reset.
  - The STOP LED is lit after memory reset.

8.4.3 CPU memory reset by means of mode selector switch

When to reset CPU memory

You reset CPU memory

- before you download a (completely) new user program to the CPU
- when the CPU requests a memory reset with its STOP LED flashing at 0.5 Hz intervals
  Possible reasons for this request are listed in the table below.

Table 8-3 Possible reasons of a CPU request to reset memory

Causes of a CPU request to reset memory	Special features
The MMC has been replaced	–
RAM error in CPU	–
Main memory is too small, that is, all blocks of the user program on an MMC cannot be loaded.	CPU with MMC: Recursive request of a CPU memory reset. For further information on the behavior of the MMC during CPU memory reset, refer to the CPU 31xC and CPU 31x Manual, Technical Data, under *Memory Reset and Restart*
Attempts to load faulty blocks; if a wrong instruction was programmed, for example.	

How to reset memory

There are two ways to reset CPU memory:

CPU memory reset using the mode selector switch	CPU memory reset using the PG
... is described in this chapter.	... is only possible when the CPU is in STOP (see *STEP 7 Online Help*).

Resetting CPU memory with mode selector switch

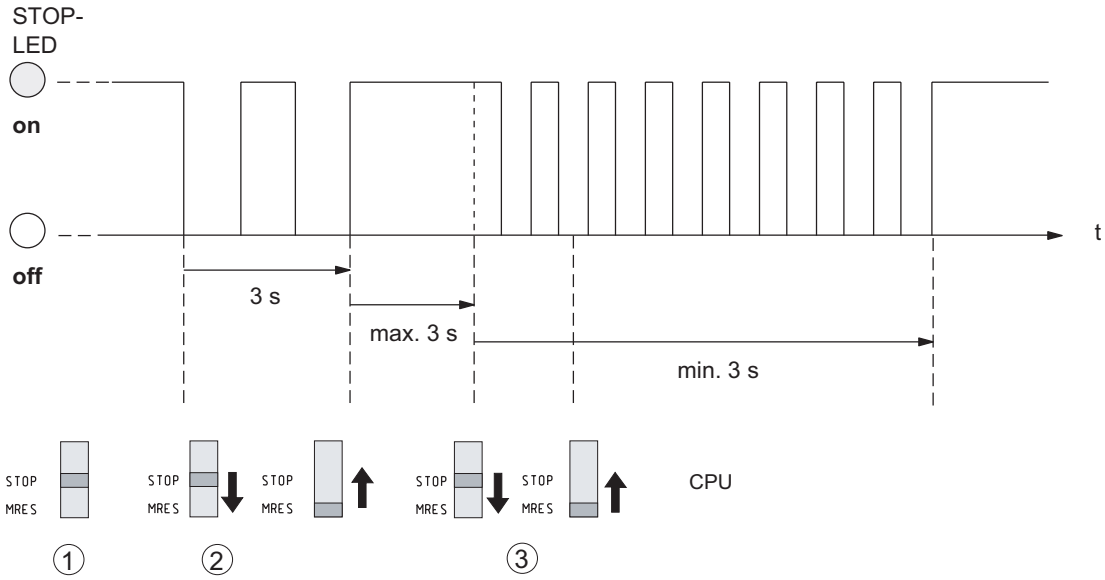
The table below shows the steps in resetting CPU memory.

Table 8-4 Procedure for CPU memory reset

Step	Reset CPU memory
1.	Turn the key to STOP position
2.	Turn the key to MRES position Hold the key in this position until the STOP LED lights up for the second time and remains on (this takes 3 seconds). Now release the key.
3.	You must turn the key to MRES position again within 3 seconds and hold it there until the STOP LED flashes (at 2 Hz). You can now release the switch. When the CPU has completed memory reset, the STOP LED stops flashing and remains lit. The CPU has reset the memory.

The procedure described in the table above is only required if the user wishes to reset the CPU memory without being requested by the CPU to reset the memory (STOP LED flashing slowly). If the CPU prompts you for a memory reset, you only have to turn the mode selector briefly to MRES position to initiate the memory reset operation.

The figure below shows how to use the mode selector switch to reset CPU memory:



If the CPU prompts you for another memory reset following a successful memory reset operation, the MMC may need to be reformatted in certain cases (*see Formatting a Micro Memory Card (MMC)*).

STOP LED does not flash during the memory reset

What should I do if the STOP LED does not flash during the memory reset or if other LEDs are lit?

1. You must repeat steps 2 and 3.
2. If the CPU still does not reset memory, evaluate the diagnostic buffer of the CPU.

What happens in the CPU during memory reset?

Table 8-5 Internal CPU events on memory reset

Event	Action in CPU	
CPU activities	1.	The CPU deletes the entire user program in the main memory.
	2.	The CPU deletes the retentive data.
	3.	The CPU tests its own hardware.
	4.	The CPU copies the sequence-relevant content of the MMC (load memory) to the main memory. **Tip:** If the CPU can not copy the MMC and requests a memory reset: • Remove the MMC • Reset CPU memory Read the diagnostic buffer.
Memory contents after reset	The user program is transferred from the MMC to the main memory again and memory utilization is indicated accordingly.	
What's left?	Data in the diagnostics buffer. You can read the diagnostic buffer with the PG (see *STEP 7 Online Help*).	
	• The MPI parameters (MPI address and highest MPI address, transmission rate, configured MPI addresses of CPs/FMs in an S7-300). • The same also applies to the CPU 317, if the MPI/DP interface of the CPU was assigned as a DP interface (PROFIBUS address, highest PROFIBUS address, baud rate, setting as active or passive interface).	
	Content of elapsed time counter	

Special feature: X1 interface parameters (MPI or MPI/DP interface)

The following parameters hold a special position when CPU memory is reset.

- Parameters of interface X1 (MPI parameter or MPI-/DP parameter with MPI-/DP interfaces).

The table below describes which interface parameters remain valid after a CPU memory reset.

CPU memory reset ...	MPI/DP parameters
with MMC inserted	...the MPI parameters on the MMC or integrated read-only load memory are valid. If this location does not contain any parameter data (SDB), the previously set parameters stay valid.
without micro memory card (MMC) inserted	... are retained and valid.

8.4.4 Formatting the Micro Memory Card (MMC)

You must format the MMC in the following cases:

- The MMC module type is not a user module
- The MMC is not formatted
- The MMC is defective
- The content of the MMC is invalid

The content of the MMC is marked invalid

- The *Load user program* operation was interrupted as a result of Power Off.
- The *Write RAM to ROM* operation was interrupted as a result of Power Off.
- Error when evaluating the module content during CPU memory reset.
- Formatting error, or formatting failed.

If one of these errors has occurred, the CPU prompts you for yet another memory reset, even after a memory reset operation has been performed. The card's content is retained until the MMC is formatted, unless the Load user program / Write RAM to ROM operation was interrupted as a result of Power Off.

The MMC is only formatted if a reason for formatting exists (see above) and not, for example, when you are prompted for a memory reset after a module replacement. In this case, a switch to MRES triggers a normal memory reset for which the module content remains valid.

Use the following steps to format your MMC

If the CPU is requesting a memory reset (STOP LED flashing slowly), you can format the MMC by setting the selector switch as follows:

1. Toggle the switch to the MRES position and hold it there until the STOP LED lights up and remains on (after approx. 9 seconds).
2. Within the next three seconds, release the switch and toggle it once again to MRES position. The STOP LED flashes to indicate that formatting is in progress.

Note

Always perform this sequence of operation within the specified time. Otherwise, the MMC will not be not formatted, but rather returns to memory reset status.

See also

CPU memory reset by means of mode selector switch (Page 8-9)

8.4.5 Connecting the programming device (PG)

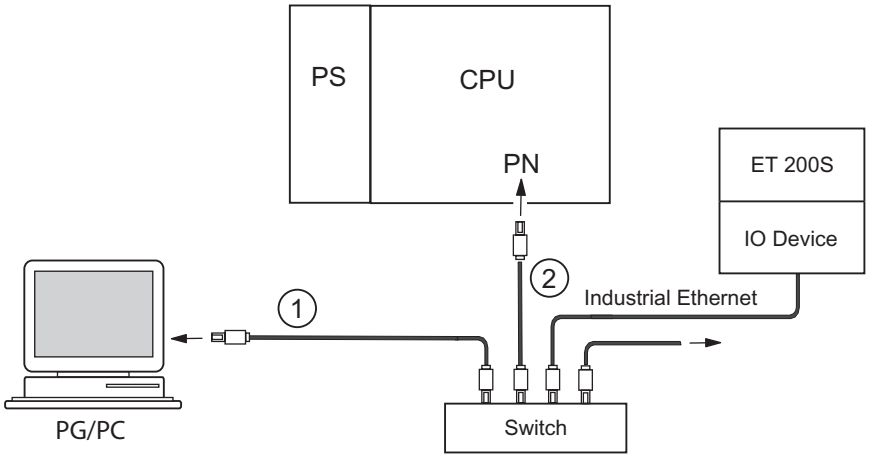
8.4.5.1 Connecting a PG/PC to the integrated PROFINET interface of the CPU 31x-2 PN/DP

Requirements

- CPU with integrated PROFINET interface (a CPU 317-2 PN/DP, for example)
- PG/PC with network card

Connecting a PG/PC to the integrated PROFINET of the CPU 31x-2 PN/DP

1. Connect the PG/PC to a switch, using a TP patch cable **(1)**.
2. In the same way, connect the switch to the integrated PROFINET interface of your CPU **(2)**.



Result

You connected the PG/PC to the integrated PROFINET interface of the CPU.

Tip

Using an Ethernet crossover cable, you can also connect your PG/PC directly to the integrated PROFINET interface of the CPU 31x-2 PN/DP.

Reference

- For information on PROFINET, refer to the *PROFINET System Description*.
- For information on passive network components such as switches, refer to the *SIMATIC NET manual: Twisted Pair and Fiber-Optic Networks.*

See also

Configuring and commissioning the PROFINET IO system (Page 8-35)

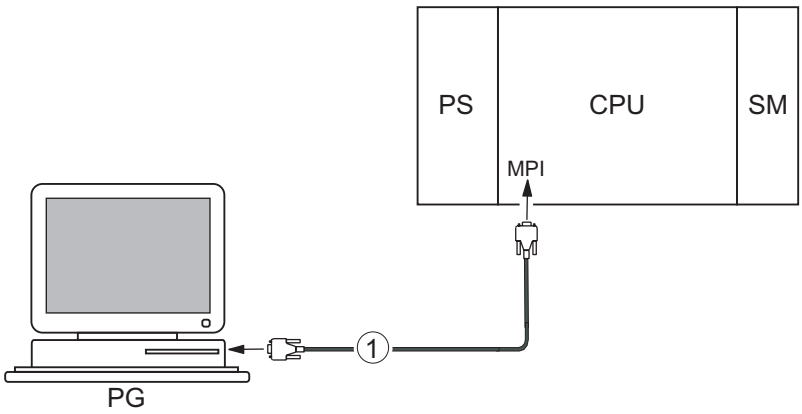
8.4.5.2 Connecting the PG to a node

Requirements

The PG must be equipped with an integrated MPI interface or an MPI card in order to connect it via MPI.

Connecting a PG to the integrated MPI interface of the CPU

1. Connect the PG to the MPI interface of your CPU by means of a PG patch cable **(1)**. You can use a self-made PROFIBUS bus cable with bus connectors. The figure below illustrates the connection between the PG and the CPU



Procedure for PROFIBUS DP

The procedure is basically the same, if the CPU interface is set to PROFIBUS DP mode

8.4.5.3 Connecting the PG to several nodes

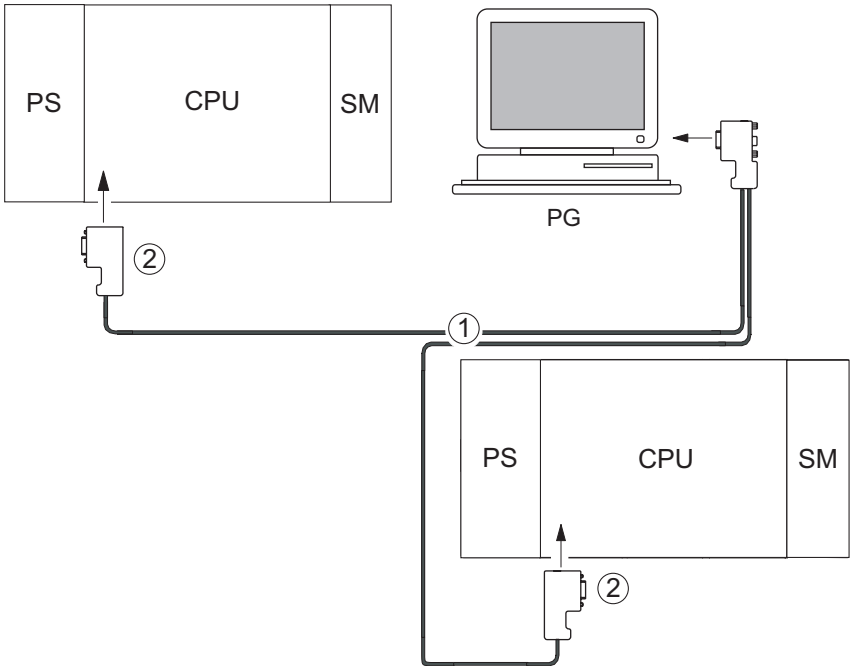
Requirements

The PG must be equipped with an integrated MPI interface or an MPI card in order to connect it to an MPI.

Connecting the PG to several nodes

1. Use bus connectors to connect a PG which is permanently installed on the MPI subnet to the other nodes of the MPI subnet.

The figure below shows two networked S7-300s which are interconnected by means of bus connectors.



The figure illustrates the following	
(1)	PROFIBUS bus cable
(2)	Connector with enabled terminating resistor

8.4.5.4 Using the PG for commissioning or maintenance

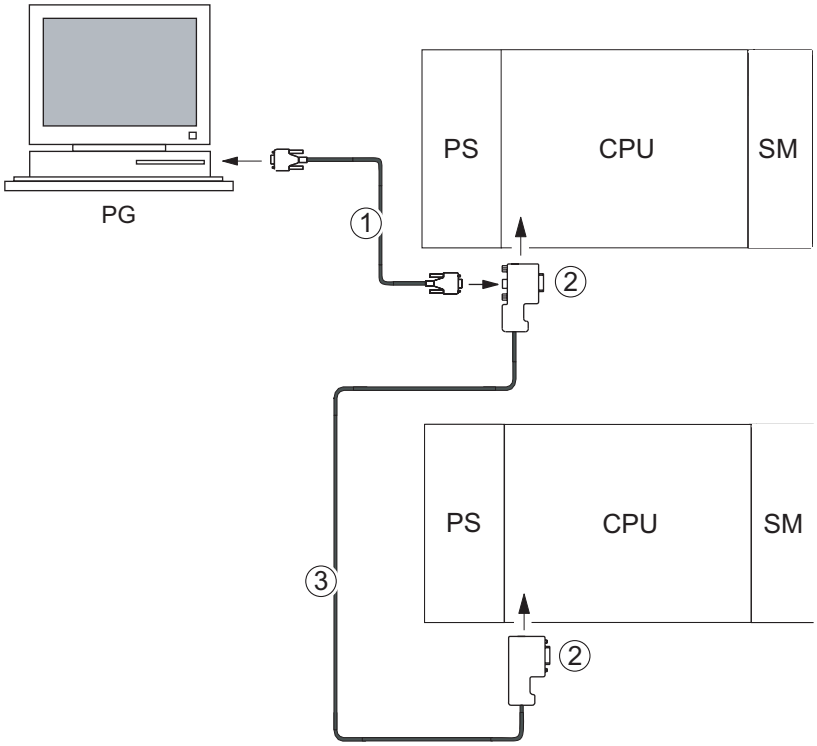
Requirements

The PG must be equipped with an integrated MPI interface or an MPI card in order to connect it to an MPI.

Using the PG for commissioning or maintenance

1. Use a stub cable to connect the commissioning and maintenance PG to the other subnet nodes. The bus connector of these nodes must be equipped with a PG socket.

The figure below shows the interconnection of two networked S7-300 and a PG.



The figure illustrates the following	
(1)	Stub cable used to create connection between PG and CPU
(2)	The enabled terminating resistor of the bus connector
(3)	PROFIBUS bus cable used to network both CPUs

MPI addresses for service PGs

If there is no stationary PG, we recommend:

To connect a PG to an MPI subnet with "unknown" node addresses, set the following addresses on the service PG:

- MPI address: 0
- Highest MPI address: 126

IN STEP 7, you then determine the highest MPI address on the MPI subnet and match the highest MPI address in the PG to that of the MPI subnet.

See also

Procedure: Commissioning the hardware (Page 8-1)

Procedure: Software commissioning (Page 8-3)

8.4.5.5 Connecting a PG to ungrounded MPI nodes (not CPU 31xC)

Requirements

The PG must be equipped with an integrated MPI interface or an MPI card in order to connect it to an MPI.

Connecting a PG to ungrounded nodes on an MPI subnet (not CPU 31xC)

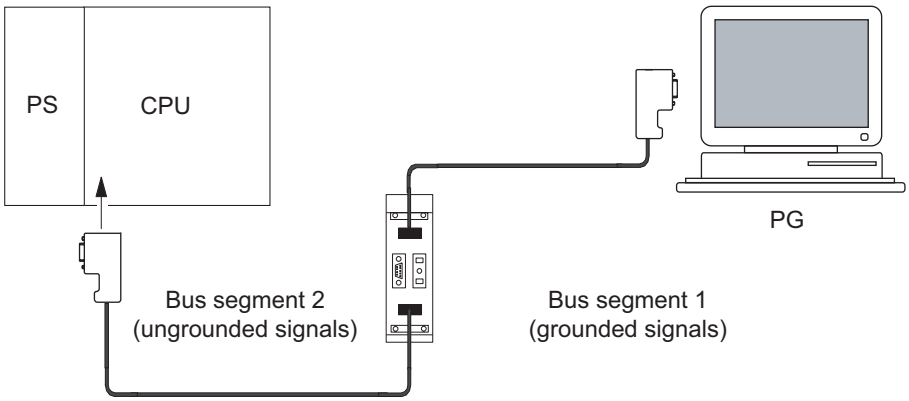
Connecting a PG to ungrounded nodes

Always use an ungrounded PG to connect to ungrounded MPI subnet nodes or to ungrounded S7-300 PLCs.

Connecting a grounded PG to the MPI

You want to operate with ungrounded nodes. If the MPI at the PG is grounded, you must interconnect the nodes and the PG with an RS485 repeater. You must connect the ungrounded nodes to bus segment 2 if the PG is connected to bus segment 1 (terminals A1 B1) or to the PG/OP interface (refer to Chapter 7 in the *Module Data* Reference Manual).

The figure below shows an RS485 repeater as interface between grounded and ungrounded nodes of an MPI subnet.



See also

PROFINET cable lengths and network expansion (Page 4-54)

Network components of MPI/DP and cable lengths (Page 4-35)

8.4.6 Starting SIMATIC Manager

Introduction

SIMATIC Manager is a GUI for online/offline editing of S7 objects (projects, user programs, blocks, hardware stations and tools).

The SIMATIC Manager lets you

- manage projects and libraries,
- call STEP 7 tools,
- access the PLC (AS) online,
- edit Memory Cards.

Starting SIMATIC Manager

After installation, the **SIMATIC Manager** icon appears on the Windows desktop, and the Start menu contains entry **SIMATIC Manager** under **SIMATIC**.

1. Run SIMATIC Manager by double-clicking the icon, or from the Start menu (same as with all other Windows applications).

User interface

A corresponding editing tool is started up when you open the relevant objects. You start the program editor by double-clicking the program block you want to edit (object-oriented start).

Online Help

The online help for the active window is always called by pressing F1.

8.4.7 Monitoring and modifying I/Os

The "Monitor and modify tags" tool

The STEP 7 "Monitor and modify tags" tool lets you:

- monitor program tags in any format
- edit the tag status or data in the CPU (modifying).

Creating a tag table

You have two options of creating a tag table (VAT):

- in the LAD / FBD / STL editor by selecting the **PLC > Monitor/Modify Variables** command

  This table is also available directly online.
- in SIMATIC Manager with the **Blocks** container open via menu item **Insert New Object > Variable table**

  This table created offline can be saved for future retrieval. You can also test it after switching to online mode.

VAT structure:

In the VAT, every address to be monitored or modified (e.g. inputs, outputs) occupies one row.

The meaning of the VAT columns is as follows:

Column text	This field ...
Address	contains the absolute address of the variable
Icon	contains the symbolic descriptor of the variable. This is identical to the specification in the Symbol Table.
Symbol comment	shows the symbol comment of the Symbol Table
Status format	contains the default format setting, e.g. HEX. You can change the format as follows: • right-click in the format field. The Format List opens. or • left-click in the format field until the relevant format appears
Status value	shows the content of the variable at the time of update
Modify value	is used to enter the new variable value (modify value)

Monitor variable

You have two options for monitoring variables:

- updating the status values once via menu item **Variable > Update Status Values**

  or

- continuous update of status values via menu item **Variable > Monitor**

Modifying variables

To modify variables, proceed as follows:

1. Left-click the field **Modify value** of the relevant variable.
2. Enter the modify value according to the data type.
3. To update modify values once, select the menu item **Variable > Activate Modify Value**.

   or

   Enable modify values permanently via menu item **Variable > Modify**.
4. In the **Monitor** test function, verify the modify value entry in the variable.

Is the modify value valid?

You can disable the modify value entered in the table. An invalid value is displayed same as a comment. You can re-enable the modify value.

Only valid modify values can be enabled.

Setting the trigger points

Trigger points:

- The "Trigger point for monitoring" determines the time of update for values of variables to be monitored.
- The "Trigger point for modifying" determines the time for assigning the modify values to the variables to be modified.

Trigger condition:

- The "Trigger condition for monitoring" determines whether to update values once when the trigger point is reached or continuously every time the trigger point is reached.
- The "Trigger condition for modifying" determines whether to assign modify values once or permanently to the variable to be modified.

You can customize the trigger points using the tool "Monitor and modify variable" in menu item **Variable > Set Trigger ...** start.

Special features

- If "Trigger condition for monitoring" is set to **once** , the menu items **Variable > Update Status Values** or **Variable > Monitor** have the same effect, namely a single update.
- If "Trigger condition for modifying" is set to **once** , the menu items **Variable > Update Status Values** or **Variable > Modify** have the same effect, namely a single assignment.
- If trigger conditions are set to **permanent** , the said menu items have different effects as described above.
- If monitoring and modifying is set to the same trigger point, monitoring is executed first.
- Under **Test > Mode** if ... **Process mode** is set, values are not cyclically updated when **permanent modification** is set.
  Remedy: Use the **Force** test function.

Saving/opening the variable table

Saving the VAT

1. After aborting or completing a test phase, you can save the variable table to memory. The name of a variable table starts with the letters VAT, followed by a number from 0 to 65535; e.g. VAT5.

Opening VAT

1. Select the menu item **Table > Open**.
2. Select the project name in the **Open** dialog.
3. In the project window below, select the relevant program and mark the **Blocks** container.
4. In the block window, select the desired table.
5. Confirm with **OK**.

establishing a connection to the CPU

The variables of a VAT represent dynamic quantities of a user program. In order to monitor or modify variables it is required to establish a connection to the relevant CPU. Every variable tables can be linked to another CPU.

In menu item **PLC > Connect to ...** , establish a connection to one of the following CPUs:

- configured CPU
- directly connected CPU
- available CPU ...

The table below lists the display of variables.

CPUs	The CPU variables are displayed, ...
configured CPU	in their S7 program (Hardware Station) in which the VAT is stored.
directly connected CPU	that is connected directly to the PG.
available CPU.	that is selected in the dialog window. Select **PLC > Connect to ... > Available CPU ...** to connect to an available CPU. This can be used to connect to any CPU available on the network.

Modifying outputs in CPU STOP mode

The function **Enable PO** resets the output disable signal for the peripheral outputs (PO), thus enabling modifying of the PO in CPU STOP mode.

In order to enable the POs, proceed as follows:

1. In menu item **Table > Open the variable table (VAT)**, open the VAT that contains the PO you want to modify, or activate the window containing the corresponding VAT.
2. To modify the PO of the active VAT, select the CPU connection in menu command **PLC > Connect to ...** .
3. Use menu command **PLC > Operating Mode** to open the **Operating Mode** dialog and switch the CPU to STOP mode.
4. Enter your values in the "Modify value" column for the PO you want to modify.

   Examples:
   PO: POB 7 modify value: 2#0100 0011
   POW 2 W#16#0027
   POD 4 DW#16#0001
5. Select **Variable > Enable PO** to set "Enable PO" mode.
6. Modify the PO by selecting **Variable > Activate Modify Values**. "Enable PO" mode remains active until reset by selecting **Variable > Enable PO** once again.

   "Enable PO" is also terminated when the connection to the PG goes down.
7. Return to step 4 if you want to set new values.

Note

For example, a message pops up to indicate a CPU mode transition from STOP to RUN or START-UP.
A message also pops up when the "Enable PO" function is set while the CPU is in RUN mode.

8.5 Commissioning PROFIBUS DP

8.5.1 Commissioning PROFIBUS DP

Requirements

Requirements for commissioning a PROFIBUS DP network:

- A PROFIBUS DP network is installed.
- In STEP 7, you configured the PROFIBUS DP network and assigned all network nodes a PROFIBUS DP address and memory area (see the Manual *SIMATIC, STEP 7 V5.x; Configuring hardware and connections with STEP 7 V5.x*).
- Note that you must also set address switches at some of the DP slaves (see the description of the relevant DP slave).
- Software requirements are shown in the table below, based on the CPU used:

Table 8-6 Software requirements

CPU	Order number	Software required
313C-2 DP	6ES/313-6CE00-0AB0	STEP 7 V 5.1 + SP 4 or higher *COM PROFIBUS* V 5.0 or higher
314C-2 DP	6ES7314-6CF00-0AB0	
315-2 DP	6ES7315-2AG10-0AB0	STEP 7 V 5.1 + SP 4 or higher
315-2 PN/DP	6ES7315-2EG10-0AB0	STEP 7 V 5.3 or higher
317-2 DP	6ES7317-2AJ10-0AB0	STEP 7 V 5.2 + SP 1 or higher
317-2 PN/DP	6ES7317-2EJ10-0AB0	STEP 7 V 5.3 or higher

DP address areas of the CPUs

Table 8-7 DP address areas of the CPUs

Address area	313C-2 DP, 314C-2 DP	315-2 DP 315-2 PN/DP	317-2 DP 317-2 PN/DP
DP address area for I/Os	1024 bytes	2048 bytes	8192 bytes
Number of those in process image for I/Os	Byte 0 to 127	Byte 0 to 127	Bytes 0 to 255 [1]
[1] At a CPU 317-2 PN/DP with FW version 2.3.0 or higher, you can set a maximum number of 2047 bytes for the process image. Default setting of the CPU is byte 0 to 255.			

DP diagnostic addresses occupy 1 byte per DP master and DP slave in the input address area. For example, at these addresses DP standard diagnostics can be called for the relevant node (LADDR parameter of SFC 13). The DP diagnostic addresses are specified in your configuration. If you do not specify any DP diagnostic addresses, STEP 7 assigns these DP diagnostic addresses in ascending order, starting at the highest byte address.

In the case of a CPU 31xC-2 DP or CPU 31x-2 DP assigned as a master, two different diagnostic addresses must be assigned for S7 slaves.

- Diagnostic address of the slave (address for slot 0)

  At this address all slave events are reported in the DP master (Node representative), e.g. Node failure.

- Diagnostic address of the module (address for slot 2)

  All module (CPU 313C-2 DP as I-Slave, for example) events are reported in the master (OB82) at this address. With a CPU as DP Slave, for example, diagnostic interrupts for operating mode transitions are reported at this address.

See also

Connecting the PG to a node (Page 8-14)

Connecting the PG to several nodes (Page 8-15)

8.5.2 Commissioning the CPU as DP master

Requirements for commissioning

- The PROFIBUS subnet has been configured.
- The DP slaves are ready for operation (see relevant DP slave manual).
- If the MPI/DP interface is a DP interface, you have to configure the interface as DP interface (CPU 317 only).
- You must configure the CPU as DP master prior to commissioning. That is, in STEP 7 you have to
  - configure the CPU as a DP master,
  - assign a PROFIBUS address to the CPU,
  - assign a master diagnostic address to the CPU,
  - integrate the DP slaves into the DP master system.

    Is the DP CPU a DP slave?

    If so, this DP slave appears in the PROFIBUS-DP catalog as **configured station**. In the DP master, assign a slave diagnostic address to this DP slave CPU. You must interconnect the DP master with the DP slave CPU and specify the address areas for data exchange with the DP slave CPU.

Commissioning

Commission the DP CPU as a DP master in the PROFIBUS subnet as follows:

1. Download the PROFIBUS subnet configuration created with STEP 7 (preset configuration) from the PG to the DP CPU.
2. Switch on all of the DP slaves.
3. Switch the DP CPU from STOP to RUN.

Start-up of DP CPU as DP master

During start-up, the DP CPU checks the configured preset configuration of its DP master system against the actual configuration.

If preset configuration = actual configuration, the CPU switches to RUN mode.

If the preset configuration ≠ to the actual configuration, the configuration of parameter **Start-up if preset configuration ≠ actual configuration** determines the start-up behavior of the CPU.

Startup when the preset configuration ≠ actual configuration = yes (default setting)	**Startup when the preset configuration ≠ actual configuration = no**
DP CPU switches to RUN. (BUSF LED flashes if any of the DP slaves cannot be addressed)	DP CPU remains in STOP mode, and the BUS LED flashes after the set **Monitoring time for transfer of parameters to modules**. The flashing BUSF LED indicates that at least one DP slave cannot be accessed. In this case, check whether all DP slaves are switched on or correspond with your configuration, or read out the diagnostic buffer with STEP 7.

Recognizing the operating state of DP slaves (Event recognition)

The table below shows how the DP CPU operating as a DP master recognizes operating mode transitions of a CPU operating as a DP slave or data exchange interruptions.

Table 8-8 Event recognition by CPUs 31x-2 DP/31xC-2 DP operating as DP master

Event	**What happens in the DP master?**
Bus failure interrupt (short-circuit, connector unplugged)	• Call of OB86 with the message **Station failure** (coming event; diagnostic address of the DP slave assigned to the DP master) • With I/O access: call of OB 122 (I/O access error)
DP slave: RUN → STOP	• Call of OB82 with the message **Module error** (incoming event; diagnostic address of the DP slave assigned to the DP master; Variable OB82_MDL_STOP=1)
DP slave: RUN → STOP	• Call of OB82 with the message **Module OK** (outgoing event; diagnostic address of the DP-Slave assigned to the DP master; Variable OB82_MDL_STOP=0)

Tip:

When commissioning the CPU as DP master, always program OB82 and OB86. This helps you to recognize and evaluate data exchange errors or interruption.

Programming, status/control via PROFIBUS

As an alternative to the MPI interface, you can program the CPU or execute the PG's status and control functions via the PROFIBUS-DP interface.

Note

The use of Status and Control function via the PROFIBUS-DP interface extends the DP cycle.

Constant Bus Cycle Time

In STEP 7 V 5.x or higher you can configure constant bus cycle times for PROFIBUS subnets. Details on constant bus cycle times are found in the *Step 7 Online Help*.

Start-up of the DP master system

CPU 31x-2 DP / 31xC-2 DP is a DP master
Customize the startup monitoring time for DP slaves at the parameter **Monitoring time for parameter transfer to modules**.
That is, the DP slaves must start up within the set time and be configured by the CPU (as DP master).

PROFIBUS address of the DP master

For the DP CPU, you **must not set "126"** as a PROFIBUS address.

8.5.3 Commissioning the CPU as DP Slave

Requirements for commissioning

- The DP master is configured and programmed.
- If the MPI/DP interface of your CPU must be a DP interface, you must configure the interface as DP interface.
- Prior to commissioning, you must set the relevant parameters and configure the DP CPU for operation as DP slave. That is, in STEP 7 you must
  - "power on" the CPU as DP slave,
  - assign a PROFIBUS address to the CPU,
  - assign a slave diagnostic address to the CPU,
  - specify whether the DP master is an S7 DP master or another DP master,
  - specify the address areas for data exchange with the DP master.
- All other DP slaves are programmed and configured.

Reference

Information on migration to a CPU 31xC, 312, 314, 315-2 DP, 317-2DP and 317-2 PN/DP can be found in the applicable section in the *CPU Data 31xC and 31x Reference Manual*.

GSD files

If you are working on an IM 308-C or third party system, you require a GSD file in order to be able to configure the DP CPU as a DP slave in a DP master system.

COM PROFIBUS V 4.0 or later includes this GSD file.

When working with an older version or another configuration tool, you can download the GSD file at:

- Internet URL http://www.ad.siemens.de/csi/gsd

  or

- via modem from the **SSC** (Interface **Center)** Fürth, Germany; phone number (0911) 737972.

Note

This note applies to CPU 31xC-2 DP, CPU 315-2 DP and CPU 317. If you wish to use the CPU as a standard slave using the GSD file, you must not set the Commissioning / Test mode check box on the DP interface properties dialog box when you configure this slave CPU in STEP 7.

Configuration and parameter assignment message frame

STEP 7 assists you during configuration and parameter assignment of the DP CPU. Should you require a description of the configuration and parameter assignment frame, in order to use a bus monitor for example, you can find it on the Internet at http://www.ad.siemens.de/csinfo under article ID 1452338.

Commissioning

Commission the DP CPU as a DP slave in the PROFIBUS subnet as follows:

1. Switch on power, but hold the CPU in STOP mode.
2. First, switch on all other DP masters/slaves.
3. Now switch the CPU to RUN mode.

Start-up of DP CPU as DP slave

When the DP-CPU is switched to RUN mode, two mutually independent operating mode transitions are executed:

- The **CPU** switches from STOP to RUN mode.
- The CPU starts data exchange with the DP master via the **PROFIBUS DP interface**.

Recognizing the Operating State of the DP master (Event Recognition)

The table below shows how the DP CPU operating as a DP slave recognizes operating state transitions or data exchange interruptions.

Table 8-9 Event recognition by CPUs 31x-2 DP/31xC-2 DP as DP slave

Event	What happens in the DP slave?
Bus failure interrupt (short-circuit, connector unplugged)	• Call of OB86 with the message **Station failure** (coming event; diagnostic address of the DP slave, assigned to the DP slave) • With I/O access: call of OB 122 (I/O access error)
DP master. RUN → STOP	• Call of OB82 with the message **Module error** (coming event; diagnostic address of the DP slave, assigned to the DP slave; Variable OB82_MDL_STOP=1)
DP master RUN → STOP	• Call of OB82 with the message **Module OK** (outgoing event; diagnostic address of the DP slave, assigned to the DP slave; Variable OB82_MDL_STOP=0)

Tip:

When commissioning the CPU as DP slave, always program OB82 and OB86. This helps you to recognize and evaluate the respective operating states or data exchange errors.

Programming, status/control via PROFIBUS

As an alternative to the MPI interface, you can program the CPU or execute the PG's status and control functions via the PROFIBUS-DP interface.

Note

The use of Status and Control function via the PROFIBUS-DP interface extends the DP cycle.

Data transfer via transfer memory

The DP-CPU operating as a DP slave provides a transfer memory for PROFIBUS DP. All data exchange between the CPU as DP slave and the DP master takes place via this transfer memory. You can configure up to 32 address areas for this function.

That is, the DP master writes its data to these transfer memory address areas, the CPU reads these data in the user program, and vice versa.

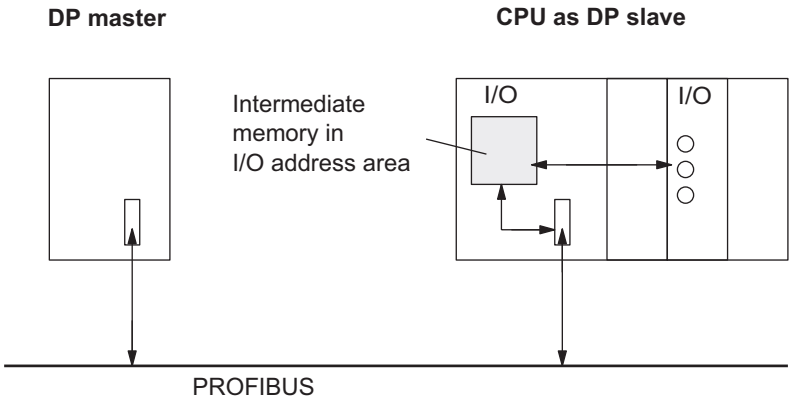


Figure 8-1 Transfer memory in a DP CPU operating as a DP slave

Address areas of transfer memory

In STEP 7, configure the I/O address areas:

- You can configure up to 32 I/O address areas.
- Maximum length per address area is 32 bytes.
- You can configure a maximum of 244 input bytes and 244 outputs bytes.

The table below shows the principle of address areas. You can also find this figure in the STEP 7 configuration.

Table 8-10 Configuration example for the address areas of transfer memory

	Type	Master address	Type	Slave address	Length	Unit	Consistency
1	E	222	A	310	2	BYTE	Unit
2	A	0	E	13	10	Word	Total length
:							
32							
	Address areas in the DP master CPU		Address areas in the DP slave CPU		These address area parameters have to be the same for DP master and DP slave.		

Sample program

Below you will see a small sample program for data exchange between DP master and DP slave. The addresses used in the example are found in the table above.

In the DP slave CPU

```
L    2           //Data preparation in DP slave
T    MB    6
L    IB    0
T    MB    7
L    MW    6     // Forward data to DP master
T    PQW   310

CALL   SFC    14            //Receive data from
  LADDR:=W#16#D              //DP master
  RET_VAL:=MW 20
  RECORD:=P#M30.0 byte 20
L      MB     30            //Received
L      MB     7             data//continue
+      I                    processing
T      MW     100
```

In the DP master CPU

```
L      PIB     222   //continued processing
T      MB      50    of//received data in DP
L      PIB     223   master
L      B#16#3
+      I
T      MB      51
L      10            //Data preparation in DP
                     master
+      3
T      MB      60
CALL   SFC     15    //Send data to
                      //DP slave
  LADDR:= W#16#0
  RECORD:= P#M60.0 Byte 20
  RET_VAL:=MW 22
```

Working with transfer memory

Note the following rules when working with the transfer memory:

- Assignment of address areas:
  - Input data of DP slaves are **always** output data of the DP master
  - Output data of DP slaves are **always** input data of the DP master
- The user can define these addresses. In the user program, access data with load/transfer instructions or with SFC 14 and SFC 15. You can also define addresses of the process image of inputs or outputs.
- The lowest address of specific address areas is their respective area start address.
- The length, unit and consistency of the address areas for DP master and DP slave must be identical.

Note

Assign addresses from the DP address area of the DP CPU to the transfer memory. You cannot assign addresses specified for the transfer memory again for the I/O modules on the DP CPU.

Further information on the use of consistent data areas in transfer memory is found at the end of this subsection.

S5 DP master

If you use an IM 308-C as a DP master and the DP CPU as a DP slave, the following applies to the exchange of consistent data.

You have to program FB192 in IM 308-C to enable exchange of consistent data between a DP master and the DP slave. With the FB192, the data of the DP CPU are only output or read out in a consistent block.

S5-95 as DP master

If you set up an AG S5-95 for operation as DP master, you also have to set its bus parameters for the DP CPU as DP slave.

Data transfer in STOP mode

The slave DP CPU goes into STOP: Data in the transfer memory of the CPU are overwritten with "0" value, that is, the DP master reads "0."

The DP master goes into STOP: Current data in the transfer memory of the CPU are retained and can thus be read by the CPU.

PROFIBUS address

For the DP CPU, you **must not set "126"** as a PROFIBUS address.

See also

Consistent data (Page 7-8)

User-specific addressing of modules (Page 7-3)

8.5.4 Direct data exchange

Requirements

STEP 7 V 5.x or higher lets you configure "Direct data exchange" for PROFIBUS nodes. DP CPUs can take part in direct data exchange as senders and receivers.

Definition

"Direct data exchange" is a special communication relationship between PROFIBUS DP nodes.

Characteristic of direct data exchange are the PROFIBUS DP nodes "Listening" on the bus for data a DP slave returns to its DP master. This mechanism allows "Listening stations" (receivers) direct access to modified input data of remote DP slaves.

Address Areas

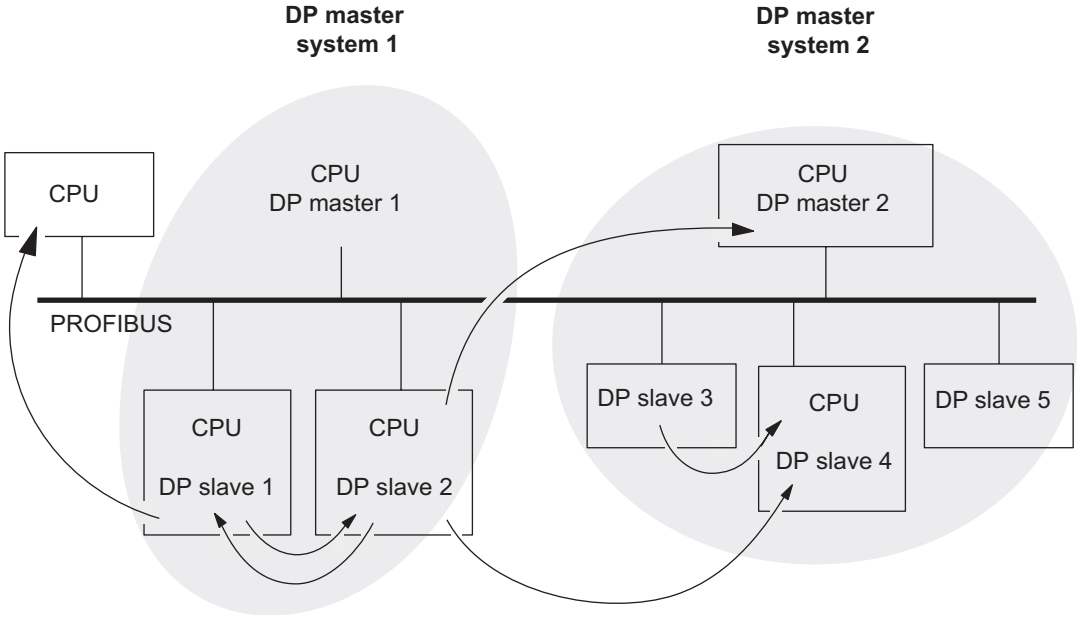
In your STEP 7 configuration of the relevant peripheral input addresses, specify which address area of the receiving node is to receive data requested from the sending node.

The following types of DP-CPU are possible:

- DP slave sending station
- Receiving station, as DP slave or DP master, or as CPU not integrated in a master system.

Example: Direct data exchange via DP CPUs

The example in the figure below shows the relationships you can configure for direct data exchange. The figure shows all DP masters and all DP slaves each as one DP CPU. Note that other DP slaves (ET 200M, ET 200X, ET 200S) can only operate as sending node.



8.6 Commissioning PROFINET IO

8.6.1 Requirements

Requirements

Requirements to be satisfied before you can start to commission your PROFINET IO system:

- You are using a CPU 31x-2 PN/DP with FW version 2.3.0 or higher.
- STEP 7 V 5.3 + SP 1 or higher is installed.
- A PROFINET IO system is installed.

PROFINET IO address areas of the CPUs

Table 8-11 PROFINET IO address areas of the CPUs

Address area	315-2 PN/DP	317-2 PN/DP
PROFINET address area, inputs and outputs respectively	2048 bytes	8192 bytes
Number of those in process image for I/Os	Byte 0 to 127	Bytes 0 to 255 [1]
[1] At a CPU 317-2 PN/DP with FW version 2.3.0 or higher, you can set a maxim number of 2047 bytes for the process image. Default setting of the CPU is byte 0 to 255.		

Diagnostics addresses occupy in the input address range 1 byte each for the IO controller, the PN interface and the IO devices (header module at slot 0), and for each module without user data within the device (power module of ET 200S, for example). You can use these addresses, for example, to read module-specific diagnostics data records by calling SFB 52. The diagnostic addresses are specified in your configuration. If you do not specify any diagnostic addresses, STEP 7 assigns these DP diagnostic addresses in ascending order, starting at the highest byte address.

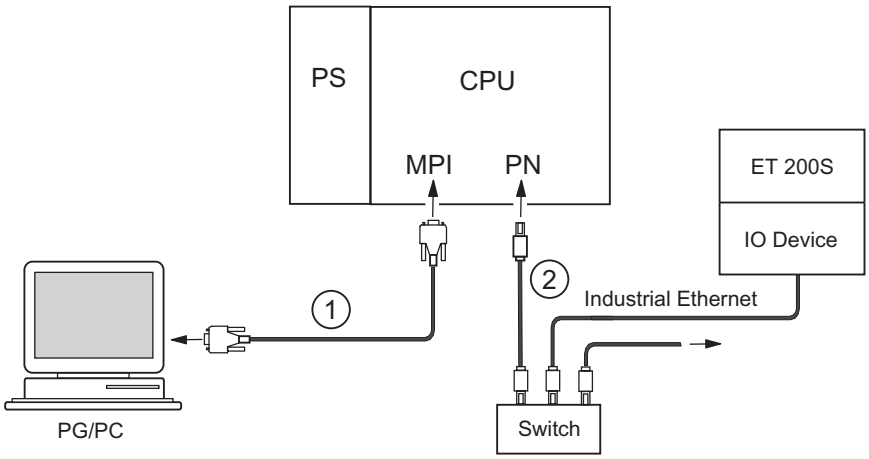
8.6.2 Configuring and commissioning the PROFINET IO system

Overview

There are several ways for you to start with commissioning the PROFINET IO interface of the CPU, and then the PROFINET IO system:

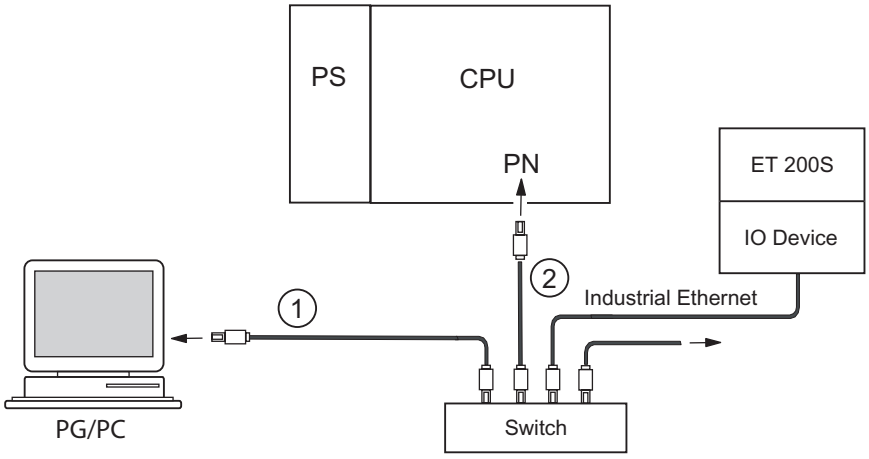
- Online via MPI/ DP interface
- Online via switch and PN interface
- Offline, by saving the data to an MMC in SIMATIC Manager on your PG, and then inserting the MMC into the CPU

Commissioning a PROFINET IO system via MPI/DP



Number	Meaning
1	Use the PG cable to connect the PG to the integrated MPI/DP interface of the CPU.
2	Use the twisted-pair patch cable to interconnect the integrated PROFINET IO interface of the CPU with the Industrial Ethernet (for example, connection to a switch).

Commissioning a PROFINET IO system directly via PN interface



Number	Meaning
1	Use a twisted-pair patch cable to connect the PG/PC to a switch
2	In the same way, connect the switch to the integrated PROFINET interface of your CPU

Commissioning requirements:

- The CPU is in STOP mode.
- The IO devices are switched on.
- The PROFINET subnet is installed, and the communication partners (PG, IO controller, IO devices, for example) are connected to the PROFINET subnet.

Configuring the PROFINET IO system

Step	Tasks
Configuring hardware in Step 7 SIMATIC Manager	
1	Select **File > New...** Assign a name to your project and confirm with OK.
2	Select **Insert > Station > SIMATIC 300 Station** to add an S7-300 station.
3	Double-click "Hardware." **Result**: HW Config opens.
4	Insert your components by means of drag-and-drop: • Mounting rail • Power supply • CPU 31x-2 PN/DP (CPU 317-2 PN/DP, V 2.3.0, for example) **Result**: The "Properties – Ethernet Interface PN-IO" dialog box opens. The properties of the PROFINET X2 interface are shown in the Parameters tab.
Assigning the IP address	
5	Click "New" on the "Properties – Ethernet Interface PN-IO" dialog box to create a new subnet. **Result**: The "Properties – New Industrial Ethernet Subnet" dialog box opens.
6	Assign a name and confirm with "OK." **Result**: You are back to the "Properties – Ethernet Interface PN-IO" dialog box.
7	Enter the IP address and the subnet mask in the dialog box. This information is available from your network administrator. Under Options, you also specify the required communication medium and duplex mode. Note: The worldwide unique MAC address is preset by the manufacturer and cannot be changed.
8	If you setup a connection via router, you must also enter the address of the router. This information is also available from your network administrator.
9	Click "OK" to close the properties dialog box.
Configuring the PROFINET IO system	
10	Insert the IO devices at the PROFINET IO system, for example, an IM 151-3 PN (ET 200S under PROFINET IO), then configure the slots and set their parameters by means of drag-and-drop, based on the physical assembly.
11	Select **Edit > Object properties** to assign device names and numbers to the IO devices.
12	To operate PROFINET IO and PROFINET CBA in parallel, adapt the PROFINET IO system properties at the "PROFINET IO communication portion" parameter in the "Update time" tab (for example, change the communication portion of PROFINET IO to 87.5 %).
13	Save your configuration with **Station > Save and compile**.

Step	Tasks
Configuration Download	
14	Download the configuration to the CPU. You have three options: • Online via MPI/ DP interface (the PG and CPU must be located on the same subnet). When you download the configuration in a system containing several node addresses, select the appropriate MPI or PROFIBUS address of the destination CPU. • Online via switch and PN interface When you download the configuration in a system containing several nodes, select the appropriate IP address of the destination CPU. Select the MAC address of the CPU if you have not assigned it an IP address yet. In the next dialog box, you can assign the configured IP address to the CPU. The PG must be connected to the subnet. The PG interface must be set to TCP/IP (Auto) mode. Setting in the **IE-PG Access** tab of the interface properties dialog box: **Assign Project-Specific IP Address**. • Offline, by saving the data to an MMC in SIMATIC Manager on your PG, and then inserting the MMC into the CPU
Assigning IO Device Names	
15	**Requirements:** The PG must be connected to the subnet. The PG interface must be set to TCP/IP (Auto) mode. Setting in the **IE-PG Access** tab of the interface properties dialog box: **Assign Project-Specific IP Address.** **Procedure:** In online mode, select the various IO devices in HW Config, then select **PLC > Ethernet > Assign Device Name** to assign the corresponding device names. **Note**: The CPU can only assign the IP address automatically, and thus enable its correct communication with the IO device, after you assigned a device name to the latter. If the configuration of the IO devices you downloaded to the CPU actually corresponds with their physical configuration on the subnet, the CPU addresses the IO devices, and the BF LED stops flashing both on the CPU and on the IO device. You can now switch the CPU to RUN, provided there are no other conditions preventing a startup, and the CPU and IO devices exchange data (read inputs, write outputs, for example).

Result

You configured the PROFINET interface X2 of your CPU and the PROFINET IO system in STEP 7. The CPU can now be reached by other nodes in your Industrial Ethernet subnet.

Reference

For detailed information on address assignment for the PROFINET IO interface, refer to the *STEP 7 Online Help*.

CPU startup for operation as IO controller

In its startup sequence, and based on the preset configuration, the CPU verifies the actual configuration

- of the local I/O,
- of the distributed I/O on the PROFIBUS DP system, and
- the PROFINET IO system.

The startup of the CPU is determined by the corresponding configuration in the "Startup" tab:

Table 8-12 CPU startup for operation as IO controller

Preset = Actual configuration	Preset ≠ Actual configuration	
	Startup permitted when Preset configuration = Actual configuration	Startup not permitted when Preset configuration = Actual configuration
CPU goes into RUN.	CPU goes into RUN. After POWER ON, and after the parameter monitoring time has expired, the CPU goes into RUN. The flashing BUSF LED indicates that at least one IO device can not be addressed. In this case, verify that all IO devices are switched on and correspond with the set configuration. For further information, read the diagnostics buffer in STEP 7.	CPU startup fails

Detecting interruptions in the data transfer to the IO device

The table below shows how the CPU 31x-2 PN/DP detects interruptions of the data transfer:

Table 8-13 Event detection by the CPU 31x-2 PN/DP operating as IO controller

Event	What happens in the IO controller?	
	CPU in RUN	CPU in STOP
Bus interrupt (short-circuit, connector removed)	• Call of OB86 with the message **Station failure** (coming event; diagnostics address of the IO device) • With I/O access: call of OB 122 (I/O access error)	• The event is written to the diagnostics buffer

Tip:

Always program OB86 when you commission the CPU. This allows you to detect and analyze interruptions in the data transfer.

Status/control, programming via PROFINET

As an alternative to the MPI interface, you can program the CPU or execute the PG's status and control functions via the PROFIBUS-DP interface.

If you have not commissioned the PROFINET interface of the CPU yet, you can connect to the CPU using its MAC address (see also **Configuring the PROFINET IO System** in the table above).

To do so, use HW Config to download your project to the CPU. Address the CPU using its MAC address. After you downloaded the configuration, the CPU is also assigned the set IP address. You can now use all PG functions at the interface, for example, Load program, Status/Control,... .

Maintenance

9

9.1 Overview

S7-300 is a maintenance-free automation system.

Thus, maintenance is considered

- The backup of the operating system on a Micro Memory Card (MMC)
- The update of operating system from MMC
- Firmware update
- Backup of project data to a Micro Memory Card (MMC)
- Replacement of modules
- Replacement of fuses in digital output modules
- Replacement of digital output module AC 120/230 V.

9.2 Backup of firmware to Micro Memory Card (MMC)

In which situations should I back up the firmware?

In some cases, we recommend that you back up your CPU firmware:

For example, you might want to replace the CPU in your system with a CPU from store. In this case, you should make sure that the shelf CPU has the same firmware that is used in the plant.

We also recommend that you create a back-up copy of the firmware for emergency situations.

For which CPUs can I back up the firmware?

You can generate a backup copy of the the firmware as of the following CPU versions:

CPU	Order number	Firmware as of	Required MMC ≥ in MB
312	as of 6ES7312-1AD10-0AB0	V 2.0.0	2
314	as of 6ES7314-1AF10-0AB0	V 2.0.0	2
315-2 DP	as of 6ES7315-2AG10-0AB0	V 2.0.0	4
312C	as of 6ES7312-5BD00-0AB0	V 1.0.0	2
313C	as of 6ES73133-5BE00-0AB0	V 1.0.0	2
313C-2 DP	as of 6ES73133-6CE00-0AB0	V 1.0.0	4
313C-2 PtP	as of 6ES73133-6BE00-0AB0	V 1.0.0	2
314C-2 DP	as of 6ES7314-6CF00-0AB0	V 1.0.0	4
314C-2 PtP	as of 6ES7314-6BF00-0AB0	V 1.0.0	2
315-2 PN/DP	as of 6ES7315-2EG10-0AB0	V 2.3.0	4
317-2 DP	as of 6ES7317-2AJ10-0AB0	V 2.1.0	4
317-2 PN/DP	as of 6ES7317-2EJ10-0AB0	V2.2.0	4

Creating a backup copy of the CPU firmware on the MMC

Table 9-1 Firmware backup to MMC

Step	Action required:	This happens in the CPU:
1.	Insert a new micro memory card into the CPU	The CPU requests memory reset
2.	Turn the mode selector switch to MRES position and hold it there.	-
3.	POWER OFF / POWER ON. Hold the mode selector switch in MRES position until ...	... the STOP, RUN and FRCE LEDs start flashing.
4.	Mode selector switch to STOP.	-
5.	Mode selector switch briefly to MRES position, then let it return to STOP.	• CPU starts backing up operating system on the MMC. • All LEDs are lit during the backup operation. • The STOP LED flashes when the backup is complete to indicate that the CPU requires a memory reset.
6.	Remove the Micro Memory Card.	-

9.3 Updating the firmware from MMC

In which situations should I update the firmware?

After (compatible) function expansions, or after an enhancement of operating system performance, the firmware should be upgraded (updated) to the latest version.

Where do I get the latest version of the firmware?

You can order the latest firmware (as *.UPD files) from your Siemens partner, or download it from the Siemens Internet homepage:

www.siemens.com/automation/service&support

Updating the CPU firmware

Table 9-2 Updating the firmware from MMC

Step	Action required:	This happens in the CPU:
1.	**Recommendation** Before you update the CPU firmware, you should create a backup copy of the "old" firmware on an empty MMC. If problems occur during the update, you can simply reload your old firmware from the MMC.	
2.	Transfer the update files to a blank MMC using STEP 7 and your programming device.	-
3.	Switch off CPU power and insert an MMC containing the firmware update.	-
4.	Switch on power.	• The CPU detects the MMC with the firmware update automatically and runs the update. • All LEDs are lit during firmware update. • The STOP LED flashes when the FW update is completed, and indicates that the CPU requires a memory reset.
5.	Switch off CPU power and remove the MMC containing the FW update.	-

9.4 Online (via networks) update of CPU FW V2.2.0 or higher.

To update the CPU firmware, you require the *.UPD files containing the latest FW version.

Requirements

- Online FW updates can be performed in STEP 7 V5.3 or higher.
- The module at the station whose firmware should be updated must be online.
- The files containing the current FW version must be available in the file system of your PG or PC. A folder may contain only the files of one firmware version.

Performing a firmware update

1. Run STEP 7 and change to HW Config.
2. Open the station containing the CPU you want to update.
3. Select the CPU.
4. Select PLC > Update Firmware. The menu command can only be executed if the selected CPU supports the "Update Firmware" function.
5. On the "Update Firmware" dialog, select the path to the FW update files (*.UPD) using the "Search" button.
6. After you selected a file, the information in the lower fields of the "Update Firmware" dialog box shows you the FW file and version for the corresponding modules.
7. Click "Run." STEP 7 verifies that the selected file can be interpreted by the module, and then downloads the file to the CPU. If this requires changing the operating state of the CPU, you will be asked to perform these tasks in the relevant dialog boxes. The CPU then automatically updates the firmware.
8. In STEP 7 (reading the CPU diagnostics buffer), verify that the CPU can start with the new firmware.

Result

You updated the CPU online with a new firmware version.

9.5 Backup of project data to a Micro Memory Card (MMC)

Function principles

Using the **Save project to Memory Card** and **Fetch project from Memory Card** functions, you can save all project data to a SIMATIC Micro Memory Card, and retrieve these at a later time. For this operation, the SIMATIC Micro Memory Card can be located in a CPU or in the MMC adapter of a PG or PC.

Project data is compressed before it is saved to a SIMATIC Micro Memory Card, and uncompressed on retrieval.

Note

In addition to project data, you may also have to store your user data on the MMC. You should therefore first verify MMC memory space.

A message warns you if the memory capacity on your MMC is insufficient.

The volume of project data to be saved corresponds with the size of the project's archive file.

Note

For technical reasons, you can only transfer the entire contents (user program and project data) using the **Save project to memory card** action.

Handling the functions

How you use the **Save project to memory card** / **Retrieve project from memory card** functions depends on the location of the SIMATIC micro memory card:

- If the micro memory card is inserted in the MMC slot, select a project level that is uniquely assigned to the CPU from the SIMATIC Manager project window (e.g. CPU, program, source or blocks). Select the **Target system > Save project to memory card** or **Target system > Retrieve project from memory card** menu command. Now the complete project data is written to / retrieved from the Micro Memory Card.
- If project data are not available on the currently used programming device (PG/PC), you can select the source CPU via "Available nodes" window. Select menu command **PLC > Show available nodes** to open the "Available nodes" window. Select the connection/CPU that contains your project data on Micro Memory Card. Now select menu command **Fetch project from Memory Card**.
- If the micro memory card is located in the MMC programming device of a PG or PC, open the "S7 memory card window using the **File > S7 Memory Card > Open** menu command. Select the **Target system > Save project to memory card** or **Target system > Retrieve project from memory card** menu command. to open a dialog in which you can select the source or target project.

Note

Project data can generate high data traffic. Especially in RUN mode with read/write access to the CPU, this can lead to waiting periods of several minutes.

Sample application

When you assign more than one member of your service and maintenance department to perform maintenance tasks on a SIMATIC PLC, it may prove difficult to provide quick access to current configuration data to each staff member.

However, CPU configuration data available locally on any CPU that is to be serviced can be accessed by any member of the service department. They can edit these data and then release the updated version to all other personnel.

9.6 Module installation / removal

Installation and wiring rules

The table below shows you points to follow when wiring, installing or removing S7-300 modules.

Rules governing	... Power supply	... CPU	... SM/FM/CP
Blade width of the screwdriver	3.5 mm (cylindrical design)		
Tightening torque • Fixing modules to the mounting rail • Connecting cables	from 0.8 N/m to 1.1 N/m from 0.5 N/m to 0.8 N/m		from 0.8 N/m to 1.1 N/m –
POWER OFF when replacing the ...	Yes		Yes
S7-300 operating mode when replacing ...	–		STOP
Load voltage OFF when replacing the ...	Yes		Yes

Initial situation

The module you want to replace is still mounted and wired. You want to install the same type of module.

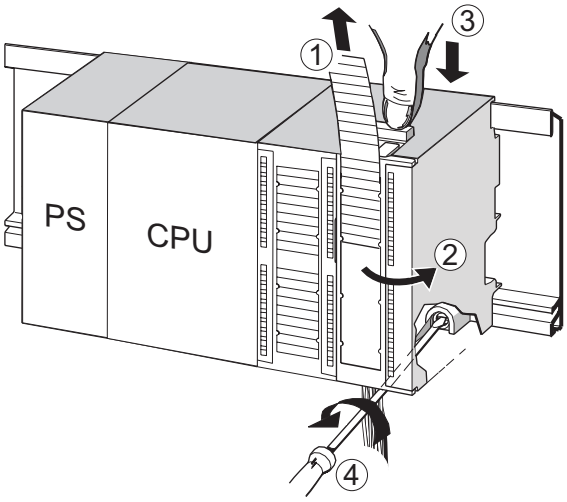
Warning

Disturbances can corrupt data if you insert or remove S7-300 modules while data are being transferred via the integrated interface of your CPU. You should never replace any modules of the S7-300 while data traffic is active at an integrated interface. If you are not certain whether or not data transfer is active on the interface, unplug the connector at the interface before you replace the module.

Removing the module (SM/FM/CP)

To remove the module:

Step	20-pin front connector	40-pin front connector
1.	Switch the CPU to STOP.	
2.	Switch off the load voltage to the module.	
3.	Remove the labeling strip from the module.	
4.	Open the front panel.	
5.	Unlock the front connector and remove it.	
	To do so, press down the unlocking mechanism with one hand and pull out the front connector at the grips using the other hand.	Remove the fixing screw from the middle of the front connector. Pull the front connector out, holding it at the grips.
6.	Undo the module fixing screw(s).	
7.	Swing the module out.	

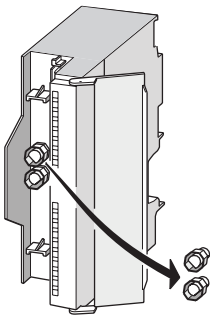


This figure illustrates the steps described:	
(1)	Remove labeling strips.
(2)	Open module.
(3)	Press unlocking mechanism/loosen mounting screw, and pull out front connector.
(4)	Remove mounting screw of module and swing module out.

Removing the front connector coding from the module

Before you start installing the new module, remove the upper part of the front connector coding pin from this module.

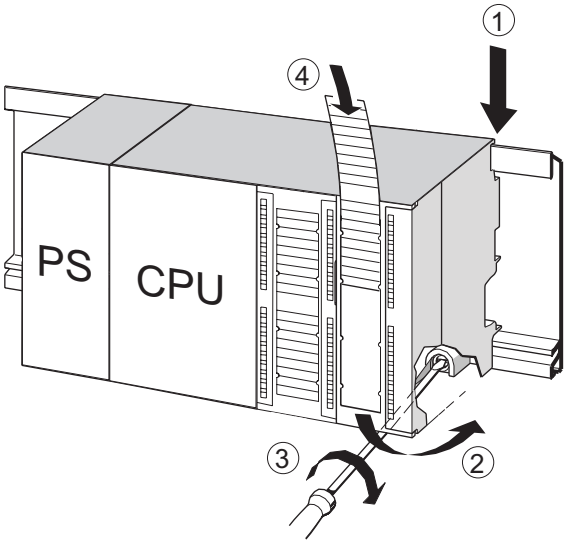
Reason: This part is already inserted in the wired front connector.



Installing a new module

To install the new module:

1. Hang in a new module of same type.
2. Swivel the module down into place.
3. Screw-tighten the module.
4. Slide the labeling strips into the module.



The figure illustrates the described steps:	
(1)	Hang module onto rail.
(2)	Swivel module downward.
(3)	Screw-tighten the module
(4)	Insert labeling strips.

Removing the front connector coding from the front connector

You may take a "used" front connector to wire another module by removing its coding mechanism:

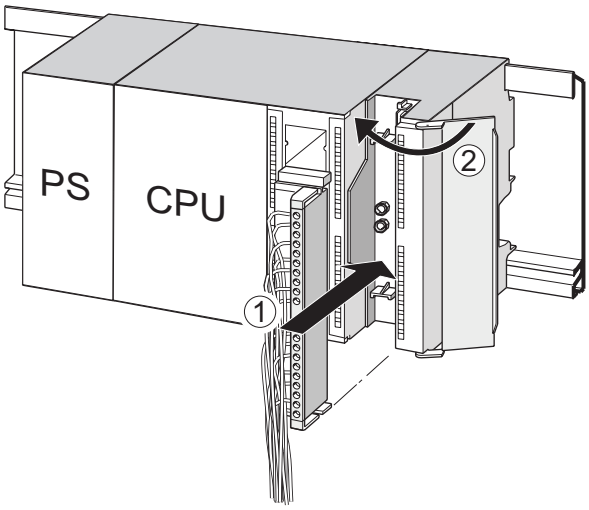
Simply use a screwdriver to push out the front connector coding.

This upper part of the coding key must then be plugged back into the old module.

Putting a new module into service

Proceed as follows to put the new module into service:

1. Open the front panel.
2. Reinstall the front connector.
3. Close the front panel.
4. Switch the load voltage back on.
5. Reset the CPU to RUN mode.



The figure illustrates the described steps:	
(1)	Move the front connector into operating position
(2)	Close front panel.

Reaction of the S7-300 after module replacement

After a module replacement, the CPU switches to run mode, provided no error has occurred. If the CPU stays in STOP, you can view the cause of error in STEP 7 (see the *STEP 7* User manual).

9.7 Digital output module AC 120/230 V: Changing fuses

Fuses for digital outputs

The digital outputs of the following digital output modules are short-circuit protected by fusing of the channel groups:

- Digit output module SM 322; DO 16 × A 120 V
- Digit output module SM 322; DO 8 × 120/230 VAC

System check

Eliminate the causes of fuse tripping.

Replacement fuses

If replacement is required, you can use the following fuses:

- 8 A, 250 V fuse
  - Wickmann 19 194-8 A
  - Schurter SP001.013
  - Littlefuse 217.008
- Fuse holder
  - Wickmann 19 653

Warning

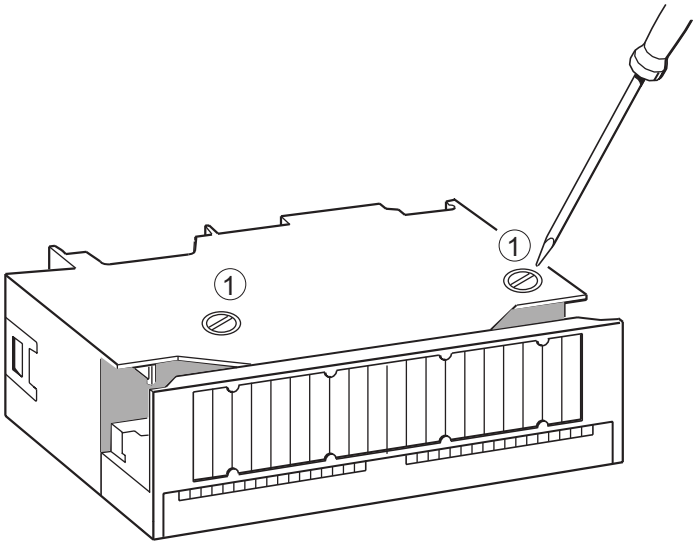
Improper handling of digital output modules could result in injury or damage to property.
There are dangerous voltages > 25 VAC or > 60 VDC beneath the covers to the right of the module.
Before you open these covers, make sure that you have either unplugged the front connector from the module or isolated the module from power.

Warning

Improper handling of front connectors could result in injury or damage to property.
When you remove the front connector while the system is in RUN, beware of dangerous live voltage > 25 VAC or > 60 VDC across the pins.
If the front connector is wired to such voltages, hot swapping of modules must always be carried out by skilled or instructed electrical staff, in order to avoid unintentional contact to the module pins.

Location of fuses in the digital module 120/230 VAC

Digital output modules are equipped with 1 fuse per channel group. The fuses are located at the left side of the digital output module. The figure below shows you the location of the fuses on digital output modules **(1)**.



Replacing fuses

The fuses are located at the left side of the module. Replace the fuses as follows:

1. Switch the CPU to STOP.
2. Switch off the load voltage of the digital output module.
3. Remove the front connector from the digital output module.
4. Loosen the fixing screw of the digital output module.
5. Swing out the digital output module.
6. Remove the fuse holder from the digital output module **(1)**.
7. Replace the fuse.
8. Screw the fuse holder back into the digital output module.
9. Reinstall the digital output module.

Debugging functions, diagnostics and troubleshooting

10

10.1 Overview

This chapter helps you to get acquainted with tools you can use to carry out the following tasks:

- Hardware/software error diagnostics.
- Elimination of hardware/software errors.
- Testing the hardware/software – for example, during commissioning.

Note

It would go beyond the scope of this manual to provide detailed descriptions of all the tools you can use for diagnostics, testing and troubleshooting functions. Further notes are found in the relevant hardware/software manuals.

10.2 Overview: Debugging functions

Determining addressed nodes with "Node flashing test" (for CPUs >= V2.2.0)

To identify the addressed node, select PLC > Diagnostics/Setting > Node/Flashing Test in STEP 7.

A dialog appears in which you can set the flashing time and start the flashing test. The directly connected node can be identified by a flashing FORCE LED. The flashing test cannot be performed if the FORCING function is active.

Debugging functions of the software: Monitoring and modifying variable, stepping mode

STEP 7 offers you the following testing functions you can also use for diagnostics:

- Monitoring and modifying variables

  Can be used for PG/PC monitoring of specific CPU or user program variables. You can also assign constant values to the variables.

- Testing with program status

  You can test your program by viewing the program status of each function (result of logical links, status bit) or the data of specific registers in real-time mode.

  For example, if you have selected the programming language LAD in STEP 7 for your presentation, the color of the symbol will indicate a closed switch or an active circuit.

Note

The STEP 7 testing function with program status extends the CPU cycle time! In STEP 7 you can customize the maximum permitted increase in cycle time (not for CPU 318-2 DP). In this case, set process mode for the CPU parameters in STEP 7.

- stepping mode

  When testing in single-step mode, you can process your program instructions in sequence (= single-step) and set break points. This is only possible in testing mode and not in process mode.

Debugging functions of the software: Forcing variables

The Force function can be used to assign the variables of a user program or CPU (also: inputs and outputs) constant values which can not be overwritten by the user program.

For example, you can use it to jumper sensors or switch outputs permanently, irrespective of the user program.

Danger

This could result in severe injury or even death, and damage to property.
Incorrect use of the Force function could result in death or severe injury, and damage to machinery or even the entire plant. Always follow the safety instructions in the *STEP 7 manuals*.

Danger

Forcing with S7-300 CPUs
The force values in the process image of the **inputs** can be overwritten by write commands (such as T IB x, = I x.y, Copy with SFC, etc.) and by read I/O commands (such as L PIW x) in the user program, or by write PG/OP functions! **Outputs** initialized with forced values only return the forced value if not accessed by the user program via peripheral write instructions (TPQB x, for example) or by PG/OP write functions!
Always ensure that forced values in the I/O process image cannot be overwritten by the user program or PG/OP functions!

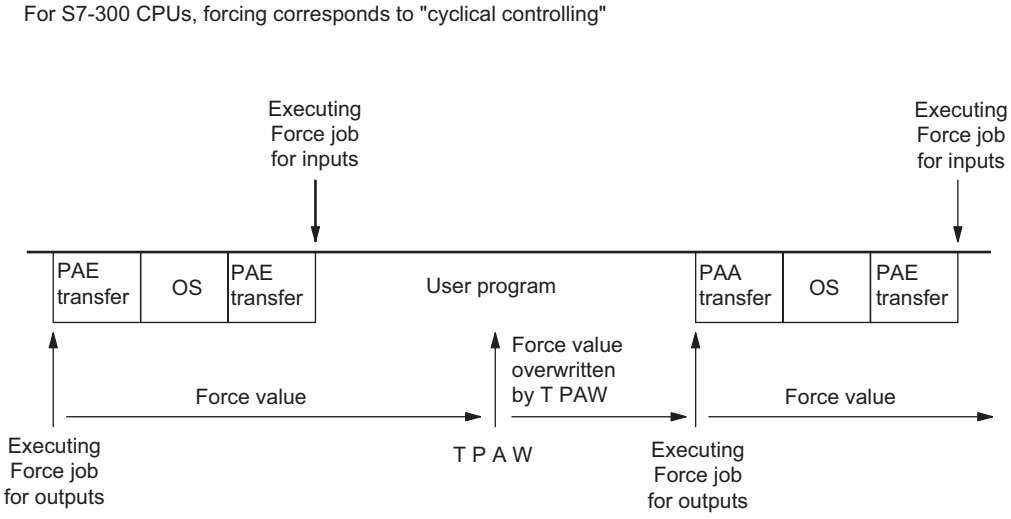


Figure 10-1 Principle of forcing in S7-300 CPUs

The differences between forcing and modifying variables

Table 10-1 The differences between forcing and modifying variables

Characteristics/function	Forcing	Modifying Variables
Memory bit (M)	-	Yes
Timers and counters (T, C)	-	Yes
Data blocks (DB)	-	Yes
Inputs and outputs (I, O)	Yes	Yes
Peripheral inputs (PI)	-	-
Peripheral outputs (PO)	-	Yes
User program can overwrite modify/force values	Yes	Yes
Maximum number of force values	10	-

Reference

Details on test functions of the software are found in the *STEP 7 Online Help* and in the *STEP 7 Programming Manual*.

10.3 Overview: Diagnostics

System errors can occur especially in the commissioning phase. Tracking these errors might be a time-consuming effort, since they can occur both on the hardware and software side. Here, the multitude of testing functions ensures commissioning without problems.

Note

Errors during **operation** are almost always a result of faults or damage to the hardware.

Type of error

Errors the S7 CPUs can recognize and to which you can react with the help of organization blocks (OBs) can be split into the following categories:

- Synchronous error: Errors you can relate to a specific point in the user program (error when accessing a peripheral module, for example).
- Asynchronous error: Errors you can **not** relate to a specific point in the user program (cycle time exceeded, module error, for example).

Error handling

Programming with foresight and, above all, knowledge and proper handling of diagnostic tools puts you into an advantageous position in error situations:

- You can reduce the effects of errors.
- It makes it easier for you to locate errors (by programming error OBs, for example).
- You can limit downtimes.

Diagnostics with LED display

SIMATIC S7 hardware offers diagnostics with LEDs.

These LEDs are implemented in three colors:

LED color	State of CPU
Green	Regular operation. Example: Power is on.
Yellow	Non-regular operating status. Example: Forcing is active.
Red	Fault. Example: Bus error
LED flashing	Special event Example: CPU memory reset

Two LEDs are used for Ethernet:

LED designation	Color	State	Meaning
LINK	Green	Off	No other device is connected with the integrated PROFINET interface of the CPU.
		On	Another device (in most cases a switch) is connected to the integrated PROFINET interface of the CPU, and the physical connection is in place.
RX/TX	Yellow	Off	No activity: No data are transferred via the integrated PROFINET interface of the CPU.
		On	Activity: Data are transferred via the integrated PROFINET interface of the CPU. Note: The LED flickers when small data volumes are transferred.

Reference

Notes on diagnostics of I/O modules capable of diagnostics are found in the relevant Manual.

Diagnostic buffer

If an error occurs, the CPU writes the cause of error to the diagnostic buffer. In *STEP 7* you can read the diagnostic buffer with your PG. This location holds error information in plain text.

Other modules capable of diagnostics can be equipped with their own diagnostic buffer. In *STEP 7* HW Config > Hardware diagnostics you can read out his buffer on your PG.

Diagnosable modules without diagnostic buffer write their error information to the CPU's diagnostic buffer.

When an error or an interrupt event occurs, (e.g. time-of-day interrupt), the CPU switches to STOP mode, or you can react in the user program via error/interrupt OBs. This would be OB82 in the above example.

Diagnostics of field devices on PROFINET

For further information, refer to the *PROFINET System Description* and to the *From PROFIBUS DP to PROFINET IO* Programming Manual. In the next chapter we will concentrate on the diagnostics of local or distributed modules on PROFIBUS.

Diagnostics with system functions

If the following CPUs are used, we recommend that you use the more user-friendly SFB 54 RALRM (called in diagnostic OB82) to evaluate the diagnostics from centralized or distributed modules or DP slaves:

CPU	As of firmware version
31xC, 312, 314, 315-2 DP	V 2.0.0
317-2 DP	V 2.1.0
317-2 PN/DP	V 2.2.0

Further options for diagnostics with system functions are listed below:

- Using SFC 51 "RDSYSST" to read an SSL partial list or an extract thereof.
- Reading the diagnostic data (slave diagnostics) of a DP slave, using SFC 13 "DPNRM_DG"

  Every DP slave provides slave diagnostic data according to EN 50 170 Volume 2, PROFIBUS. You can use SFC 13 "DPNRM_DG" to read these diagnostic data. Error information is stored in hex code. Refer to the relevant module manual for information on the meaning of the read code.

  For example, the entry of the value 50H (= dual 0101 0000) in byte 7 of the slave diagnostics for the distributed I/O module ET 200B indicates a faulty fuse or missing load voltage in channel group 2 and 3.

- Reading a data record with SFC 59 "RD_REC"

  You can use SFC 59 "RD_REC" (read record) to read a specific data record from the addressed module. Data records 0 and 1 are especially suitable for reading diagnostic information from a diagnosable module.

  Data record 0 contains 4 bytes of diagnostic data describing the current state of a signal module. Data record 1 contains the 4 bytes of diagnostic data also stored in data record 0, plus module-specific diagnostic data.

- Reading out the start information of the current OB, using SFC 6 "RD_SINFO"

  Error information is also found in the start information of the relevant error OB.

  You can use SFC 6 "RD_SINFO" (read start information) to read the start information of the OB that was last called and not yet processed completely, and of the start-up OB that was last called.

10.4 Diagnostic options with STEP 7

Diagnostics with the "Hardware Diagnostics" function

Locate the cause of a module error by viewing the online information on the module. You can locate the cause of an error in the user program cycle with the help of the diagnostic buffer and of the stack content. You can also check whether a user program will run on a specific CPU.

Hardware diagnostics give you an overview of the PLC status. In an overview representation, a symbol can display the error status of every module. A double-click on the faulty module opens detailed error information. The scope of this information depends on the specific module. You can view the following information:

- Display of general information on the module (e.g. order No., version, designation) and module status (e.g. error).
- Indication of module errors (channel error, for example) at local I/O and PROFIBUS DP slaves or PROFINET IO devices.
- Display of messages from the diagnostic buffer.
- In addition, diagnostics data about the PROFINET interface are presented.

For CPUs you can also view the following module status information:

- Cause of an error in the user program cycle.
- Indication of the cycle time (longest, shortest and last cycle).
- Options and utilization of MPI communication.
- Indication of performance data (number of possible I/O, memory bits, counters, timers and blocks).

For details on diagnostic functions in STEP 7 and on procedures, refer to the *Programming with STEP 7* Manual and to the *HW Config Online Help*.

10.5 Network Infrastructure Diagnostics (SNMP)

Network Diagnostics

SNMP (Simple Network Management Protocol) is the standardized protocol for diagnostics of the Ethernet network infrastructure and for assignment of parameters to it.

Within the office area and in automation engineering, devices of a wide range of vendors support SNMP on Ethernet.

Applications based on SNMP can be operated on the same network at the same time as applications with PROFINET.

The range of functions supported differs depending on the device type. A switch, for example, has more functions than a CP 1616.

Uses of SNMP

SNMP can be used as follows:

- By the IT administration of users of machines and plants to monitor their Industrial Ethernet network using standard network management systems.
- By users to integrate network diagnostics in a central HMI/SCADA system.
- By the IT administration to monitor primarily the office network but also in many cases the automation network using standard network management systems (for example HP Openview).
- By automation engineers (plant operator) to integrate network diagnostics in a central HMI/SCADA system using the SNMP OPC server.

Software for SNMP

As an open standard, you can use any systems or software solutions for diagnostics based on SNMP in PROFINET.

The SNMP OPC server, for example, supports SNMP.

Application Examples for SNMP

- Network administrator of IT sets parameters for switches / routers during commissioning and service
  - using vendor-specific network management software
- Network administrator of IT runs overview and detailed diagnostics during operation using the network management system
  - using vendor-specific network management software
- Plant operator runs diagnostics during operation
  - using HMI/SCADA system.
    The SNMP OPC server is required for this.

Further Information

At the Web address "www.profibus.com", you will find information on SNMP in the Network Management standardization group.

At the Web address "www.snmp.org", you will find further details on SNMP.

At the Web address "www.siemens.com/snmp-opc-server", you will find further information on the SNMP OPC server.

10.6 Diagnostics using status and error LEDs

10.6.1 Introduction

Diagnostics with LEDs is an initial tool for error localization. Usually, you evaluate the diagnostic buffer for further error localization.

The buffer contains plain text information on the error that has occurred. For example, you will find the number of the appropriate error OB here. If you generate this error OB, you can prevent the CPU from going into STOP mode.

10.6.2 Status and error displays of all CPUs

Table 10-2 Status and error displays

LED					Meaning
SF	5 VDC	FRCE	RUN	STOP	
Off	Off	Off	Off	Off	CPU power supply missing. Remedy: Check whether the power supply module is connected to mains and switched on.
Off	On	X (see the description)	Off	On	The CPU is in STOP mode. Remedy: Start the CPU.
On	On	X	Off	On	The CPU is in STOP mode as a result of error. Remedy: refer to the tables below, evaluation of the SF LED
X	On	X	Off	Flashes (0.5 Hz)	The CPU requests memory reset.
X	On	X	Off	Flashes (2 Hz)	The CPU executes memory reset.
X	On	X	Flashes (2 Hz)	On	The CPU is in startup mode.
X	On	X	Flashes (0.5 Hz)	On	The CPU was halted by a programmed break point. For details, refer to the Programming Manual *Programming with STEP 7* .
On	On	X	X	X	Hardware or software error Remedy: refer to the tables below, evaluation of the SF LED
X	X	On	X	X	You enabled the Force function For details refer to the Programming Manual *Programming with STEP 7* .
X	X	Flashes (2 Hz)	X	X	Node flashing test was activated.
Flashes	Flashes	Flashes	Flashes	Flashes	Your CPU has an internal system error. The procedure is as follows: 1. Set the mode selector switch to STOP. 2. Perform POWER ON/OFF. 3. Read the diagnostics buffer with STEP 7. 4. Contact your local SIEMENS partner.

Description of status X:
This status is irrelevant for the current CPU function.

Reference

- Details on the OBs and on SFCs required for their evaluation can be found in the *STEP 7 Online Help* and in the Manual *System Software for S7-300/400 - System and Standard Functions*.

10.6.3 Evaluating the SF LED in case of software errors

Table 10-3 Evaluation of the SF LED (Software error)

Possible errors	Response of the CPU	Remedies
TOD interrupt is enabled and triggered. However, a matching block is not loaded. (Software/configuration error)	Calls OB85. CPU does not STOP if OB85 is loaded.	Load OB10 (OB number is apparent from the diagnostic buffer).
Start time of the enabled TOD interrupt was jumped, e.g. by advancing the internal clock.	Calls OB80. CPU does not STOP if OB80 is loaded.	Disable the TOD interrupt before you set the time-of-day with SFC 29.
Delay interrupt triggered by SFC 32. However, a matching block is not loaded. (Software/configuration error)	Calls OB85. CPU does not STOP if OB85 is loaded.	Load OB 20 or 21 (CPU 317 only) (the OB number can be viewed in the diagnostic buffer).
Process interrupt is enabled and triggered. However, a matching block is not loaded. (Software/configuration error)	Calls OB85. CPU does not STOP if OB85 is loaded.	Load OB40 (OB number is apparent from the diagnostic buffer).
Status alarm is generated, but the appropriate OB55 is not loaded.	Calls OB85. CPU does not STOP if OB85 is loaded.	Load OB55
Update alarm is generated, but the appropriate OB 56 is not loaded.	Calls OB85. CPU does not STOP if OB85 is loaded.	Load OB56
Vendor-specific alarm is generated, but the appropriate OB57 is not loaded.	Calls OB85. CPU does not STOP if OB85 is loaded.	Load OB57
Access to missing or defective module upon updating the process image (software or hardware error)	Call OB 85 (depending on the configuration in HW Config). CPU goes into STOP if OB 85 is not loaded.	Load OB85, the start information of the OB contains the address of the relevant module. Replace the relevant module or eliminate the program error.
The cycle time was exceeded. Probably too many interrupt OBs called simultaneously.	Call OB80. CPU switches to STOP if OB80 is not loaded. The CPU switches to STOP despite loaded OB80 if the doubled cycle time was exceeded without retriggering cycle time 80.	Extension of the cycle time (STEP 7 – Hardware configuration), changing the program structure. Remedy: If necessary, retrigger cycle time monitoring by calling SFC 43
Programming error • Block not loaded • Wrong block number • Wrong timer/counter number • Read/write access to wrong area • Etc.	Calls OB121. CPU does not STOP if OB121 is loaded.	Eliminate the programming error. The STEP 7 testing function helps you to locate the error.

Possible errors	Response of the CPU	Remedies
I/O access errors An error has occurred when module data was accessed	Calls OB122. CPU does not STOP if OB122 is loaded.	Check module addressing in HW Config or whether a module/DP slave has failed.
Global data communication error, e.g. insufficient length of the DB for global data communication.	Calls OB87. CPU does not STOP if OB87 is loaded.	Check global data communication in STEP 7. If required, correct the DB size.

Tip:

- You can use SFC 39 to disable all interrupts and asynchronous error events.
- You can set the times in the cyclic interrupt OB32 and OB35, starting from 1 ms.

Note

The shorter the selected cyclic interrupt period, the more likely it is that cyclic interrupt errors will occur. You must take into account the operating system times of the CPU in question, the user program runtime and extension of the cycle time by active PG functions, for example.

Reference

Details on the OBs and on SFCs required for their evaluation can be found in the *STEP 7 Online Help* and in the Manual *System Software for S7-300/400 - System and Standard Functions*.

10.6.4 Evaluating the SF LED in case of hardware errors

Table 10-4 Evaluation of the SF LED (Hardware error)

Possible errors	Response of the CPU	Remedies
A module was removed or inserted while the system was in RUN.	CPU goes into STOP.	Screw-tighten the modules and restart the CPU.
A distributed module was removed or inserted on PROFIBUS DP while the system was in RUN.	Calls OB86. CPU does not STOP if OB86 is loaded. When the module is integrated by means of GSD file: Call of OB82. CPU goes into STOP when OB82 is not loaded.	Load OB86 or OB82.
A distributed module was removed or inserted on PROFINET IO while the system was in RUN.	Call of OB 83. CPU goes not STOP if OB 83 is not loaded. OB 86 is also called when one or several modules of an ET 200S (IO device) are removed or inserted while the system is in RUN. CPU switches to STOP if OB86 is not loaded.	Load OB 83 and OB 86.
A diagnosable module reports a diagnostic interrupt.	Calls OB82. CPU goes into STOP if OB 82 is not loaded.	Reaction to the diagnostic event, based on the module configuration.
Attempt to access a missing or faulty module. Loose connector (software or hardware error).	Call of OB85, if access was attempted during update of the process image (OB 85 call must be enabled accordingly in the parameters). Call of OB122 with direct I/O access. CPU switches to STOP if the OB is not loaded.	Load OB 85, the start information of the OB contains the address of the relevant module. Replace the relevant module, tighten the plug or eliminate the program error.
MMC is defective.	The CPU goes into STOP mode and requests memory reset.	Replace MMC, reset CPU memory, transfer the program again, then set the CPU to RUN mode.

Reference

Details on the OBs and on SFCs required for their evaluation can be found in the *STEP 7 Online Help* and in the Manual *System Software for S7-300/400 - System and Standard Functions*.

10.6.5 Status and Error Indicators: CPUs with DP Interface

Description of the BUSF, BUSF1 and BUSF2 LEDs

Table 10-5 BUSF, BUSF1 and BUSF2 LEDs

LED					Meaning
SF	5 VDC	BUSF	BUSF1	BUSF2	
On	On	On/ flashes	-	-	PROFIBUS DP interface error. Remedy: See table below
On	On	-	On/ flashes	X	Error at the first PROFIBUS DP interface of CPU 317-2 DP. Remedy: See the table below
On	On	-	X	On/ flashes	Error at the second PROFIBUS DP interface of CPU 317-2 DP. Remedy: See the tables below

Description of status X:
The LED can assume the On or Off state. This status, however, is irrelevant for the current CPU function. For example, the states Force On or Off do not influence the CPU STOP status

Table 10-6 BUSF LED is lit

Possible errors	CPU reaction	Remedies
• Bus fault (hardware fault). • DP interface error. • Different transmission rates in multiple DP master mode. • If the DP slave / master interface is active: short-circuit on the bus. • With passive DP slave interface: transmission rate search, i.e. there are no other active nodes on the bus (a master, for example)	Call of OB86 (when CPU is in RUN mode). CPU switches to STOP if OB86 is not loaded.	• Check the bus cable for short-circuit or breaks. • Analyze the diagnostic data. Edit the configuration.

Table 10-7 BUSF LED flashes

Possible errors	CPU reaction	To correct or avoid error
The CPU is DP master: • Failure of a connected station • At least one of the configured slaves cannot be accessed. • Faulty configuration	Call of OB 86 (when CPU is in RUN mode). CPU switches to STOP if OB 86 is not loaded.	Verify that the bus cable is connected to the CPU, or that the bus is not interrupted. Wait until the CPU has completed its startup. If the LED does not stop flashing, check the DP slaves or evaluate the diagnostic data for the DP slaves.
The CPU is active DP slave Possible causes: • The response monitoring time has expired. • PROFIBUS DP communication is down. • Wrong PROFIBUS address. • Faulty configuration	Call of OB 86 (when CPU is in RUN mode). CPU switches to STOP if OB 86 is not loaded.	• Check the CPU. • Verify that the bus connector is properly seated. • Check for breaks in the bus cable to the DP master. • Check the configuration data and parameters.

Reference

Details on the OBs and on SFCs required for their evaluation can be found in the *STEP 7 Online Help* and in the Manual *System Software for S7-300/400 - System and Standard Functions*.

10.6.6 Status displays: CPUs with PN Interface

Status and Error Indicators: PROFINET devices

Note

The RX and TX LEDs can be combined in one LED, same as on CPU 317-2 DP/PN or CP 343-1 The LED on this device is located, for example, behind the front cover.

LED	LED status			Description of the status
	Not lit	Flashes	Lit	
LINK	-	-	X	The Ethernet connection between the PROFINET interface X2 of your PROFINET device and a communication partner is up (for example, a switch).
	-	X	-	Only with an IO device: The user activated flashing from STEP 7.
	X	-	-	The Ethernet connection between the PROFINET interface of the PROFINET device and the communication partner is down.
RX	-	-	X (flickers)	At the current time, data are being received from a communication partner on Ethernet via PROFINET interface of the PROFINET device.
	X	-	-	No data are currently received via the PROFINET interface.
TX	-	-	X (flickers)	Data are currently sent to a communication partner on Ethernet via the PROFINET interface of the PROFINET device.
	X	-	-	No data are currently transmitted via the PROFINET interface.
BF2 or BUSF	-	-	X	Error on the PROFINET interface, communication no longer possible (for example, with a CPU as IO controller, when the connection to the switch is down) To correct or avoid error: See the table below
	-	X	-	Error on the PROFINET interface (for example, due to station failure of one or more IO devices) To correct or avoid error: See the table below
	X	-	-	No error at the PROFINET interface

To correct or avoid error on the PROFINET Interface - BF2/ BUSF LED is lit

Table 10-8 BF2/ BUSF LED is lit

Possible errors	Reaction based on the example of a CPU	To correct or avoid error:
• Bus problem (no physical connection to a subnet/switch) • Wrong transmission speed • Full duplex mode not set	Call of OB 86 (when CPU is in RUN mode). CPU switches to STOP if OB 86 is not loaded.	• Check the bus cable for a short-circuit or break. • Check that the module is connected to a switch and not to a hub. • Check that data are being transmitted at 100 Mbps and in full duplex mode. • Analyze the diagnostic data. Edit the configuration.

To correct or avoid error on the PROFINET Interface of an IO Controller - BF2/ BUSF LED flashes

Table 10-9 BF2/ BUSF LED flashes on a PROFINET IO controller

Possible errors	Reaction based on the example of a CPU	To correct or avoid error:
• Failure of a connected IO device • At least one of the assigned IO devices cannot be addressed • Faulty configuration	Call of OB 86 (when CPU is in RUN mode). CPU switches to STOP if OB 86 is not loaded.	• Check that the Ethernet cable is connected to the module or whether the bus is interrupted. • Wait until the CPU has completed its startup. If the LED does not stop flashing, check the IO devices or evaluate its diagnostic information. • Verify that the configured device name matches its actually assigned name.

See also

Evaluating the SF LED in case of software errors (Page 10-11)

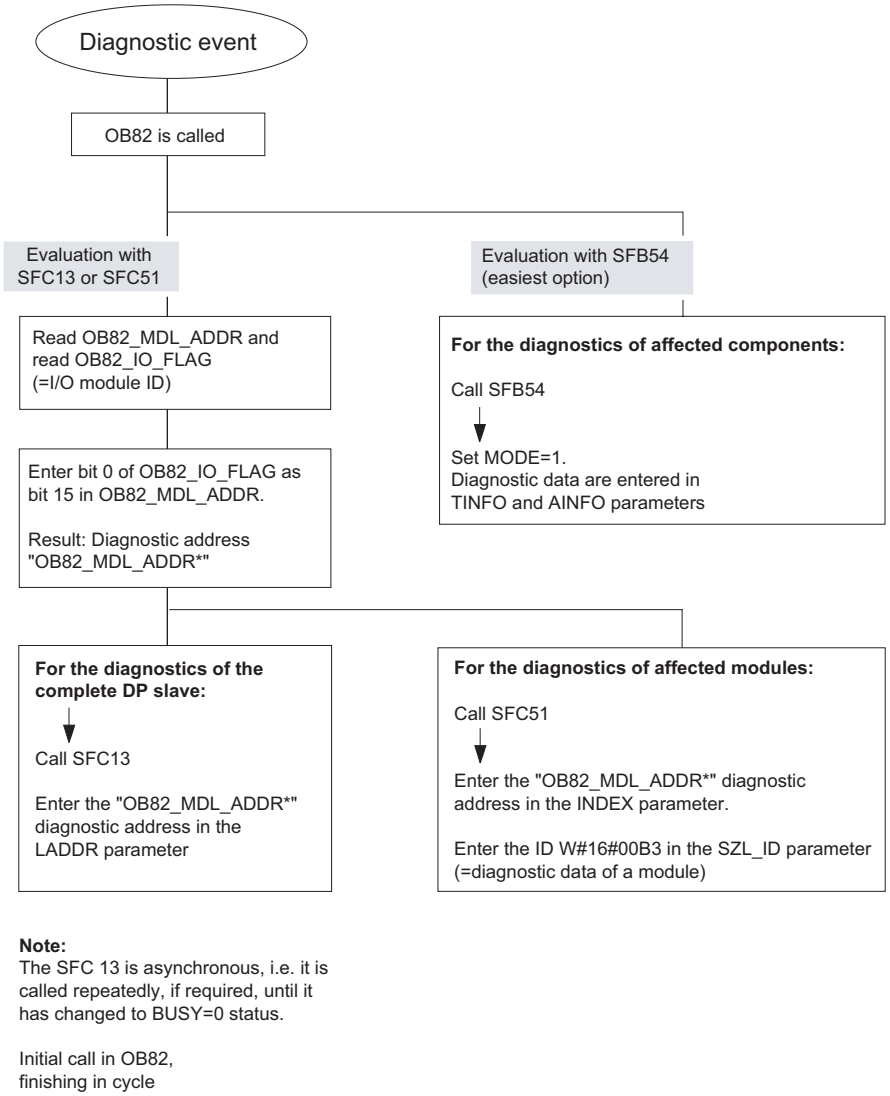
Evaluating the SF LED in case of hardware errors (Page 10-13)

10.7 Diagnostics of DP CPUs

10.7.1 Diagnostics of DP CPUs operating as DP Master

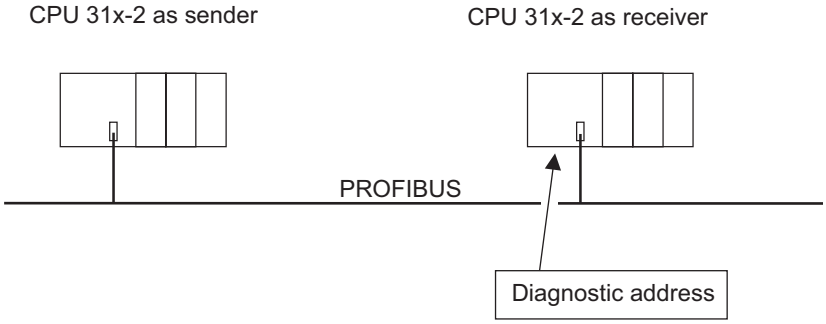
Evaluate diagnostics in the user program

The figure below illustrates the procedure for evaluating diagnostics data in the user program.



Diagnostic addresses for DP masters and DP slaves

At a CPU 31x-2, you assign diagnostic addresses for PROFIBUS DP. Verify in your configuration that the DP diagnostic addresses are assigned once to the DP master and once to the DP slave.



Information on DP master configuration	Information on DP slave configuration
When you configure the DP master, assign two different diagnostic addresses for an intelligent slave, that is, one diagnostic address for slot 0, and one for slot 2. Functions of those two addresses: • The diagnostic address for slot 0 reports in the master all events relating to the entire slave (station representative), for example, node failure. • The diagnostic address for slot 2 is used to report events concerning this slot. For example, if the CPU is acting as an intelligent slave, it returns the diagnostic interrupts for operating state transitions. Hereinafter, these diagnostic addresses are referred to as *assigned to the DP master*. These diagnostic addresses are used by the DP master to obtain information about the status of DP slave, or about bus interruptions.	When you configure the DP slave, you also assign it a diagnostic address (in the associated DP slave project). Below, this diagnostic address is labeled *assigned to DP slave*. This diagnostic addresses is used by the DP slave to obtain information on the status of the DP master, or on bus interruptions.

Event detection

The table below shows how a CPU 31x-2 operating as DP master detects operating mode transitions of a CPU operating as DP slave, or data exchange interruptions.

Table 10-10 Event detection of CPU 31x-2 operating as DP master

Event	What happens in the DP master?
Bus interrupt (short-circuit, connector removed)	• Call of OB 86 with the message **Station failure** (incoming event; diagnostic address of Slot 0 of the DP slave that is assigned to the DP master) • with I/O access: call of OB 122 (I/O access error)
DP slave: RUN → STOP	• Call of OB 82 with the message **Module error** (incoming event; diagnostic address of Slot 2 of the DP slave that is assigned to the DP master; Variable OB82_MDL_STOP=1)
DP slave: RUN → STOP	• Call of OB 82 with the message **Module OK** (outgoing event; diagnostic address of Slot 2 of the DP slave that is assigned to the DP master; Variable OB82_MDL_STOP=0)

Evaluation in the user program

The table below shows how you can, for example, evaluate RUN to STOP transitions of the DP slave in the DP master.

Table 10-11 Evaluating RUN to STOP transitions of the DP slave in the DP master

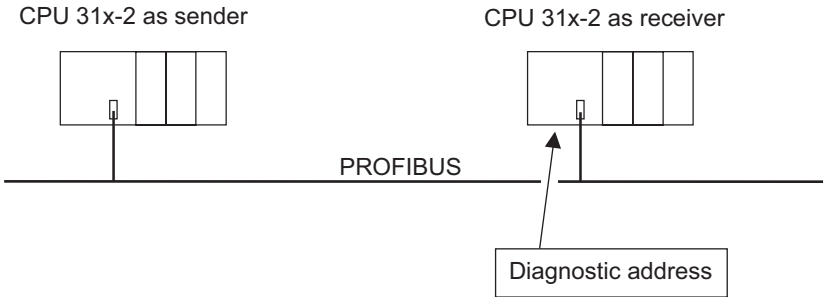
In the DP master	In the DP slave (CPU 31x-2 DP)
Diagnostic addresses: (Example) Master diagnostic address = **1023** Slave diagnostic address = **1022** (Slot 0 of slave) (Diagnostic) address for "Slot 2"= **1021** (Slot 2 of slave)	Diagnostic addresses: (Example) Slave diagnostic address = **422** Master diagnostic address = irrelevant
The CPU calls OB82 with the following information: • OB82_MDL_ADDR:= **1021** • OB82_EV_CLASS:=B#16#39 (incoming event) • OB82_MDL_DEFECT: = Module error Tip: The CPU diagnostic buffer also contains this information In the user program you should also include SFC 13 "DPNRM_DG" for reading out DP slave diagnostic data.	CPU: RUN -> STOP The CPU generates a DP slave diagnostics message frame

10.7.2 Reading out slave diagnostic data

The slave diagnostic data is compliant with EN 50170, Volume 2, PROFIBUS. Depending on the DP master, diagnostic data for all DP slaves conforming to standard can be read with STEP 7.

Diagnostic addresses for the receiving station with direct data exchange

For direct data exchange, you assign a diagnostic address in the receiving station:



In this figure, you see that assign a diagnostic address to the receiving station in your configuration. The receiving station receives information about the status of the transmitting station or about a bus interruption by means of this diagnostic address.

Reading out the diagnostic data

The table below shows you how the various DP master systems can read diagnostic information from a slave.

Table 10-12 Reading out diagnostic data in the master system, using STEP 5 and STEP 7

Automation system with DP master	Blocks or registers in STEP 7	Application	Further Information
SIMATIC S7/M7	"DP slave diagnostics" tab	Output of slave diagnostic data in plain text to a STEP 7 user interface	Found under the keyword *Hardware diagnostics* in the STEP 7 Online Help and in the *Programming STEP 7* Manual
	SFB 54 "RALRM"	Reading additional interrupt information from a DP slave or local module from the relevant OB.	*System and Standard Functions* Reference Manual
	SFC 13 “DP NRM_DG”	Reading slave diagnostic data (stored in the data area of the user program)	*System and Standard Functions* Reference Manual
	SFC 51 “RDSYSST”	Reading SSL sublists. In the diagnostic interrupt, call SFC 51 with the SSL ID W#16#00B4, and then read out the SSL of the slave CPU.	*System and Standard Functions* Reference Manual

Automation system with DP master	Blocks or registers in STEP 7	Application	Further Information
	SFB 52 “RD_REC” and SFC 59 “RD_REC”	Reading the data records of S7 diagnostics (stored in the data area of the user program)	*System and Standard Functions* Reference Manual
	FB 125/FC 125	Evaluating slave diagnostic data	On the Internet at http://www.ad.siemens.de/simatic-cs, article ID 387 257
SIMATIC S5 with IM 308-C operating in DP master mode	FB 192 “IM308C”	Reading slave diagnostic data (stored in the data area of the user program)	*Distributed I/O System ET 200* Manual
SIMATIC S5 with S5-95U PLC operating in DP master mode	FB 230 “S_DIAG”		

Example of reading slave diagnostic data, using FB 192 "IM 308C"

This shows you an example of how to use FB 192 in the **STEP 5** user program to read out slave diagnostics data for a DP slave.

Assumptions regarding the STEP 5 user program

For this **STEP 5** user program it is assumed that:

- The IM 308-C operating in DP master mode uses the page frames 0 to 15 (number 0 of IM 308-C).
- The DP slave is assigned PROFIBUS address 3.
- Slave diagnostics data should be stored in DB 20. You may also use any other DB.
- Slave diagnostic data has a length of 26 bytes.

STEP 5 user program

```
STL                                  Description
       :A      DB 30
       :SPA    FB 192
Name   :IM308C
DPAD   :       KH F800               //Default address area of IM 308-C
IMST   :       KY 0, 3               //IM no. = 0, PROFIBUS address of the DP slave = 3
FCT    :       KC SD                 //function: Read slave diagnostics
GCGR   :       KM 0                  //not evaluated
TYP    :       KY 0, 20              //S5 data area: DB 20
STAD   :       KF +1                 //Diagnostic data starting at data word 1
LENG   :       KF 26                 //Length of diagnostic data = 26 bytes
ERR    :       DW 0                  //Error code storage in DW 0 of DB 30
```

Example of reading out S7 diagnostic data with SFC 59 "RD REC"

Here you will find an example of how to use SFC 59 in the STEP 7 user program to read S7 diagnostics data records for a DP slave. The process of reading the slave diagnostics is similar to SFC 13.

Assumptions regarding the STEP 7 user program

Exceptions for this STEP 7 user program:

- Diagnostic data for the input module at address 200_H is to be read.
- Data record 1 is to be read out.
- Data record 1 is to be stored in DB 10.

STEP 7 user program

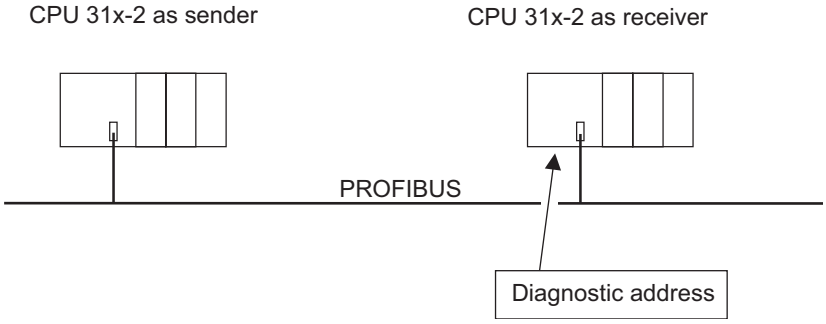
```
STL                                    Description
CALL SFC 59

REQ      :=TRUE                        //Request to read
IOID     :=B#16#54                     //Identifier of the address area, here the I/O input
LADDR    :=W#16#200                    //Logical address of the module
RECNUM   :=B#16#1                      //Data record 1 is to be read
RET_VAL  :=MW2                         //An error code is output if an error occurs
BUSY     :=MO.0                        //Read operation not finished
RECORD   :=P# DB10.DBX 0.0 BYTE 240    //DB 10 is target area for the read data record 1
```

Note:

Data is only returned to the target area if BUSY is reset to 0 and if no negative RET_VAL has occurred.

Diagnostic addresses

At a CPU 31x-2, you assign diagnostic addresses for PROFIBUS DP. Verify in your configuration that the DP diagnostic addresses are assigned once to the DP master and once to the DP slave.



Description of the DP master configuration	Description of the DP slave configuration
When you configure the DP master, assign two different diagnostic addresses for an intelligent slave, that is, one diagnostic address for slot 0, and one for slot 2. Functions of those two addresses: • The diagnostic address for slot 0 reports in the master all events relating to the entire slave (station representative), for example, node failure. • The diagnostic address for slot 2 is used to report events concerning this slot. For example, if the CPU is acting as an intelligent slave, it returns the diagnostic interrupts for operating state transitions. From now on, these diagnostic addresses are referred to as *assigned to the DP master*. These diagnostic addresses are used by the DP master to obtain information about the status of of DP slave, or about bus interruptions.	When you configure the DP slave, you also assign it a diagnostic address (in the associated DP slave project). Below, this diagnostic address is labeled *assigned to DP slave*. This diagnostic addresses is used by the DP slave to obtain information on the status of the DP master, or on bus interruptions.

Event recognition

The table below shows how CPU 31x-2 operating as DP slave recognized operating state transitions or data exchange interruptions.

Table 10-13 Event recognition of CPUs 31x-2 operating in DP slave mode

Event	What happens in the DP slave?
Bus interrupt (short-circuit, connector removed)	• Calls OB86 with the message **Station failure** (incoming event; diagnostic address of the DP slave, assigned to the DP slave) • With I/O access: call of OB 122 (I/O access error)
DP master RUN → STOP	• Calls OB82 with the message **Module error** (incoming event; diagnostic address of the DP slave assigned to the DP slave; Variable OB82_MDL_STOP=1)
DP master RUN → STOP	• Call of OB82 with the message **Module OK.** (outgoing event; diagnostic address of the DP slave, assigned to the DP slave; Variable OB82_MDL_STOP=0)

Evaluation in the user program

The table below shows an example of you how you can evaluate RUN-STOP transitions of the DP master in the DP slave (see also the previous table).

Table 10-14 Evaluating RUN-STOP transitions in the DP Master/DP Slave

In the DP master	In the DP slave
Diagnostic addresses: (Example) Master diagnostic address = **1023** Slave diagnostic address in the master system= **1022** (Slot 0 of slave) (Diagnostic) address for "Slot 2"= **1021** (Slot 2 of slave)	Diagnostic addresses: (Example) Slave diagnostic address = **422** Master diagnostic address = irrelevant
CPU: RUN → STOP	The CPU calls OB82 with the following information, for example: • OB82_MDL_ADDR:= 422 • OB82_EV_CLASS:=B#16#39 (incoming event) • OB82_MDL_DEFECT: = Module error Tip: The CPU diagnostic buffer also contains this information

10.7.3 Interrupts on the DP Master

Interrupts with S7 DP master

Process interrupts from an intelligent slave with SFC 7

In the CPU 31x-2 operating in DP slave mode, you can trigger a user-defined process interrupt from the DP master from the user program.

A call of SFC 7 "DP_PRAL" triggers the execution of OB 40 in the user program on the DP master. The SFC 7 allows you to forward interrupt information to the DP master in a double word. This information can then be evaluated in the OB40_POINT_ADDR variable in the OB40. The interrupt information can be programmed user-specific. For a detailed description of SFC 7 "DP_PRAL", refer to the *System Software for S7-300/400 - System and Standard Functions* Reference Manual.

Setting user-defined interrupts of Intelligent Slaves using SFB 75

In the CPU 31x-2 operating in DP slave mode, you can trigger user-defined interrupts from the user program in the DP master. SFB 75 "SALRM" is used to send a process or diagnostic interrupt from a slot in the transfer area (virtual slot) to the associated DP master from the user program on an intelligent slave. This starts the associated OB on the DP master.

Additional interrupt-specific information may be included. You can read this additional information in the DP master using SFB 54 "RALRM."

Interrupts with another DP master

When CPU 31x-2 operates with another DP master, an image of these interrupts is created in its device-specific diagnostic data. You have to post-process the relevant diagnostic events in the DP master's user program.

Note

In order to allow the evaluation of diagnostics and process interrupts by means of device-specific diagnostics using a different DP master, please note that:

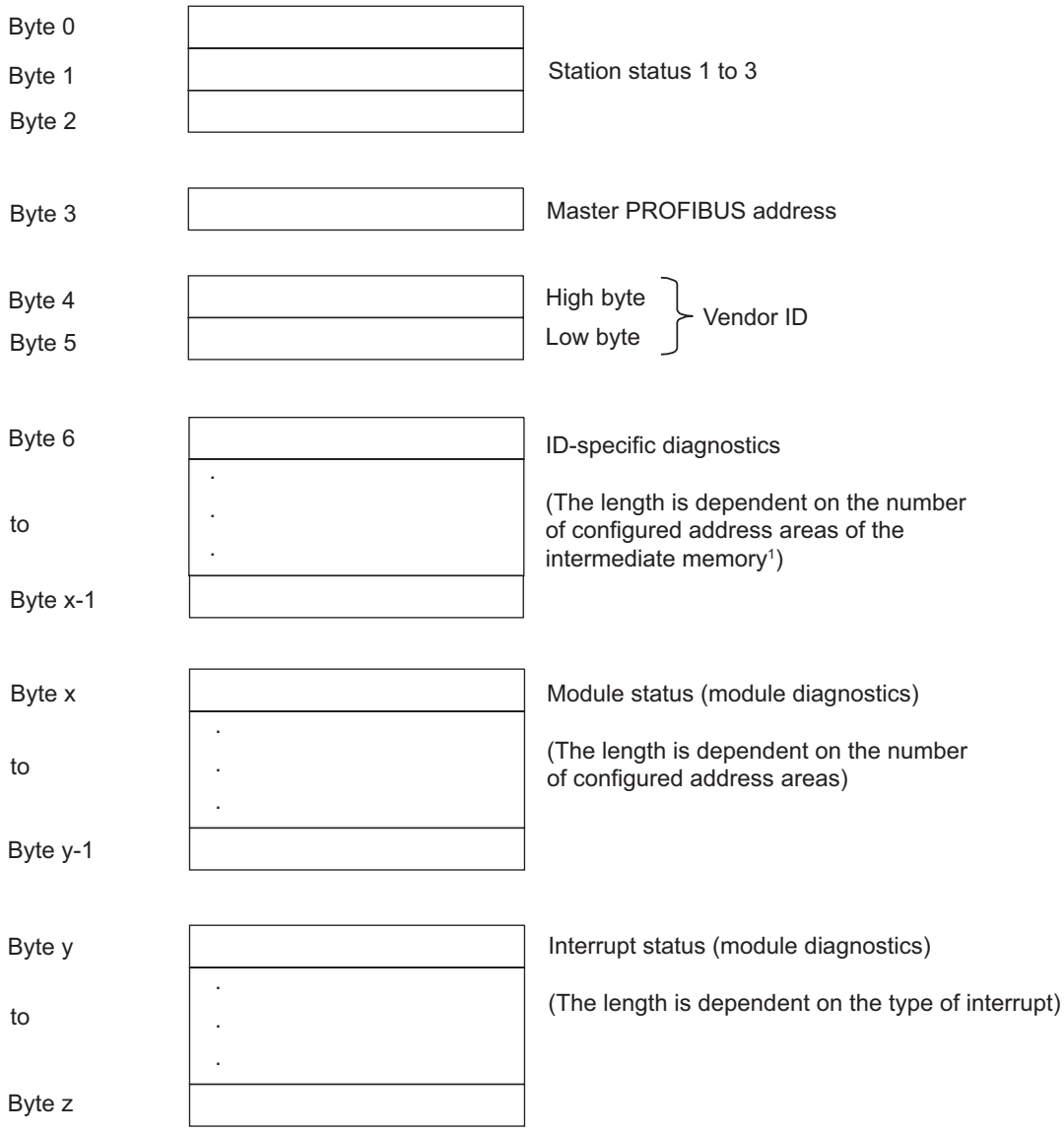
The DP master should be able to save the diagnostics messages to its ring buffer. For example, if the DP master can not save the diagnostic messages, only the last incoming diagnostic message would be saved.

In your user program, you have to poll the relevant bits in the device-specific diagnostic data in cyclic intervals. Make allowances for the PROFIBUS DP bus cycle time, for example, to be able to poll these bits at least once and in synchronism to the bus cycle time.

With an IM 308-C operating in DP master mode, you cannot utilize process interrupts in device-specific diagnostics, because only incoming events are reported, rather than outgoing events.

10.7.4 Structure of slave diagnostic data when the CPU is operated as Intelligent Slave

Syntax of the diagnostics datagram for slave diagnostics



[1]Exception: If the DP master is incorrectly configured,
the DP slave interprets 35 configured address ranges (46H in byte 6).

Figure 10-2 Structure of slave diagnostic data

Station Status 1

Table 10-15 Structure of station status 1 (Byte 0)

Bit	Meaning	Remedy
0	**1:** DP slave cannot be addressed by DP master.	• Is the correct DP address set on the DP slave? • Is the bus connector in place? • Does the DP slave have power? • Correct configuration of the RS485 Repeater? • Perform a reset on the DP slave.
1	**1:** DP slave is not ready for data exchange.	• Wait for the slave to complete start-up.
2	**1:** Configuration data sent by DP master to the DP slave is inconsistent with slave configuration.	• Was the software set for the correct station type or DP slave configuration?
3	**1:** Diagnostic interrupt, generated by a STOP to RUN transition on the CPU or by the SFB 75 **0:** Diagnostic interrupt, generated by a STOP to RUN transition on the CPU or by the SFB 75	• You can read the diagnostic data.
4	**1:** Function not supported; e.g. changing the DP address at software level	• Check configuration data.
5	**0:** This bit is always "0".	• -
6	**1:** DP slave type inconsistent with software configuration.	• Was the software set for the right station type? (parameter assignment error)
7	**1:** DP slave was configured by a DP master other than the master currently accessing the slave.	• The bit is always 1 if, for example, you are currently accessing the DP slave via PG or a different DP master. The configuring master's DP address is located in the "Master PROFIBUS Address" diagnostics byte.

Station Status 2

Table 10-16 Structure of station status 2 (Byte 1)

Bit	Meaning
0	**1:** The DP slave requires new parameters and configuration.
1	**1:** A diagnostic message was received. The DP slave cannot resume operation until the error has been cleared (static diagnostic message).
2	**1:** This bit is always "1" if a DP slave exists with this DP address.
3	**1:** The watchdog monitor is enabled on this DP slave.
4	**1:** DP slave has received control command "FREEZE".
5	**1:** DP slave has received control command "SYNC".
6	**0:** This bit is always "0."
7	**1:** DP slave is disabled, that is, it has been excluded from cyclic processing.

Station Status 3

Table 10-17 Structure of station status 3 (Byte 2)

Bit	Meaning
0 to 6	**0:** These bits are always "0"
7	**1:**The incoming diagnostic messages exceeds the memory capacity of the DP slave. The DP master cannot write all diagnostic messages sent by the DP slave to its diagnostic buffer.

Master PROFIBUS address

The "Master PROFIBUS address" diagnostic byte stores the DP address of the DP master:

- that has configured the DP slave and
- has read and write access to the DP slave.

Table 10-18 Structure of the Master PROFIBUS address (byte 3)

Bit	Meaning
0 to 7	DP address of the DP master that has configured the DP slave and has read/write access to that DP slave.
	FFH: DP slave was not configured by a DP master

Vendor ID

The vendor ID contains a code specifying the type of the DP slave.

Table 10-19 Structure of the manufacturer ID (byte 4 and 5)

Byte 4	Byte 5	Vendor ID for the CPU
80_H	$D0_H$	313C-2-DP
80_H	$D1_H$	314C-2-DP
80_H	EE_H	315-2 DP
81_H	17_H	315-2 PN/DP
80_H	$F0_H$	317-2 DP
80_H	$F1_H$	317-2 PN/DP

Structure of module diagnostics of CPU 31x-2

Module diagnostics indicate the configured address area of intermediate memory that has received an entry.

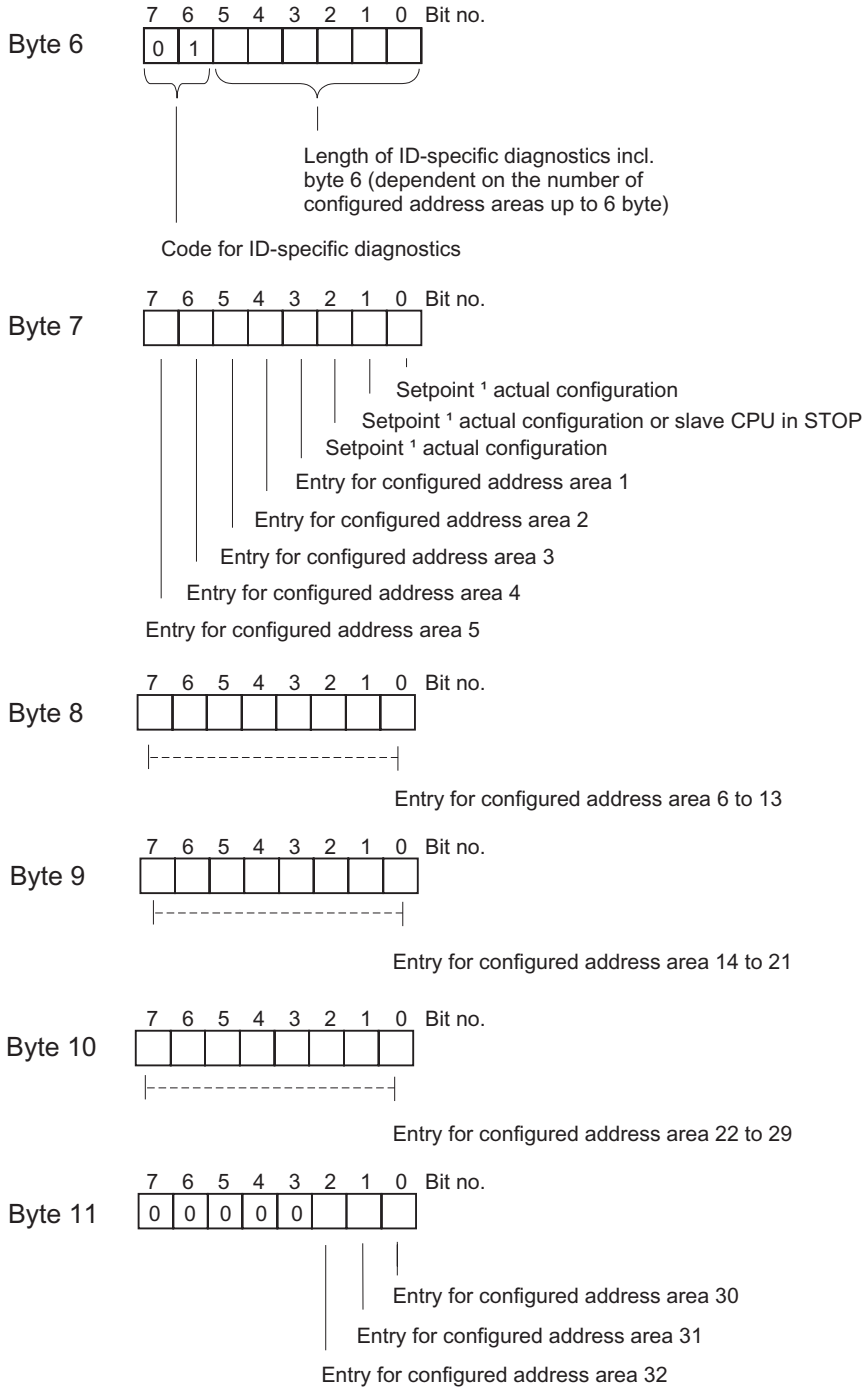


Figure 10-3 Module diagnostics

Structure of the module status

The module status reflects the status of the configured address areas, and provides detailed ID-specific diagnostics with respect to the configuration. Module status starts with module diagnostics and consists of a maximum of 13 bytes.

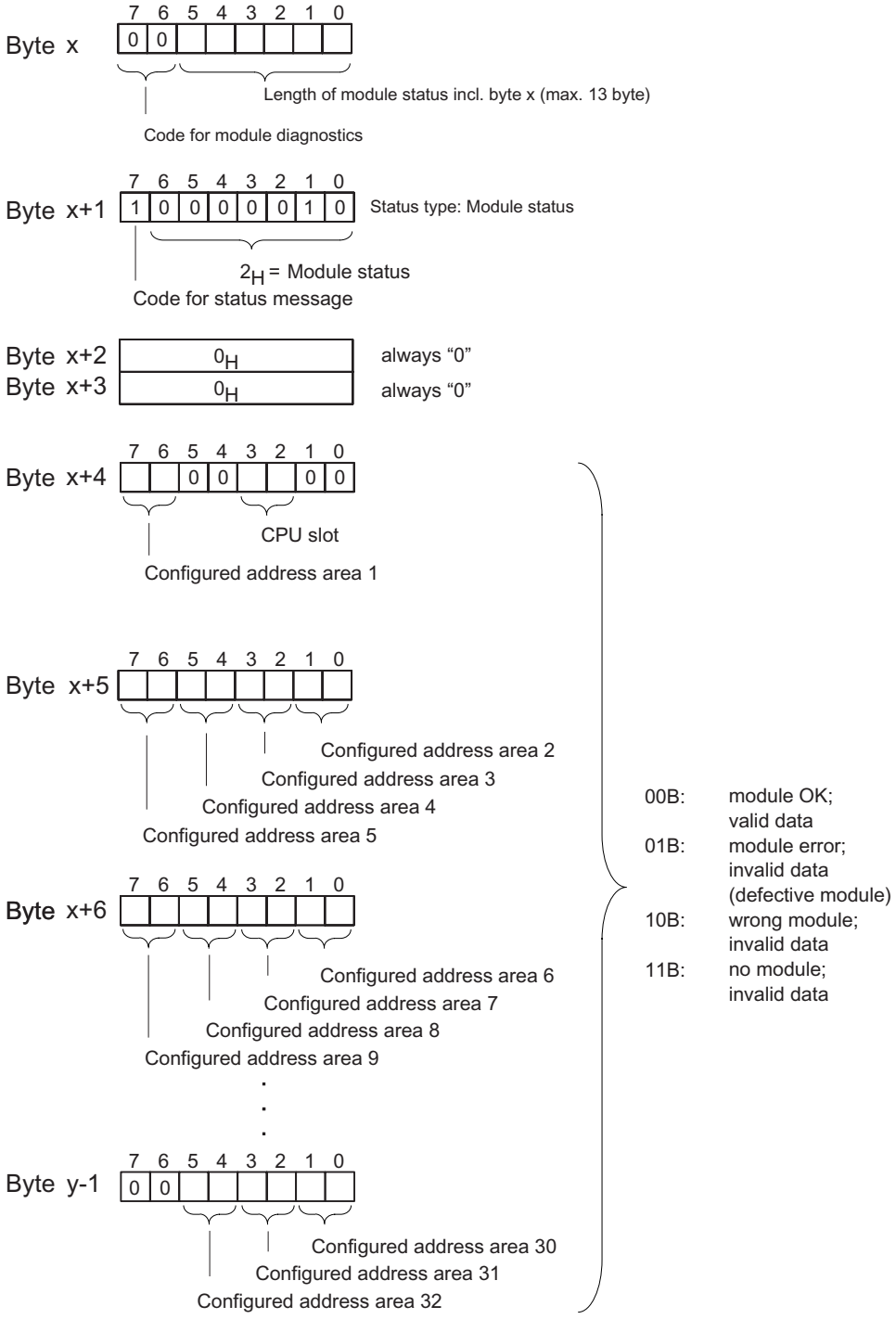
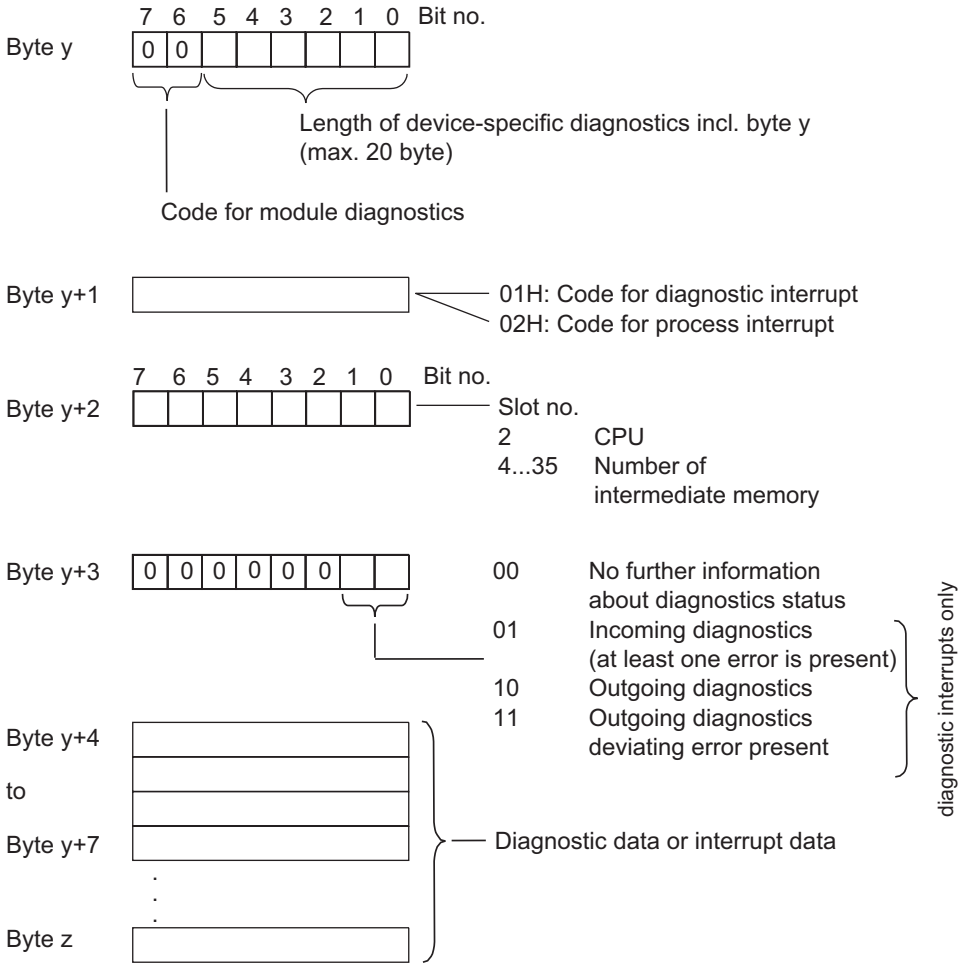


Figure 10-4 Structure of the module status for CPU 31xC

Structure of the interrupt status:

The interrupt status of module diagnostics provides details on a DP slave. Device-specific diagnostics starts at byte y and has a maximum length of 20 bytes.

The following figure describes the structure and content of the bytes for a configured address area of transfer memory.



Example for byte y+2:
CPU: =02H
1st address area: =04H
2nd address area: =05H
etc.

Figure 10-5 Device-specific diagnostics

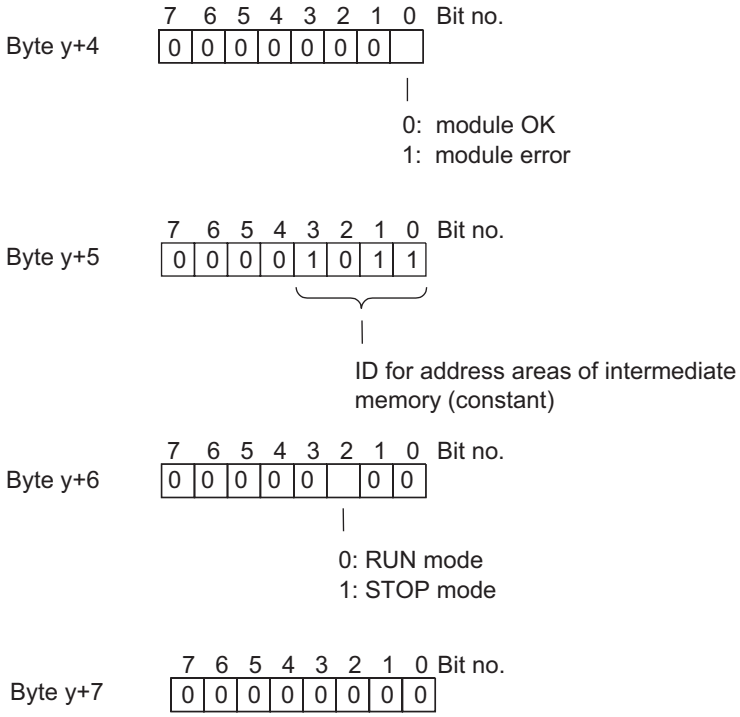
Structure of the interrupt data for a process interrupt (from byte y+4)

When a process interrupt occurs (code 02_H for process interrupt in byte y+1), 4 bytes of interrupt information after byte y+4 are transferred. These 4 bytes are transferred to the intelligent slave using SFC 7 "DP_PRAL" or SFC 75 "SALRM" when the process interrupt for the master was generated.

Structure of the interrupt data when a diagnostic interrupt is generated in response to an operating status change by the intelligent slave (after byte y+4)

Byte y+1 contains the code for a diagnostic interrupt (01_H). The diagnostic data contains the 16 bytes of status information from the CPU. The figure below shows the allocation of the first four bytes of diagnostic data. The next 12 bytes are always 0.

The data in these bytes correspond to the contents of data record 0 of diagnostic data in **STEP 7** (in this case, not all bits are used).



Note: Byte y+8 to byte y+19 are always 0.

Figure 10-6 Bytes y+4 to y+7 for a diagnostic interrupt (operating status change by intelligent slave)

Structure of the interrupt data when a diagnostic interrupt is generated by SFB 75 on the intelligent slave (after byte y+4)

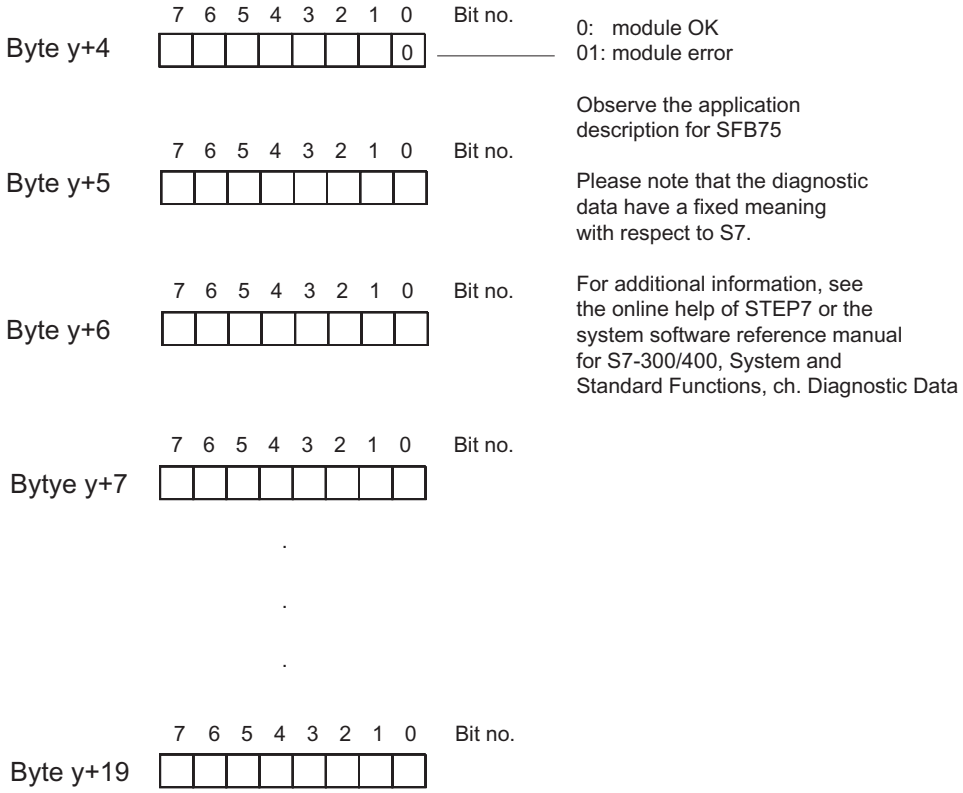


Figure 10-7 Bytes y+4 to y+7 for the diagnostic interrupt (SFB 75)

10.8 Diagnostics of PN CPUs

Diagnostics of field devices on PROFINET

For further information, refer to the *PROFINET System Description* and to the *From PROFIBUS DP to PROFINET IO* Programming Manual.

Appendix

A

A.1 General rules and regulations for S7-300 operation

Introduction

Seeing that an S7-300 can be used in many different ways, we can only describe the basic rules for the electrical installation in this document.

Warning

Always observe these basic rules for electrical installation in order to achieve a fully functional S7-300 system.

EMERGENCY-OFF equipment

EMERGENCY-OFF equipment to IEC 204 (corresponds to VDE 113) must remain effective in all operating modes of the plant or system.

System startup after specific events

The table below shows what you have to observe when restarting a plant after specific events.

Table A-1 System startup after specific events

If there is...	then ...
Restart following a voltage dip or power failure,	dangerous operating states must be excluded. If necessary, force EMERGENCY-OFF.
Startup after releasing the EMERGENCY OFF device,	uncontrolled or undefined startup operations must be excluded.

Mains voltage

The table below shows what you have to watch with respect to the mains voltage.

Table A-2 Mains voltage

In the case of ...	the ...
Stationary systems or systems without all-pole mains disconnect switch	building installation must contain a mains disconnect switch or a fuse.
Load power supplies, power supply modules	set rated voltage range must correspond to local mains voltage.
All circuits of the S7-300	rated mains voltage fluctuation / deviation must lie within the permitted tolerance (refer to Technical Data of S7-300 modules).

24 VDC power supply

The table below shows what you must observe for the 24 VDC power supply.

Table A-3 Protection against external electrical interference

In the case of ...	you need to observe ...	
Buildings	external lightning protection	Install lightning protection (e.g. lightning conductors).
24 VDC power supply cables, signal cables	internal lightning protection	
24 VDC power supply	safe (electrical) extra-low voltage isolation	

Protection against external electrical interference

The table below shows how you must protect your system against electrical interference or faults.

Table A-4 Protection against external electrical interference

In the case of ...	Make sure that ...
All plants or system in which the S7-300 is installed	the plant or system is connected to a protective conductor for the discharge of electromagnetic interference.
Supply / signal / bus cables	the cable routing and installation is correct.
Signal and bus cables	a cable/conductor break does not cause undefined plant or system states.

A.2 Protection against electromagnetic interference

A.2.1 Basic Points for EMC-compliant system installations

Definition: EMC

EMC (electromagnetic compatibility) describes the capability of electrical equipment to operate free of errors in a given electromagnetic environment, without being subject to external influence and without influencing external devices in any way.

Introduction

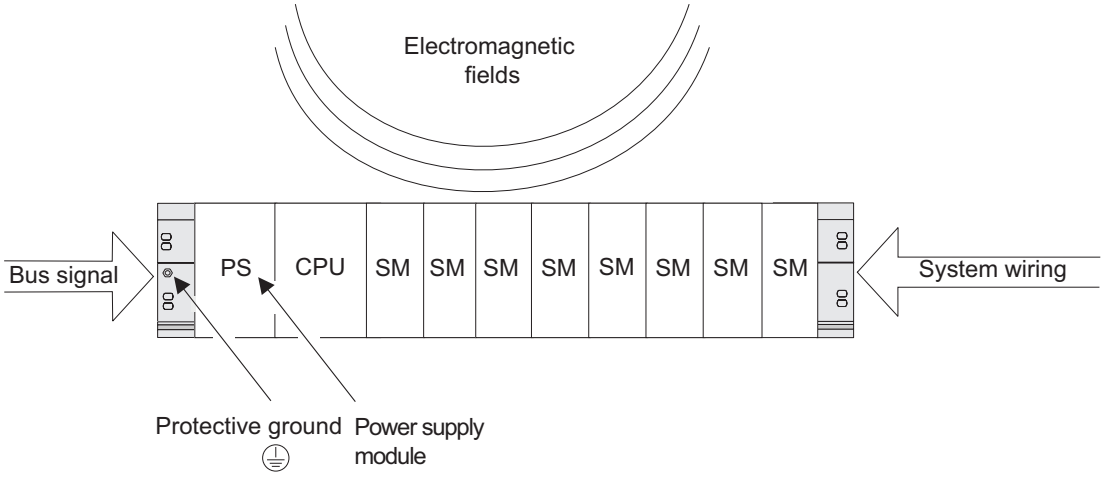
Although your S7-300 and its components are developed for an industrial environment and high electromagnetic compatibility, you should draw up an EMC installation plan before you install the controller taking into consideration all possible sources of interference.

Possible interferences

Electromagnetic interference can influence a PLC in various ways:

- Electromagnetic fields having a direct influence on the system
- Interference coupling caused by bus signals (PROFIBUS DP etc.)
- Interference coupling via the system wiring
- Interference influencing the system via the power supply and/or protective ground

The figure below shows the likely paths of electromagnetic interference.



Coupling mechanisms

Depending on the emitting media (line or isolated) and the distance between the interference source and the device, four different coupling mechanisms can influence the PLC.

Table A-5 Coupling mechanisms

Coupling mechanisms	Cause	Typical interference sources
Electrical coupling	Electrical or mechanical coupling always occurs when two circuits use one common cable.	• Clocked devices (influence on the network due to converters and third-party power supply modules) • Starting motors • Potential differences on component enclosures with common power supply • Static discharge
Capacitive coupling	Capacitive or electrical coupling occurs between conductors connected to different potentials. The coupling effect is proportional to voltage change over time.	• Interference coupling due to parallel routing of signal cables • Static discharge of the operator • Contactors
Inductive coupling	Inductive or magnetic coupling occurs between two current circuit loops. Current flow in magnetic fields induces interference voltages. The coupling effect is proportional to current change over time.	• Transformers, motors, arc welding devices • Power supply cables routed in parallelism • Switched cable current • High-frequency signal cable • Coils without suppression circuit
Radio frequency coupling	Radio frequency coupling occurs when an electromagnetic wave reaches a conductor system. This wave coupling induces currents and voltages.	• Neighboring transmitters (e.g. radio phones) • Sparking (spark plugs, collectors of electrical motors, welding devices)

A.2.2 Five basic rules for securing EMC

A.2.2.1 1. Basic rule for ensuring EMC

If you comply with theses five basic rules ...

you can ensure EMC in many cases!

Rule 1: Large area grounding contact

When you install the automation equipment, make sure that the surfaces of inactive metal parts are properly bonded to chassis ground.

- Bond all passive metal parts to chassis ground, ensuring large area and low-impedance contact.
- When using screw connections on varnished or anodized metal parts, support contact with special contact washers or remove the protective insulating finish on the points of contact.
- Wherever possible, avoid the use of aluminum parts for ground bonding. Aluminum oxidizes very easily and is therefore less suitable for ground bonding.
- Create a central connection between chassis ground and the equipotential grounded/protective conductor system.

A.2.2.2 2. Basic rule for ensuring EMC

Rule 2: Proper cable routing

Always ensure proper cable routing when wiring your system.

- Sort your wiring system into groups (high-voltage/power supply/signal/data cables).
- Always route high-voltage, signal or data cables through separated ducts or in separate bundles.
- Install the signal and data cables as close as possible to grounded surfaces (e.g. supporting beans, metal rails, steel cabinet walls).

See also

Cable routing inside buildings (Page A-16)

Outdoor routing of cables (Page A-18)

A.2.2.3 3. Basic rule for ensuring EMC

Rule 3: Fixing the cable shielding

Ensure proper fixation of the cable shielding.

- Always use shielded data cable. Always connect both ends of the shielding to ground on a large area.
- Analog cables must always be shielded. For the transmission of low-amplitude signals it might prove to be more efficient to have only one side of the shielding connected to ground.
- Directly behind the cable entry in the cabinet or enclosure, terminate the shielding on a large area of the shielding/protective ground bar and fasten it with the help of a cable clamp. Then, route the cable to the module; however, do not connect the shielding once again to ground in this place.
- Connections between the shielding/protective ground conductor bar and the cabinet/enclosure must be of a low impedance.
- Always install shielded data cables in metal/metallized connector housings.

See also

Cable shielding (Page A-12)

A.2.2.4 4. Basic rule for ensuring EMC

Rule 4: Special EMC measures

Take special EMC measures for particular applications.

- Connect anti-surge elements to all inductive devices not controlled by S7-300 modules.
- For cabinet or cubicle lighting in the immediate range of your controller, use incandescent lamps or interference suppressed fluorescent lamps.

See also

How to protect digital output modules against inductive surge voltage (Page A-28)

A.2.2.5 5. Basic rule for ensuring EMC

Rule 5: Homogeneous reference potential

Create a homogeneous reference potential and ground electrical equipment whenever possible (refer to the section on Equipotential bonding).

- Route your equipotential conductors over a wide area if potential differences exist or are expected between your system components.
- Make sure you carefully direct your grounding measures. Grounding measures protect the controller and its functions.
- Form a star circuit to connect the equipment in your system and the cabinets containing central/expansion units to the grounding/protective conductor system. This prevents the formation of ground loops.

See also

Equipotential bonding (Page A-14)

A.2.3 EMC-compliant installation of PLCs

Introduction

Quite often it is the case that interference suppression measures are not taken until corruption of user signals is detected after the controller is actually in operation.

Frequently, the causes of such interference are found in inadequate reference potentials as a result of faulty installation. This section shows you how to avoid such errors.

Inactive metal parts

Inactive parts are referred to as electrically conductive elements, separated from active elements by a basic insulating and only subject to electrical potential if an error occurs.

Installation and ground bonding of inactive metal parts

Bond all inactive metal parts to a large-surface ground when you install the S7-300. Proper ground bonding ensures a homogeneous reference potential for the controller and reduces the effect of interference coupling.

The ground connection establishes an electrically conductive interconnection of all inactive parts. The sum of all interconnected inactive parts is referred to as chassis ground.

This chassis ground must never develop a hazardous potential even if a fault occurs. Therefore, chassis ground must be connected to the protective conductor using cables with an adequate conductor cross-section. To avoid ground loops, physically separate chassis ground elements (cabinets, parts of the building construction or machine) must be bonded to the protective conductor system in a star circuit.

Observe the following for ground connection:

- In the same way as with active elements, exercise meticulous care to interconnect inactive metal elements.
- Always make sure that you have a low-impedance interconnection between metal elements (e.g. large and highly conductive contact surface).
- The protective insulating finish on varnished or anodized metal elements must be pierced or removed. Use special contact washers or completely remove the finish on the point of contact.
- Protect your connecting elements against corrosion (e.g. with a suitable grease).
- Interconnect moving chassis ground elements (e.g. cabinet doors) with flexible ground straps. Always use short ground straps with a large surface (the surface is decisive for the diversion of high-frequency currents).

A.2.4 Examples of an EMC-compliant installation: Cabinet installation

Cabinet installation

The figure below shows a cabinet installation with the measures described above (bonding of inactive metal parts to chassis ground and connecting the cable shielding to ground). This sample applies only to grounded operation. Note the points in the figure when you install your system.

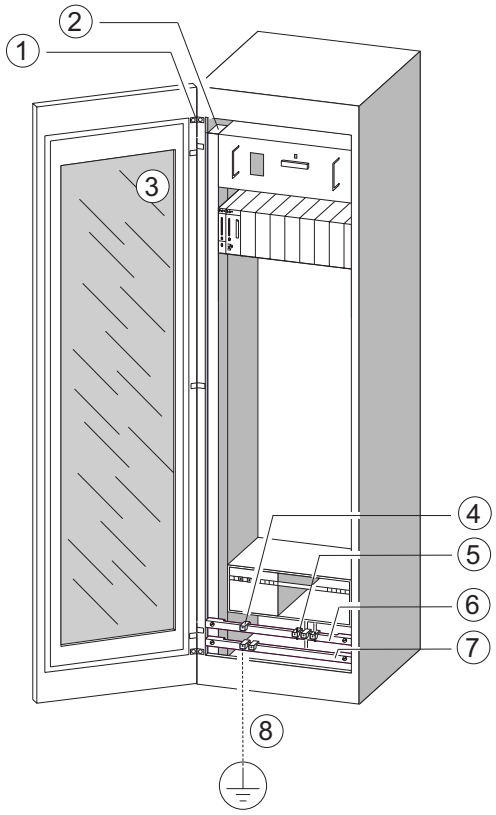


Figure A-1 Example of an EMC compatible cabinet installation

Key to installation

The numbers in the following list refer to the numbers in the figure above.

Table A-6 Key to example 1

No.	Meaning	Explanation
1	Ground straps	If no large-surface metal-to-metal connections are available, you must either interconnect inactive metal parts (e.g. cabinet doors or mounting plates) or bond them to chassis ground using ground straps. Use short ground straps with a large surface.
2	Supporting bars	Interconnect the supporting bars on a large area to the cabinet walls (metal-to-metal connection).
3	Mounting the rail	The mounting bar and rack must be interconnected with large-area metal-to-metal connections.
4	Signal cables	Connect the shielding of signal cables on a large area of the protective conductor/additional shielding conductor bar and fasten them with cable clamps.
5	Cable clamp	The cable clamp must cover a large area of the shielding braid and ensure good contact.
6	Shielding conductor bar	Interconnect the shielding conductor bar on a large surface with the supporting bars (metal-to-metal connection). The cable shielding is terminated on the conductor bar.
7	Protective conductor bar	Interconnect the protective conductor bar on a large surface with the supporting bars (metal-to-metal connection). Interconnect the grounding busbar with the protective ground system, using a separate cable (minimum cross-section 10 ^{2}).
8	Cable to the protective ground system (equipotential ground)	Interconnect the cable on a large area with the protective ground system (equipotential ground).

A.2.5 Examples of an EMC-compliant installation: Wall mounting

Wall mounting

When operating your S7 in a low-noise environment that conform with permitted ambient conditions (see Appendix Ambient conditions), you can also mount your S7 in frames or to the wall.

Interference coupling must be diverted to large metal surfaces. Therefore, always mount standard profile/shielding/protective conductor rails on metal parts of the construction. Steel sheet panels reference potential surfaces have been found especially suitable for wall-mounting.

Provide a shielding conductor bar for connecting your cable shielding. This shielding conductor bar can also be used as protective ground bar.

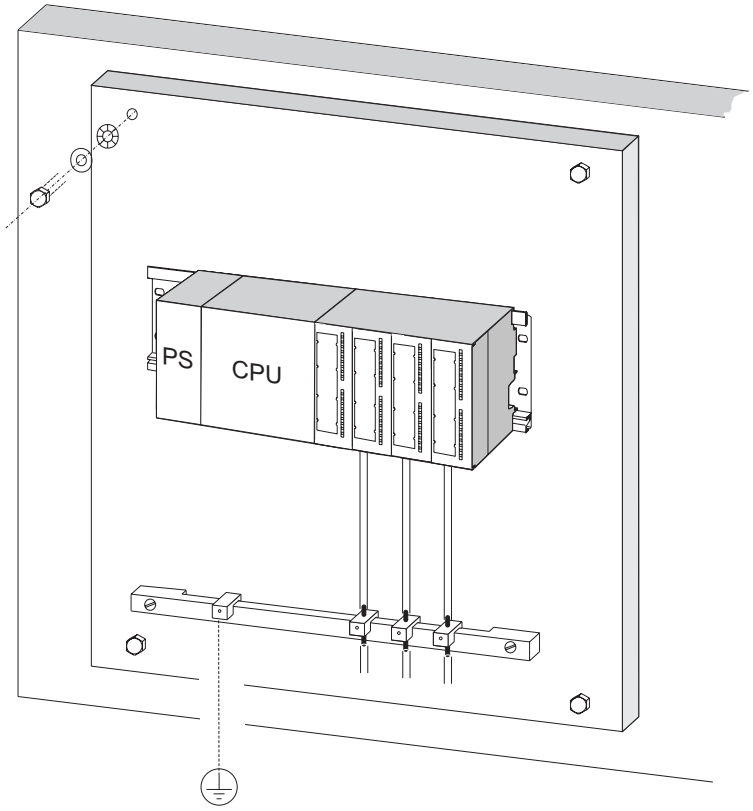
Reference for ambient conditions

For information on ambient conditions, refer to the *S7-300 Automation System, Module data* Reference Manual.

Please note

- When mounting on varnished or anodized metal parts, use special contact washers or remove the insulating layers.
- Provide a large-surface and low-impedance metal-to-metal connection for fastening the shielding/protective protective ground bar.
- Always touch-protect live mains conductors.

The figure below shows an example of EMC compatible wall-mounting of an S7.



A.2.6 Cable shielding

Purpose of the shielding

A cable is shielded to attenuate the effects of magnetic, electrical and electromagnetic interference on the cable.

Operating principle

Interference currents on cable shielding is diverted to ground conductive interconnection between the shielding and the cabinet. To avoid interference as a result of these currents, it is imperative to provide a low-impedance connection to the protective conductor.

Suitable cables

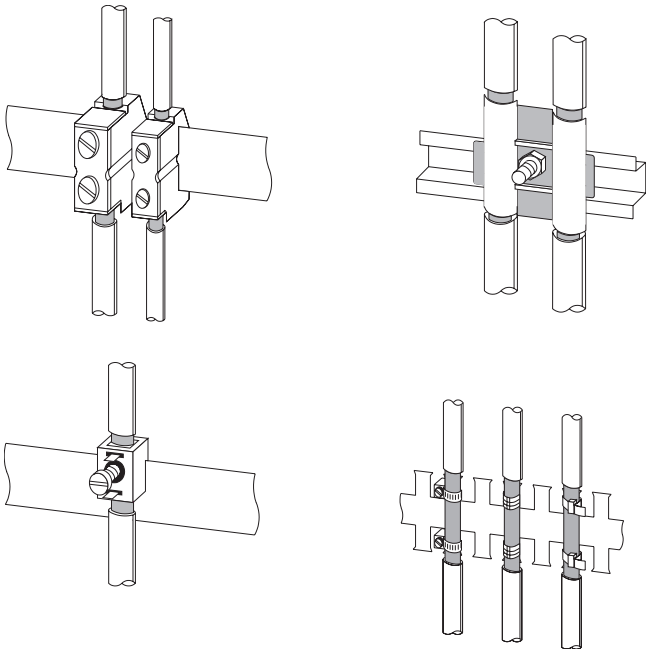
Whenever possible, use cables equipped with a shielding braid. Shielding density should be at least 80%. Avoid cables with film shielding, because the film can be easily damaged by tensile or pressure stress, thus reducing its shielding effect.

Handling of the shielding

Note the following points on handling the shielding:

- Always use metal clamps to mount shielding braid. The clamps must contact a large area of the shielding and provide appropriate contact force.
- Directly behind the cabinet's cable entry, terminate the shielding on a shielding bus. Then, route the cable to the module; however, do not connect the shielding once again to ground in this place.
- In installations outside of cabinets (e.g. for wall-mounting) you can also terminate the shielding on a cable duct.

The figure below shows some options for mounting shielded cables, using cable clamps.



A.2.7 Equipotential bonding

Potential differences

Potential differences can occur between separate system elements. This can result in high equipotential currents, e.g. if the cable shielding is terminated at both ends and grounded to different system components.

The cause of potential difference can be differences in the power supplies.

Warning

Cable shielding is not suitable for equipotential bonding. Always use the prescribed cables (e.g. with a cross-section of 16 mm^2). When installing MPI/DP networks, provide a sufficient conductor cross-section. Otherwise, interface hardware might get damaged or even be destroyed.

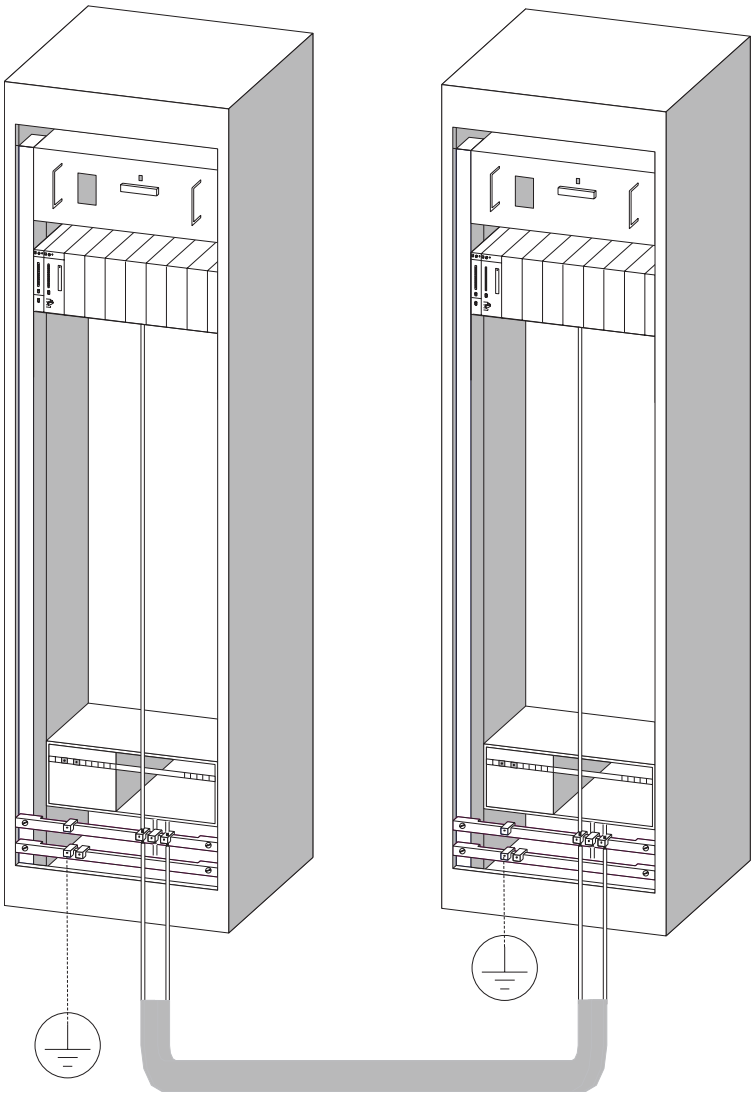
Equipotential bonding conductor

To reduce potential differences and ensure proper functioning of your electronic equipment, you must install equipotential bonding conductors.

Note the following points on the use of equipotential bonding conductors:

- The lower the impedance of an equipotential bonding conductor, the more effective is equipotential bonding.
- When shielded signal cables interconnect two system components and the shielding is connected on both ends to ground/protective conductors, the impedance of the additional equipotential bonding conductor must not exceed 10% of the shielding impedance.
- Determine the cross-section of your equipotential bonding conductor on the basis of the maximum equalizing current that will flow through it. The equipotential bonding conductor cross-section that has proven best in practice is 16 mm^2.

- Always use equipotential bonding conductors made of copper or galvanized steel. Always connect the cables on a large surface to the equipotential conductor bar/protective conductor and protect it against corrosion.
- Route your equipotential bonding conductor to minimize the area between the equipotential bonding conductor and signal lines as far as possible (see the figure below).



A.2.8 Cable routing inside buildings

Introduction

Inside buildings (inside and outside cabinets), clearances must be maintained between groups of different cables to achieve the necessary electromagnetic compatibility (EMC). The table contains information on the general rules governing clearances to enable you to choose the right cables.

How to read the table

To find out how to run two cables of different types, proceed as follows:

1. Look up the type of the first cable in column 1 (Cables for ...).
2. Look up the type of the second cable in the corresponding field in column 2 (and cables for ...).
3. Note the applicable directives in column 3 (Run ...).

Table A-7 Cable routing inside buildings

Cables for ...	and cables for ...	Run ...
• Bus signals, shielded (PROFIBUS) • Data signals, shielded (programming devices, operator panels, printers, counter inputs, etc.) • Analog signals, shielded • DC voltage (≤ 60 V), unshielded • Process signals (≤ 25 V), shielded • AC voltage (≤ 25 V), unshielded • Monitors (coaxial cable)	• Bus signals, shielded (PROFIBUS) • Data signals, shielded (programming devices, operator panels, printers, counter inputs, etc.) • Analog signals, shielded • DC voltage (≤ 60 V), unshielded • Process signals (≤ 25 V), shielded • AC voltage (≤ 25 V), unshielded • Monitors (coaxial cable)	In common bundles or cable ducts
	• DC voltage (> 60 V and ≤ 400 V), unshielded • AC voltage (> 25 V and ≤ 400 V), unshielded	In separate bundles or cable ducts (no minimum clearance necessary)
	• DC and AC voltage (> 400 V), unshielded	**Inside cabinets:** In separate bundles or cable ducts (no minimum clearance necessary) **Outside cabinets:** On separate cable racks with a clearance of at least 10 cm

Cables for ...	and cables for ...	Run ...
• DC voltage (> 60 V and ≤ 400 V), unshielded • AC voltage (> 25 V and ≤ 400 V), unshielded	• Bus signals, shielded (PROFIBUS) • Data signals, shielded (programming devices, operator panels, printers, counter inputs, etc.) • Analog signals, shielded • DC voltage (≤ 60 V), unshielded • Process signals (≤ 25 V), shielded • AC voltage (≤ 25 V), unshielded • Monitors (coaxial cable)	In separate bundles or cable ducts (no minimum clearance necessary)
	• DC voltage (> 60 V and ≤ 400 V), unshielded • AC voltage (> 25 V and ≤ 400 V), unshielded	In common bundles or cable ducts
	• DC and AC voltage (> 400 V), unshielded	**Inside cabinets:** In separate bundles or cable ducts (no minimum clearance necessary) **Outside cabinets:** On separate cable racks with a clearance of at least 10 cm
DC and AC voltage (> 400 V), unshielded	• Bus signals, shielded (PROFIBUS) • Data signals, shielded (programming devices, operator panels, printers, counter inputs, etc.) • Analog signals, shielded • DC voltage (≤ 60 V), unshielded • Process signals (≤ 25 V), shielded • AC voltage (≤ 25 V), unshielded • Monitors (coaxial cable)	**Inside cabinets:** In separate bundles or cable ducts (no minimum clearance necessary) **Outside cabinets:** On separate cable racks with a clearance of at least 10 cm
	• DC and AC voltage (> 400 V), unshielded	In common bundles or cable ducts
ETHERNET	ETHERNET	In common bundles or cable ducts
	Others	In separate bundles or cable ducts with a clearance of at least 50 cm

A.2.9 Outdoor routing of cables

Rules for EMC-compliant cable routing

The same EMC-compliant rules apply both to indoor and outdoor routing of cables. The following also applies:

- Running cables on metal cable trays.
- Electrical connection of the joints of cable trays/ducts.
- Ground the cable carriers.
- If necessary, provide adequate equipotential bonding between connected devices.
- Take the necessary (internal and external) lightning protection and grounding measures in as far as they are applicable to your particular application.

Rules for lightning protection outside buildings

Run your cables either:

- in metal conduits grounded at both ends, or
- in concrete cable ducts with continuous end-to-end armoring.

Overvoltage protection equipment

An individual appraisal of the entire plant is necessary before any lightning protection measures are taken.

A.3 Lightning and surge voltage protection

A.3.1 Overview

We show you solutions for the protection of your S7-300 against damage as a result of surge voltage.

Failures are very often the result of surge voltage caused by:

- Atmospheric discharge or
- Electrostatic discharge.

We will begin by showing you what the theory of surge protection is based on: the lightning protection zone concept

At the end of this section, you will find rules for the transition points between individual lightning protection zones.

Note

This section can only provide information on the protection of a PLC against surge voltage. However, complete surge protection is guaranteed only if the whole surrounding building is designed to provide protection against overvoltage. This applies especially to constructional measures for the building at the planning stage.
If you wish to obtain detailed information on surge protection, we therefore recommend you contact your Siemens partner or a company specialized in lightning protection.

A.3.2 Lightning protection zone concept

Principally of the Lightning protection zone concept to IEC 61312-1/DIN VDE 0185 T103

The principle of the lightning protection zone concept states that the volume to be protected against overvoltage, for example, a manufacturing hall, is subdivided into lightning protection zones in accordance with EMC directives (see Figure).

The specific lightning protection zones are formed by the following measures:

Lightning protection of the building exterior (field side)	Lightning protection zone 0
Shielding • Buildings • Rooms and/or • Devices	 Lightning protection zone 1 Lightning protection zone 2 Lightning protection zone 3

Effects of the Lightning Strike

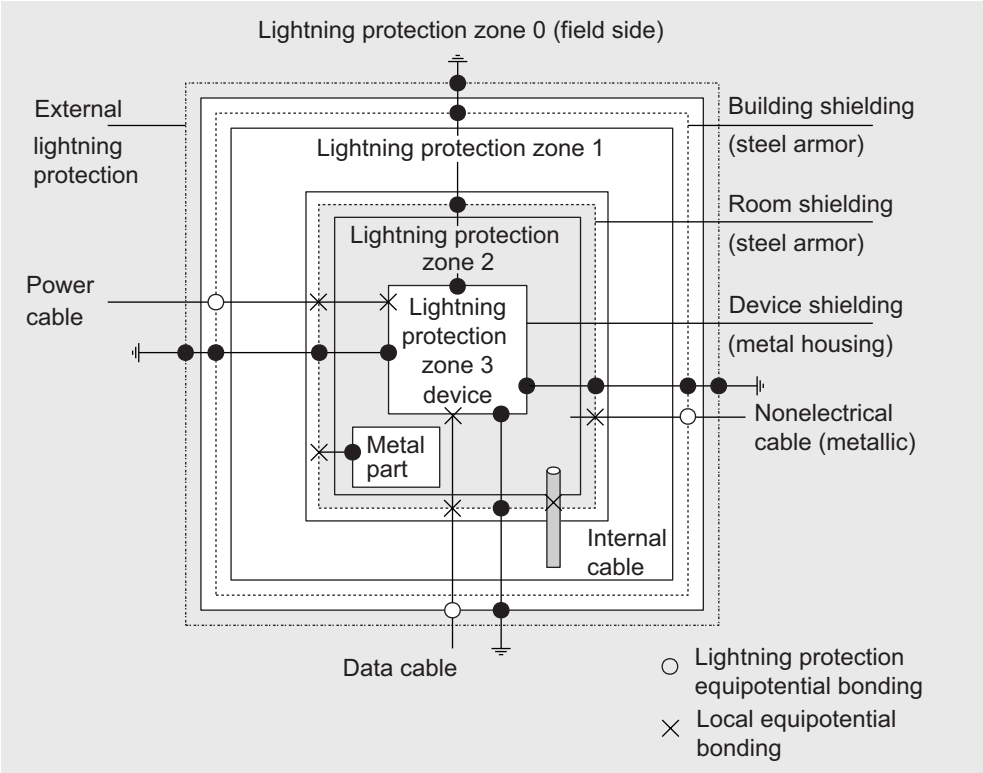
Direct lightning strikes occur in lightning protection zone 0. Lightning strike generates high-energy electromagnetic fields which can be reduced or eliminated from one lightning protection zone to the next by suitable lightning protection elements/measures.

Overvoltage

In lightning protection zones 1 and higher, a lightning strike might additionally cause overvoltage as a result of switching operations, coupling etc.

Scheme of the lightning protection zones of a building

The figure below shows a block diagram of the lightning protection zone concept for a detached building.



Principle of the transition points between lightning protection zones

At the transitions points between lightning protection zones, you must take measures to prevent surges being conducted downstream.

The principle of the lightning protection zone concept also specifies that all cables which are capable of carrying lightning current (!) and installed at the transition points of lightning protection zones must be included in the equipotential bonding.

Conductors and cables capable of carrying lightning current are:

- Metal pipes (e.g. water, gas and heat)
- Power cables (for example, mains voltage, 24 V supply)
- Data cables (for example, bus cable).

A.3.3 Rules for the transition point between lightning protection zones 0 <-> 1

Rules for transition point 0 <-> 1 (lightning protection equipotential bonding)

The following measures are suitable for lightning protection equipotential bonding at the transition between lightning protection zones 0 <-> 1:

- Use grounded, spiraled, current-conducting metal straps or metal braiding as a cable shield at both ends, for example, NYCY or A2Y(K)Y.
- Install cables in one of the following media:
  - in continuous metal pipes that are grounded at both ends, or
  - in continuously armored concrete ducts or
  - on closed metal cable trays grounded at both ends.
  - use fiber-optic cables instead of metal conductors.

Additional Measures

If you cannot take measures as described above, you must install a high-voltage protection for your system between the 0 <-> 1 transition points with a lightning conductor. The table below contains the components you can use for high-voltage protection of your plant.

Table A-8 High-voltage protection of cables with the help of surge protection equipment

Consec. no.	Cables for ...	... ... equip transition point 0 <-> 1 with:		Order number
1	3-phase TN-C system	1 x	DEHNbloc/3 lightning conductor Phase L1/L2/L3 to PEN	900 110* 5SD7 031
	3-phase TN-S system	1 x	DEHNbloc/3 lightning conductor Phase L1/L2/L3 to PE	900 110* 5SD7 031
		1 x	DEHNbloc/1 lightning conductor N to PE	900 111* 5SD7 032
	3-phase TT system	1 x	DEHNbloc/3 lightning conductor Phase L1/L2/L3 to N	900 110* 5SD7 031
		1 x	DEHNgap B/n N-PE lightning conductor N to PE	900 130*
	AC TN-S system	2 x	DEHNbloc/1 lightning conductor Phase L1 + N to PE	900 111* 5SD7 032
	AC TN-C system	1 x	DEHNbloc/1 lightning conductor Phase L to PEN	900 111* 5SD7 032
	AC TT system	1 x	DEHNbloc/1 lightning conductor Phase to N	900 111* 5SD7 032
		1 x	DEHNgap B/n N-PE lightning conductor N to PE	900 130*

Consec. no.	Cables for ...	... ... equip transition point 0 <-> 1 with:		Order number
2	24 VDC power supply	1 x	Blitzductor VT, Type A D 24 V -	918 402*
3	MPI bus cable, RS485, RS232 (V.24)	1 x	Blitzductor CT lightning conductor, type B	919 506* and 919 510*
4	Inputs/outputs of 24 V digital modules		DEHNrail 24 FML	909 104*
5	24 VDC power supply module	1 x	Blitzductor VT Type A D 24 V -	918 402* 900 111* 5SD7 032
6	Inputs/outputs of digital modules and 120/230 VAC power supply	2 x	DEHNbloc/1 lightning conductor	900 111* 5SD7 032
7	Inputs/outputs of analog modules up to 12 V +/-	1 x	Lightning conductor Blitzductor CT type B	919 506* and 919 510*

* You can order these components directly from:
DEHN + SÖHNE
GmbH + Co. KG
Elektrotechnische Fabrik
Hans-Dehn-Str. 1
D-92318 Neumarkt

A.3.4 Rules for the transition point between lightning protection zones 1 <-> 2 and higher

Rules for transition points 1 <-> 2 and higher (local equipotential bonding)

The following measures must be taken on all transition points 1 <-> 2 and higher:

- Set up local equipotential bonding at each subsequent lightning protection zone transition.
- Include all lines (also metal conduits, for example) in the local equipotential bonding of all subsequent lightning protection zone transition points.
- Include all metal installations located within the lightning protection zone in the local equipotential bonding (for example, metal part within lightning protection zone 2 at transition 1 <-> 2).

Additional Measures

We recommend fine-wire fusing for following elements:

- All 1 <-> 2 and greater lightning protection zone transitions
- All cables that run within a lightning protection zone and are longer than 100 m

Lightning protection element for the 24 VDC power supply module.

Always use the Blitzductor VT, type AD 24 V SIMATIC for the 24 VDC power supply module of the S7-300. All other surge protection components do not meet the required tolerance range of 20.4 V to 28.8 V of the S7-300 power supply.

Lightning Conductor for Signal Modules

You can use standard surge protection components for the digital I/O modules. However, please note that these only permit a maximum of 26.8 V for a rated voltage of 24 VDC. If the tolerance of your 24 VDC power supply is higher, use surge protection components with 30 VDC rating.

You can also use Blitzductor VT, type AD 24 V. Note that input current can increase if negative input voltages are generated.

Low-voltage protection elements for 1 <-> 2

For the transition points between lightning protection zones 1 <-> 2 we recommend the surge protection components listed in the table below. This low-voltage protection must be used in S7-300 for CE compliance.

Table A-9 Surge-protection components for lightning protection zones 1 <-> 2

Consec. no.	Cables for ...	... equip transition point 1 <-> 2 with:		Order number
1	3-phase TN-C system	3 x	DEHNguard 275 surge arresters	900 600* 5SD7 030
	3-phase TN-S system	4 x	DEHNguard 275 surge arresters	900 600* 5SD7 030
	3-phase TT system	3 x	DEHNbloc/275 surge arrester, phase L1/L2/L3 to N	900 600* 5SD7 030
		1 x	DEHNgap C, N-PE surge arrester, N to PE	900 131*
	AC TN-S system	2 x	DEHNguard 275 surge arresters	900 600* 5SD7 030
	AC TN-C system	1 x	DEHNguard 275 surge arresters	900 600* 5SD7 030
	AC TT system	1 x	Surge arrester DEHNguard 275 phase L to N	900 600* 5SD7 030
		1 x	N-PE surge arrester DEHNgap C N to PE	900 131*
2	24 VDC power supply	1 x	Blitzductor VT, type AD 24 V	918 402*
3	Bus cable			
	• MPI, RS485		• Blitzductor CT surge arrester, type MD/HF	919 506* and 919,570*
	• RS232 (V.24)	1 x	• per cable pair Blitzductor CT surge arrester, type ME 15 V	919 506* and 919 522*
4	Inputs of digital modules DC 24 V	1 x	Low-voltage surge arrester type FDK 2 60 V	919 993*
5	Outputs of digital modules 24 V	1 x	Low-voltage surge arrester	919 991*
6	Inputs/outputs of digital modules	2 x	Surge arrester	
	• 120 VAC		• DEHNguard 150	900 603*
	• 230 VAC		• DEHNguard 275	900 600*
7	Inputs of analog modules up to 12 V +/-	1 x	Low-voltage surge arrester Blitzductor CT, type MD 12 V	919 506* and 919 541*

* Please order these components directly from:
DEHN + SÖHNE
GmbH + Co. KG
Elektrotechnische Fabrik
Hans-Dehn-Str.
D-92318 Neumarkt

Low-voltage protection elements for 2 <-> 3

For the transition points between lightning protection zones 2 <-> 3 we recommend the surge protection components listed in the table below. This low-voltage protection must be used in S7-300 for CE compliance.

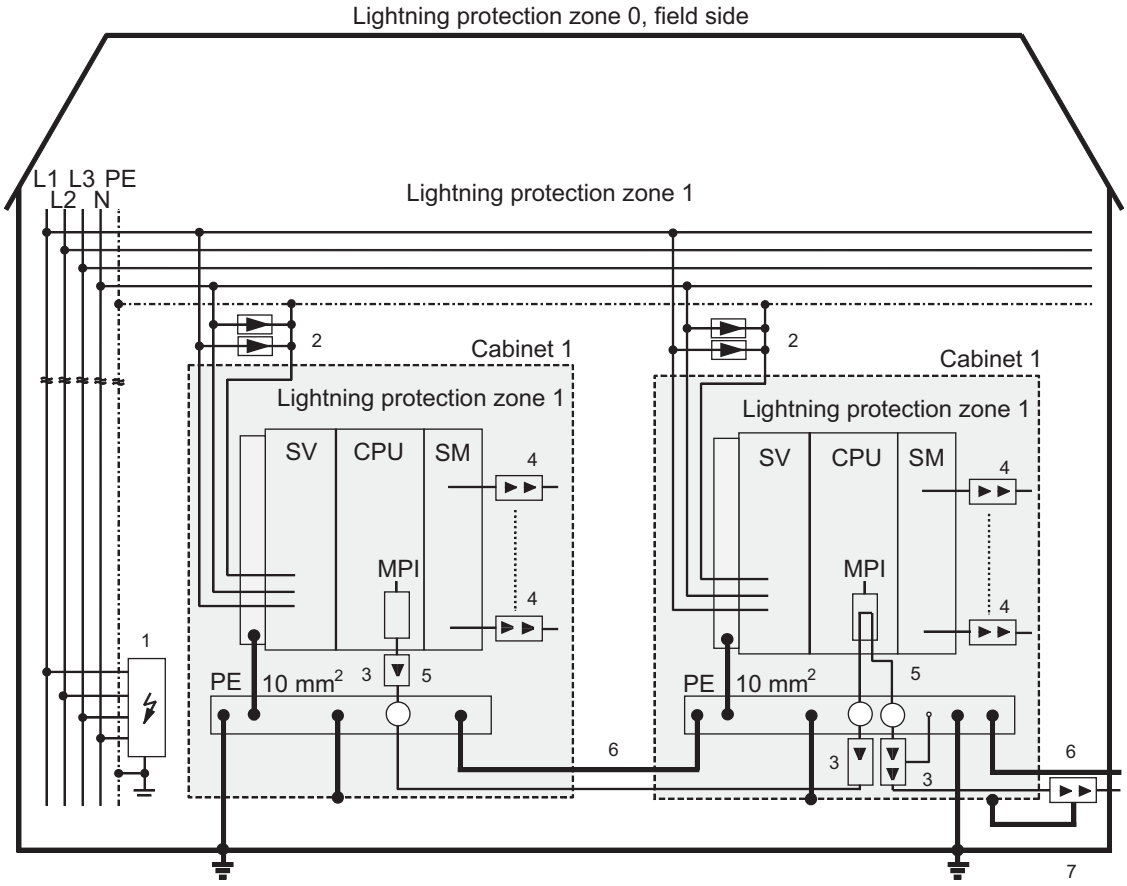
Table A-10 Surge-protection components for lightning protection zones 2 <-> 3

Consec. no.	Cables for ...	... equip transition point 2 <-> 3 with:		Order number
1	3-phase TN-C system	3 x	DEHNguard 275 surge arresters	900 600* 5SD7 030
	3-phase TN-S system	4 x	DEHNguard 275 surge arresters	900 600* 5SD7 030
	3-phase TT system	3 x	DEHNbloc/275 surge arrester, phase L1/L2/L3 to N	900 600* 5SD7 030
		1 x	N-PE surge arrester DEHNgap C N to PE	900 131*
	AC TN-S system	2 x	DEHNguard 275 surge arresters	900 600* 5SD7 030
	AC TN-C system	1 x	DEHNguard 275 surge arresters	900 600* 5SD7 030
	AC TT system	1 x	Surge arrester DEHNguard 275 phase L to N	900 600* 5SD7 030
		1 x	N-PE surge arrester DEHNgap C N to PE	900 131*
2	24 VDC power supply	1 x	Blitzductor VT, type AD 24 V	918 402*
3	Bus cable			
	• MPI, RS485		• Blitzductor CT surge arrester, type MD/HF	919 506* and 919 570*
	• RS232 (V.24)	1 x	• per cable pair Low-voltage surge protection FDK 2 12 V	919 995*
4	Inputs of digital modules			
	• 24 VDC	1 x	Low-voltage surge protection Type FDK 2 60 V, on insulated rail	919 993*
		2 x	Surge arrester	
	• 120 VAC		• DEHNrail 120 FML	901 101*
	• 230 VAC		• DEHNrail 230 FML	901 100*
5	Outputs of digital modules 24 V	1 x	Low-voltage protection FDK 2 D 5 24	919 991*
6	Outputs of analog modules up to 12 V +/-	1 x	Low-voltage surge protection Type FDK 2 12 V, on insulated rail connected with M- of the power supply for the modules.	919 995*

* Please order these components directly from:
DEHN + SÖHNE
GmbH + Co. KG
Elektrotechnische Fabrik
Hans-Dehn-Str.
D-92318 Neumarkt

A.3.5 Example: Surge protection circuit for networked S7-300 PLCs

The sample in the figure below shows you how install an effective surge protection for two networked S7-300 PLCs:



Key

The table below explains consecutive numbers in the figure above:

Table A-11 Example of a circuit conforming to lightning protection requirements (legend to previous figure)

Consec. no. from figure above	Component	Meaning
1	Lightning arrester, depending on the mains system, for example, a TN-S system: 1 x DEHNbloc/3 Order no.: 900 110* and 1 x DEHNbloc/1 Order no.: 900 111*	High-voltage protection against direct lightning strike and surge voltage as of transition 0 <-> 1
2	Surge arresters, 2 x DEHNguard 275; Order no.: 900 600*	High-voltage surge protection at transition 1 <-> 2
3	Surge arrester Blitzductor CT surge arrester, type MD/HF Order no.: 919 506* and 919 570*	Low-voltage surge protection for RS485 interfaces at transition 1 <-> 2
4	Digital input modules: FDK 2 D 60 V order no.: 919 993* Digital output modules: FDK 2 D 5 24 V order no.: 919 991* Analog modules: MD 12 V Blitzductor CT, order no.: 919 506 and 919 541	Low-voltage surge protection, signal modules I/O at transition 1 <-> 2
5	Bus cable shielding mounting device with EMC spring clamp on the basic unit of Blitzductor CT, order no.: 919 508*	Discharge of interference current
6	Cable for equipotential bonding: 16 mm	Standardization of reference potentials
7	Blitzductor CT, Type B for building transitions; order no.: 919 506* and 919 510*	High-voltage surge protection for RS485 interfaces at transition 0 <->1

* Please order these components directly from:
DEHN + SÖHNE GmbH + Co. KG
Elektrotechnische Fabrik
Hans-Dehn-Str.
D-92318 Neumarkt

A.3.6 How to protect digital output modules against inductive surge voltage

Inductive surge voltage

Overvoltage occurs when inductive devices are switched off. Examples are relay coils and contactors.

Integrated surge arrester

S7-300 digital output modules are equipped with an integrated surge arrester.

Additional overvoltage protection

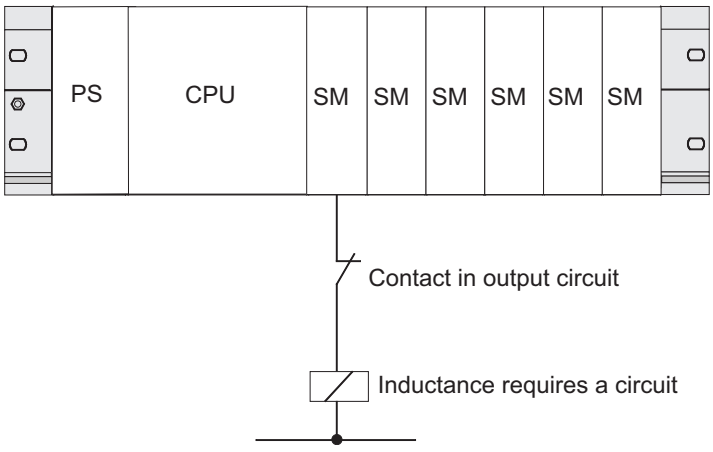
Inductive devices require additional surge arresters only in following cases:

- If SIMATIC output circuits can be switched off by additionally installed contacts (e.g. relay contacts).
- If the inductive loads are not controlled by SIMATIC modules

Note: Request information on relevant surge protection rating from the supplier of inductive devices.

Example: EMERGENCY-OFF relay contact in the output circuit

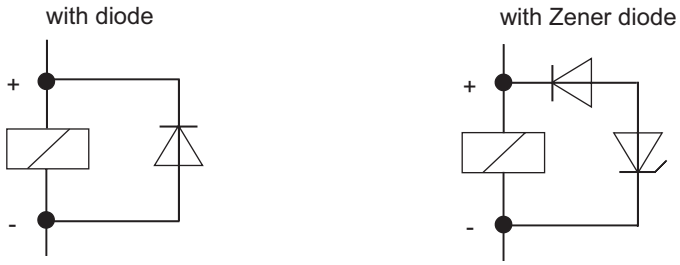
The figures illustrates an output circuit requiring additional overvoltage protectors.



Refer also to the rest of the information in this section.

Circuit for coils operated with DC voltage

The figure below shows DC-operated coils equipped with diode or Zener diode circuit.

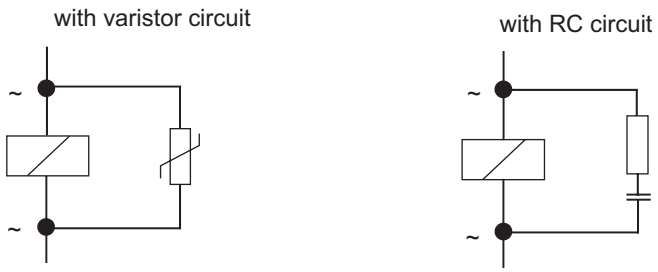


Diode/Zener diode circuits have the following characteristics:

- Opening surge voltage can be totally avoided.
  The Zener diode has a higher switch-off voltage capacity.
- High switch-off delay (6 to 9 times higher than without protective circuit).
  The Zener diode switches off faster than a diode circuit.

Circuit for coils operated with AC voltage

The figure shows coils operated with AC voltage and varistor or RC circuit.



The characteristics of varistor circuits are:

- The amplitude of the opening surge is limited rather than attenuated.
- The surge rise-ratio remains the same.
- Short off-delay.

The characteristics of RC circuits are:

- Amplitude and steepness of the opening surge are reduced.
- Short off-delay.

A.4 Safety of electronic control equipment

Introduction

The notes below apply regardless of the type or manufacturer of the electronic control.

Reliability

Maximum reliability of SIMATIC devices and components is achieved by implementing extensive and cost-effective measures during development and manufacture:

This includes the following:

- Use of high-quality components;
- Worst-case design of all circuits;
- Systematic and computer-aided testing of all components;
- Burn-in of all large-scale integrated circuits (e.g. processors, memory, etc.);
- Measures preventing static charge when handling MOS ICs;
- Visual checks at different stages of manufacture;
- Continuous heat-run test at elevated ambient temperature over a period of several days;
- Careful computer-controlled final testing;
- Statistical evaluation of all returned systems and components to enable the immediate initiation of suitable corrective measures;
- Monitoring of major control components, using on-line tests (cyclic interrupt for the CPU, etc.).

These measures are referred to as basic measures.

Risks

In all cases where the occurrence of failures can result in material damage or injury to persons, special measures must be taken to enhance the safety of the installation – and therefore also of the situation. System-specific and special regulations exist for such applications. They must be observed on installing the control system (e.g. VDE 0116 for burner control systems).

For electronic control equipment with a safety function, the measures that have to be taken to prevent or rectify faults are based on the risks involved in the installation. As of a certain degree of hazard the basic measures mentioned above are no longer sufficient. Additional measures must be implemented and approved for the controller.

Important information

The instructions in the operating manual must be followed exactly. Incorrect handling can render measures intended to prevent dangerous faults ineffective, or generate additional sources of danger.

Which fail-safe systems are available in SIMATIC S7?

Two fail-safe systems are available for integrating safety engineering in the SIMATIC S7 automation systems.

The fail-safe controller S7 Distributed Safety is available for implementing safety concepts in the area of protection of machine and personnel (e.g. EMERGENCY OFF devices for the use of processing machines) and in the process industry (e.g. for performing protective functions for MCE safety devices and burners).

The fail-safe and, in particular, optionally redundant automation system S7 F/FH systems is perfectly suited for systems in the process technology and the oil industry.

Fail-safe and redundant S7 FH system

To increase the availability of the automation system and thereby, avoid process interruption in case of errors in the F system, it is possible to build in fail-safe S7 F systems as optionally redundant (S7 FH systems). This increase in availability can be achieved via redundancy of the components (power supply, central module, communication and I/O).

Attainable safety requirements

S7 Distributed Safety F systems and S7 F/FH systems can meet the following safety requirements:

- Requirement class RC1 to RC6 to DIN V 19250/DIN V VDE 0801
- Safety Integrity Level SIL1 to SIL3 to IEC 61508
- Category Cat.2 to Cat.4 to EN 954-1.

Reference

You can find further information in the *Safety Engineering in SIMATIC S7* System Description manual.

Glossary

Accumulator

Accumulators represent CPU registers, used as interim memory for load, transfer comparison, arithmetical and conversion operations.

Address

The identifier for a certain address or address or address range. Examples: Input I 12.1; memory Word MW 25; Data Block DB 3.

Analog module

Analog modules convert process values (e.g. temperature) into digital values which can be processed in the CPU, or they convert digital values into analog manipulated variables.

Application

See User program

An application is a program that runs directly on the MS-DOS / Windows operating system. Applications on the PG include, for example, the STEP 5 basic package, GRAPH 5 and others.

ASIC

ASIC is the acronym for Application Specific Integrated Circuits.

PROFINET ASICs are components with a wide range of functions for the development of your own devices. They implement the requirements of the PROFINET standard in a circuit and allow extremely high packing densities and performance.

Because PROFINET is an open standard, SIMATIC NET offers PROFINET ASICs for the development of your old devices under the name ERTEC .

Backplane bus

The backplane bus is a serial data bus. It supplies power to the modules and is also used by the modules to communicate with each other. Bus connectors interconnect the modules.

Back-up memory

The backup memory provides a backup of memory areas of the CPU without a backup battery. It backs up a configurable number of timers, counters, flag bits and data bytes as well as retentive timers, counters, flag bits and data bytes).

Bus

A bus is a communication medium connecting several nodes. Data can be transferred via serial or parallel circuits, that is, via electrical conductors or fiber optic.

Bus segment

A bus segment is a self-contained section of a serial bus system. Bus segments are interconnected via repeaters.

Clock flag bits

Flag bit which can be used to generate clock pulses in the user program (1 byte per flag bit).

Note

When operating with S7300 CPUs, make sure that the byte of the clock memory bit is not overwritten in the user program!

Coaxial Cable

A coaxial cable, also known as "coax", is a metallic cabling system used in high-frequency transmission, for example as the antenna cable for radios and televisions as well as in modern networks in which high data transmission rates are required. In a coaxial cable, an inner conductor is surrounded by an outer tube-like conductor. The two conductors are separated by a dielectric layer. In contrast to other cables, this design provides a high degree of immunity to and low emission of electromagnetic interference.

Code block

A SIMATIC S7 code block contains part of the **STEP 7** user program (In contrast to a DB: this only contains data).

Communication processor

Communications processors are modules for point-to-point and bus links.

Component-Based automation

See PROFINET CBA

Compress

The PG online function "Compress" is used to rearrange all valid blocks in CPU RAM in one continuous area of user memory, starting at the lowest address. This eliminates fragmentation which occurs when blocks are deleted or edited.

Configuration

Assignment of modules to module racks/slots and (e.g. for signal modules) addresses.

Consistent data

Data which are related in their contents and not to be separated are referred to as consistent data.

For example, the values of analog modules must always be handled consistently, that is, the value of an analog module must not be corrupted as a result of read access at two different points of time.

Counters

Counters are part of CPU system memory. The content of "Counter cells" can be modified by **STEP 7** instructions (for example, up/down count).

CP

See Communication processor

CPU

See CPU

Central processing unit = CPU of the S7 automation system with a control and arithmetic unit, memory, operating system, and interface for programming device.

Cycle time

The cycle time represents the time a CPU requires for one execution of the user program.

Cyclic interrupt

See Interrupt, cyclic interrupt

Data block

Data blocks (DB) are data areas in the user program which contain user data. Global data blocks can be accessed by all code blocks, and there are instance data blocks which are assigned to a specific FB call.

Data, static

Static data can only be used within a function block. These data is saved in an instance data block that belongs to a function block. Data stored in an instance data block are retained until the next function block call.

Data, temporary

Temporary data represent local data of a block. They are stored in the L-stack when the block is executed. After the block has been processed, these data are no longer available.

Default Router

The default router is the router that is used when data must be forwarded to a partner located within the same subnet.

In STEP 7, the default router is named *Router*. STEP 7 assigns the local IP address to the default router.

Determinism

See Real Time

Device Name

Before an IO device can be addressed by an IO controller, it must have a device name. In PROFINET, this method was selected because it is simpler to work with names than with complex IP addresses.

The assignment of a device name for a concrete IO device can be compared with setting the PROFIBUS address of a DP slave.

When it ships, an IO device does not have a device name. An IO device can only be addressed by an IO controller, for example for the transfer of project engineering data (including the IP address) during startup or for user data exchange in cyclic operation, after it has been assigned a device name with the PG/PC .

Diagnostic buffer

The diagnostics buffer represents a buffered memory area in the CPU. It stores diagnostic events in the order of their occurrence.

Diagnostic Interrupt

Modules capable of diagnostics operations report detected system errors to the CPU by means of diagnostic interrupts.

Diagnostics

See System diagnostics

DP master

A master which behaves in accordance with EN 50170, Part 3 is known as a DP master.

DP slave

A slave operated on PROFIBUS with PROFIBUS DP protocol and in accordance with EN 50170, Part 3 is referred to as DP slave.

DPV1

The designation DPV1 means extension of the functionality of the acyclical services (to include new interrupts, for example) provided by the DP protocol. The DPV1 functionality has been incorporated into IEC 61158/EN 50170, volume 2, PROFIBUS.

Electrically isolated

The reference potential of the control and on-load power circuits of isolated I/O modules is electrically isolated; for example, by optocouplers, relay contact or transformer. I/O circuits can be interconnected with a root circuit.

Equipotential bonding

Electrical connection (equipotential bonding conductor) which eliminates potential difference between electrical equipment and external conductive bodies by drawing potential to the same or near the same level, in order to prevent disturbing or dangerous voltages between these bodies.

Error display

One of the possible reactions of the operating system to a runtime error is to output an error message. Further reactions: Error reaction in the user program, CPU in STOP.

Error handling via OB

After the operating system has detected a specific error (e.g. access error with **STEP 7**), it calls a dedicated block (Error OB) that determines further CPU actions.

Error response

Reaction to a runtime error. Reactions of the operating system: It sets the automation system to STOP, indicates the error, or calls an OB in which the user can program a reaction.

ERTEC

See ASIC

Fast Ethernet

Fast Ethernet describes the standard with which data is transmitted at 100 Mbps. Fast Ethernet uses the 100 Base-T standard.

FB

See Function block

FC

See Function

Flag bits

Flag bits are part of the CPU's system memory. They store intermediate results of calculations. They can be accessed in bit, word or dword operations.

Flash EPROM

FEPROMs can retain data in the event of power loss, same as electrically erasable EEPROMs. However, they can be erased within a considerably shorter period of time (FEPROM = Flash Erasable Programmable Read Only Memory). They are used on Memory Cards.

Force

The Force function can be used to assign the variables of a user program or CPU (also: inputs and outputs) constant values.

In this context, please note the limitations listed in the *Overview of the test functions section in the chapter entitled Test functions, diagnostics and troubleshooting in the S7-300 Installation manual*.

Function

According to IEC 1131-3, a function (FC) is a --> code block without --> static data. A function allows transfer of parameters in user program. Functions are therefore suitable for programming frequently occurring complex functions, e.g. calculations.

Function block

According to IEC 1131-3, a function block (FB) is a --> code block with --> static data. An FB allows the user program to pass parameters. Function blocks are therefore suitable for programming frequently occurring complex functions, e.g. controls, mode selections.

Functional ground

Grounding which has the sole purpose of safeguarding the intended function of electrical equipment. With functional grounding you short-circuit interference voltage which would otherwise have an unacceptable impact on equipment.

GD circuit

A GD circuit comprises a number of CPUs sharing data by means of global data communication, and is used as follows:

- A CPU broadcasts a GD packet to the other CPUs.
- A CPU sends and receives a GD packet from another CPU.

A GD circuit is identified by a GD circuit number.

GD element

A GD element is generated by assigning shared global data. It is identified by a unique global data ID in the global data table.

GD packet

A GD packet can consist of one or several GD elements transmitted in a single message frame.

Global data

Global data can be addressed from any code block (FC, FB, OB). In particular, this refers to flag bits M, inputs I, outputs Q, timers, counters and data blocks DB. Global data can be accessed via absolute or symbolic addressing.

Global data communication

Global data communication is a method of transferring global data between CPUs (without CFBs).

Ground

The conductive earth whose electrical potential can be set equal to zero at any point.

Ground potential can differ from zero in the area of grounding electrodes. The term reference ground is frequently used to describe this situation.

Grounding means, to connect an electrically conductive component via an equipotential grounding system to a grounding electrode (one or more conductive components with highly conductive contact to earth).

Chassis ground is the totality of all the interconnected passive parts of a piece of equipment on which dangerous fault-voltage cannot occur.

GSD file

The properties of a PROFINET device are described in a GSD file (General Station Description) that contains all the information required for configuration.

Just as in PROFIBUS, you can integrate a PROFINET device in STEP 7 using a GSD file.

In PROFINET IO, the GSD file is in XML format. The structure of the GSD file complies with ISO 15734, the worldwide standard for device descriptions.

In PROFIBUS, the GSD file is in ASCII format.

Hub

See Switch

In contrast to a switch, a hub sets itself to the lowest speed at the ports and forwards the signals to all connected devices. A hub is also not capable of giving priority to signals. This would lead to a high communication load on Industrial Ethernet.

Industrial Ethernet

See Fast Ethernet

Industrial Ethernet (formerly SINEC H1) is a technology that allows data to be transmitted free of interference in an industrial environment.

Due to the openness of PROFINET, you can use standard Ethernet components. We recommend, however, that you install PROFINET as Industrial Ethernet.

Instance data block

The **STEP 7** user program assigns an automatically generated DB to every call of a function block. The instance data block stores the values of inputs / outputs and in/out parameters, as well as local block data.

Interface, MPI-capable

See MPI

Interrupt

The CPU operating system knows 10 different priority classes for controlling user program execution. These priority classes include interrupts, e.g. process interrupts. When an interrupt is triggered, the operating system automatically calls an assigned OB. In this OB the user can program the desired response (e.g. in an FB).

Interrupt, cyclic interrupt

A cyclic interrupt is generated periodically by the CPU in a configurable time pattern. A corresponding OB will be processed.

Interrupt, delay

The delay interrupt belongs to one of the priority classes in SIMATIC S7 program processing. It is generated on expiration of a time started in the user program. A corresponding OB will be processed.

Interrupt, delay

See Interrupt, delay

Interrupt, diagnostic

See Diagnostic Interrupt

Interrupt, process

See Process interrupt

Interrupt, status

A status interrupt can be generated by a DPV1 slave and causes OB 55 to be called on the DPV1 master. For detailed information on OB 55, see the *Reference Manual System software for S7-300/400: System and Standard Functions*.

Interrupt, time-of-day

The time-of-day interrupt belongs to one of the priority classes in SIMATIC S7 program processing. It is generated at a specific date (or daily) and time-of-day (e.g. 9:50 or hourly, or every minute). A corresponding OB will be processed.

Interrupt, update

An update interrupt can be generated by a DPV1 slave and causes OB56 to be called on the DPV1 master. For detailed information on OB56, see the *Reference Manual System software for S7-300/400: System and Standard Functions*.

Interrupt, vendor-specific

A vendor-specific interrupt can be generated by a DPV1 slave. It causes OB57 to be called on the DPV1 master.

Detailed information on OB 57 can be found in the *Reference Manual "System Software for S7-300/400: System and Standard Functions*.

IO controller

See PROFINET IO Controller

See PROFINET IO Device

See PROFINET IO Supervisor

See PROFINET IO System

IO device

See PROFINET IO Controller

See PROFINET IO Device

See PROFINET IO Supervisor

See PROFINET IO System

IO supervisor

See PROFINET IO Controller

See PROFINET IO Device

See PROFINET IO Supervisor

See PROFINET IO System

IO system

See PROFINET IO System

IP address

To allow a PROFINET device to be addressed as a node on Industrial Ethernet, this device also requires an IP address that is unique within the network. The IP address is made up of 4 decimal numbers with a range of values from 0 through 255. The decimal numbers are separated by a period.

The IP address is made up of

- The address of the (subnet) network and
- The address of the node (generally called the host or network node).

LAN

Local area network to which several computers are connected within an enterprise. The LAN therefore has a limited geographical span and is solely available to a company or institution.

Load memory

Load memory is part of the CPU. It contains objects generated by the programming device. It is implemented either as a plug-in Memory Card or permanently integrated memory.

Load power supply

Power supply to the signal / function modules and the process I/O connected to them.

Local Data

See Data, temporary

MAC address

Each PROFINET device is assigned a worldwide unique device identifier in the factory. This 6-byte long device identifier is the MAC address.

The MAC address is divided up as follows:

- 3 bytes vendor identifier and
- 3 bytes device identifier (consecutive number).

The MAC address is normally printed on the front of the device.
Example: 08-00-06-6B-80-C0

Master

See Slave

When a master is in possession of the token, it can send data to other nodes and request data from other nodes (= active node).

Memory Card (MC)

Memory Cards are memory media for CPUs and CPs. They are implemented in the form of RAM or FEPROM. An MC differs from a Micro Memory Card only in its dimensions (MC is approximately the size of a credit card).

Micro Memory Card (MMC)

Micro Memory Cards are memory media for CPUs and CPs. Their only difference to the Memory Card is the smaller size.

Module parameters

Module parameters are values which can be used to configure module behavior. A distinction is made between static and dynamic module parameters.

MPI

The multipoint interface (MPI) is the programming device interface of SIMATIC S7. It enables multiple-node operation (PGs, text-based displays, OPs) on one or several PLCs. Each node is identified by a unique address (MPI address).

MPI address

See MPI

NCM PC

See SIMATIC NCM PC

Nesting depth

A block can be called from another by means of a block call. Nesting depth is referred to as the number of simultaneously called code blocks.

Network

A network consists of one or more interconnected subnets with any number of nodes. Several networks can exist alongside each other.

A network is a larger communication system that allows data exchange between a large number of nodes.

All the subnets together form a network.

Node

See PROFIBUS node

Within the context of PROFINET, "node" is the generic term for:

- Automation systems
- Field devices (for example, PLC, PC, hydraulic devices, pneumatic devices)
- Active network components (for example, distributed I/O, valve blocks, drives)

The main characteristics of a node is its integration into PROFINET communication by means of Ethernet or PROFIBUS.

The following device types are distinguished based on their attachment to the bus:

- PROFINET nodes
- PROFIBUS nodes

Non-isolated

The reference potential of the control and on-load power circuits of non-isolated I/O modules is electrically interconnected.

OB

See Organization blocks

OB priority

The CPU operating system distinguishes between different priority classes, for example, cyclic program execution, process interrupt controlled program processing. Each priority class is assigned organization blocks (OBs) in which the S7 user can program a response. The OBs are assigned different default priority classes. These determine the order in which OBs are executed or interrupt each other when they appear simultaneously.

Operating state

The SIMATIC S7 automation systems know the following operating states: STOP, STARTUP, RUN.

Operating system

See CPU

The CPU OS organizes all functions and processes of the CPU which are not associated to a specific control task.

Organization blocks

Organization blocks (OBs) form the interface between CPU operating system and the user program. OBs determine the sequence for user program execution.

Parameters

1. Variable of a **STEP 7** code block
2. Variable for declaring module response (one or several per module). All modules have a suitable basic factory setting which can be customized in **STEP 7**.
There are static and dynamic parameters

Parameters, dynamic

Unlike static parameters, you can change dynamic module parameters during runtime by calling an SFC in the user program, e.g. limit values of an analog signal input module.

Parameters, static

Unlike dynamic parameters, static parameters of modules cannot be changed by the user program. You can only modify these parameters by editing your configuration in **STEP 7**, for example, modification of the input delay parameters of a digital signal input module.

PC station

See SIMATIC PC Station

PG

See Programming device

PLC

See CPU

See PLC

Programmable controllers (PLCs) are electronic controllers whose function is saved as a program in the control unit. Therefore, the configuration and wiring of the unit does not dependen on the PLC function. A programmable logic controller has the structure of a computer; it consists of a CPU with memory, input/output modules and an internal bus system. The I/O and the programming language are oriented to control engineering needs.

A PLC in the context of SIMATIC S7 is a programmable logic controller.

PNO

See PROFIBUS International

Priority class

The S7 CPU operating system provides up to 26 priority classes (or "Program execution levels"). Specific OBs are assigned to these classes. The priority classes determine which OBs interrupt other OBs. Multiple OBs of the same priority class do not interrupt each other. In this case, they are executed sequentially.

Process image

The process image is part of CPU system memory. At the start of cyclic program execution, the signal states at the input modules are written to the process image of the inputs. At the end of cyclic program execution, the signal status of the process image of the outputs is transferred to the output modules.

Process interrupt

A process interrupt is triggered by interrupt-triggering modules as a result of a specific event in the process. The process interrupt is reported to the CPU. The assigned organization block will be processed according to interrupt priority.

Process-Related Function

See PROFINET Component

Product version

The product version identifies differences between products which have the same order number. The product version is incremented when forward-compatible functions are enhanced, after production-related modifications (use of new parts/components) and for bug fixes.

PROFIBUS

See PROFIBUS DP

See PROFIBUS International

Process Field Bus - European fieldbus standard.

PROFIBUS DP

See PROFIBUS

See PROFIBUS International

A PROFIBUS with the DP protocol that complies with EN 500170. DP stands for distributed peripheral I/O (fast, real-time, cyclic data exchange). From the perspective of the user program, the distributed I/O is addressed in exactly the same way as the central I/O.

PROFIBUS International

Technical committee that defines and further develops the PROFIBUS and PROFINET standard.

Also known as the PROFIBUS User Organization (PNO).

Home page www.profibus.com

PROFIBUS node

See Node

A PROFIBUS node has at least one or more ports.

A PROFIBUS node cannot take part directly in PROFINET communication, but must be implemented by means of PROFIBUS master with PROFINET port or Industrial Ethernet/PROFIBUS link (IE/PB Link) with proxy functionality.

PROFINET

See PROFIBUS International

Within the framework of Totally Integrated Automation (TIA), PROFINET is the consistent further development of:

- PROFIBUS DP, the established fieldbus and
- Industrial Ethernet, the communication bus for the cell level.

The experience gained from both systems was and is being integrated in PROFINET.

PROFINET as an Ethernet-based automation standard from PROFIBUS International (previously PROFIBUS Users Organization) defines a vendor-independent communication, automation, and engineering model.

PROFINET ASIC

See ASIC

PROFINET CBA

Within the framework of PROFINET, PROFINET CBA is an automation concept for the implementation of applications with distributed intelligence.

PROFINET CBA lets you create distributed automation solutions, based on default components and partial solutions. This concept satisfies demands for a higher degree of modularity in the field of mechanical and systems engineering by extensive distribution of intelligent processes.

Component based Automation allows you to use complete technological modules as standardized components in large systems.

PROFINET CBA is implemented by:

- the PROFINET standard for programmable controllers and
- the SIMATIC iMAP engineering tool.

The components are also created in an engineering tool that can differ from vendor to vendor. Components of SIMATIC devices are generated, for example, with STEP 7.

The following figures illustrate how automation solutions are being transformed as a result of PROFINET CBA.

PROFINET Component

A PROFINET component includes the entire data of the hardware configuration, the parameters of the modules, and the corresponding user program. The PROFINET component is made up as follows:

- Technological Function

  The (optional) technological (software) function includes the interface to other PROFINET components in the form of interconnectable inputs and outputs.

- Device

  The device is the representation of the physical programmable controller or field device including the I/O, sensors and actuators, mechanical parts, and the device firmware.

PROFINET IO

Within the framework of PROFINET, PROFINET IO is a communication concept for the implementation of modular, distributed applications.

PROFINET IO allows you to create automation solutions familiar from PROFIBUS.

PROFINET IO is implemented by the PROFINET standard for the programmable controllers on the one hand, and on the other hand by the engineering tool STEP 7.

This means that you have the same application view in STEP 7 regardless of whether you configure PROFINET devices or PROFIBUS devices. Programming your user program is essentially the same for PROFINET IO and PROFIBUS DP if you use the expanded blocks and system status lists for PROFINET IO.

PROFINET IO Controller

See PROFINET IO Device

See PROFINET IO Supervisor

See PROFINET IO System

Device via which the connected IO devices are addressed. This means that the IO controller exchanges input and output signals with assigned field devices. The IO controller is often the controller on which the automation program runs.

PROFINET IO Device

See PROFINET IO Controller

See PROFINET IO Supervisor

See PROFINET IO System

Distributed field device assigned to one of the IO controllers (for example, remote I/O, valve terminal, frequency converter, switches)

PROFINET IO Supervisor

See PROFINET IO Controller

See PROFINET IO Device

See PROFINET IO System

PG/PC or HMI device for commissioning and diagnostics.

PROFINET IO System

See PROFINET IO Controller

See PROFINET IO Device

PROFINET IO controller with assigned PROFINET IO devices.

PROFINET node

A PROFINET node always has at least one Industrial Ethernet port. A PROFINET node can also have a PROFIBUS port, that is, as master with proxy functionality. In exceptional circumstances, a PROFINET node can also have more than one PROFIBUS port (for example the CP 5614).

Programming device

Basically speaking, PGs are compact and portable PCs which are suitable for industrial applications. Their distinguishing feature is the special hardware and software for SIMATIC programmable logic controllers.

Proxy

See PROFINET node

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 nodes on PROFINET.

You can integrate existing PROFIBUS systems in PROFINET communication, for example with the help of an IE/PB Link or a CPU 31x-2 PN/DP. The IE/PB Link then handles communication over PROFINET as a substitute for the PROFIBUS components.

Currently, you can include DPV0 slaves in PROFINET in this way.

Proxy functionality

See Proxy

RAM

Work memory is a RAM memory in the CPU accessed by the processor during user program execution.

RAM (Random Access Memory) is a semiconductor read/write memory.

Real Time

See Real Time

Real time means that a system processes external events within a defined time.

Determinism means that a system reacts in a predictable (deterministic) manner.

In industrial networks, both these requirements are important. PROFINET meets these requirements. PROFINET is implemented as a deterministic real-time network as follows:

- The transfer of time-critical data between different stations over a network within a defined interval is guaranteed.

  To achieve this, PROFINET provides an optimized communication channel for real-time communication : to: Real Time (RT).
- An exact prediction of the time at which the data transfer takes place is possible.
- It is guaranteed that problem-free communication using other standard protocols, for example industrial communication for PG/PC can take place within the same network.

Reduction factor

The reduction rate determines the send/receive frequency for GD packets on the basis of the CPU cycle.

Reference ground

See Ground

Reference potential

Voltages of participating circuits are referenced to this potential when they are viewed and/or measured.

Repeater

See Hub

Restart

On CPU start-up (e.g. after is switched from STOP to RUN mode via selector switch or with POWER ON), OB100 (restart) is initially executed, prior to cyclic program execution (OB1). On restart, the input process image is read in and the **STEP 7** user program is executed, starting at the first instruction in OB1.

Retentive memory

A memory area is considered retentive if its contents are retained even after a power loss and transitions from STOP to RUN. The non-retentive area of memory flag bits, timers and counters is reset following a power failure and a transition from the STOP mode to the RUN mode.

Retentive can be the:

- Flag bits
- S7 timers
- S7 counters
- Data areas

Router

See Default Router

See Switch

A router works in a way similar to a switch. With a router, however, it is also possible to specify which communications nodes can communicate via the router and which cannot. Communication nodes on different sides of a router can only communicate with each other if you have explicitly enabled communication via the router between the two nodes.

RT

See Real Time

Runtime error

Errors occurred in the PLC (that is, not in the process itself) during user program execution.

Segment

See Bus segment

SFB

See System function block

SFC

See System function

Signal module

Signal modules (SM) form the interface between the process and the PLC. There are digital input and output modules (input/output module, digital) and analog input and output modules. (input/output module, analog)

SIMATIC

Name of products and systems for industrial automation from Siemens AG.

SIMATIC NCM PC

SIMATIC NCM PC is a version of STEP 7 tailored to PC configuration. For PC stations, it offers the full range of functions of STEP 7.

SIMATIC NCM PC is the central tool with which you configure the communication services for your PC station. The configuration data generated with this tool must be downloaded to the PC station or exported. This makes the PC station ready for communication.

SIMATIC NET

Siemens business area for industrial communication, networks, and network components.

SIMATIC PC Station

A "PC station" is a PC with communication modules and software components within a SIMATIC automation solution.

Slave

See Master

A slave can only exchange data after being requested to by the master.

SNMP

SNMP (Simple Network Management Protocol) is the standardized protocol for diagnostics of the Ethernet network infrastructure and for assignment of parameters to it.

Within the office area and in automation engineering, devices of a wide range of vendors support SNMP on Ethernet.

Applications based on SNMP can be operated on the same network at the same time as applications with PROFINET.

The range of functions supported differs depending on the device type. A switch, for example, has more functions than a CP 1616.

STARTUP

A START-UP routine is executed at the transition from STOP to RUN mode. Can be triggered with the mode selector switch, or automatically after power on, or by an operator action on the programming device. An S7-300 performs a restart.

STEP 7

Engineering system. Contains programming software for the creation of user programs for SIMATIC S7 controllers.

Subnet mask

The bits set in the subnet mask decides the part of the IP address that contains the address of the subnet/network.

In general:

- The network address is obtained by an AND operation on the IP address and subnet mask.
- The node address is obtained by an AND NOT operation on the IP address and subnet mask.

Subnetwork

All the devices connected by switches are located in the same network - a subnet. All the devices in a subnet can communicate directly with each other.

All devices in the same subnet have the same subnet mask.

A subnet is physically restricted by a router.

Substitute

See Proxy

Substitute value

Substitute values are configurable values which output modules transfer to the process when the CPU switches to STOP mode.

In the event of an I/O access error, a substitute value can be written to the accumulator instead of the input value which could not be read (SFC 44).

Switch

PROFIBUS is based on a bus topology. Communication nodes are connected by a passive cable - the bus.

In contrast, Industrial Ethernet is made up of point-to-point links: Each communication node is connected directly to one other communication node.

If a communication node needs to be connected to several other communication nodes, this communication node is connected to the port of an active network component- a switch. Other communications nodes (including switches) can then be connected to the other ports of the switch. The connection between a communication node and the switch remains a point-to-point link.

The task of a switch is therefore to regenerate and distribute received signals. The switch "learns" the Ethernet address(es) of a connected PROFINET device or other switches and forwards only the signals intended for the connected PROFINET device or connected switch.

A switch has a certain number of ports). At each port, connect a maximum of one PROFINET device or a further switch.

System diagnostics

System diagnostics refers to the detection, evaluation and signaling of errors which occur within the PLC, Examples of such error/faults include: Program errors or failures on modules. System errors can be indicated by LEDs or in **STEP 7**.

System function

A system function (SFC) is a --> function integrated in the operating system of the CPU that can be called when necessary in the STEP 7 user program.

System function block

A system function block (SFB) is a --> function block integrated in the operating system of the CPU that can be called when necessary in the STEP 7 user program.

System memory

System memory is an integrated RAM memory in the CPU. System memory contains the address areas (e.g. timers, counters, flag bits) and data areas that are required internally by the operating system (for example, communication buffers).

System status list

The system status list contains data that describes the current status of an S7-300. You can always use this list to obtain an overview of:

- The configuration of the S7-300
- the current CPU configuration and configurable signal modules
- the current status and processes in the CPU and in configurable signal modules.

Terminating resistor

The terminating resistor is used to avoid reflections on data links.

Timer

See Timers

Timers

Timers are part of CPU system memory. The content of timer cells is automatically updated by the operating system, asynchronously to the user program. **STEP 7** instructions are used to define the precise function of the timer cell (for example, on-delay) and to initiate their execution (for example, start).

TOD interrupt

See Interrupt, time-of-day

Token

Allows access to the bus for a limited time.

Topology

Structure of a network. Common structures include:

- Bus topology
- Ring topology
- Star topology
- Tree topology

Transmission rate

Data transfer rate (in bps)

Twisted Pair

Fast Ethernet via twisted-pair cables is based on the IEEE 802.3u standard (100 Base-TX). The transmission medium is a 2x2 wire, twisted and shielded cable with a characteristic impedance of 100 ohms (AWG 22). The transmission characteristics of this cable must meet the requirements of category 5 (see glossary).

The maximum length of the connection between end device and network component must not exceed 100 m. The ports are implemented according to the 100 Base-TX standard with the RJ-45 connector system.

Ungrounded

Having no direct electrical connection to ground

User memory

User memory contains the code and data block of the user program User memory can be integrated in the CPU or stored on plug-in Memory Cards or memory modules. However the user program is principally processed from the RAM of the CPU.

User program

See Operating system

See STEP 7

In SIMATIC, a distinction is made between the operating system of the CPU and user programs. The user program contains all instructions and declarations, as well as signal processing data that can be controlled by the plant or the process. It is assigned to a programmable module (for example CPU or FM) and can be structured in smaller units (blocks).

Varistor

Voltage-dependent resistor

WAN

Network with a span beyond that of a local area network allowing, for example, intercontinental operation. Legal rights do not belong to the user but to the provider of the transmission networks.

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