SIEMENS

SIMATIC

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

Operating Instructions

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

Edition 12/2003

A5E00105492-04

Safety Guidelines

This manual contains notices which should observe to ensure your own personal safety, as well to protect the product and connected equipment. These notices are highlighted in the manual by a warning triangle and are marked as follows to the level of danger.

Danger

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

Warning

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

Caution

used with the saftey 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

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

Qualified Personnel

The device/sytem 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 ground, and to tag circuits, equipment, and systems in accordance with established safety practices and standards.

Intended Use

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 which have been approved or recommended by Siemens.

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

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Preface

Purpose of the Manual

This manual contains the information you will need to plan, assemble, wire up, address and commission a S7-300.

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

Required basic knowledge

To understand this manual you will require a general knowledge of automation technology. You also require knowledge of the STEP 7 basic software. You may find it useful to read the Programming with STEP 7 V5.3 manual.

Range of applicability

CPU	Convention: The CPUs are designated as follows:	Order number	From 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 317-2 DP		6ES7317-2AJ10-0AB0	V2.1.0	01
CPU 317-2 PN/DP		6ES7317-2EJ10-0AB0	V2.2.0	01

Note

The special features of CPU 315F-2 DP and CPU 317F-2 DP is available as product information on the Internet in the Product & Support area under article ID 17015818.

Note

You receive a description of all the modules available at the time of publishing.

We reserve the right to enclose product information for new modules or modules with more recent versions which contain the latest information about those modules.

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 mark

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

- EU Directive 73/23/EWE "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 conform to IEC 61131-2.

Documentation Classification

These instructions are part of the documentation package for the S7-300.

Name of the manual	Description
Instruction Manual • CPU 31xC and CPU 31x, 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 Operating Instructions • S7-300, CPU 31xC and CPU 31x: Hardware and Installation	Planning, assembling, wiring up, addressing, commissioning, maintaining and the test functions, diagnosis and troubleshooting.
Installation Manual • S7-300 Automation System: Installing and Commissioning: CPU 312 IFM – 318-2 DP	Planning, assembling, wiring up, addressing, commissioning, maintaining and the test functions, diagnosis and troubleshooting.
Manual • CPU 31xC: Technological Functions • Examples	Description of the individual technological functions Positioning, Counting. Point-to-point communication, Rules The CD contains examples of the technological functions
Reference Manual • S7-300 Automation System: Module data	Function descriptions and technical data of the signal modules, power supplies and interface modules.
Instruction List • CPU 312 IFM – 318-2 DP • CPU 31xC and CPU 31x	List of operational supply of the CPU and their run times. List of ready-to-run 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 314C: Positioning with Digital Output • CPU 31xC: Counting • CPU 31xC: Rules • CPU 31xC: Point-to-point communication • CPU 317-2 PN/DP: Configuration of PROFInet interface X2	Getting Started uses step-by-step procedures to guide you through the individual commissioning steps to a functional application.

The following information is required in addition to these instructions:

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. The description can also be found in the online help to STEP 7.
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.
Component-based automation: Configuring systems with SIMATIC iMap	Description of the iMAP configuration software
Programming with STEP 7 V5.3 manual.	Programming with STEP 7

Documentations of S7-300: Additional documentation

Recycling and Disposal

The units described in this manual are recyclable, due to the low levels of harmful substances they contain. For correct recycling and disposal of your old units, contact a certified disposal facility for electronic scrap.

See also

Technical support (Page A-30)

Table of contents

Tables

Guide to the S7-300 documentation

1

Overview

Here you will find a guide to the documentation for the S7-300.

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 Operating Instructions: Hardware and Installation: Configuring - Dimensions of components S7-300, CPU 31xC and CPU 31x Operating Instructions: Hardware and Installation: Mounting - Mounting the rail
How do environmental conditions influence the PLC?	S7-300, CPU 31xC and CPU 31x Operating Instructions: Hardware and 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: Hardware and Installation: Configuring - Electrical Assembly, Protective Measures and Grounding Module Specifications 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: Hardware and Installation: Configuring - Electrical Assembly, Protective Measures and Grounding CPU 31xC and CPU 31x Operating Instructions: Hardware and 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: Hardware and 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 Device 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 Device Manual, Technical data for 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: Hardware and Installation: Wiring – Wiring Front Connectors
When do I need expansion modules (EM) and how do I connect them?	S7-300, CPU 31xC and CPU 31x Operating Instructions: Hardware and Installation: Configuring – Arranging Modules on Multiple Racks
How do I mount modules on racks / on profile rails?	S7-300, CPU 31xC and CPU 31x Operating Instructions: Hardware and Installation: Mounting – Mounting Modules on Profile Rails

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 / expansion modules: Module Specifications Reference Manual For distributed I/Os / PROFIBUS DP: Manual of the Corresponding I/O Device

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

Information on..	is available in ...
Which rack / profile rail is best suitable for my application?	S7-300, CPU 31xC and CPU 31x Operating Instructions: Hardware and 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: Hardware and Installation: Configuring – Arranging Modules on Multiple Racks
What is the right power supply (PS) for my application?	S7-300, CPU 31xC and CPU 31x Operating Instructions: Hardware and 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 Device Manual, Technical Data
How do I insert and remove Micro Memory Cards?	S7-300, CPU 31xC and CPU 31x Operating Instructions: Hardware and Installation: Commissioning – Commissioning Modules – Inserting/Replacing a Micro Memory Card (MMC)
Which CPU meets my demands on performance?	S7-300 Instruction List: CPU 31xC and CPU 31x
How fast is the response / processing time of the CPU?	CPU 31xC and CPU 31x Device 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
Which options and resources does the CPU offer?	CPU 31xC and CPU 31x Device Manual, Technical Data
How do I use communication processors (CPs) to optimize communication?	CP Device Manual
Which type of communication network is best suited to my application?	S7-300, CPU 31xC and CPU 31x Operating Instructions: Hardware and Installation: Configuring – Configuring Subnets
How do I network the individual components?	S7-300, CPU 31xC and CPU 31x Operating Instructions: Hardware and Installation: Configuring – Configuring Subnets
What do I have to take into account relating to the configuration of PROFInet networks?	SIMATIC NET Manual, Twisted-Pair and Fiber Optic Networks (6GK1970-1BA10-0AA0) - Network Configuration

Table 1-8 Software

Information on..	is available in ...
Which software do I need for my S7-300 system?	CPU 31xC and CPU 31x Device Manual, Technical Data – Technical Data

Table 1-9 Supplementary properties

Information on..	is available in ...
How do I implement operator control and monitoring? (Human Machine Interface)	For text-based display units: the device manual For OPs: the device manual For WinCC: the device manual
How can I integrate process control modules?	For PCS7: the device manual
What options are offered by redundant and fail-safe systems?	S7-400H Manual – Redundant Systems Fail-Safe Systems Manual

Installation Order

2

We will show you first the sequence of steps you must follow to install your system. We shall then go on to explain the basic rules that you should follow, and how you can modify an existing system.

Installation procedure

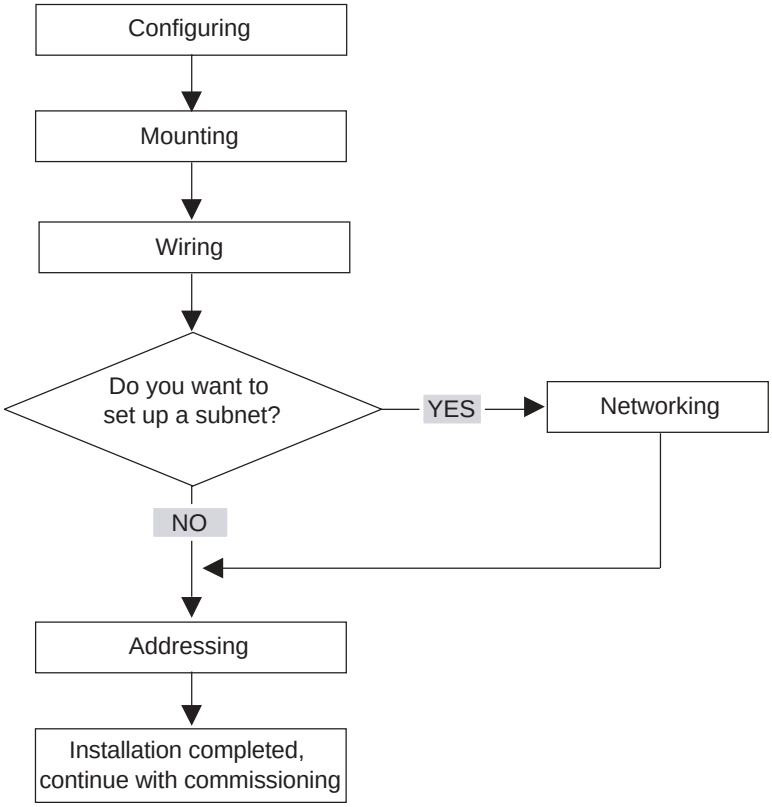


Figure 2-1 Installing an S7 system

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 must at least keep to these basic rules if you want your SIMATIC S7 system to operate correctly.

Modifying the structure of an existing S7 system

If you want to modify the configuration of an existing system at a later time, proceed using the steps indicated above.

Note

If you want to install a signal module at a later time, consult the relevant information for the respective module.

Reference

Also note the description of your specific module in the manual *SIMATIC S7-300 PLCs Module Specifications Reference Manual*.

Modules of the S7-300

3

3.1 Sample configuration of an S7-300

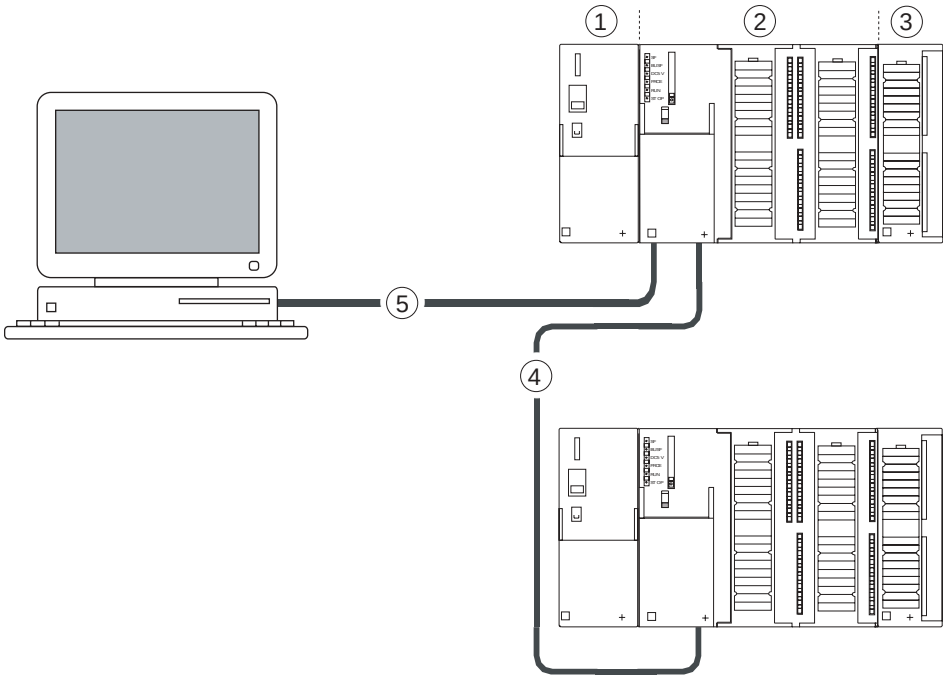


Figure 3-1 Modules in an S7-300

The figure illustrates under number	the following modules of an S7-300
(1)	Power supply (PS)
(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)

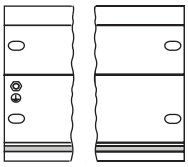
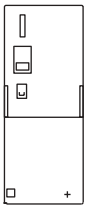
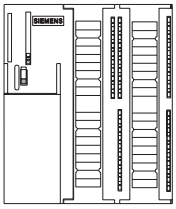
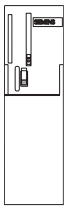
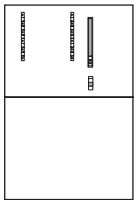
You use a programming device (PG) to program the S7-300 PLC. PG and CPU are connected via PG cable.

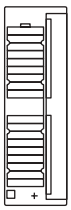
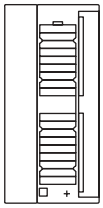
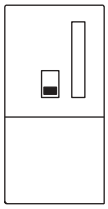
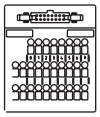
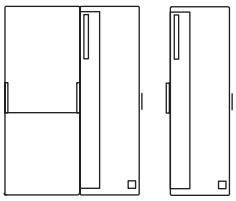
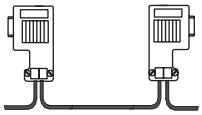
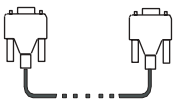
Several S7-300 CPUs communicate with one another and with other SIMATIC S7 PLCs via the PROFIBUS cable. Several S7-300 are connected via the PROFIBUS bus cable.

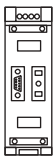
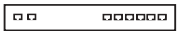
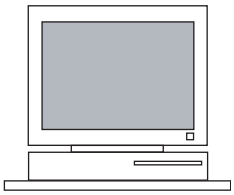
3.2 Overview of the major modules of an S7-300

You can choose from a number of modules for installation and commissioning. The major modules and their functions are shown below.

Table 3-1 S7-300 modules:

Component	Function	Illustration
Rails Accessories: • Shielding terminal	Module racks of the S7-300	
Power supply (PS)	The PS converts the line voltage (120/230 VAC) to 24 VDC operating voltage and is used to supply the S7-300 and 24 VDC load circuits.	
CPU Accessories: • Front connectors (CPU 31xC only)	The CPU runs the user program, supplies 5 V to the S7-300 backplane bus; communicates with other nodes of an MPI network via the MPI interface. Additional properties of specific CPUs: • DP master or DP slave in a PROFIBUS subnet • Technological functions • Point-to-point communication • Ethernet communication via integrated PROFInet interface	 e.g. CPU 31xC
		 e.g. CPU 312, 314, or 315-2 DP
		 e.g. CPU 317

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, such as positioning or controlling.	
Communication processor (CP) Accessory: Connecting cable	The CP relieves the CPU of communication tasks. Example: CP 342-5 DP connection 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 connects the individual rows in an S7-300	
PROFIBUS cable with bus connector	Connect the nodes of an MPI or PROFIBUS subnet to one another	
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 connect nodes with each other via Ethernet.	
Twisted-pair cables with RJ45 connectors.	Devices with an Ethernet interface are connected with each other (e.g. a switch with a CPU 317-2 PN/DP).	
Programming device (PG) or PC with the STEP 7 software package	You will need a PG to configure, set parameters, program and test your S7-300	

Configuring

4

4.1 Overview

Here you will find all the necessary information

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

Reference

- For additional information, see the *Communication with SIMATIC* manual or
- the *SIMATIC NET Twisted-Pair and Fiber Optic Networks* manual (6GK1970-1BA10-0AA0)

4.2 Basic Principles of Planning

Important information about planning

Warning

Open equipment
The modules that make up an S7-300 are regarded as open equipment. This means that you must always install the S7-300 in a cubicle, cabinet or electrical control room that 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

Depending on the field of application, the operation of an S7-300 in a plant or system is defined by special rules and regulations . Note the safety and accident prevention regulations relating to specific applications, e.g. 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 consider 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, if required, one or multiple expansion modules (EMs).

The rack containing the CPU is referred to as the central unit (CU). Racks equipped with modules form the expansion modules (EMs) connected to the system's CU.

Use of an expansion module (EM)

You can use EMs if the number of CU slots is insufficient 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 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 installation: from 0 °C to 40 °C
- Horizontal installation: from 0 °C to 60 °C.

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

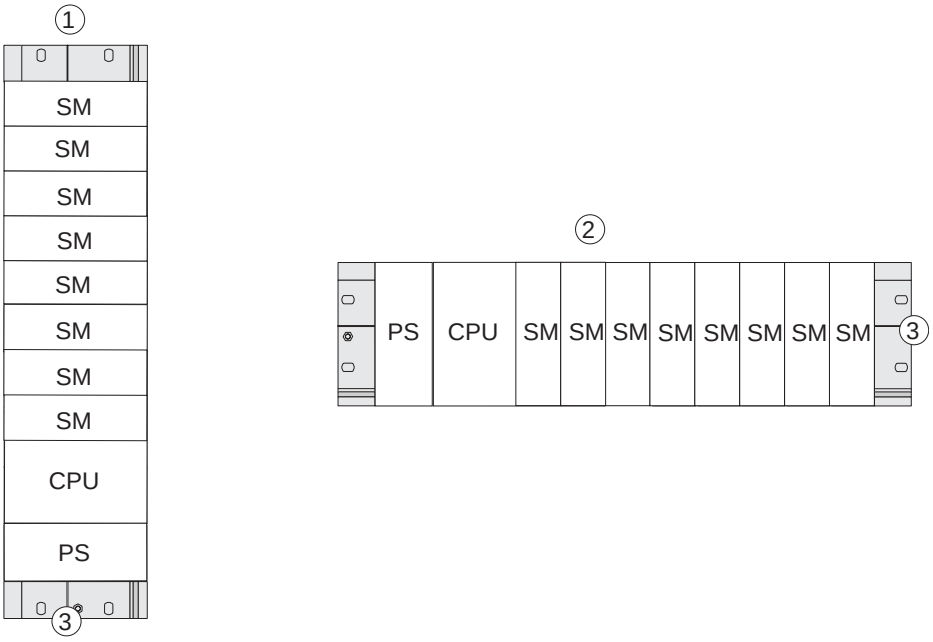


Figure 4-1 Horizontal and vertical installation

The figure illustrates under number	
(1)	Vertical installation of an S7-300
(2)	Horizontal installation of an S7-300
(3)	Rail

4.3 Component Dimensions

Length of rails

Table 4-1 Profile rails - Overview

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 if required	6ES7 390-1BC00-0AA0

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

Dimensions of modules

Table 4-2 Module width

Module	Width
Power supply PS 307, 2 A	50 mm
Power supply PS 307, 5 A	80 mm
Power supply PS 307, 10 A	200 mm
CPU	The installation dimensions are listed in the Technical Data section of your *CPU 31xC and CPU 31x Device 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 mounting depth: 130 mm
- Maximum mounting depth of a CPU with an inserted DP connector with angled cable outlet: 140 mm
- Maximum mounting depth with open hinged 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 rail makes it easy for you to connect all shielded cables of your S7 modules to ground.

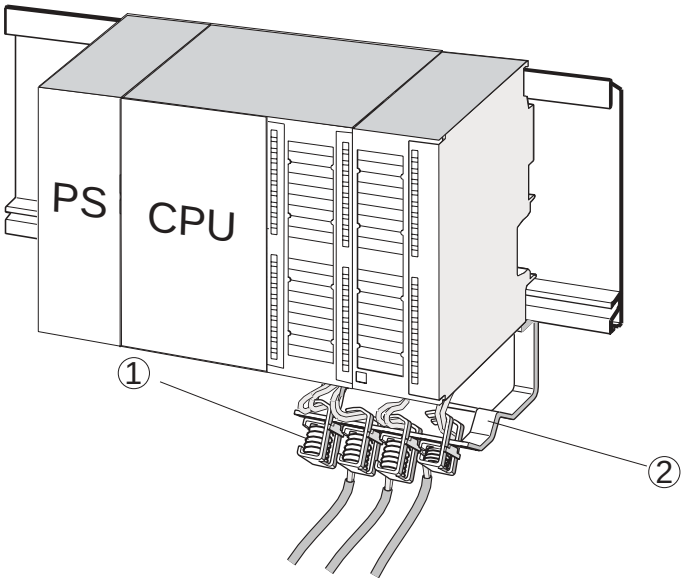


Figure 4-2 Shielding contact element

The figure illustrates under number	
(1)	Shielding terminals
(2)	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 apply from the lower edge of the module.

- 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 shielding diameter 2 mm to 6 mm	6ES7 390-5AB00-0AA0
Cable shielding diameter 3 mm to 8 mm	6ES7 390-5BA00-0AA0
Cable shielding diameter 4 mm to 13 mm	6ES7 390-5CA00-0AA0

4.4 Required clearances

You must maintain the clearance shown in the figure in order to provide sufficient space to install the modules and to dissipate the heat generated by the modules.

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

For example, if you wire your modules using a cable duct, the clearance between the bottom edge of the shielding contact element and the cable duct must be 40 mm.

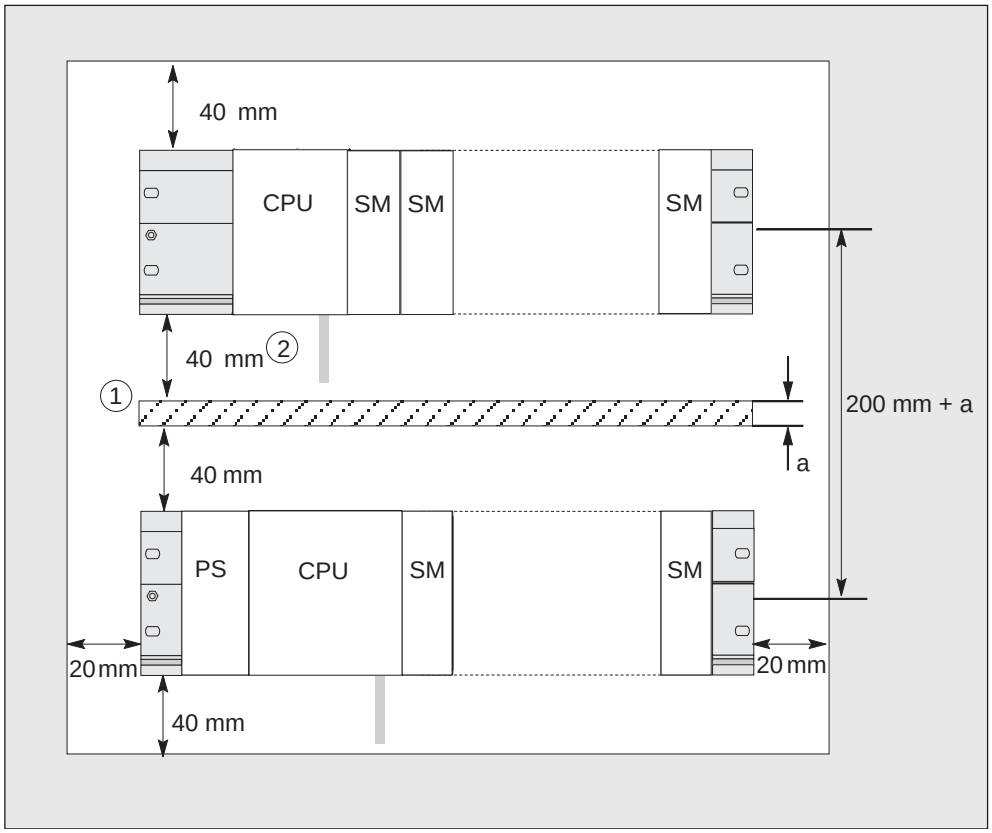


Figure 4-3 Clearances

The figure illustrates under number	
(1)	Wiring using a cable duct
(2)	Clearance between cable channel and bottom edge of shielding contact element must be 40 mm

4.5 Arranging 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 • Centralized use of your modules • Fewer signals to be processed	• More signals to be processed • Insufficient slots available

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 inserting a second rack for your application in the future, simply by replacing the dummy module with an interface module and without having to reinstall and rewire the first rack.

Rules: Arranging modules on a single module rack

The following rules apply to single-rack module installations:

- No more than eight modules (SM, FM, CP) may be installed to the right of the CPU.
- All modules mounted on a rack must not consume more than a total of 1.2 A from the S7-300 backplane bus.

Reference

More information is listed under the technical data, e.g. *S7-300 Module Specifications Reference Manual* or in the *Reference Manual* for your CPU.

Example

The figure below shows the arrangement of eight signal modules in an S7-300 assembly.

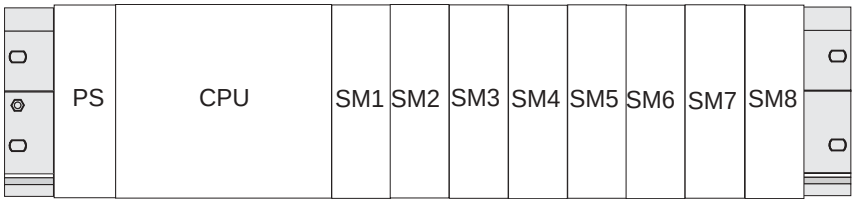


Figure 4-4 Rack with eight signal modules

4.6 Arranging Modules on Multiple 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 a structure distributed between 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	Low-cost 2-row configuration
Send IM in rack 0	IM 360 Order no.: 6ES7 360-3AA01-0AA0	IM 365 Order no.: 6ES7 365-0AB00-0AA0
Receive IM in rack 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; total 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: Arranging modules on several racks

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

- The interface module always uses slot 3 (slot 1: power supply; 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 total power consumption must not exceed 1.2 A per row.

Note

The power consumption of the individual modules is given in the *Module Specifications Reference Manual.*

Rules: Interference-proof installation of the connection

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 that

- all racks are interconnected with low impedance,
- the racks of a grounded assembly are grounded in a star pattern,
- the contact springs on the racks are clean and not bent, thus ensuring that interference currents are dissipated.

Example of a full assembly

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

Figure 4-5 Full assembly using racks

The figure illustrates under number	
(1)	Rack 0 (central unit)
(2)	Rack 1 (expansion module)
(3)	Rack 2 (expansion module)
(4)	Rack 3 (expansion module)
(5)	Connection cable 368
(6)	Restriction for CPU 31xC: when this CPU is used, you must not insert Signal Module 8 on 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 S7-300s in an environment subject to interference or contamination and
- to meet UL/CSA requirements, which require installation in cabinets

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 (rails)
- Total 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

Further information on degree of protection can be found in IEC 529 and DIN 40050.

The cabinet's power dissipation

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

Reference for power loss

Siemens catalogs NV21 and ET1 contain more detailed information about power dissipation.

Specifications for cabinet dimensions

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

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

Warning

Modules may get damaged if exposed to inadmissible ambient temperatures.

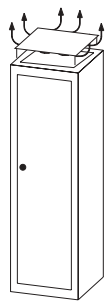
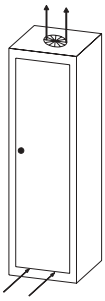
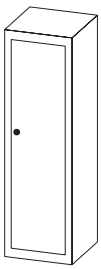
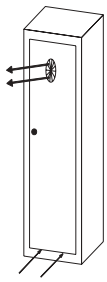
Reference for ambient temperatures

Information on permissible ambient temperatures is in the Appendix: see *Ambient Conditions*

Overview of typical cabinet types

The table below gives you an overview of the 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 via 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 heat concentration develops at the top of the cabinet interior.	Heat dissipation only across the cabinet wall. Forced convection of the interior air improves heat dissipation and prevention of heat concentration.	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 a total power loss of 650 W.

Power loss dissipated

The figure 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, depending on power loss. these values only apply if you maintain the specified installation and clearance dimensions for racks (rails).

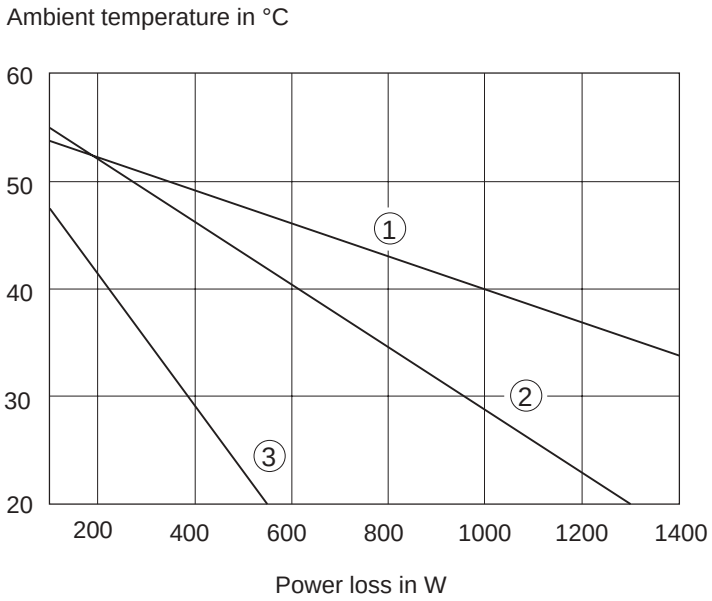


Figure 4-6 Power loss dissipated

Curve	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 ventilation by equipment fans

Result

From the figure we can see that the following ambient temperatures are obtained for a total power loss of 650 W:

Table 4-6 Cabinet selection

Cabinet design	Maximum permitted ambient temperature
Closed with natural convection and forced ventilation (Curve 3)	Operation not possible
Open with through-ventilation (Curve 2)	approx. 100.40 °F
Closed with heat exchanger (Curve 1)	approx. 45 °C

If you install the S7-300 horizontally, you can use the following types of cabinet:

- 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 on a grounded incoming supply (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. You must observe at least these basic rules if you want your S7-300 to operate free of trouble.

Definition: Grounded incoming supply

The neutral is grounded in a grounded power supply system (PEN). A single short-circuit to ground between a live conductor or 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
Disconnecting devices for control systems, sensors and actuators	(1)	...Part 460: Master switch	... Part 1: Circuit breaker
Short-circuit/overload protection: In groups for sensors and actuators	(2)	...Part 725: Single-pole fusing of circuits	... Part 1: • In the case of a grounded secondary circuit: Provide single-pole protection • Otherwise: Provide all-pole protection
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

Additional information on protective measures is in the Appendix.

4.9.2 Installing an S7-300 with Grounded Reference Potential

Introduction

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

Note

Your CPU already is supplied complete with a grounded reference potential, so if you wish to install an S7-300 with grounded reference potential, then you do not need to make any changes to your CPU.

Grounded reference potential of the CPU 31x

The figure illustrates an S7-300 configuration with ungrounded reference potential.

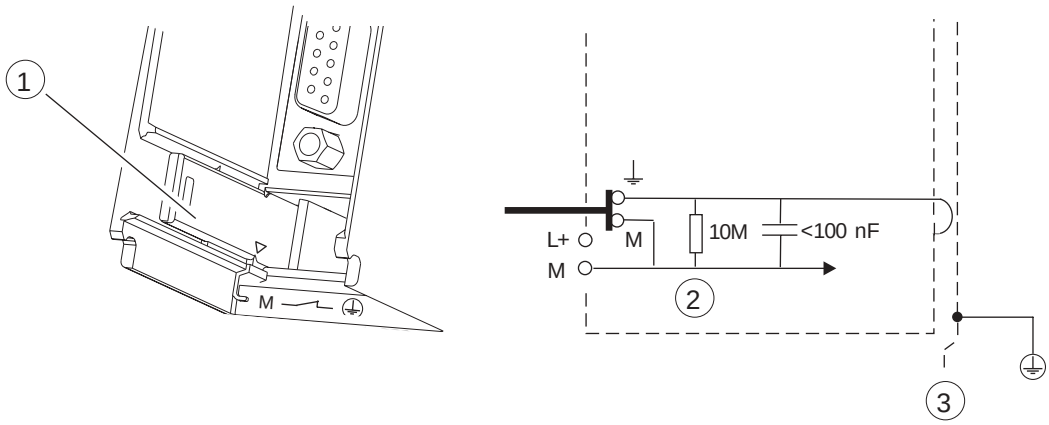


Figure 4-7 CPU with grounded reference potential (as supplied)

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

Note

If you configure an S7-300 with grounded reference potential, you must not pull out the grounding slide contact.

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 occurring interference current is dissipated 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 extended systems, the S7-300 may require 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 illustrates an S7-300 configuration with floating reference potential

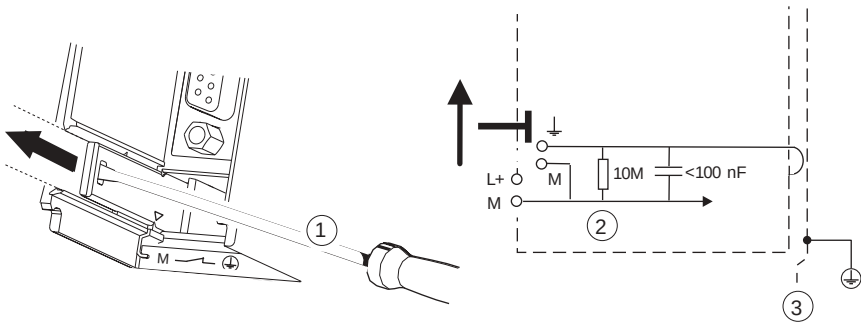


Figure 4-8 Creating an ungrounded reference potential on a CPU

The figure illustrates under number	
(1)	If you implement an ungrounded reference potential in your CPU: Use a screwdriver with 3.5 mm blade width and push the grounding slide contact forwards in the direction of the arrow until it snaps into place.
(2)	Ground of internal CPU circuitry
(3)	Rail

Note

If at all possible, set up the ungrounded reference potential before mounting on the rail. If you have already installed and wired up the CPU, you may have to detach the connection to the MPI interface before you pull out the grounding slide contact.

4.9.4 Isolated or non-isolated modules?

Isolated modules

When isolated modules are installed, the reference potentials of the control circuit ($M_{internal}$) and load circuit ($M_{external}$) are electrically isolated.

Application

Use isolated modules for:

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

  Examples:

  - DC load circuits whose sensors have different reference potentials (for example if grounded sensors are located at some considerable distance from the control system and no equipotential bonding is possible)
  - DC load circuits with grounded positive pole (L+) (battery circuits).

Isolated modules and grounding concept

You can use isolated modules, regardless of whether or not the control system's reference potential is grounded.

Example: CPU 31xC

The figure below shows a sample configuration of a CPU 31xC with isolated modules. The ground connection is automatically generated for the CPU 31xC (1).

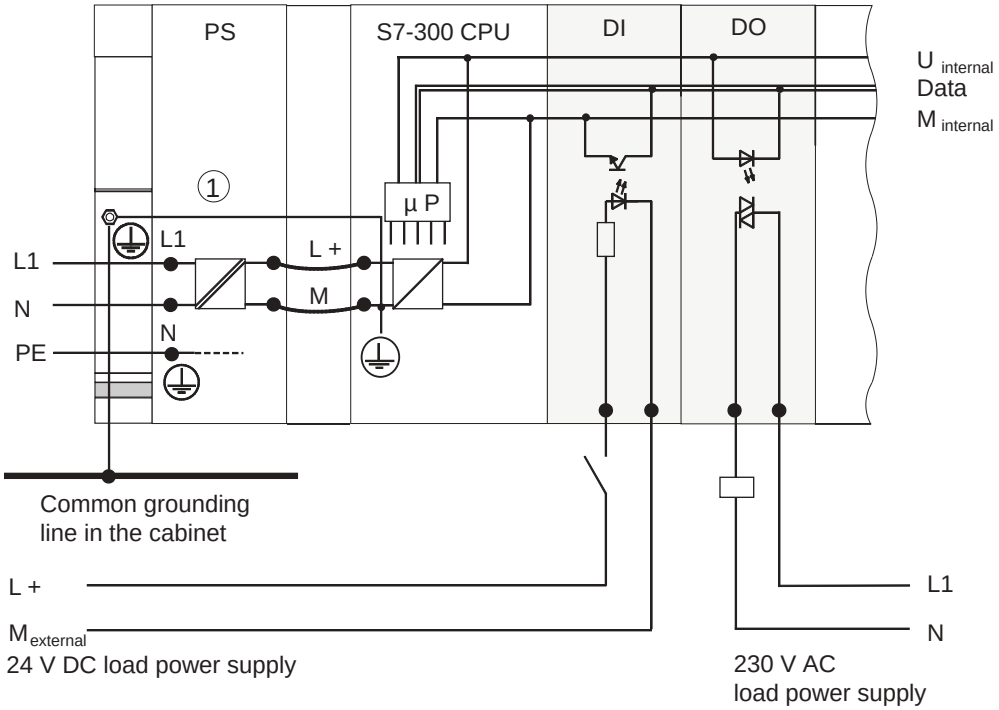


Figure 4-9 Configuration with isolated modules

Non-isolated modules

When non-isolated modules are installed, the reference potentials of the control circuit ($M_{internal}$) and analog circuit (M_{analog}) are electrically isolated.

Example

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

The figure below shows a sample configuration of an S7-300 CPU with non-isolated modules.

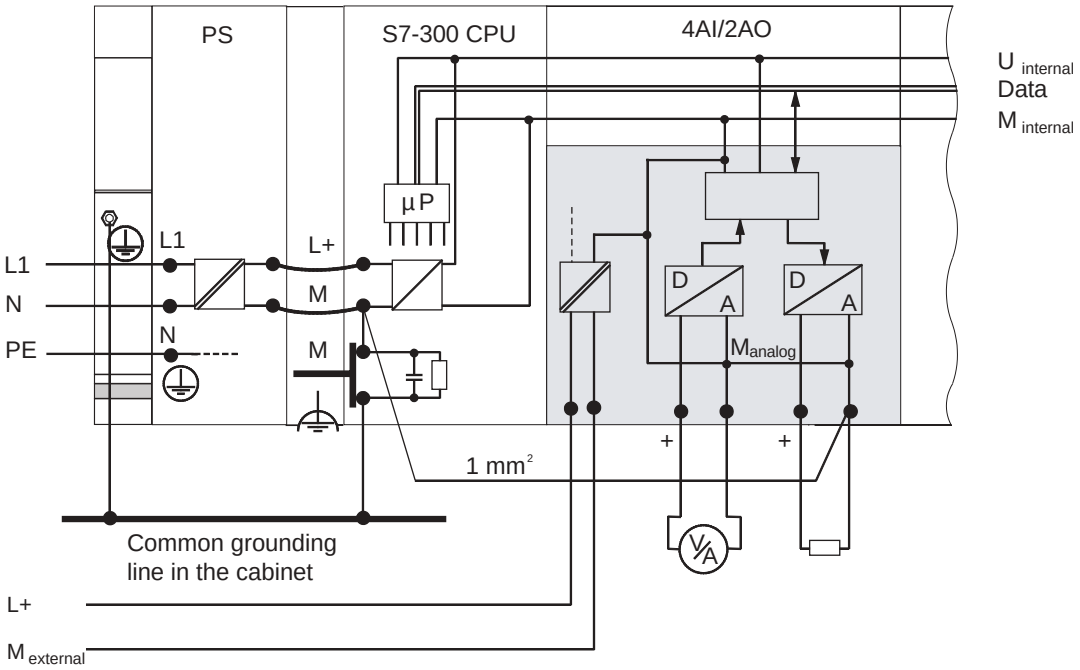


Figure 4-10 Configuration with non-isolated modules

4.9.5 Grounding measures

Bonding

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

Warning

All protection class 1 devices, and all larger metal parts, must be connected to protective ground. This is the only way to ensure that the system user is protected from electrical shock. It also deflects interference which is emitted from external power supply cables and signal cables to cables connected to 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 structure	Connection to central ground (e.g. equipotential bus line) via cables with protective conductor quality
Rack / rail	Connection to central ground with cable of 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 actuators	Grounding in accordance with regulations applying to the system

Rule: Ground cable shielding

You should always connect both ends of the cable shielding to ground/functional ground, since this is the only way to achieve good interference suppression in the higher frequency range.

If you connect only one end of the shielding (that is, at one or the other end of the cable) to ground, you will merely achieve an attenuation in the lower frequency range. One-sided shielding connections could be more favorable in situations

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

Note

With 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 circuits Ground

You should always ground the load circuits. This common reference potential (earth) 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* Number 4).

Connecting the load voltage reference potential

Numerous output modules require an additional load voltage for switching control devices.

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

Table 4-9 Connecting the load voltage reference potential

Installation	Non-isolated modules	Isolated modules	Note
grounded	Connect $M_{external}$ with M on the CPU	Connect or do not connect $M_{external}$ to the common grounding line	-
ungrounded	Connect $M_{external}$ with M on the CPU	Connect or do not connect $M_{external}$ to the common grounding line	Ungrounded installation with CPU 31xC 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 arrangement displayed does not correspond with the physical arrangement; it was merely selected to give you a clear overview.

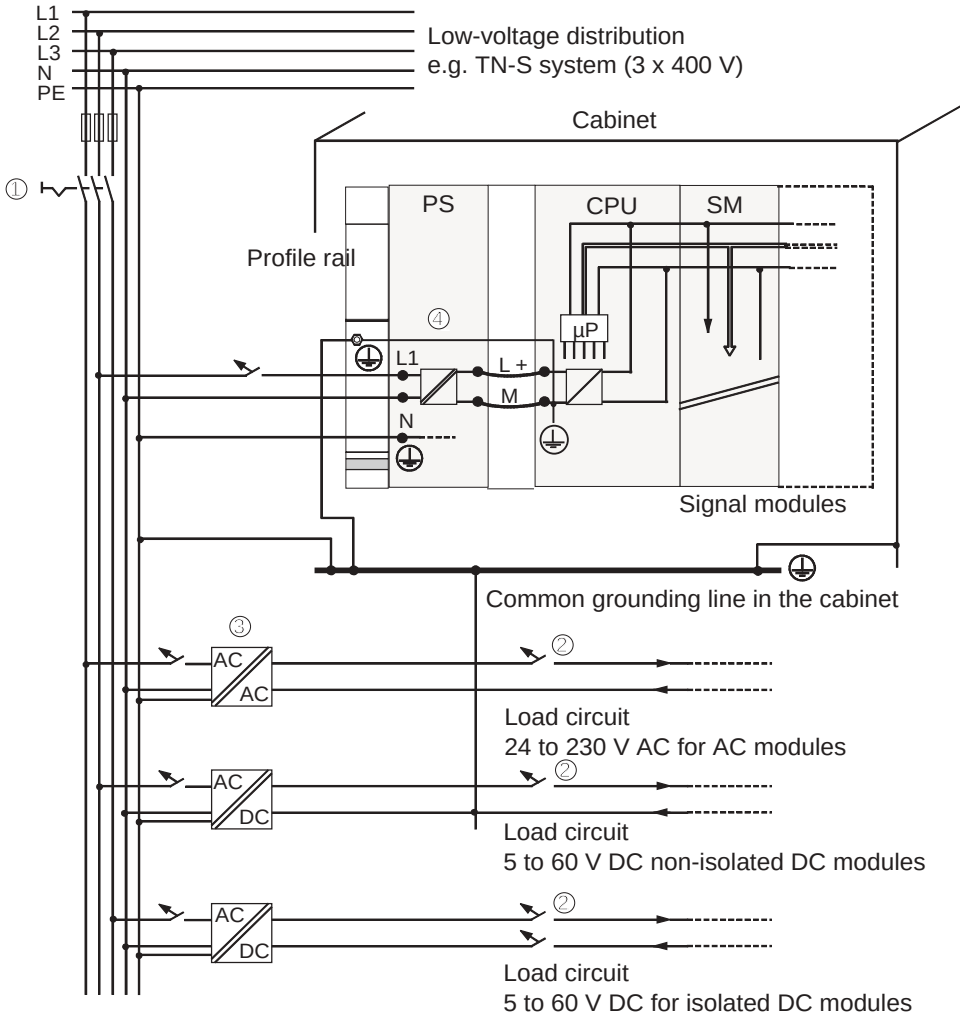


Figure 4-11 Grounding concept for the S7-300 with CPU 31xC

Table 4-10 Connecting the load voltage reference potential

The figure illustrates under number	
(1)	The main switch
(2)	Short-circuit/overload protection
(3)	The load current supply (galvanic isolation)
(4)	This connection is automatically generated 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 arrangement displayed does not correspond with the physical arrangement; it was merely selected to give you a clear overview.

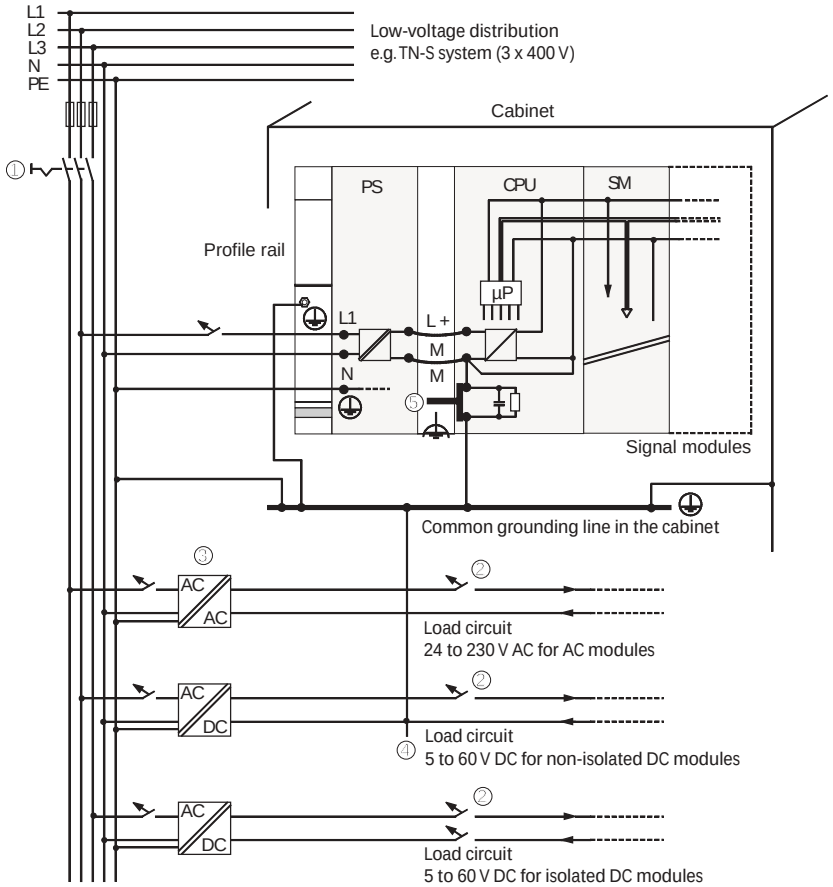


Figure 4-12 Grounding concept for the S7-300 (excluding CPU 31xC)

Table 4-11 Connecting the load voltage reference potential

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

4.10 Selecting the Load Power Supply

Task of load power supply

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

Characteristics of load power supply units

You will have to adapt the load power supply unit to your specific application. The following table compares the various load power supply units and their characteristics to help you make your choice:

Table 4-12 Characteristics of load power supply units

Mandatory for ...	Characteristics of the load power supply	Remarks
Modules requiring voltage supplies of ≤ 60 VDC or ≤ 25 VAC. 24 VDC load circuits	Protective separation	These characteristics apply to Siemens power supplies of the series PS 307 and to 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	-

Requirements for load power supplies

It must provide an extra-low voltage of = 60 VDC and be safely isolated from mains. Safe isolation from mains can be realized, 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 determining

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

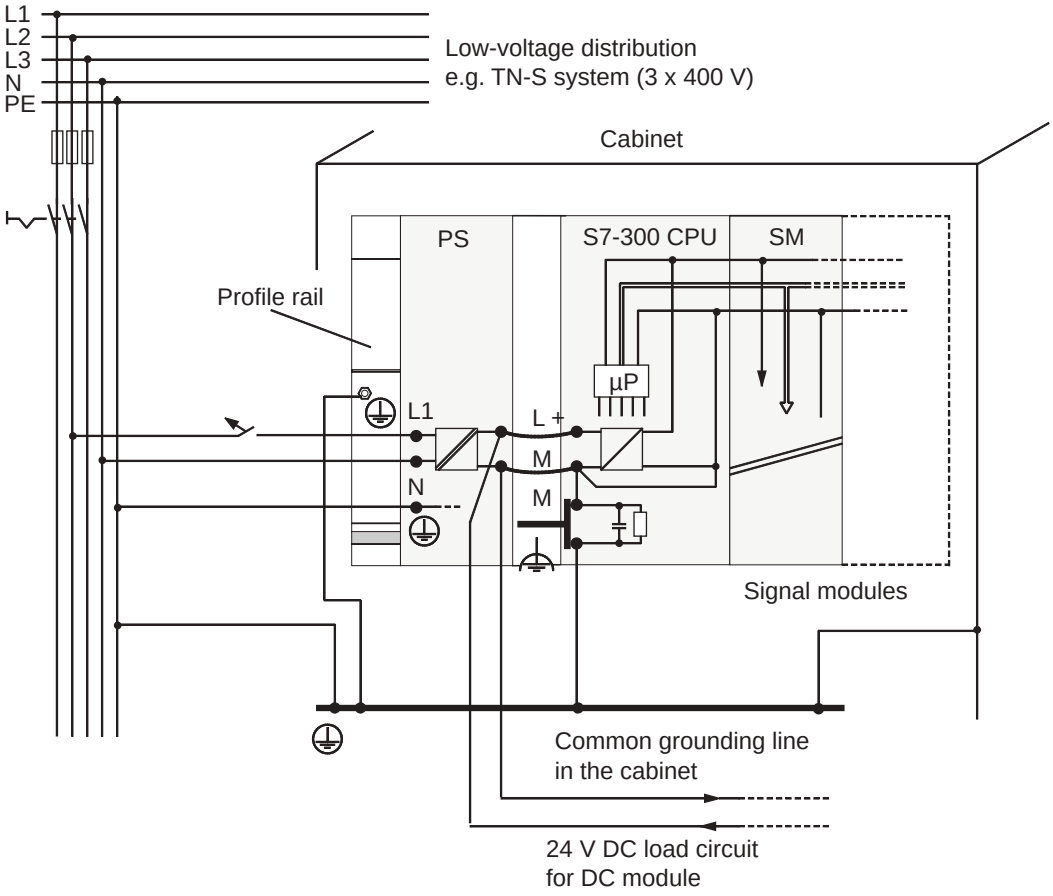
In the event of a short-circuit the DC outputs are briefly loaded with twice to three times the rated output current before the clocked electronic short-circuit protection comes into effect. Thus, you must consider this increased short-circuit current when selecting your load power supply unit. Uncontrolled load power supplies usually provide this excess current. With controlled load power supplies – especially for low output power (up to 20 A) – you must 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. Apart from powering the CPU, the PS 307 also supplies the load current for the 24 VDC modules.

Note

The arrangement of supply connections displayed does not correspond with the 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

SIMATIC offers the following subnets, according to different 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: In all the CPUs described in this document.

MPI is a small subnet with just a few nodes at the field/cell level. It is a multipoint-capable interface in SIMATIC S7/M7 and C7, intended for operation as PG interface for networking just a few CPUs or for exchanging small volumes of data with PGs.

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

For your MPI network configuration, we recommend you use the same network components as in a PROFIBUS DP network configuration. The same configuration rules apply in this case. Exception: OWG modules are not allowed in the MPI network.

PROFIBUS

Availability: CPUs with "DP" in their name have a PROFIBUS interface (e.g. CPU 315-2 DP)

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

PROFIBUS is available in two versions:

1. PROFIBUS DP field bus for fast cyclic data exchange, and PROFIBUS-PA for the intrinsically safe area (requires DP/PA coupler).
2. The cell level as PROFIBUS (FDL or PROFIBUS FMS) for fast data exchange with communication partners equipped with equal rights (can only be implemented via CP).

PROFInet (Industrial Ethernet)

Availability: CPUs with "PN" in their name have a PROFInet interface as the second interface (e.g. CPU 317-2 PN/DP) With S7-300 CPUs, you can implement Industrial Ethernet connections with the help of a PROFInet interface or communication processors.

Industrial Ethernet in an open multivendor communication system represents the SIMATIC network at the process and cell level. But real-time capable communication on the field level is supported for PROFInet CPUs using the communication with CbA. In addition, communication is possible S7 communication. Industrial Ethernet is suitable for fast and high-volume data exchange and offers offsite networking options via gateway.

Point-to-point communication (PtP)

Availability: CPUs with "PtP" in their name have a PtP interface as a second interface (e.g. CPU 314C-2 PtP)

Point-to-Point communication is no subnet in the common sense, because only two stations are interconnected.

If no PtP interface is available, you require PtP communication processors (CP).

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 used especially for networking digital sensors and actuators. The maximum data volume is 4-bit-per-slave station.

With S7-300 CPUs, you can connect to an ASI only with the help of communication processors.

Reference

Additional information on communication can be found in the *Communication with SIMATIC* manual.

4.11.2 Configuring MPI and PROFIBUS subnets

4.11.2.1 Basic principles of MPI and PROFIBUS subnets

Convention: Device = Node

All devices networked in an MPI or PROFIBUS network are referred to as nodes.

Segment

A segment is a bus link between two terminating resistors. A segment can include up to 32 nodes. It is also limited by the permitted line length, depending on the transmission rate.

Transmission rate

These maximum transmission rates are possible:

- MPI:
  - CPU 317: 12 Mbps
  - All other CPUs: 187.5 kbps
- PROFIBUS DP: 12 Mbps

Number of nodes

Maximum possible number of nodes per subnet:

Table 4-13 Subnet nodes

Parameters	MPI	PROFIBUS DP
Number	127	126 [1]
Analog modules	0 to 126	0 to 125
Note	Default: 32 addresses Reserved are: • 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 respective CPU manual.

MPI/PROFIBUS DP addresses

To ensure that all nodes can intercommunicate, you must assign them an address:

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

On the PG you can specify individual MPI/PROFIBUS addresses for each one of the nodes (on some of the PROFIBUS DP slaves this is also possible per selector switch).

Default MPI/PROFIBUS DP addresses

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

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

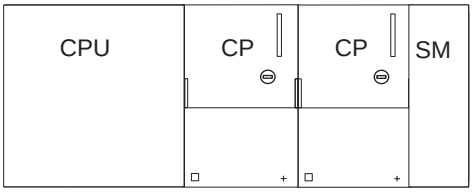
Rules: Assigning MPIs/PROFIBUS DP addresses

Note the following rules before assigning MPI/PROFIBUS addresses:

- All MPI/PROFIBUS addresses in a subnet must be unique.
- The highest MPI/PROFIBUS address must be = of the physical MPI/PROFIBUS address, and it must be identical for each node. (Exception: Connecting a PG to multiple nodes; refer to the next Chapter).

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

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

Options	Example			
Example: An S7-300 CPU and 2 CPs in one unit. You have two options for assigning MPI addresses of CPs/FMs installed in one unit:				
	CPU	CP	CP	
First option: The CPU adopts the CP MPI addresses you specify in STEP 7.	MPI address	MPI address +x	MPI address +y	
Second option: The CPU automatically determines the MPI addresses of the CPs in their configuration as follows: MPI address of CPU; MPI address +1; MPI address +2. (Default)	MPI address	MPI address +1	MPI address +2	
Special features: CPU 317	If there are FM/CPs with their own MPI address in the central rack of an S7-300, then the CPU forms its own communication bus via the backplane bus with these FM/CPs, which are separated from the other subnets. The MPI address of these FMs/CPs is no longer relevant for the nodes of other subnets. The communication to the FM/CP is made via the MPI address of the CPU.			

MPI address recommendationn

Reserve MPI address "0" for a service PG or "1" for a service OP. You can later connect them temporarily to the subnet. Also, assign other MPI addresses to PGs/OPs operating on the MPI subnet.

Recommended MPI address for the CPU in case of replacement or service:

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 must assign an MPI address greater than "2" to CPUs on the MPI subnet.

PROFIBUS address recommendationn

Reserve PROFIBUS address "0" for a service PG that you can subsequently connect briefly to the PROFIBUS subnet if required. Therefore, assign unique PROFIBUS addresses to PGs integrated in the PROFIBUS subnet.

PROFIBUS DP: Electrical conductor or fiber optic cable?

Use fiber optic cables instead of copper conductors if you want your field bus to cover greater distances regardless of the transmission rate and be insensitive to external noise fields.

Potential differences

For information on what to take into account relating to equipotential bonding when you configure your network, refer to the corresponding chapter in the appendix.

Reference

Also observe the section on Communication in *CPU 31xC and CPU 31x Device Manual, Technical Data*.

4.11.2.2 Multi-Point Interface (MPI)

Availability

All CPUs described in this manual feature an MPI X1.

If your CPU features an MPI/DP interface, it is configured and supplied as MPI. To use the DP interface, you will need to reconfigure it as DP interface in STEP 7.

Properties

The MPI (Multipoint Interface) represents the CPU's interface for PG/OP connections or for communication in an MPI subnet.

The typical (default) baud rate for all CPUs is 187.5 Kbps. You can also set the rate to 19.2 kbps for communication with an S7-200. Other baud rates are only possible with CPU 317 (up to 12 Mbps).

The CPU broadcasts its bus parameter configuration via the MPI (e.g. the transmission rate). This allows a PG, for example, to acquire the correct parameters and automatically connect to an MPI subnet.

Note

In RUN mode you may only connect PGs to the MPI subnet.
Other stations (e.g. OP, TP, ...) should not be connected to the MPI subnet while the system is in run mode. Otherwise, transferred data might be corrupted as a result interference, or global data packages may be lost.

Connectable devices via MPI

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

4.11.2.3 PROFIBUS DP interface

Availability

CPUs with “DP“ in their name have at least one DP X2 interface.

The CPU 317 has one MPI/DP X1 interface. An MPI/DP interface is always configured as MPI when the CPU is supplied. To use the DP interface, you will need to reconfigure it as DP interface in STEP 7.

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 • DP master • DP slave [1]	• Not assigned • DP master • DP slave [1]

[1] Excluded: DP slave at both interfaces simultaneously

Properties

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

The PROFIBUS DP interface can be configured as either master or slave, and offers a transmission speed of up to 12 Mbps.

The CPU sends its bus parameters (e.g. the baud rate) to the PROFIBUS DP interface (if it is used as the master). A programming device, for example, can then acquire the correct parameters and automatically connect to a PROFIBUS subnet. In your configuration you can specify to disable bus parameter broadcasting.

Note

(For the DP interface in slave mode).

If you disabled the Commissioning / Test mode check box in the DP interface properties in STEP 7, the baud rate you have set will be ignored, and the baud rate of the master will be used automatically. The routing function is then no longer possible over this interface.

Connectable devices via PROFIBUS DP

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

Reference

For additional information about PROFIBUS, visit http://www.profibus.com

4.11.2.4 Network components of MPI/DP and cable lengths

Segment in the MPI subnet

You can implement cable lengths of up to 50 m in an MPI subnet segment. This 50 m applies from the first node to the last node in the segment.

Table 4-17 Permissible cable lengths in an MPI subnet segment

Transmission rate	S7-300 CPUs (non-isolated 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 in the PROFIBUS subnet

In a segment of a PROFIBUS subnet, the maximum cable lengths depends on the transmission rate.

Table 4-18 Permissible cable lengths in an MPI subnet segment

Transmission rate	Maximum cable length in 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

If you want to implement cable lengths above those permitted in a segment, you must use RS485 repeaters. Information on this topic can be found in the RS485 repeater product information.

Stub cables

If bus nodes are connected to a bus segment via stub cables (e.g. PG via a normal PG cable), then you must consider the maximum possible length of the stub cable.

You can use a PROFIBUS bus cable with bus connector as the stub cable for up to 3 Mbps. Use the patch cord to connect the PG or PC when operating above 3 Mbps. You can connect several PG patch cords in a bus configuration (for order numbers see table 4-20). Do not use other types of stub cable.

Length of stub cables

The following table lists 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 above 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. Do not use other types of stub cable.

PG patch cord

Table 4-20 PG patch cord

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

PROFIBUS bus 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 bus cable with PE sheath for the food and beverages industry	6XV1 830-0BH10
PROFIBUS bus cable for festooning	6XV1 830-3CH10

Properties of PROFIBUS cables

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

The table below lists the characteristics of these bus cables.

Table 4-22 Properties of PROFIBUS bus cables

Properties	Values
Impedance level	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

Wiring of bus cables

When wiring 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 stationary operating temperature range	–30 °C to +65 °C

Reference

If you want to use fiber optic cable cables for PROFIBUS, you can find further information on this topic in 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

Application

You require these 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 (e.g. ET 200X)
- RS 485 repeater.

RS 485 repeater

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

Purpose

An RS 485 repeater amplifies data signals on bus lines and interconnects bus segments.

You require this RS 485 Repeater in the following situations:

- for operation with more than 32 network nodes
- when interconnecting a grounded and 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 no other node is 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.

See also

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

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

4.11.2.5 Cable lengths of MPI and PROFIBUS subnets

Example: Configuration of an MPI subnet

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

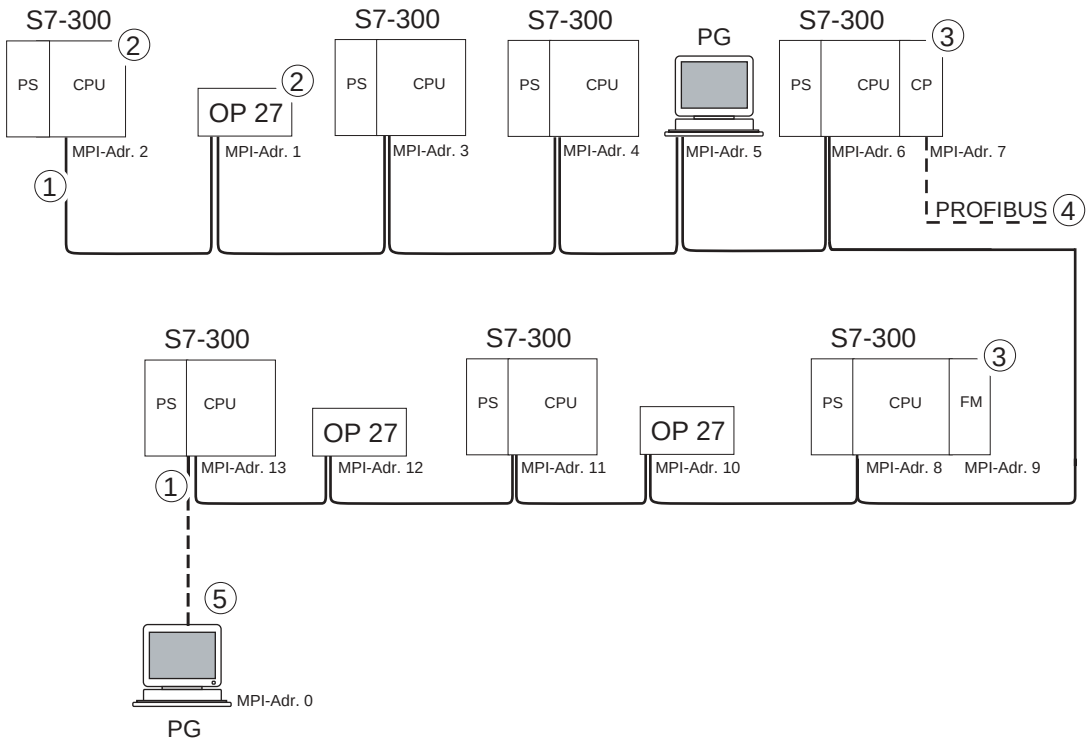


Figure 4-13 Example of an MPI subnet

Key to numbers in the figure	
(1)	Terminating resistor inserted
(2)	S7-300 and OP 27 have subsequently been connected to the MPI subnet using their MPI default address.
(3)	CPU 31xC, 312, 314, 315-2 DP You can also assign MPI addresses of CPs/FMs for 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

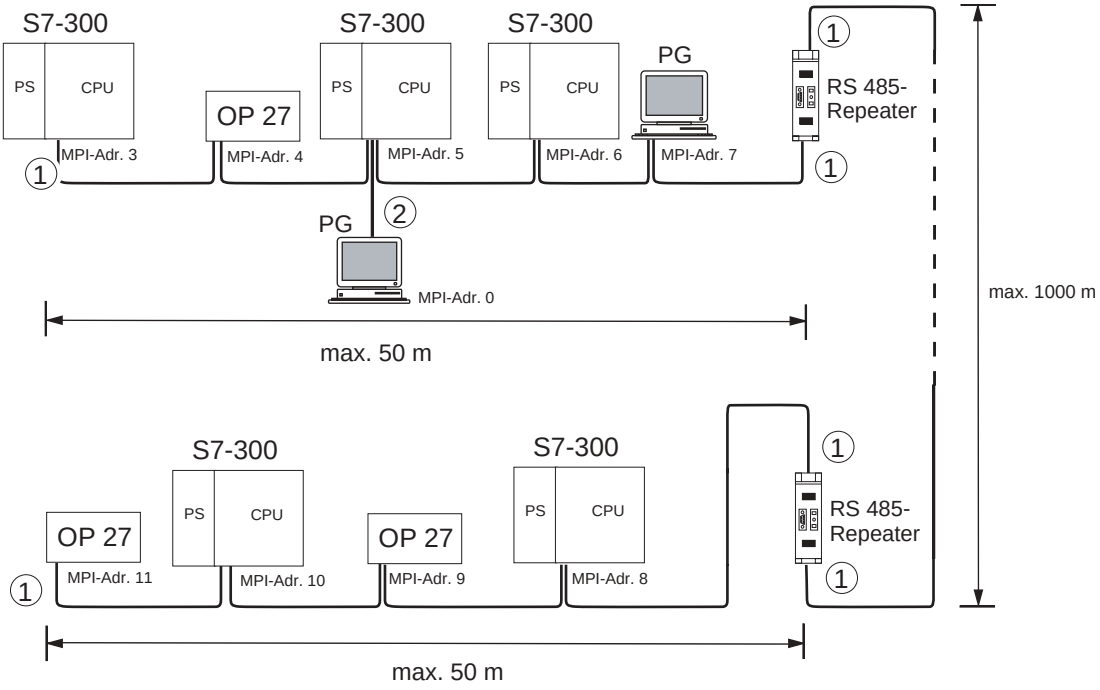


Figure 4-14 Example: Maximum distances in the MPI subnet

Key to numbers in the figure	
(1)	Terminating resistor inserted
(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 install the terminating resistor.

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

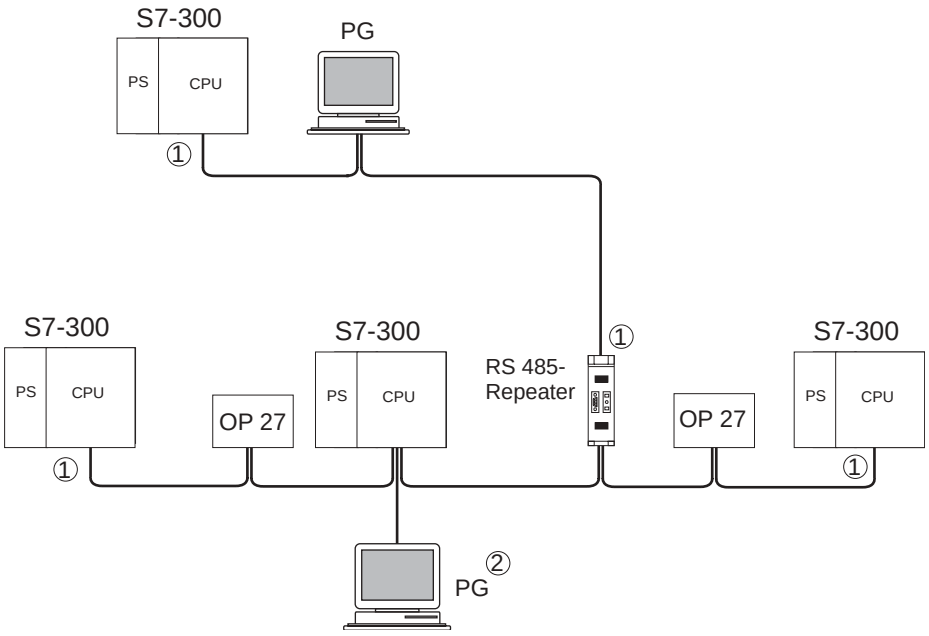


Figure 4-15 Activation of the terminating resistors in an MPI subnet

Key to numbers in the figure	
(1)	Terminating resistor inserted
(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. Since the bus connector draws its power from the station, the terminating resistor has no effect. 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: Configuration of a PROFIBUS subnet

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

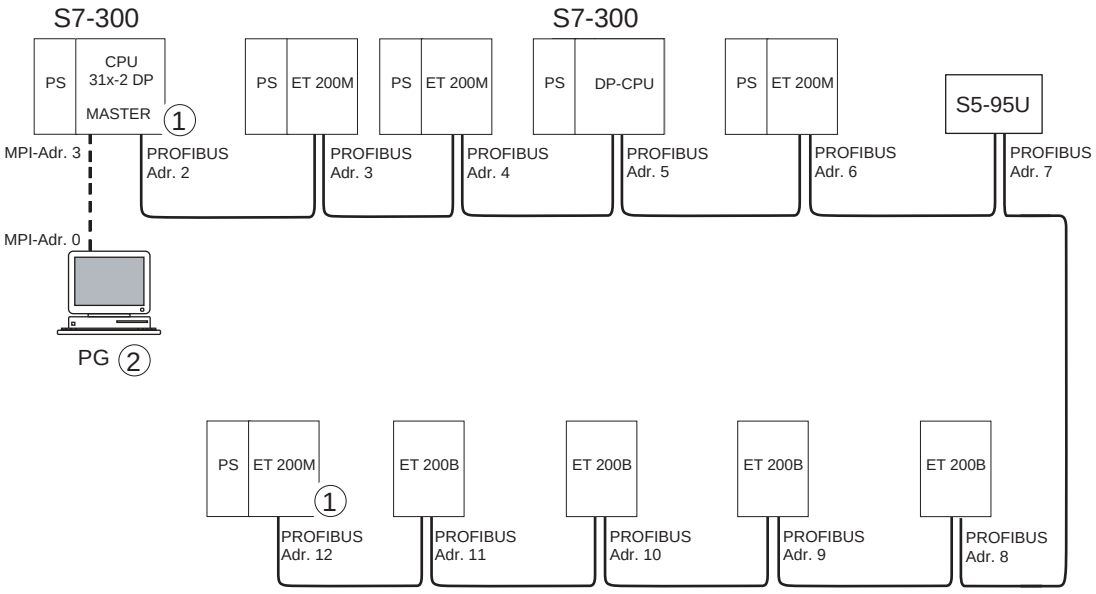


Figure 4-16 Example of a PROFIBUS Subnet

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

Example: CPU 314C-2 DP as MPI and PROFIBUS node

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.

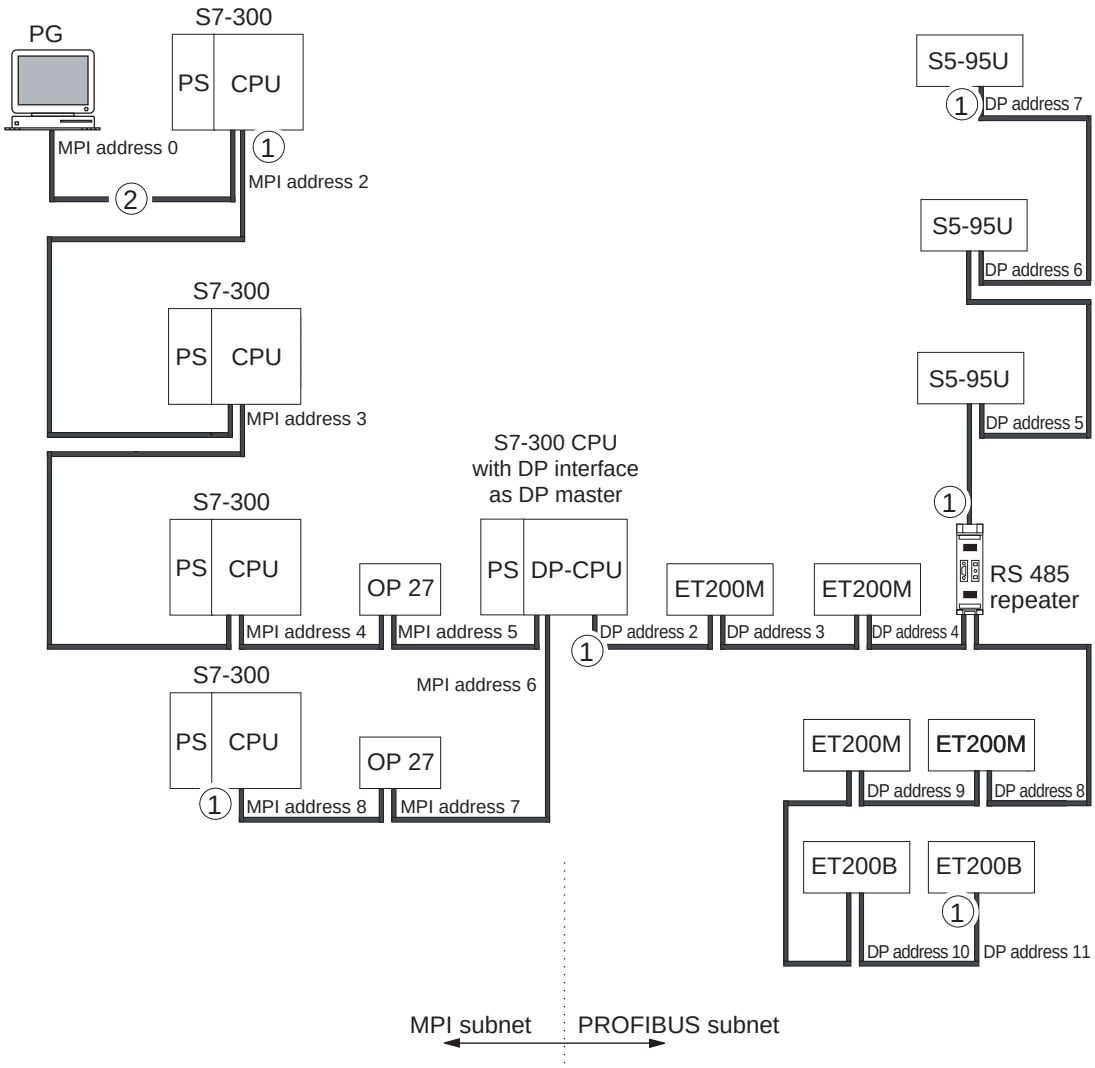


Figure 4-17 Example: CPU 314C-2 DP as MPI and PROFIBUS node

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

4.11.3 Planning PROFInet subnets

4.11.3.1 Basics about PROFInet subnets

Availability

CPUs with “DN“ in their name have at least one PROFInet X2 interface.

Note

When the CPU is supplied, the PN interface is not yet configured (the PN interface has only one worldwide unique MAC address). If you want to establish a connection to the Industrial Ethernet via PN interface, you must configure it in STEP 7.

Reference

If you want to configure the PN interface of CPU 317-2 PN/DP, please read *Configuring the PROFInet X2 Interface.*

Requirements

You require STEP 7 V5.3 or higher for the connection and configuration of a CPU with PN interface.

Installation

An integrated communication via Ethernet is achieved by using the integrated PROFInet interface of your CPU

- between your existing company network and the field level (e.g. PROFIBUS).
- among the automation system of the field level.

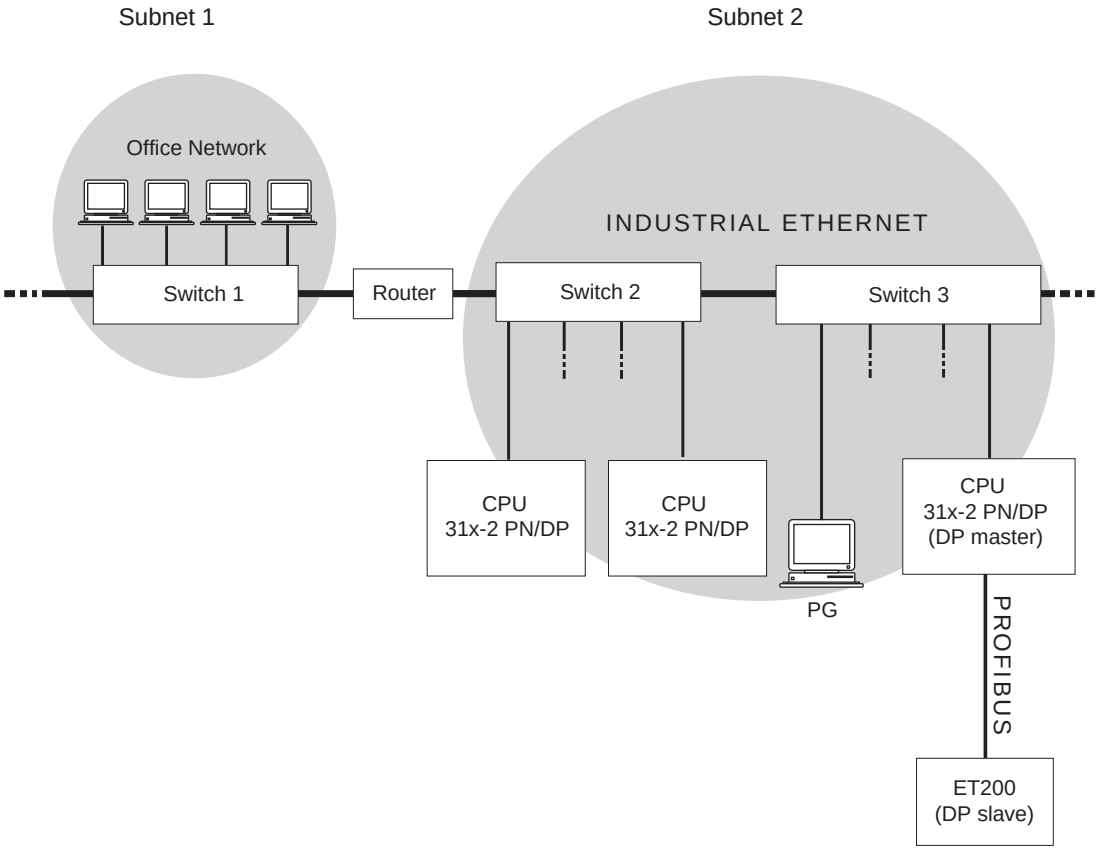


Figure 4-18 PROFInet – a possible configuration

The graphic displays
The connection between your existing company network and the field level: Company network — Switch 1 — Router — Switch 2 — Switch 3 — CPU 31x-2 PN/DP
The connection among the automation system of the field level: • PG — Switch 3 / 2 — CPU 31x-2 PN/DP • CPU 31x-2 PN/DP — Switch 2 — CPU 31x-2 PN/DP • CPU 31x-2 PN/DP — Switch 2 — Switch 3 — CPU 31x-2 PN/DP

Installation guidelines

PROFInet provides communication with high Performance and continuity. You can further increase performance by using the following installation guidelines.

- Connect a router between office network and PROFInet system. The router lets you specify exactly who may access your PROFInet system.
- Wherever applicable, configure your PROFInet system as a star circuit (e.g. in the cabinet).
- Keep the number of switches low. At the same time, this increases the clear overview of the PROFInet system.
- Connect your programming device (PG) close to the communication partner (e.g. PG and communication partner at the same switch).
- Modules with PROFInet interfaces may only be operated in LANs in which all connected nodes are equipped with SELV/PELV power supplies (or similar protections).
- A data transfer device that ensures this safety must be specified for the coupling to the WAN.

Reference

- Detailed information about Ethernet networks, network configuration and network components is available in the manual *SIMATIC NET: Twisted-Pair and Fiber Optic Networks* under article ID 8763736 on the Internet at http://www.siemens.com/automation/service&support
- *Tutorial: Commissioning Component-Based Automation Systems*, article ID 14142554
- For additional information about PROFInet, visit http://www.profibus.com

Properties of the PROFInet X2 interface

Table 4-25 Properties of the PROFInet X2 interface

Properties	
IEEE standard	802.3
Connector design	RJ45
Transmission speed	Max. 100 Mbit/s
Media	Twisted-pair Cat5 (100BASE-TX)

Note

The use of switches instead of hubs for networking PROFInet components results in significantly improved decoupling of the bus traffic and subsequently an improved run-time behavior, particularly with higher bus load. The use of CBA with cyclical PROFInet interconnections requires the use of switches to maintain the performance data.

In addition, 100-Mbit full-duplex operation is mandatory with cyclical PROFInet interconnections.

Connectable devices via PN

- S7-300/S7-400 with PN interface (e.g. CPU 317-2 PN/DP or CP 343-1PN)
- PG/PC with network card

4.11.3.2 PROFInet cable lengths and network expansion

A possible network expansion depends on different 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 as well as Sub-D connectors.

Product range for the RJ45 connection

The following prefabricated twisted-pair cables are available:

Table 4-26 Data for prefabricated twisted-pair 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	Crossed TP cable with a 9-pin Sub-D connector and an 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

Cable designation	Application	Available lengths	Order number
TP cord 9-45/RJ45	TP cable with an RJ45 connector and a Sub-D connector with 45° cable exit (for OSM/ESM only)	1.0 m	6XV1 850-2NH10
TP XP cord 9-45/RJ45	Crossed TP cable with an RJ45 connector and a Sub-D connector with 45° cable exit (for OSM/ESM only)	1.0 m	6XV1 850-2PH10
TP XP cord 9/9	Crossed TP 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 cord RJ45/15	TP cable with a 15-pin Sub-D connector and an RJ45 connector.	0.5 m 1.0 m 2.0 m 6.0 m 10.0 m	6XV1 850-2LE50 6XV1 850-2LH10 6XV1 850-2LH20 6XV1 850-2LH60 6XV1 850-2LN10
TP XP cord RJ45/15	Crossed TP cable with a 15-pin Sub-D connector and an RJ45 connector	0.5 m 1.0 m 2.0 m 6.0 m 10.0 m	6XV1 850-2SE50 6XV1 850-2SH10 6XV1 850-2SH20 6XV1 850-2SH60 6XV1 850-2SN10

Reference

More detailed information about network configuration is available on the Internet in 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)

4.11.3.3 Connectors and other components for Ethernet

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

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

Reference

Detailed information about Ethernet components is available on the Internet under http://www.siemens.com/automation/service&support.

- *Communication with SIMATIC* (EWA 4NEB 710 6075-01)
- *SIMATIC NET Twisted-Pair and Fiber Optic Networks* (6GK1970-1BA10-0AA0)

4.11.3.4 Example of a PROFInet subnet

Example: Configuration of a PROFInet subnet

The graphic illustrates the combination of corporate level and management level via industrial Ethernet. PCs in a classical office setting can be used to call up information from process automation.

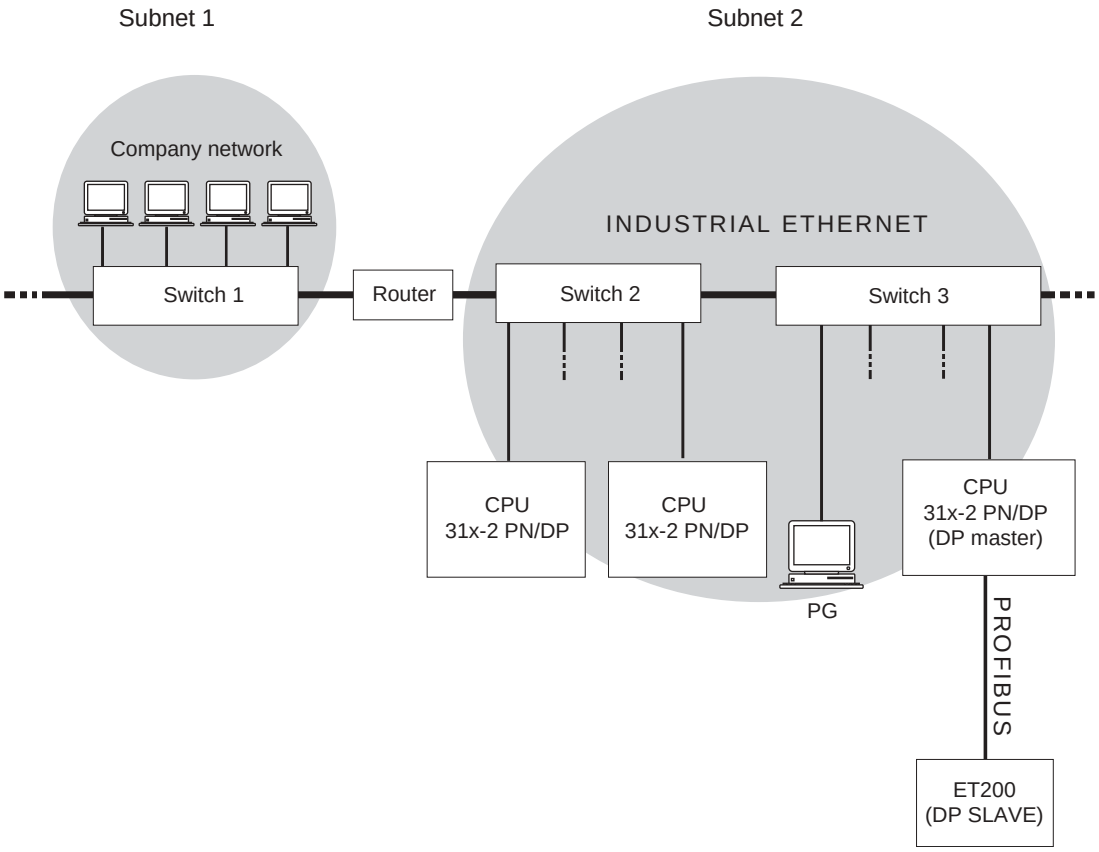


Figure 4-19 Example of a PROFInet subnet

Installation guidelines

PROFInet provides communication with high Performance and continuity. You can further increase performance by using the following installation guidelines.

- Connect a router between office network and PROFInet system. The router lets you specify exactly who may access your PROFInet system.
- Wherever applicable, configure your PROFInet system as a star circuit (e.g. in the cabinet).
- Keep the number of switches low. At the same time, this increases the clear overview of the PROFInet system.
- Connect your programming device (PG) close to the communication partner (e.g. PG and communication partner at the same switch).
- Modules with PROFInet interfaces may only be operated in LANs in which all connected nodes are equipped with SELV/PELV power supplies (or similar protections).
- A data transfer device that ensures this safety must be specified for the coupling to the WAN.

Reference

Detailed information about industrial Ethernet network or components is available on the Internet under .

- More details about IP address assignment are available in the online help of STEP 7.
- Communication with SIMATIC (EWA 4NEB 710 6075-01)
- SIMATIC NET: Twisted-Pair and Fiber Optic Networks (6GK1970-1BA10-0BA0)

4.11.4 Network transitions through routing

Example: PG access across network boundaries (Routing)

CPU with several interfaces can also serve as link for the communication between different subnets (router). With a programming device you can access all modules across network boundaries.

Requirements

- You are using STEP 7 Version 5.0 or higher.
  Note: for STEP 7 requirements on utilized CPUs, refer to technical specifications.
- You must assign the PG/PC to a network in your STEP 7 project (SIMATIC Manager, assigning a PG/PC).
- The network boundaries must be bridged by modules with routing capability.
- After having configured all networks in NETPRO, you have initiated a new compilation for all stations and downloaded the configuration to every module capable of routing. This also applies to all changes made in the network.

  Thus, every router knows all possible paths to a target station.

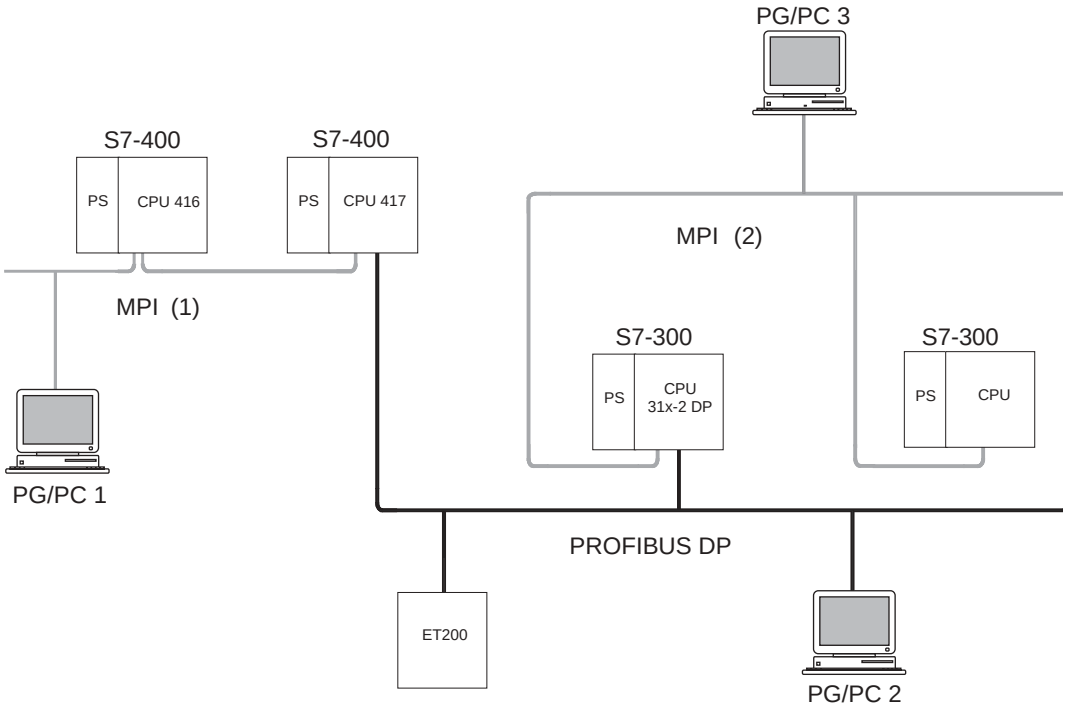


Figure 4-20 Example of PG access across network boundaries (routing)

Note

For CPUs with DP interface only:

If these CPUs are operated as I-slaves and you want to use the routing function, you must activate the Commissioning/Test Mode functionality in the Properties – DP Interface for DP Slave in STEP 7.

Information on routing can be found in the ...

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

4.11.5 Point-to-point (PtP)

Availability

CPUs with “PtP“ in their name have a PtP X2 interface.

Properties

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

Transmission rate

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

Driver

The following PtP communication drivers are installed in the CPUs:

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

Connectable devices via PtP

Devices equipped with a serial port, e.g. 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 used especially for networking digital sensors and actuators. The maximum data volume is 4 bit per slave station.

With S7-300 CPUs, you can connect to an ASI only with the help of communication processors.

Installing

5

5.1 Installing an S7-300

Here we shall 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 EU 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 406745.
Communication module (CP)	1 bus connector	For electrical interconnection of modules
	1 inscription label (only CP 342-2)	for labeling the connection to the PLC interface Tip: Templates for labeling strips are available on the Internet at http://www.ad.siemens.de/csinfo under article ID 406745.
Interface module (IM)	1 x Slot number label (only IM 361 and IM 365)	For assigning slot numbers on racks 1 to 3

Required tools and material

For your S7-300 installation 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	Standard tool
scribing and drilling holes on the 2 m rail	Standard 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 in the floating state	screwdriver with 3.5 mm blade width (cylindrical design)

5.2 Installing the Rail

Versions of the profile rail

- Ready-to-use, in four standard lengths (with 4 holes for fixing screws and 1 ground conductor bolt)
- Meter rail
  This may be shortened to any length if unusual size attachments are required. It has no holes for fixing screws and no ground conductor screw.

Requirements

You have prepared the 2 m rail for installation.

Preparing 2 m rail for installation

1. Cut the 2 m 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 to a diameter of 6.5 $^{+0,2}$mm for M6 screws.
5. Mount an M6 bolt for fixing the ground conductor.

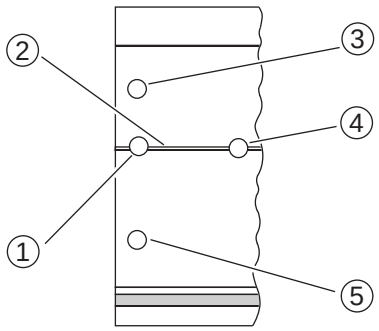


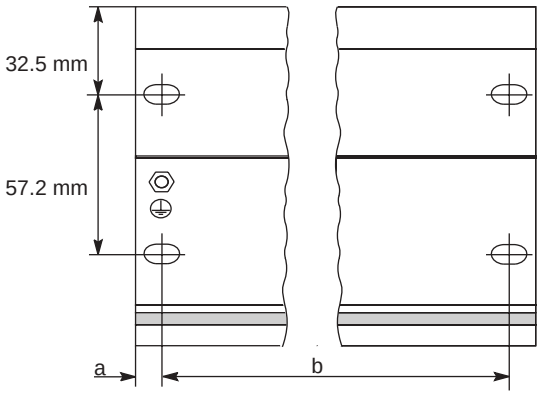
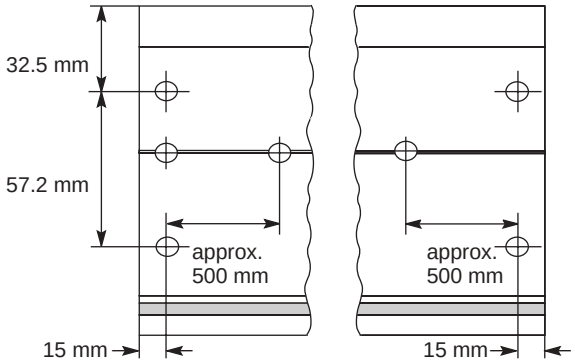
Figure 5-1 Holes for mounting the 2 m rail

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

Dimension of the mounting holes

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

Table 5-3 Mounting holes for profile rails

Standard rail			2 m 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

For mounting the profile rails you can use the following types of screws:

For ...	Type of screw	Explanation
Lateral 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 rail)	Cylindrical head screw M6 to ISO 1207/ISO 1580 (DIN 84/DIN 85)	

Installing the Rail

1. When you mount the rails, allow sufficient space for mounting modules and heat elimination (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 to a diameter of 6.5 $^{+0.2}$ mm.
3. Screw on the rail (M6 screws).

Note

Take care to create a low-impedance connection between the rail and a mounting surface which is a grounded metal plate or equipment mounting plate. In the case of varnished or anodized metals, for instance, use a suitable contacting agent or contact washers.

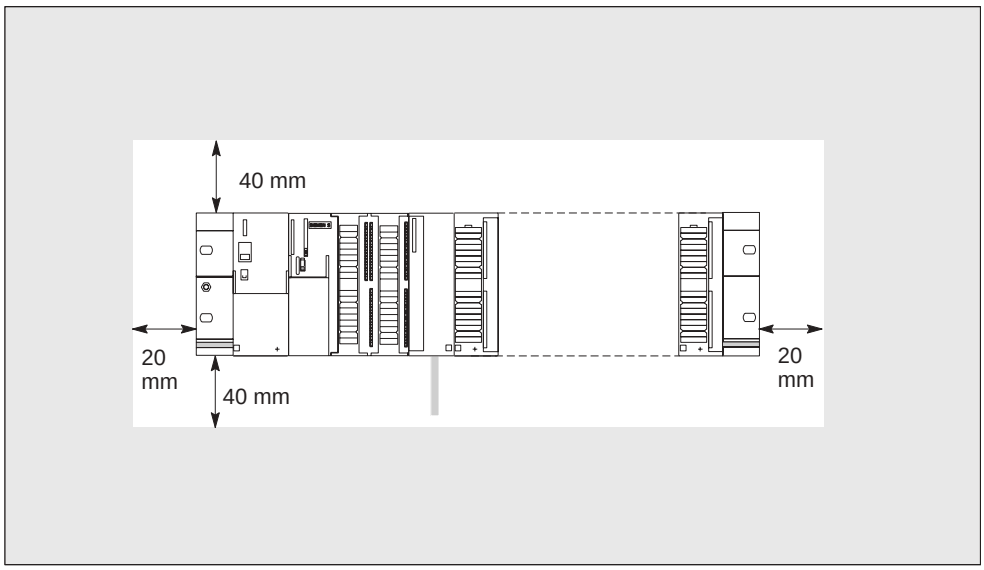


Figure 5-2 Free space required for an S7-300 installation

5.3 Installing modules on the rail

Requirements for module installation

- Configuration of the automation system is complete.
- The rail is installed.

Order of the modules

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

1. Power supply module
2. CPU
3. Signal modules, function modules, communication modules, interface modules

Note

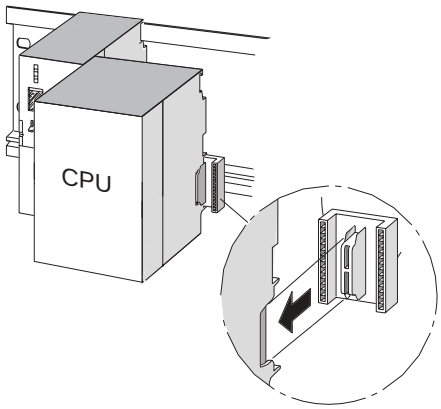
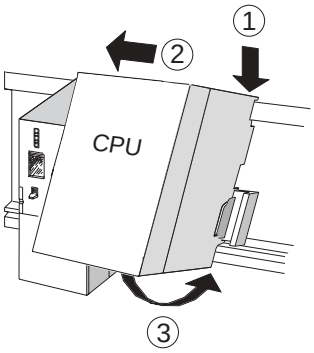
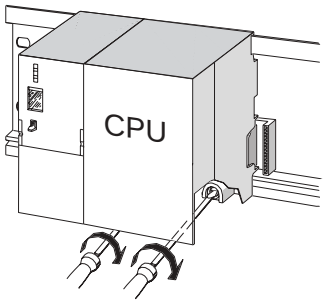
If you install SM 331 analog input modules, please check **before** installation whether you have to reposition the measuring range submodules at the side of the module. See Chapter 4 on "Analog Modules" in the *Module Data* reference manual.

Note

If you want to create the S7-300 with a floating reference potential, you must establish this state on the CPU, ideally before you attach it to the rail. The section entitled *Creating an S7-300 with floating reference potential* contains the necessary instructions.

Installation steps

The individual steps for the installation of the modules are explained below.

1.	Plug the bus connectors into the CPU and signal/function/communication/interface modules. One bus connector is included per module, but not for the CPU. • Always start at the CPU when you plug in the bus connectors. For this purpose, remove the bus connector of the "last" module in the row. • Insert the bus connectors into the other modules. The "last" module is not equipped with a bus connector.	
2.	Add all modules in their specified sequence to the rail **(1)**, slide them up to the module on the left **(2**), then swing them down **(3)**.	
3.	Manually tighten the module screws.	

5.4 Labeling the Modules

Slot numbers Assign

After installation, you should assign a slot number to each module. This makes 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	Note
1	Power supply (PS)	–
2	CPU	–
3	Interface module (IM)	To the right of the CPU
4	1. Signal module	To the right of the CPU or IM
5	2. Signal module	–
6	3. Signal module	–
7	4. Signal module	–
8	5. Signal module	–
9	6. Signal module	–
10	7. Signal module	–
11	8. Signal module	–

Slot numbers Inserting

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.

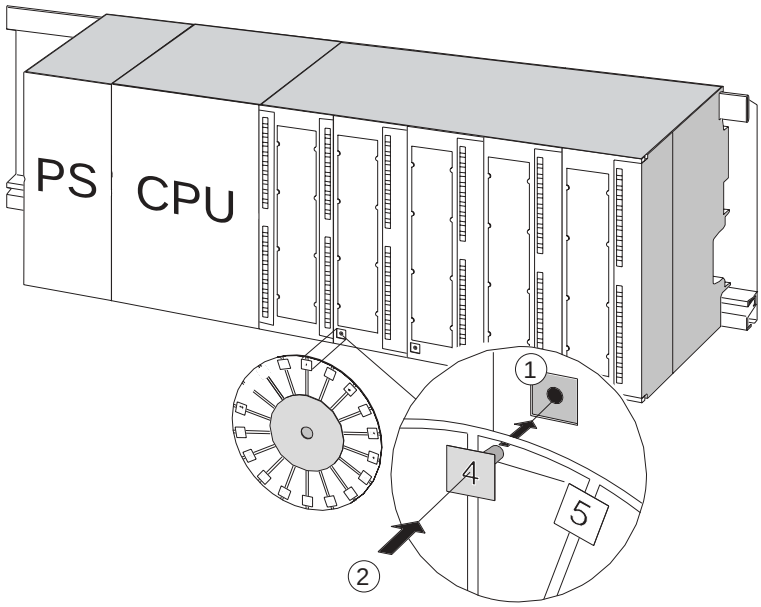


Figure 5-3 Inserting slot numbers in modules

Wiring

6

6.1 Requirements for wiring the S7-300

This chapter

contains explanations of the necessary requirements for wiring PS, CPU and front connectors.

Required accessories

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

Table 6-1 Wiring accessories

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

Tools and material required

The following tools and materials are required for wiring the S7-300.

Table 6-2 Tools and material for wiring

You require ...	for ...
connecting the protective conductor to the rail	Wrench (size 10) Protective conductor cable (cross-section ≥ 10 mm²) with M6 cable lug M6 nut, washer, spring lock washer
Adjusting the power supply module to mains voltage	Screwdriver with a blade width of 4.5 mm
Wiring the power supply module and the CPU	Screwdriver with a blade width of 3.5 mm, side-cutter, wire stripping tool Flexible cable, e.g. sheathed flexible cable 3 x 1.5 mm² If required, wire end ferrules to DIN 46228
Wiring the front connector	Screwdriver with a blade width of 3.5 mm, side-cutter, wire stripping tool Flexible cables 0.25 mm² to 0.75/1.5 mm² If required, shielded cables If 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 mm² to 2.5 mm² 0.25 mm² to 2.5 mm²
Number of conductors per terminal	1 conductor, or 2 conductors up to 1.5 mm² (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	 Version A, 10 mm to 12 mm length Version E, up to 12 mm in long

Wiring conditions for front connectors

Table 6-4 Wiring conditions for front connectors

Connectable cables	Front connectors	
	20-pin	40-pin
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 • Potential supply: 1.5 mm^2
Number of conductors per terminal	1 conductor, or 2 conductors up to 1.5 mm^2 (total) in a common wire end ferrule	1 conductor, or 2 conductors 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 conductors? • max. 3.1 mm for 20 conductors?
Stripped length	6 mm	6 mm
Wire end ferrules to DIN 46228 • Without insulating collar • With insulating collar	 Version A, 5 mm to 7 mm length Version E, up to 6 mm long	 Version A, 5 mm to 7 mm length Version E, up to 6 mm long

6.2 Connecting the Protective Conductor to the Rail

Requirements

The rail is fixed to the mounting surface.

Protective conductor PG

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 must be bonded to the rail.

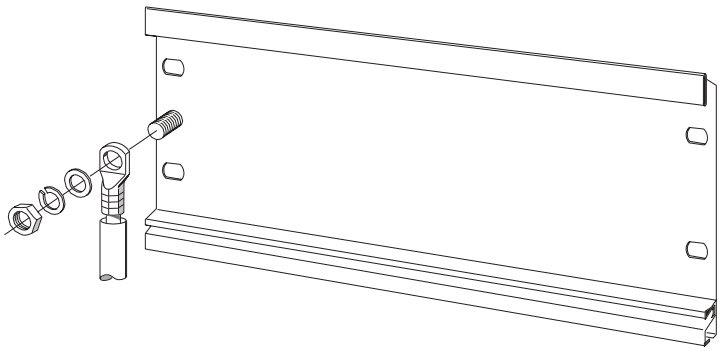


Figure 6-1 Connecting the protective conductor to the rail

Note

Always ensure a low-impedance connection of the protective conductor. You can achieve this by bonding a cable with low impedance and as short as possible to a large contact surface.
For example, if the S7-300 is mounted on a hinged frame you must use a flexible ground strap.

6.3 Adjusting the Power Supply Module to the Mains Voltage

Introduction

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

Setting the mains voltage selector switch

Check whether the voltage selector switch is set according to your mains voltage.

You can change the selector switch setting as follows:

1. Remove the protective cap with a screwdriver.
2. Set the selector switch to the available line voltage.
3. Replace the cover.

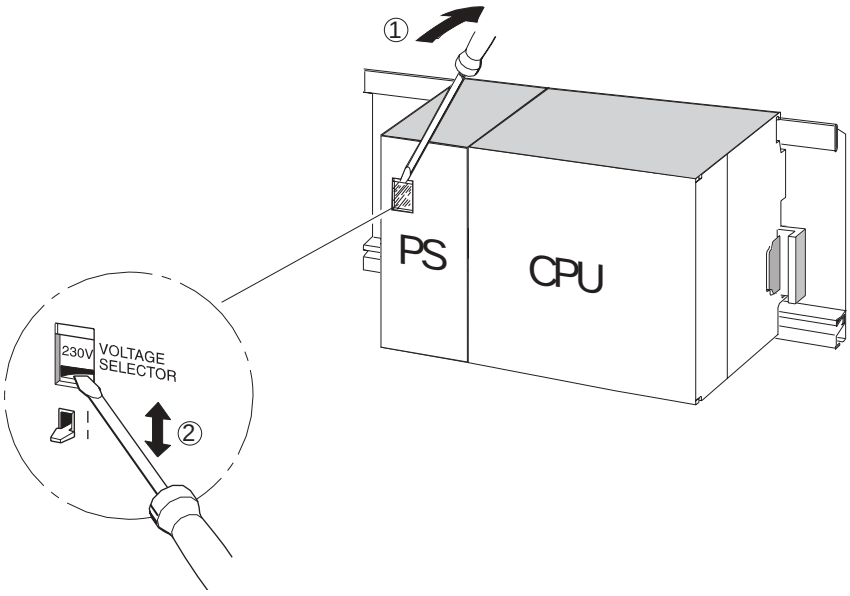


Figure 6-2 Setting the mains voltage selector switch for the PS 307

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

6.4 Wiring the Power Supply Module and the CPU

Requirements

The modules are mounted on the rail.

Wiring PS and CPU

Note

The PS 307 power supply module is equipped with two additional DC 24 V connections (L+ and M) for the supply of I/O modules.

Note

The power supply connection of your CPU can be inserted and removed.

Warning

You may come into contact with live wires if the power supply module and any additional load power supply units are connected to the mains.

You should therefore disconnect the S7-300 from the power supply before starting the wiring. Only use ferrules with insulating collars to press-fit onto the ends of the cables. Once you have wired the modules, close all the front panels. You can then switch on the S7-300 again.

1. Open the front panel to the PS 307 power supply module and CPU.
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 ground conductor terminal of the PS 307.
4. Screw-tighten the strain relief again.
5. Wire the PS and CPU now

   The power supply connection of the CPUs can be inserted and removed.

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

Warning

Reversing the polarity of the M and L+ terminals trips the internal fuse on your CPU. Always connect the M terminal of the power supply and CPU and the L+ terminal of the power supply and CPU to one another.

6. Close the front panel.

The figure below illustrates the procedures described above.

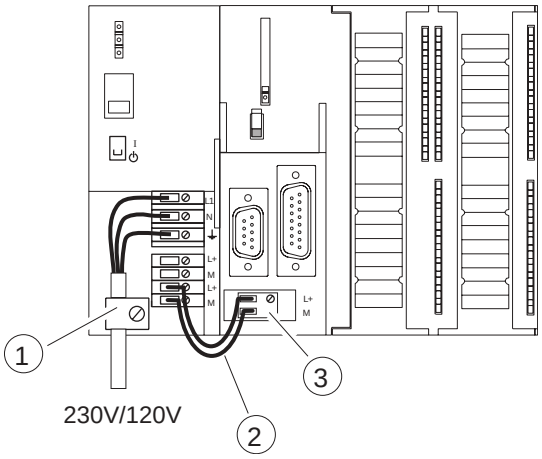


Figure 6-3 Wiring the Power Supply Module and the CPU

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

Note

The PS 307 power supply module is equipped with two additional DC 24 V connections (L+ and M) for the supply of I/O modules.

6.5 Wiring Front Connectors

Introduction

The front connector is used to connect the sensors and actuators of your system to the S7-300 PLC. Wire the sensors and actuators to this front connector and then plug it into the module.

Front connector versions

Front connectors come in 20-pin and 40-pin versions, each with screw contacts or spring terminals. 40-pin front connectors are required for CPUs 31xC and 32-channel signal modules.

You must use the following front connectors, depending on the module:

Table 6-5 Assigning front connectors to modules

Module	Front connectors with screw terminals; Order No.:	Front connectors with spring terminals; Order No.:
Signal modules (not 32-channel), Function modules, Communication module CP 342-2	6ES7 392-1AJ00-0AA0	6ES7 392-1BJ00-0AA0
Signal modules (32-channel) and CPU 31xC	6ES7 392-1AM00-0AA0	6ES7 392-1BM01-0AA0

Connecting to spring terminals

To terminate a conductor in 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 can damage the spring-based opening mechanism of the front connector if the screwdriver slips sideways or if you insert the wrong size of screwdriver. Always slide a suitable screwdriver vertically into the desired opening until it reaches the stop. This will ensure that the spring terminal is fully open.

Hint

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.

Prepare front connectors and cables

Warning

You may come into contact with live wires if the power supply module and any additional load power supply units are connected to the mains.

You should therefore disconnect the S7-300 from the power supply before starting the wiring. Once you have wired the modules, close all the front panels. You can then switch on the S7-300 again.

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

   Slide the front connector into the signal module until it latches. The front connector still protrudes from the module in this position.

   Advantage of the wiring position: Easy wiring.
   In this wiring position the front connector does not contact the module.
4. Strip the leads to a length of 6 mm.
5. Crimp on the cable end sleeves, e.g. for terminating 2 conductors on 1 terminal.

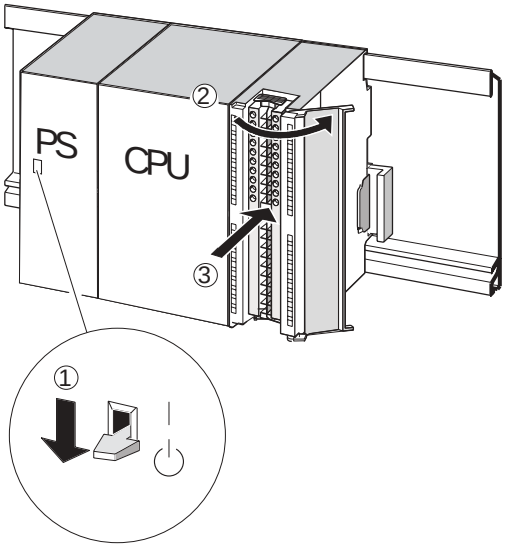


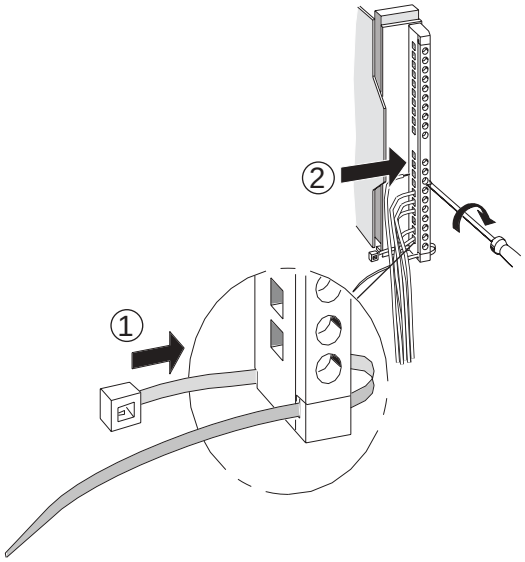
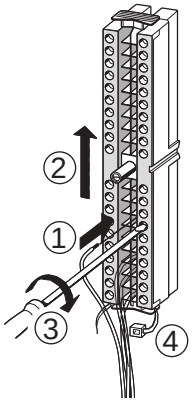
Figure 6-4 Move the front connector into wiring position

Table 6-6 Assigning front connectors to modules

The diagram illustrates under number	
(1)	Power supply switched off (PS)
(2)	Opened module
(3)	Front connector in wiring position

Wiring front connectors

Table 6-7 Wiring front connectors

Step	20-pin front connector	40-pin front connector
1.	Thread the accompanying strain relief for the cable line into the front connector.	–
2.	Do you want to exit the cables at the bottom of the module?	
	If yes: Starting at terminal 20, work your way down to terminal 1.	Starting at terminal 40 or 20, wire the connector, working in alternating passes from terminals 39, 19, 38, 18 etc. until you have reached terminals 21 and 1.
	If not: Starting at terminal 1, work your way up to terminal 20.	Starting at terminal 1 or 21, wire the connector, working in alternating passes from terminals 2, 22, 3, 23 etc. until you have reached terminals 20 and 40.
3.	**Front connectors with screw terminals:** Screw-tighten unused terminals also.	
4.	–	Attach the cable strain-relief assembly around the cable and the front connector.
5.	Pull the strain relief for the cable line tight. Push in the strain relief to the left to improve utilization of the available cable space.	
–		
	The work step numbers are shown in the figure above	
	(1) Thread the strain relief. **(2)** Wire the terminals.	**(1)** to **(3)** Wire the terminals. **(4)** Tighten the strain relief clamp.

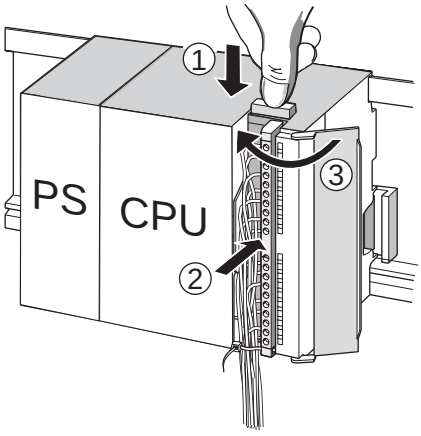
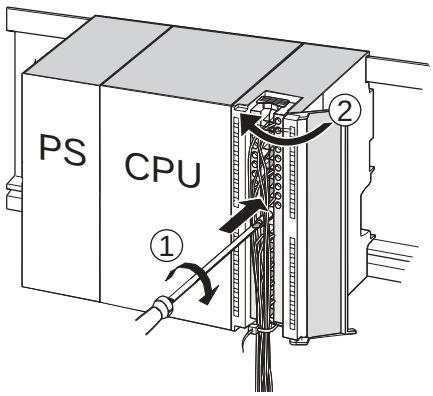
6.6 Inserting Front Connectors into Modules

Requirements

The front connectors are completely wired.

Front connectors plugging

Table 6-8 Inserting the front connector

Step	with 20-pin front connector	with 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 in 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 between inputs/outputs of the modules and the sensors/actuators of your plant.

You must use the labeling strips, depending on the module:

Table 6-9 Labeling strips assignment to modules

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

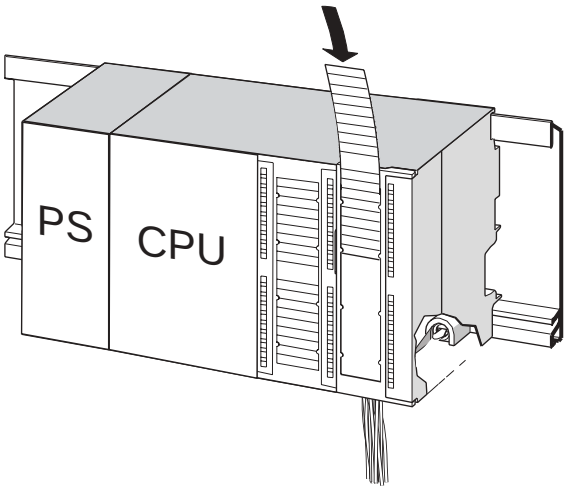


Figure 6-5 Slide the labeled strips into the front panel

Hint

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

6.8 Connecting shielded cables to the shielding contact element

Application

With the shielding contact element , you can easily ground all shielded cables of S7 modules, due to the direct contact of the shielding contact element to the rail.

Design of the shielding contact element

The shielding contact element consists of:

- a bracket for screw-mounting (with two screws) it onto the rail (Order No.: 6ES5 390-5AA00-0AA0) and
- the shielding terminals.

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

Table 6-10 Specifying the shielding diameter for shielding terminals

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

The shielding contact element width is 80 mm. It provides termination space in two rows, each one for 4 shielding terminals.

Shielding contact element installing

1. Push the two screw bolts of the fixing bracket into the guide on the underside of the rail.
2. Position 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.

   The two rows of the shielding contact element allow you install a maximum of 4 shielding terminals.

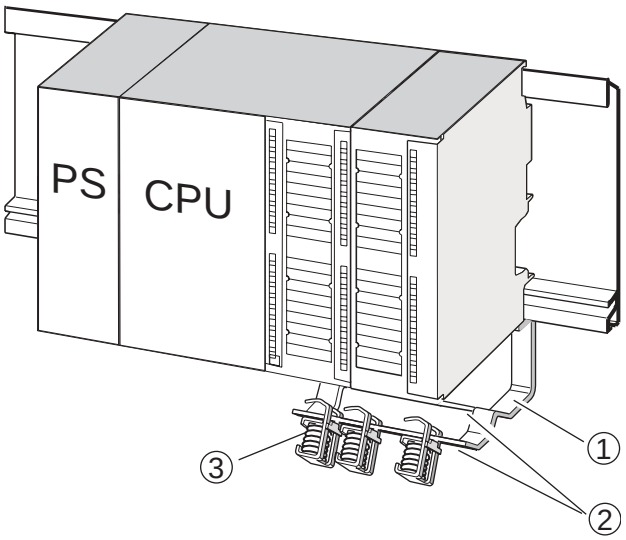


Figure 6-6 Shielding contact element underneath two signal modules

The diagram illustrates under number	
(1)	Bracket of shielding contact element
(2)	Edge of bracket where the shielding terminal(s) must be placed.
(3)	Shielding terminals

Laying cables

Only one or two shielded cables can be terminated per shielding terminal (see the figure below). The cable is clamped in 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 underneath the clamp (2).

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

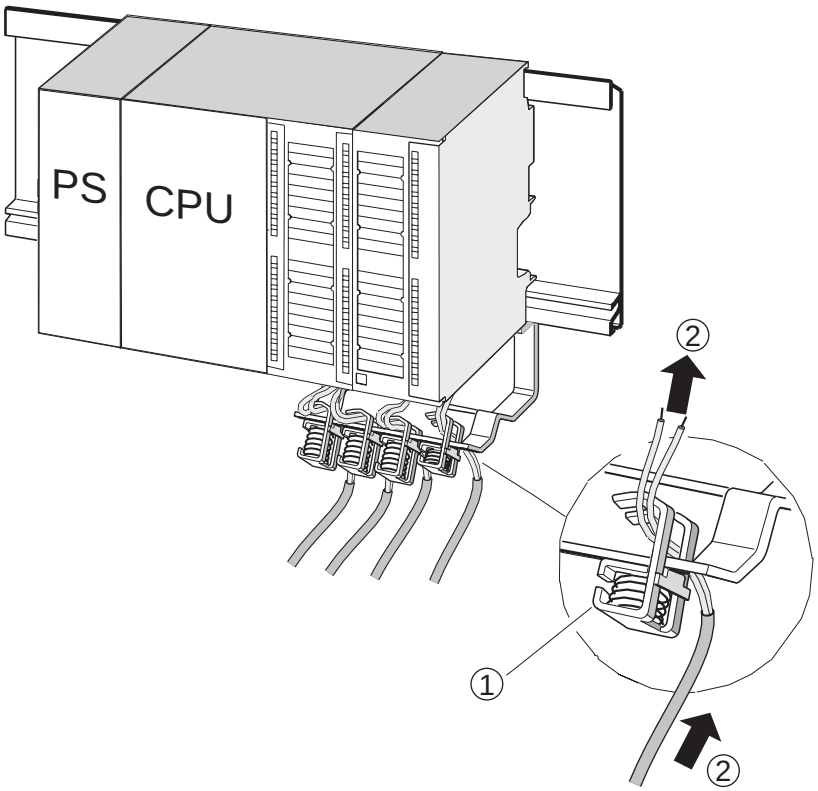


Figure 6-7 Connecting 2-wire cables to the shielding contact element

The diagram illustrates under number	
(1)	Magnified view of shielding terminal
(2)	Wiring of shielding terminal

Hint

For your connection to the front connector, leave a sufficient cable length behind the shielding terminal. This allows you to disconnect the front connector, e.g. for repairs, without having to open the shielding terminal.

6.9 Wiring the MPI/PROFIBUS DP bus connectors

6.9.1 Wiring the bus connector

Introduction

You need to network the nodes if you want to create a multiple-node subnet. The components you require here are listed in the Chapter *Configuring, Configuring a Subnet*. 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.

   Note that you always have to connect the same wires to the same terminal (e.g. always wire green to terminal A and red to terminal B).

4. Press the cable sheath into the clamp. Take care that the bare shielding contacts the shielding contact surface.
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.

   Note that you always have to connect the same wires to the same terminal (e.g. always wire green to terminal A and red to terminal B).

4. Close the contacting cover.

   This presses the wires down into the insulation displacement terminals .

5. Screw-tighten the strain relief clamp. Take care that the bare shielding contacts the shielding contact surface.

Note

Use a bus connector with a 90° cable exit.

6.9.2 Setting terminating resistor on the bus connector

Bus connector plugging on module

1. Insert 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 connect it at the beginning or end of a segment.

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

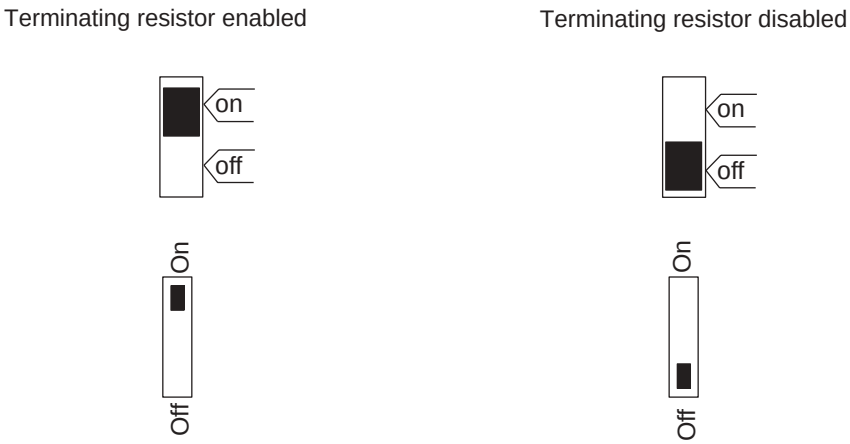


Figure 6-8 Bus connector: Enabled and disabled terminating resistor

Removing the Fast Connect bus connectors

With a looped-through bus cable, you can unplug the bus connector from the PROFIBUS-DP interface at any time, without interrupting data communication on the network.

Possible data traffic errors

Warning

Data traffic error 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. Since the bus connector draws its power from the station, the terminating resistor has no effect. Please make sure that power is always supplied to stations on which the terminating resistor is active.

6.10 RJ45 Ethernet connector

The RJ45 connector is an 8-pin connector whose design meets ISO/IEC 8877:1992. This connector type is recommended according to IEEE 802.3 for 10BASE-T and 100BASE-TX.

At present, the RJ45 connector is only available with prefabricated lengths (TP cord).

Reference

More detailed information about the RJ45 connector is available on the Internet in the manual SIMATIC NET Twisted-Pair and Fiber Optic Networks (6GK1970-1BA10-0AA0) at http://www.siemens.com/automation/service&support.

Addressing

7

7.1 Slot-defined addressing of modules

Introduction

In slot-based addressing (default addressing if no configuration was loaded to the CPU), a module start address is allocated to each slot number. This is a digital or analog address, depending 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 start from the same module start address.

Note

With the CPU 31xC, you cannot insert any modules into Slot 11 of Rack 3. The address area is reserved for the integrated I/O.

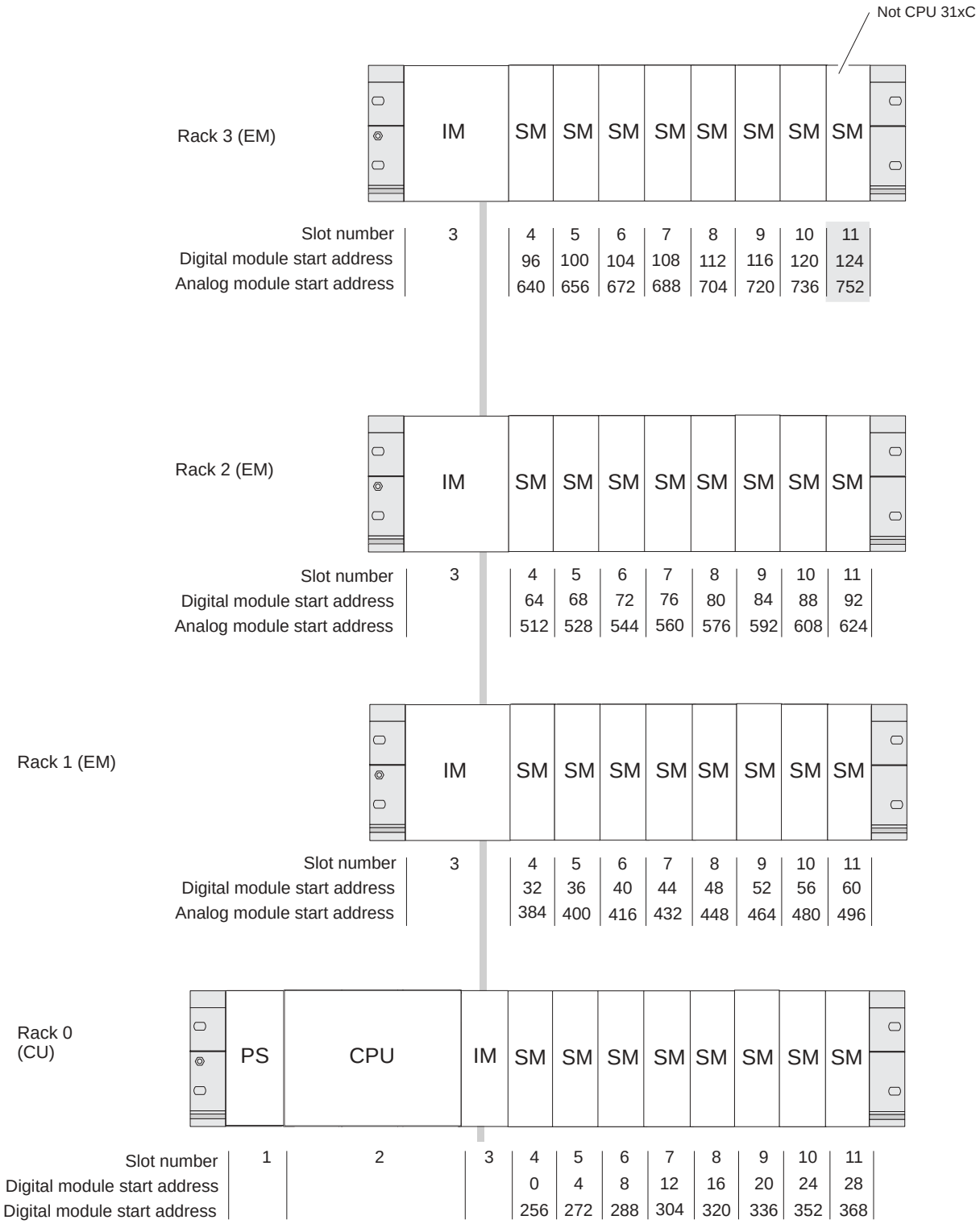


Figure 7-1 S7-300 slots and the corresponding module start addresses

7.2 User-defined addressing of modules

7.2.1 User-defined addressing of modules

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

Advantages of user-defined addressing:

- Optimization of the address areas available, since address gaps will not occur between the modules.
- When creating standard software, you can program addresses which are independent of the relevant S7-300 configuration.

7.2.2 Addressing digital modules

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

Addresses of digital modules

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

Example: **I 1.2**

The example consists of:

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

The byte address depends on the module start address.

The bit address is the number printed on the module.

Insert the first digital module into slot 4 so that it has default start address 0. The start address of every subsequent digital module will be incremented by 4 per slot (see diagram under *Slot-based module addressing*).

The figure below shows you how the addresses of the individual channels of a digital module are obtained.

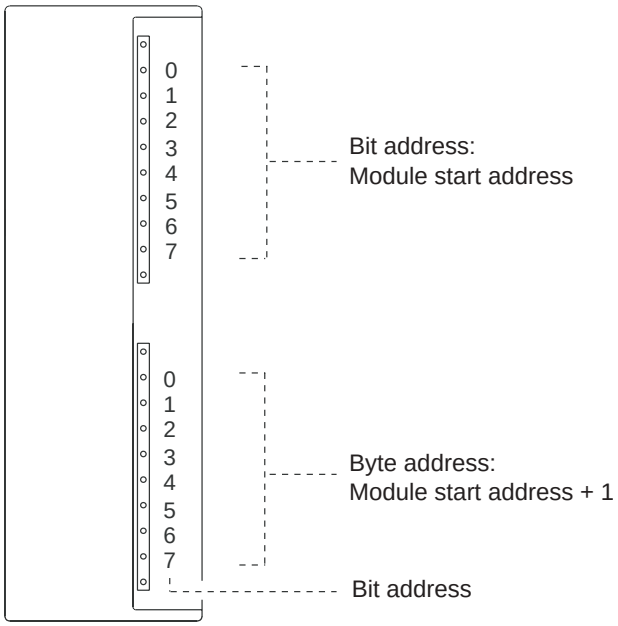


Figure 7-2 Addresses of the I/O of digital modules

An example for digital modules

The example in the figure below shows which default addresses are obtained if a digital module is inserted in slot 4 (that is, when the module start address is 0). Slot number 3 has not been assigned since there is no interface module in the example.

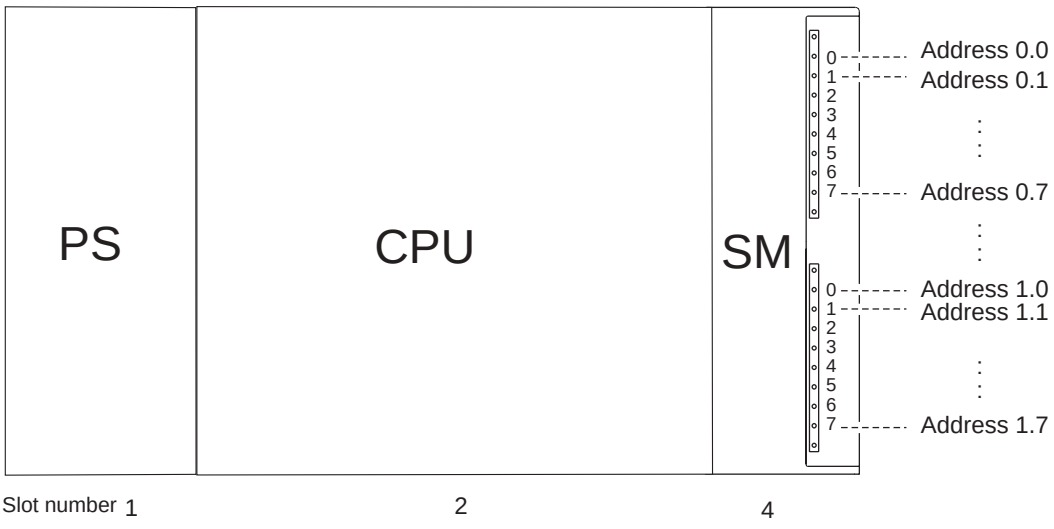


Figure 7-3 I/O Addresses of a digital module in Slot 4

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 address of an analog input or output channel is always a word address. The channel address depends on the module start address. Insert the first analog module into slot 4 so that it has default start address 256. The start address of every subsequent analog module will be incremented by 16 per slot (see diagram under *Slot-based module addressing*).

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

An example for analog modules

The example in the figure below shows you which default channel addresses are obtained if an analog module is inserted in 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 has not been assigned since there is no interface module in the example.

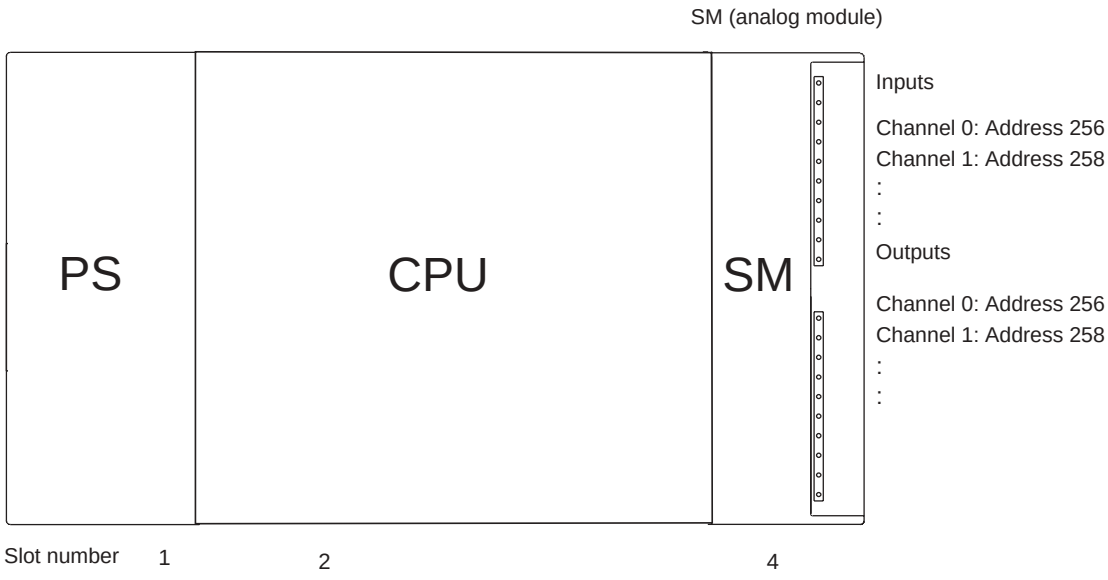


Figure 7-4 I/O addresses of an analog module in Slot 4

7.2.4 Addressing the integrated I/Os of CPU 31xC

CPU 312C

The integrated inputs and outputs of this CPU have the following addresses:

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

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

CPU 313C

The integrated inputs and outputs of this CPU have the following addresses:

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

Inputs/Outputs	Default addresses	Remarks
24 digital inputs	124.0 to 126.7 of those are 12 inputs for technological functions: 124.0 to 125.0 125.4 to 125.6	All digital inputs can be programmed as interrupt input. Optional technological functions: • Counting • Frequency measurement • Pulse width modulation
16 digital outputs	124.0 to 125.7 of those are 3 Inputs 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

The integrated inputs and outputs of these CPUs have the following addresses:

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

Inputs/Outputs	Default addresses	Remarks
16 digital inputs	124.0 to 125.7 of those are 12 inputs for technological functions: 124.0 to 125.0 125.4 to 125.6	All digital inputs can be programmed as interrupt input. Optional technological functions: • Counting • Frequency measurement • Pulse width modulation
16 digital outputs	124.0 to 125.7 of those are 3 Inputs for technological functions: 124.0 to 124.2	

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

The integrated inputs and outputs of these CPUs have the following addresses:

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

Inputs/Outputs	Default addresses	Remarks
24 digital inputs	124.0 to 126.7 of those are 16 Inputs for technological functions: 124.0 to 125.7	All digital inputs can be programmed as interrupt input. Optional technological functions: • Counting • Frequency measurement • Pulse width modulation • Positioning
16 digital outputs	124.0 to 125.7 of those are 4 inputs 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 illustrates the points to consider with respect to communication **in a DP master system** if you want to transfer I/O areas with "Total length" consistency.

CPU 315-2 DP, 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 (e.g. L PEW or T PAW).

You can transfer a maximum of 32 bytes of consistent data.

Commissioning

8

8.1 Overview

This section contains notes on commissioning which you should take into account in order to avoid personal injury or damage to machines.

Note

Since your commissioning phase is determined primarily by your application, 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 plant section and equipment.

8.2 Commissioning procedure

8.2.1 Procedure: Commissioning 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 317-2 PN/DP is configured with STEP 7 (IP address and transfer medium/duplex operation is set via hardware configuration) and
  - CPU is connected directly to the subnet.

Recommended procedure: Hardware

With its modular structure and many different upgrade 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	Remarks	Information can be found
an installation and wiring check according to checklist	-	in the following chapter
Disabling connections to drive aggregates and control elements	This prevents negative effects on your system as a result of program errors. Tip: Redirecting output data from your outputs to a data block, allows you to check the status of the outputs at any time	-
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 (EDs) which are equipped with an auxiliary power supply module and then switch on the power supply module of the CD.	*Initial power on*
	Check the LED displays on both modules.	*Testing functions, diagnostics and fault elimination*
Initialize the CPU and check the LEDs	-	*Memory reset by means of the CPU mode selector switch*
CU: commission all other modules	Insert further modules into the CU and commission them in succession.	*Module Data* Reference Manual
Expansion module (EM): Connecting	If required, interconnect the CU and the EMs: Insert only one Send IM into the CU and the matching receiver IM into the EM.	*Installing*
EM: Commissioning	Insert further modules into the EMs and commission them in succession.	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 *Test Functions, Diagnostics and Fault Elimination.*

See also

Procedure: Commissioning software (Page 8-3)

8.2.2 Procedure: Commissioning software

Requirements

To utilize the full functional scope of the CPUs, you require

- STEP 7 starting with the following version:
  - CPU 31xC, 312, 314, 315-2 DP: V 5.1 + SP 4 or later
  - CPU 317-2 DP: V 5.2 + SP 1 or later
  - CPU 317-2 PN/DP: V 5.3 or later
- 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 317-2 PN/DP is configured with STEP 7 (IP address and transfer medium/duplex operation is set via hardware configuration) and
  - CPU is connected directly 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	Remarks	Information can be found in ...
• Switch on the PG and start SIMATIC Manager • Download the configuration and the program to the CPU	-	in the *STEP 7* Programming Manual
Testing the I/Os	Helpful functions are here: • Monitoring and modifying of variables • Testing with program status • force • Modifying 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 • *Testing functions, diagnostics and fault elimination*
Commissioning PROFIBUS DP or Ethernet	-	*Commissioning PROFIBUS DP* *Planning PROFInet X2 interface*
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.

Response to errors

React to errors as follows:

- Check the system with the help of the Checklist in the chapter below.
- Check the LED displays on all modules. Notes on their significance can be found in 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 *Test Functions, Diagnostics and Fault Elimination.*

See also

Procedure: Commissioning hardware (Page 8-1)

8.3 Commissioning checklist

Introduction

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

The checklist 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: Hardware and Installation
Are the rails mounted firmly to the wall, in the frame or in the cabinet?	Configuring, installation
Have you maintained free space required?	Configuring, installation
Are the cable ducts installed properly?	Configuring
Is the air convection OK?	Installing

Concept of grounding and chassis ground

Points to be examined are in the manual	S7-300: Hardware and Installation
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: Hardware and Installation
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

Voltage

Points to be examined	S7-300: Hardware and Installation	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: Hardware and Installation	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 Device 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 the memory *(see Resetting Memory via Mode Selector of CPU)*

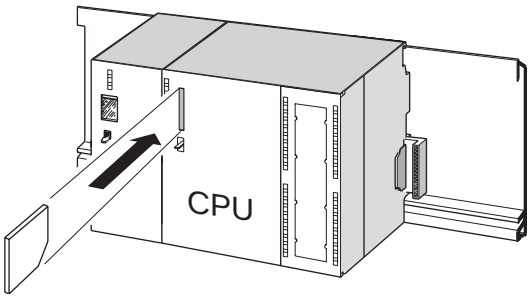


Figure 8-1 Insert the micro memory card into the CPU

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

A memory reset is automatically performed after POWER ON.

Reference

- *Properties of the Micro Memory Card (MMC)*, CPU 31xC and CPU 31x Device Manual, Technical data
- *Technical Data of the Micro Memory Card (MMC)*, CPU 31xC and CPU 31x Device 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 Memory reset by means of the CPU mode selector switch

When to reset CPU memory

You must reset the CPU memory,

- before you download a (completely) new user program to the CPU
- If the CPU requests 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 causes 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	–
The main memory is too small, that is, all blocks of the user program on an MMC cannot be loaded.	CPU with MMC inserted: A further memory reset is requested. Additional information about the behavior of the MMC during memory reset is available in the CPU 31xC and CPU 31x Device Manual, Technical Data, under *Memory Reset and Restart*
Attempts to load faulty blocks; e.g. if the wrong instruction was programmed.	

How to reset memory

There are two ways to reset CPU memory:

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

Resetting CPU memory with mode selector switch

The table below shows the steps required for 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). Then 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 are 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.

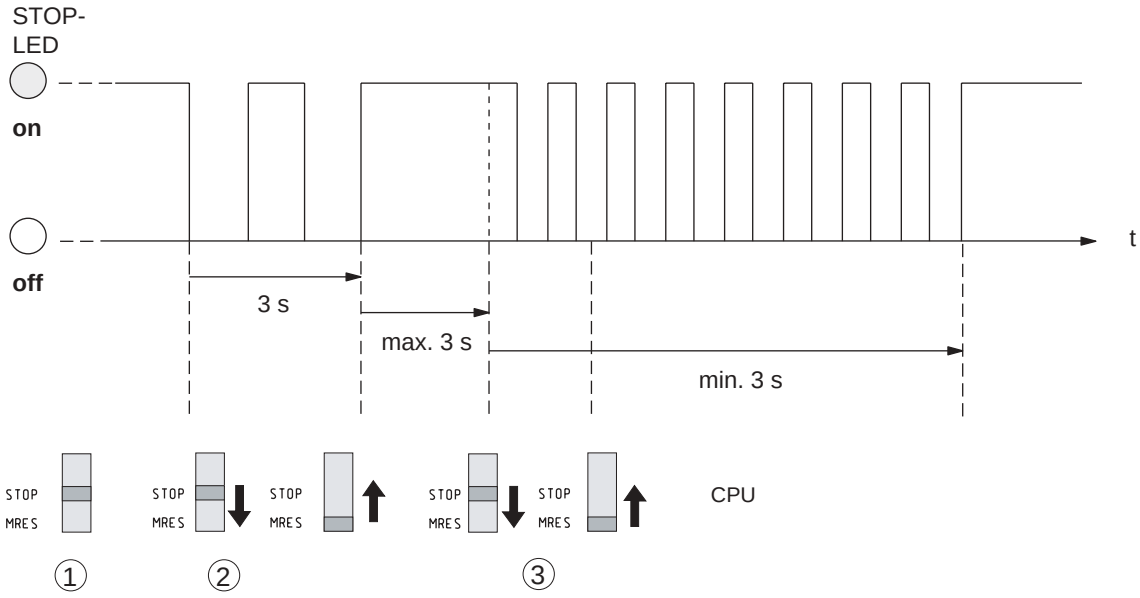


Figure 8-2 Using the mode selector switch to reset the memory

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 cannot copy the MMC and prompts you for 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 the memory utilization is displayed 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 features: X1 interface parameter (MPI or MPI/DP interface)

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

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

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

Memory reset ...	MPI/DP parameters
With MMC inserted	MPI parameter on the MMC or integrated read-only load memory are valid. If this location does not contain 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 has not yet been 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 during evaluation of module content during memory reset.
- Formatting error or formatting could not be carried out.

If one of these errors has occurred, the CPU prompts you for another memory reset 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

Memory reset by means of the CPU mode selector switch (Page 8-10)

8.4.5 Connecting the programming device (PG)

8.4.5.1 Connecting the PG to a node

Requirements

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

Connecting a PG to an S7-300

1. Connect the programming device (PG) to the MPI interface of your CPU by means of a preassembled PG cable **(1)**. Alternatively, you can manufacture the connecting cable with PROFIBUS bus cable and bus connectors yourself. The figure below illustrates the connection between PG and CPU

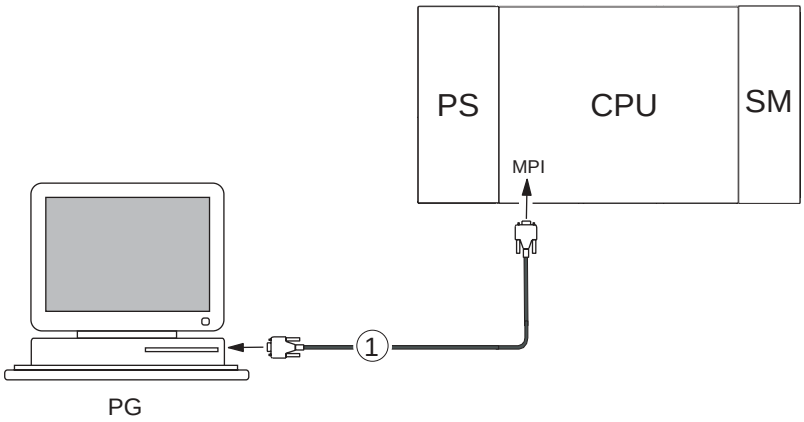


Figure 8-3 Connecting a PG to an S7-300

Reference (CPU 317-2 PN/DP only)

If you want to connect the PG via PROFInet interface for CPU 317-2 PN/DP, you must first configure the PROFInet interface with STEP 7 after initial commissioning. For this purpose, read Planning PROFInet X2 interface.

8.4.5.2 Connecting the PG to several nodes

Requirements

The programming device 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 stationary PG in the MPI subnet to the other nodes of the MPI subnet.

The following picture illustrates two networked S7-300s which are connected to one another using bus connectors.

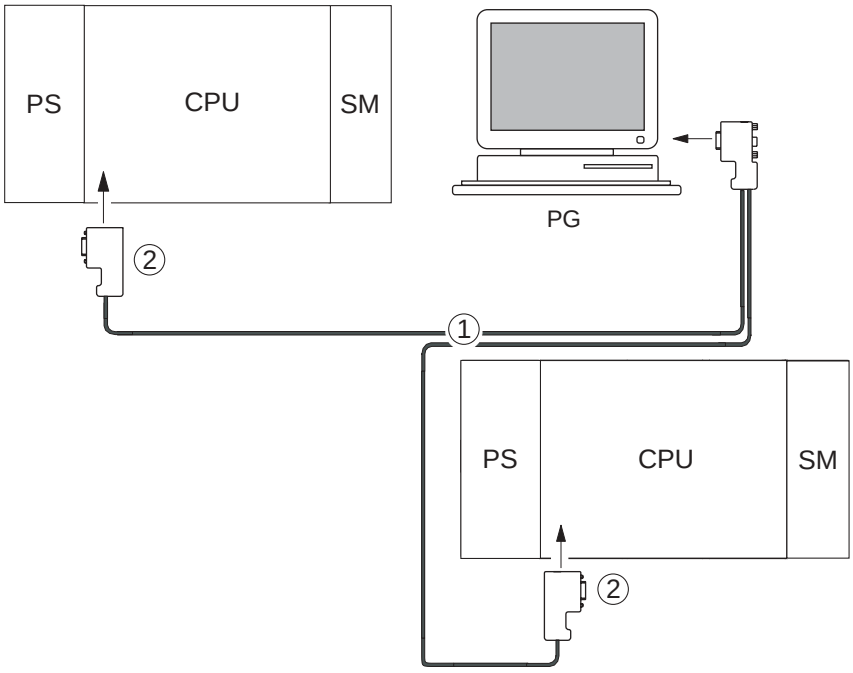


Figure 8-4 Connecting a PG to multiple S7-300 PLCs

The diagram illustrates under number	
(1)	PROFIBUS bus cable
(2)	Connector with inserted terminating resistor

Reference (CPU 317-2 PN/DP only)

If you want to connect the PG via PROFInet interface for CPU 317-2 PN/DP, you must first configure the PROFInet interface with STEP 7 after initial commissioning. For this purpose, read Planning PROFInet X2 interface.

8.4.5.3 Using the PG for commissioning or maintenance

Requirements

The programming device 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.

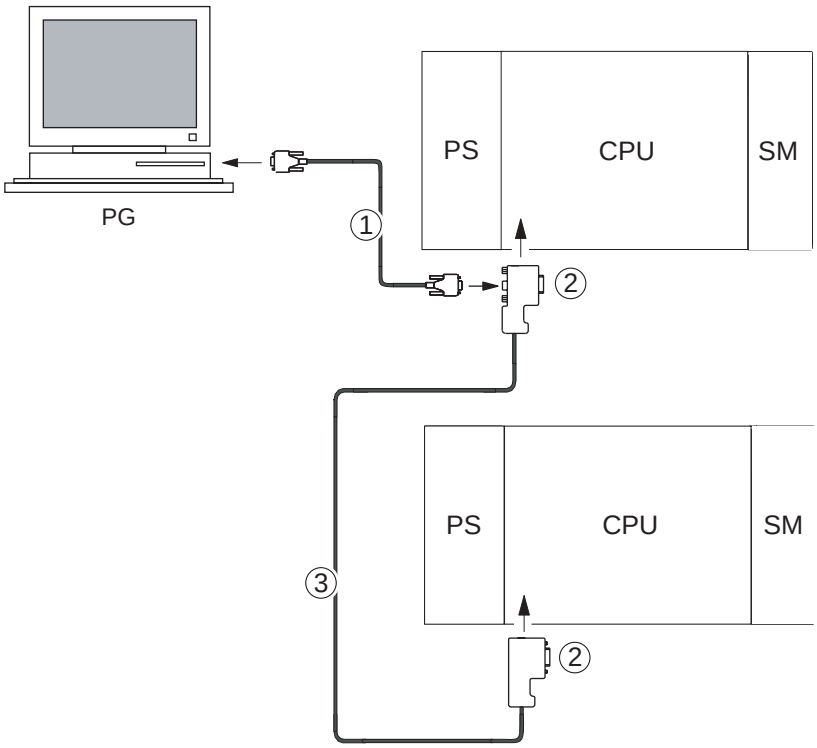


Figure 8-5 Connecting a PG to a subnet

The diagram illustrates under number	
(1)	Stub cable used to create connection between PG and CPU
(2)	Inserted terminating resistor of 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 it to an MPI subnet with "unknown" node addresses, set the following addresses on the service PG:

- MPI address: 0
- Highest MPI address: 126.

Using *STEP 7*, you then determine the highest MPI address in the MPI subnet and adapt the highest MPI address in the PG to that of the MPI subnet.

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

Requirements

The programming device 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 MPI subnet nodes (not CPU 31xC)

Connecting a PG to ungrounded nodes

Always connect an ungrounded PG to ungrounded MPI subnet nodes or 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.

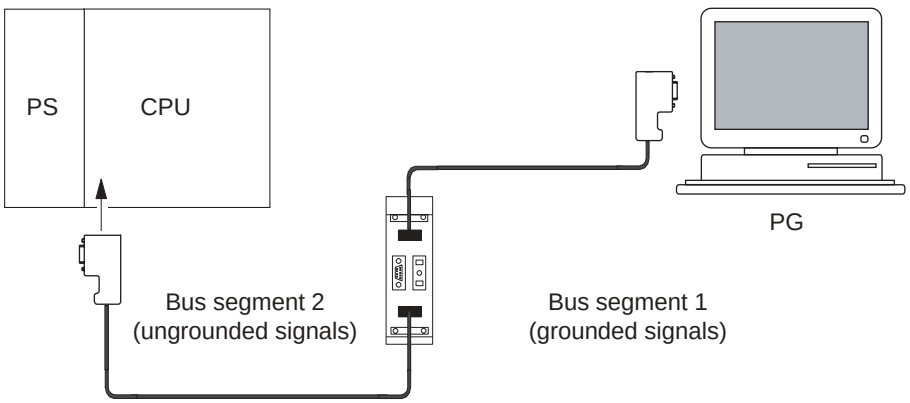


Figure 8-6 PG connected to an ungrounded S7-300

See also

Cable lengths of MPI and DP subnets (Page 4-35)

PROFInet cable lengths and network expansion (Page 4-48)

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 Windows desktop displays the **SIMATIC Manager** icon and in the Start menu under **SIMATIC** it displays the program item **SIMATIC Manager**.

1. Start SIMATIC Manager with a double-click on the icon or via Start menu (same as with all other Windows applications).

User interface

A corresponding editing tool pops up when you open the relevant objects. Double-click on a program block starts the program editor; the block can be edited (object-oriented start).

Online help

The online help for the active window is always called with the F1 function key.

8.4.7 Monitoring and modifying I/Os

"Monitoring and modifying variables" tool

The STEP 7 "Monitoring and modifying variables" tool lets you:

- monitor program variables in any format
- edit the status or data of variables in the CPU (modifying)

creating a variable table

You have two options for creating a variable table (VAT):

- in the ladder diagram/sequential function chart/statement list editor via menu item **PLC > Monitor/Modify Variables**

  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 on the format field. The Format List pops up. or • Left-click on the format field until the desired 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.
- With some CPU versions (e.g. CPU 314-1AE03) values are not assigned at every cycle when **permanent control** is set.
  Remedy: Use the testing function **Force**.

Saving/opening the variable table

Saving 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 variable 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. The menu item **PLC > Connect to ... > Accessible CPU ...** is used to establish a connection to any CPU. available on the network.

Modifying outputs in CPU STOP mode

The function **Enable PO** switches off output disable 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.

   Example:
   PO: POB 7 modify value: 2#0100 0011
   POW 2 W#16#0027
   POD 4 DW#16#0001
5. Use menu item **Variable > Enable PO** to switch to "Enable PO" mode.
6. Modify the PO via menu item **Variable > Activate Modify Values**. "Enable PO mode remains active until switched off again via **Variable > Enable PO**.

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

Note

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

8.5 Commissioning PROFIBUS DP

8.5.1 Commissioning PROFIBUS DP

Requirements

Requirement for commissioning a PROFIBUS DP network is:

- A PROFIBUS DP network has been created.
- In *STEP 7*, you have configured the PROFIBUS DP network and you have 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 in some of the DP slaves (see the description of the relevant DP slave).
- Software requirements are shown in the table below, depending on the CPU:

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 later
314C-2 DP	6ES7314-6CF00-0AB0	*COM PROFIBUS* V 5.0 or later
315-2 DP	6ES7315-2AG10-0AB0	*STEP 7* V 5.1 + SP 4 or later
317-2 DP	6ES7317-2AJ10-0AB0	*STEP 7* V 5.2 + SP 1 or later
317-2 PN/DP	6ES7317-2EJ10-0AB0	*STEP 7* V5.3 or later

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	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	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, starting at the highest byte address downwards .

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)

  At this address all module (e.g. CPU 313C-2 DP as I-Slave) events are reported in the master (OB82). 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 must 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 must:
  - 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, you will find that DP slave in the PROFIBUS-DP catalog as **already configured Node**. 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 configuration of the PROFIBUS subnet created with *STEP 7* (preset configuration) to the DP CPU using the PG.
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..

Start-up with preset configuration ≠ actual configuration = yes (Default setting)	**Start-up with 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 OB122 (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: STOP → RUN	• 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

As of *STEP 7* V 5.x you can configure equidistant lengths for PROFIBUS subnet (constant bus cycle time) bus cycles. Details on constant bus cycle time 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 start-up monitoring time for DP slaves in 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 assign and configure the DP CPU as a 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 changing over 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 via the GSD file, then you must not select the Commissioning / Test mode check box under the DP interface properties 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.
- At the **PROFIBUS-DP interface** the CPU starts data transfer with the DP master.

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 OB122 (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 STOP → RUN	• 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 intermediate memory

The DP-CPU operating as a DP slave provides an intermediate memory for the 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 intermediate memory address areas and the CPU reads these data in the user program, and vice versa.

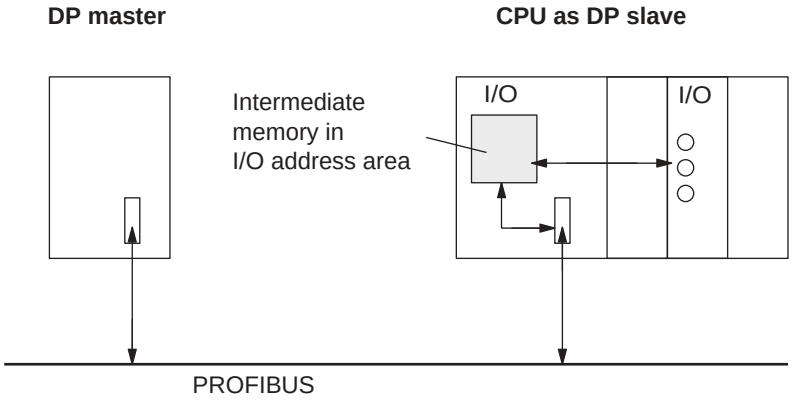


Figure 8-7 Intermediate memory in a DP CPU operating as a DP slave

Address areas in intermediate 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 in intermediate 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 must be identical 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            //Reprocess received
L      MB     7             data
+      I
T      MW     100
```

In the DP master CPU

```
L      PIB     222   //continued processing of
T      MB      50    //received data in
L      PIB     223   DP 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 intermediate 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 specify addresses from the input/output process image (refer to Chapter *Addressing, User-Defined Addressing of Modules*).
- 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 for the intermediate memory. You must not assign addresses specified for the intermediate memory again for the I/O modules on the DP CPU. When using consistent data areas in transfer memory, note the section on *Consistent Data* in Chapter *Addressing*.

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 must 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 as a DP master, you must also set its bus parameters for the DP CPU as a DP slave.

Data transfer in STOP mode

The DP slave CPU goes into STOP mode: Data in CPU intermediate memory are overwritten with "0". That is, the DP master reads "0".

The DP master goes into STOP mode: Actual data in CPU intermediate memory is maintained and can still be read by the CPU.

PROFIBUS address

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

8.5.4 Direct data exchange

Requirements

In *STEP 7* V 5.x or later, you can 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 is that PROFIBUS DP nodes "listen" 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

The sample 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.

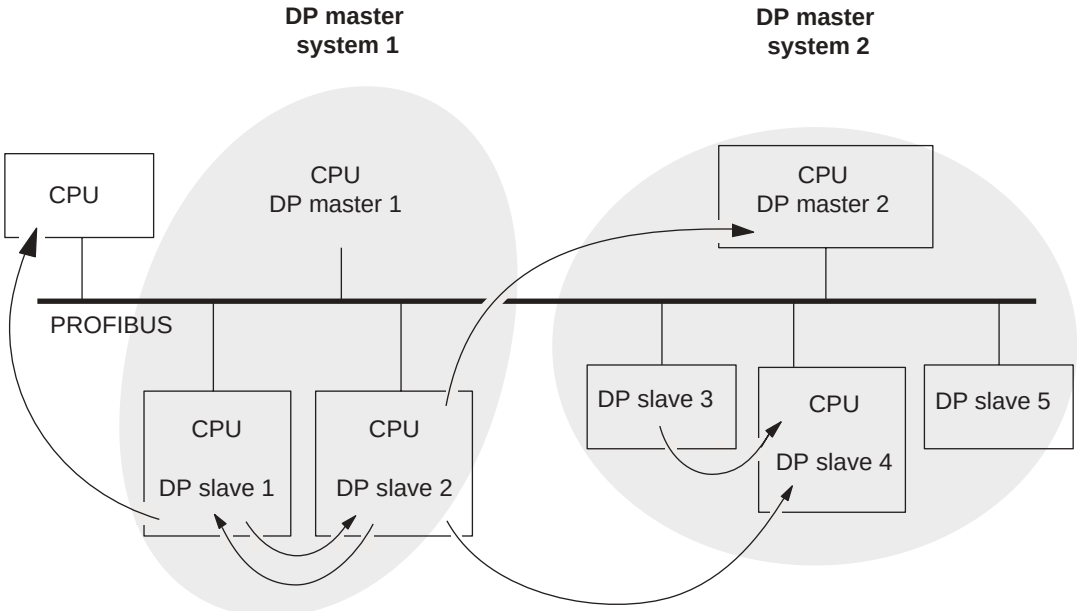


Figure 8-8 Direct Data Exchange with CPUs 31x-2 DP/31xC-2 DP

8.6 Planning PROFInet X2 interface

You learn how to configure the PROFInet X2 interface of CPU 317-2 PN/DP. This allows you to communicate with nodes from the same Ethernet subnet via the PROFInet interface of the CPU.

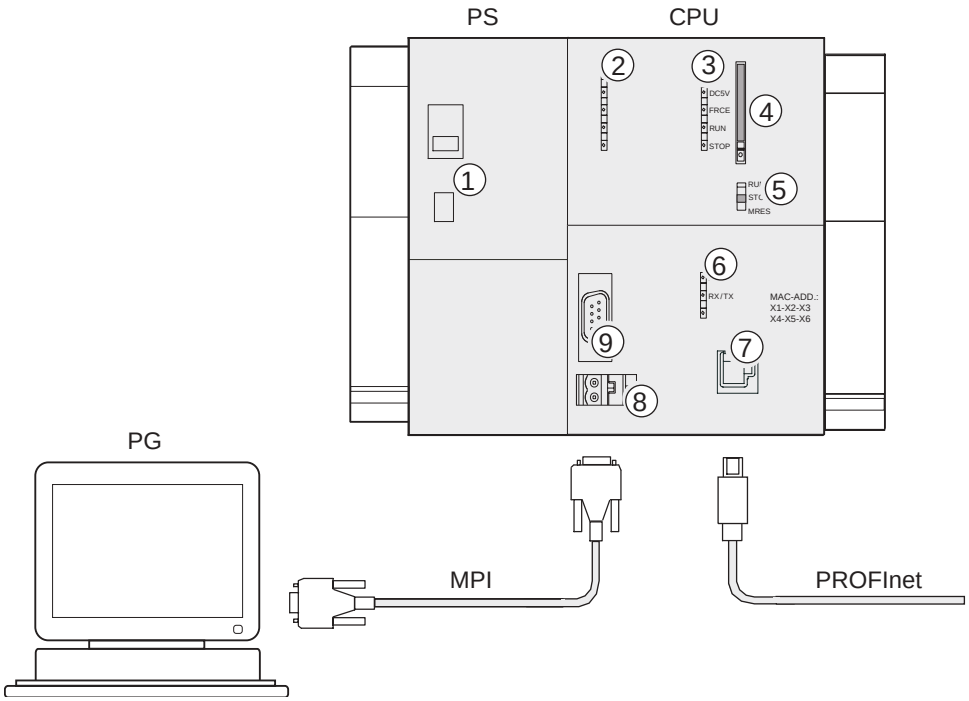


Figure 8-9 Planning PROFInet interface

Key to numbers in the figure	
(1)	Controls of the power supply module: Setting the mains voltage and the ON/OFF switch
(2)	Bus error display
(3)	Status and error displays
(4)	MMC bay with ejector device
(5)	Memory reset
(6)	Status displays for the PROFInet X2 interface (visible with open hinged front panel)
(7)	PROFInet X2 interface
(8)	Power supply connector of CPU
(9)	MPI X1 interface

Requirements

- CPU 317-2 PN/DP with firmware version 2.2.0.
- STEP 7, V5.3 or later
- You commissioned your hardware and software. For this purpose, read *Procedure: Hardware Commissioning* and *Procedure: Software Commissioning.*

Planning PROFInet X2 interface

Table 8-11 Planning PROFInet X2 interface of CPU 317-2 PN/DP in STEP 7

Step	Tasks
Hardware planning in HW Config of STEP 7	
1	Creating a new project: Select the menu command File > New.... Assign a name to your project and confirm with OK.
2	Planning the hardware in HW Config Insert your components via drag & drop: • S7-300 node • Rail • Power supply • CPU 317-2 PN/DP
Assigning the IP address	
3	In HW Config, double-click on the PROFInet X2 interface for CPU 317-2 PN/DP. The properties of the PROFInet X2 interface are displayed on the Parameter tab.
4	Enter the IP address and the subnet mask. This information is available from your network administrator. Under Options, you also specify the desired communication medium and the desired duplex operation. Note: The worldwide unique MAC address is preassigned by the manufacturer and cannot be changed.
5	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.
6	Close the Properties window by clicking on > OK.
7	Loading the configuration in the CPU via • PG-MPI connection (online) or • Saving to MMC at PG (off-line) and subsequently plugging the MMC into the CPU

Result

The PROFInet X2 interface of your CPU 317-2 PN/DP was configured in STEP 7:

- The CPU can now be reached by other nodes in your Ethernet subnet.
- It is now also possible to configure/reconfigure via integrated PROFInet interface of the CPU.

Reference

- Details information about assigning the PROFInet interface is available in the online help of STEP 7.

See also

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

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

Using the PG for commissioning or maintenance (Page 8-16)

Maintenance

9

9.1 Overview

S7-300 is a maintenance-free automation system.

Thus, by maintenance we mean

- Back-up of operating system on a Micro Memory Card (MMC)
- Update of operating system by MMC
- Updating the firmware
- Back-up of project data on a Micro Memory Card (MMC)
- Replacement of modules
- Replacement of the fuses in digital output modules
- Replacing digital output module AC 120/230 V.

9.2 Back-up of firmware on a Micro Memory Card (MMC)

In which situations should I back up the firmware?

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

For example, you might want to replace the CPU in your plant with a CPU from store. In this case, you should make sure that the CPU from store 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 back up the firmware as of the following CPU versions:

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

Backing up the firmware of your CPU on the MMC

Table 9-1 Firmware back-up on MMC

Step	Action required	CPU response
1.	Insert 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 ...	... STOP, RUN and FRCE LEDs start flashing.
4.	Mode selector switch to STOP position.	-
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 back-up. • The STOP LED flashes when the back-up is complete to indicate that the CPU requires a memory reset.
6.	Remove Micro Memory Card.	-

9.3 Updating firmware via 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 to the latest version (update).

Where do I get the latest version of the firmware?

You can obtain the latest firmware (as *.UPD files) from your Siemens partner or from the Siemens home page:

http://www.siemens.com/automation/service&support

Updating firmware of CPU

Table 9-2 Updating firmware via MMC

Step	Action required	CPU response
1.	**Recommendation** Before updating the firmware of the CPU, you should back up the "old" firmware on an empty MMC. If problems occur during the update, you can reload your old firmware from the MMC.	
2.	Transfer update files to a blank MMC using STEP 7 and your programming device.	-
3.	De-energize the CPU and insert an MMC containing the firmware update.	-
4.	Switch on power.	• The CPU detects the MMC with the firmware update automatically and starts the firmware update. • All LEDs are lit during firmware update. • The STOP LED flashes when the firmware has been updated to indicate that the CPU requires a memory reset.
5.	De-energize the CPU and remove the MMC containing the firmware update.	-

9.4 Updating the firmware online (via networks) for CPUs from V2.2.0.

Updating the firmware of the CPU requires the files (*.UPD) with the latest firmware version.

Requirements

- An online update of the firmware is possible starting with STEP 7 V5.3.
- The module at the node whose firmware should be updated must be reachable online.
- The files with the current firmware version must be available in the file system of your PG or PC. A folder must contain only files for one firmware version.

Performing a firmware update

1. Start STEP 7 and change to HW Config.
2. Open the node with the CPU to be updated.
3. Select the CPU.
4. Select the menu command PLC > Update Firmware. The menu command can only be activated if the selected CPU supports the "Update Firmware" function.
5. In the displayed "Update Firmware" dialog, select the path to the firmware update files (*.UPD) using the "Browse" button.
6. After selecting a file, the lower fields of the "Update Firmware" dialog show the information for which module the file is suitable and starting at which firmware version.
7. Click on the "Run" button. STEP 7 checks whether the selected file can be interpreted by the module and loads the file into the CPU if the check is positive. If this requires changing the operating state of the CPU, you will be asked to perform these tasks by means of dialogs. The CPU then automatically performs the firmware update.
8. Check with STEP 7 (reading the CPU diagnostics buffer) whether the CPU starts successfully with the new firmware.

Result

You updated the CPU online with a new firmware version.

9.5 Back-up of project data on a Micro Memory Card (MMC)

Function mode of operation

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 for future retrieval. For this operation, the SIMATIC Micro Memory Card can be located in a CPU or in the MMC programming device of a PG or PC.

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

Note

You may also have to store your user data on the micro memory card, in addition to just the project data. You should therefore check in advance whether your chosen MMC has sufficient memory.

A message will indicate if your MMC is running out of memory.

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 Assembling/disassembling a module

Rules for mounting and wiring

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

Rules governing	... Power supply	... CPU	... SM/FM/CP
Blade width of screwdriver	3.5 mm (cylindrical model)		
Tightening torque • Attaching modules to the rail • Connecting cables	from 0.8 N/m to 1.1 N/m from 0.5 Nm to 0.8 Nm		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 installed 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 is being transferred via the integrated interface of your CPU. In general, you should not replace modules of the S7-300 during data traffic via 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.

Disassembling the module (SM/FM/CP)

Remove the module as follows:

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.	
	Press down the unlocking mechanism with one hand and with the other hand, pull out the front connector at the grips.	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.	

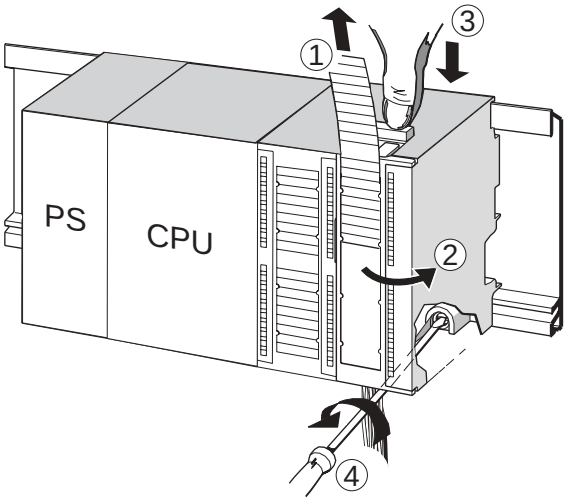


Figure 9-1 Unlocking the front connector and removing the module

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 tilt 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.

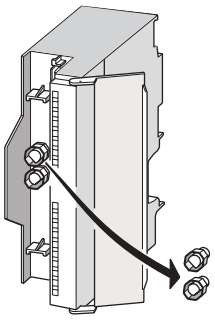


Figure 9-2 Removing the front connector coding pin

Installing a new module

Install the new module as follows:

1. Install new module of same type.
2. Pivot the module down into place.
3. Screw-tighten the module.
4. Slide the labeling strips into the module.

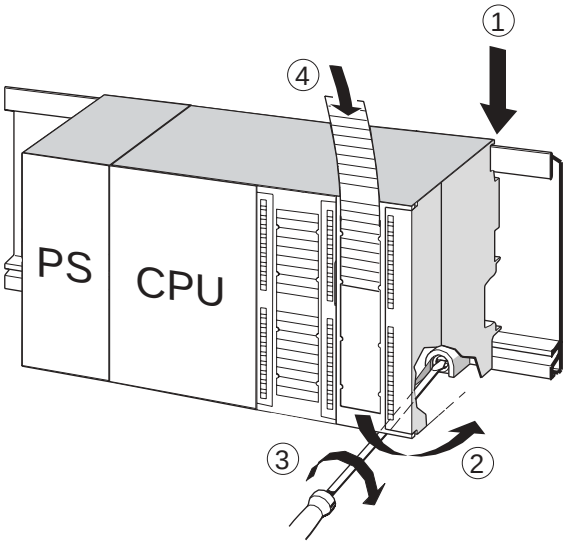


Figure 9-3 Installing a new module

The figure illustrates the described steps:	
(1)	Lower module onto rail.
(2)	Tilt module down.
(3)	Screw the module in tightly.
(4)	Insert labeling strips.

Removing the front connector coding from the front connector

If you want to take a "used" front connector to wire another module, you can remove its coding mechanism:

Simply push out the front connector coding with a screwdriver.

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.

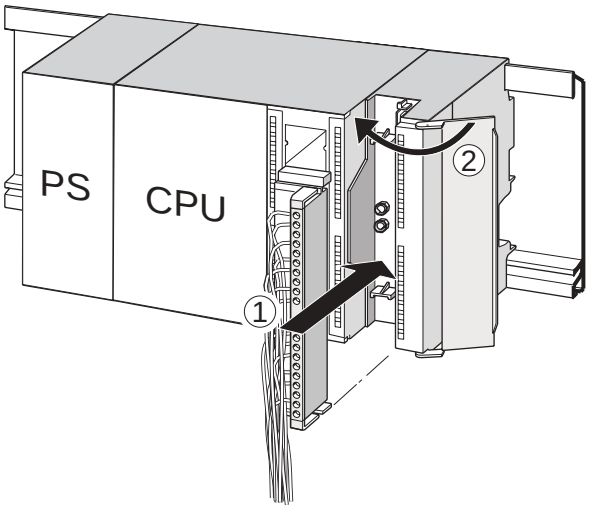


Figure 9-4 Inserting the front connector

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

Behavior of S7-300 after module replacement

After module replacement the CPU switches to run mode, provided no error has occurred. If the CPU maintains STOP status, you can view the cause of error with *STEP 7* (refer to the *STEP 7* User Manual).

9.7 Digital output module 120/230 VAC: Replacing the fuses

Fuses for digital outputs

the digital outputs of the following digital output modules are short-circuit protected by individual 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 you have disconnected the module from the supply voltage.

Warning

Improper handling of front connectors could result in injury or damage to property.
When you remove the front connector during operation, 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.

Position of the fuses

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)**

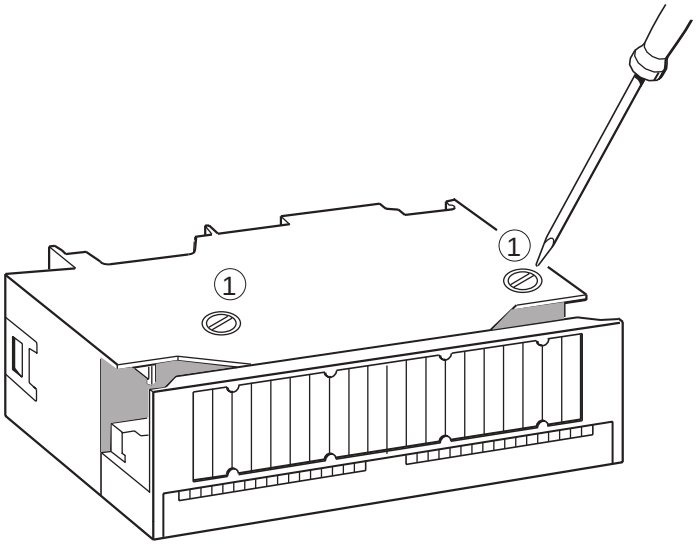


Figure 9-5 Location of fuses in the digital output module 120/230 VAC

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.

Testing functions, diagnostics and fault elimination 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: Testing Functions

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

To be able to identify the addressed node, use the menu command 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.

Test functions of the software: Monitoring and modifying variables, single-step mode

STEP 7 offers you the following testing functions you can also use for diagnostics:

- Monitoring and modifying of variables

  Can be used for PG/PC monitoring of specific CPU or user program variables. You can also declare permanent values for 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.

- single-step 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.

Testing functions of the software: Forcing variables

The Force function can be used to declare permanent values in specific variables of a user program or CPU (also: inputs and outputs) which cannot be overwritten subsequently by the user program.

For example, you can use it to jumper sensors or switch outputs permanently, irrespective of the user program.

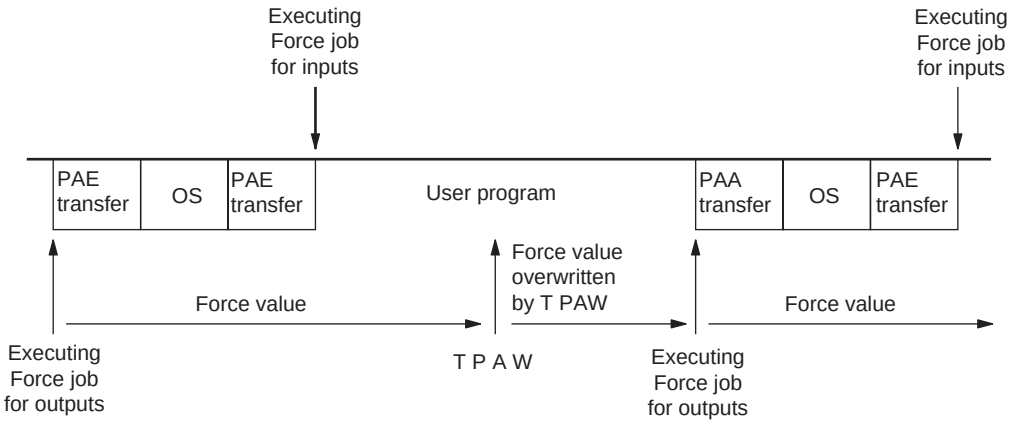
Danger

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 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 (e.g. TPQB x) 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!

For S7-300 CPUs, forcing corresponds to "cyclical controlling"



OS: operating system processing

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 likewise on hardware and on 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 errors: Errors you can relate to a specific point in the user program (e.g. error when accessing a peripheral module).
- Asynchronous errors: Errors you can **not** relate to a specific point in the user program (e.g. cycle time exceeded, module error).

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 (e.g. by programming error OBs).
- 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: Supply voltage is applied.
Yellow	Non-regular operating status. Example: Forcing is active.
Red	Fault. Example: Bus error
LED flashing	Special event Example: 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 with low data volumes.

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 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).
- Display of module errors (e.g. channel error) in the central I/O and DP slave.
- 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.
- Display of the cycle time (longest, shortest and last cycle).
- Options and utilization of MPI communication.
- Display of performance data (number of possible I/O, memory bits, counters, timers and blocks).

Details on diagnostic options in STEP 7 and procedures are found in the *Programming with STEP 7* Manual and in the *HW Config Online Help*.

10.5 Diagnostics using status and error LEDs

10.5.1 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.

10.5.2 Status and error displays of all CPUs

Table 10-2 Status and error displays

LED					Meaning
SF	DC5V	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, evaluate 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 start-up 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, evaluate the SF LED
X	X	On	X	X	You have activated the Force function For details refer to the Programming Manual *Programming with STEP 7* .

LED					Meaning
SF	DC5V	FRCE	RUN	STOP	
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 has no effect on 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*.

10.5.3 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

Possible Errors	Response of the CPU	Remedies
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 required, retrigger cycle time monitoring via 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.
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 watchdog OB32 and OB35, starting from 1 ms.

Note

The shorter the selected watchdog interrupt period, the more likely it is that watchdog 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*.

10.5.4 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 during operation.	CPU goes into STOP	Screw-tighten the modules and restart the CPU.
A diagnosable module reports a diagnostic interrupt.	Calls OB82. CPU does not STOP if OB82 is loaded.	response to the diagnostic event, depending on the module's 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 (here, the OB85 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 OB85, 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, retransfer program, and change 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*.

10.5.5 Status and error displays of all CPUs with DP interface

Explanation of BUSF, BUSF1 and BUSF2 LEDs

Table 10-5 BUSF, BUSF1 and BUSF2 LEDs

LED					Meaning
SF	DC5V	BUSF	BUSF1	BUSF2	
On	On	On/ flashes	-	-	PROFIBUS DP interface error. Remedy: Refer to the table below
On	On	-	On/ flashes	X	Error at the first PROFIBUS DP interface of CPU 317-2 DP. Remedy: Refer to the table below
On	On	-	X	On/ flashes	Error at the second PROFIBUS DP interface of CPU 317-2 DP. Remedy: Refer to the table below

Description of status X:
The LED can assume the status On or Off, but this status has no effect on the current CPU function. For example, the states Force On or Off do not influence the STOP status of the CPU

Table 10-6 BUSF LED is lit

Possible errors	Response of the CPU	Remedies
• Bus fault (hardware fault). • DP interface error. • Different transmission rates in multiple DP master mode. • If the DP slave interface is active or there is a bus short-circuit on the master. • For a passive DP slave interface: baud rate search, i.e. there are currently no other active nodes on the bus (e.g. a master)	Calls OB86 (when CPU is in RUN mode). CPU switches to STOP if OB86 is not loaded.	• Check the bus cable for short or interruption. • Evaluate the diagnostic data. Reconfigure, or correct the configuration.

Table 10-7 BUSF LED flashes

Possible errors	Response of the CPU	Remedies
The CPU is the DP master/active slave: • Failure of a connected station • At least one of the configured slaves cannot be accessed. • Incorrect configuration	Calls OB86 (when CPU is in RUN mode). CPU switches to STOP if OB86 is not loaded.	Ensure that the bus cable is connected to the CPU and that the bus is not interrupted. Wait until the CPU has started. If the LED does not stop flashing, check the DP slaves or evaluate the diagnostic data for the DP slaves.
The CPU is the DP slave Possible causes: • The response monitoring time has expired. • PROFIBUS DP communication is interrupted. • Wrong PROFIBUS address. • Incorrect configuration	Calls OB86 (when CPU is in RUN mode). CPU switches to STOP if OB86 is not loaded.	• Check the CPU. • Check to make sure that the bus connector is properly inserted. • Check for interruptions in the bus cable to the DP master. • Check configuration data and the 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*.

10.5.6 Status displays: CPUs with PN interface

Significance of flashing RX/TX: Data traffic via PB interface

Table 10-8 LINK and RX/TX LEDs

LED		Meaning
LINK	RX/TX	
On	-	Indicates existing Ethernet connection
On	Flashes	Send/receive data via PN interface

10.6 Diagnostics of DP CPUs

10.6.1 Diagnostics of DP CPUs Operating as DP Master

Evaluate diagnostics in user program

The figure below illustrates the procedure for evaluating the diagnostics in the user program.

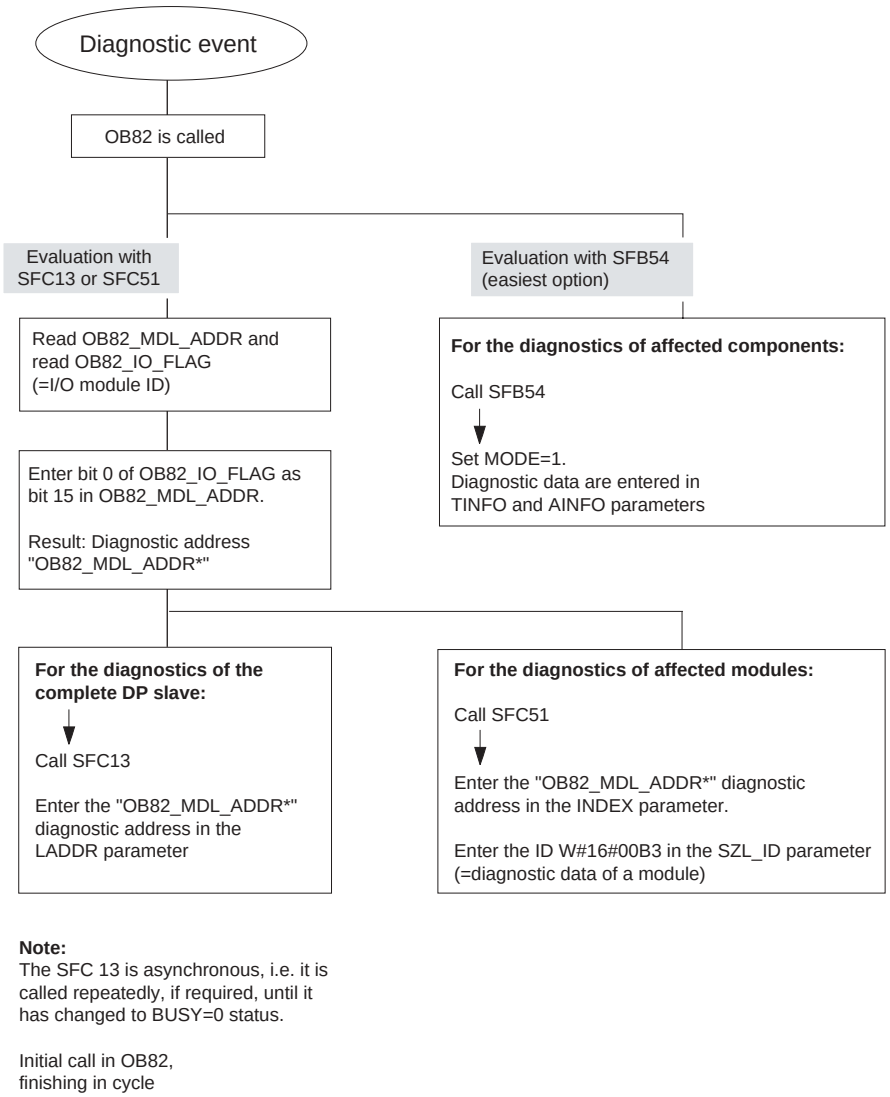


Figure 10-2 Diagnostics with CPU 31x-2

Diagnostic addresses

With CPU 31x-2 you assign diagnostic addresses for the PROFIBUS DP. Make sure DP diagnostic addresses are assigned once to the DP master and to the DP slave during configuration.

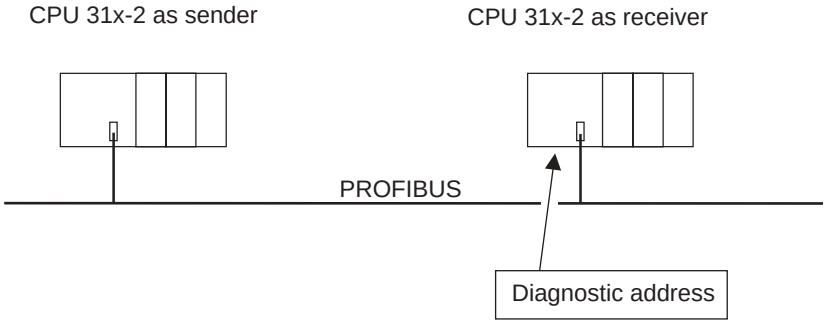


Figure 10-3 Diagnostic addresses for DP masters and DP slaves

Description of DP master configuration	Description of DP slave configuration
When configuring the DP master, you assign two different diagnostic addresses for an I-slave: one diagnostic address for Slot 0 and one diagnostic address for Slot 2. The two addresses have the following functions: • The diagnostic address for slot 0 reports in the master all events relating to the complete slave (node representative), e.g. node failure. • The diagnostic address for slot 2 is used to report events that affect 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 on the status of the DP slave or a bus interruption.	During configuration of the DP slave, you also specify a diagnostic address assigned to the DP slave (in the associated project of the DP slave). 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 a bus interruption.

Event recognition

The table below shows how CPU 31x-2 operating as DP master recognizes operating mode transitions of a CPU operating as DP slave or data exchange interruptions.

Table 10-9 Event recognition of CPU 31x-2 operating as DP master

Event	What happens in the DP master?
Bus failure interrupt (short-circuit, connector unplugged)	• Calls OB86 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 OB122 (I/O access error)
DP slave: RUN → STOP	• Call of OB82 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: STOP → RUN	• Call of OB82 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 10-10 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

10.6.2 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 with direct data exchange

For direct data exchange, you assign a diagnostic address in the receiver:

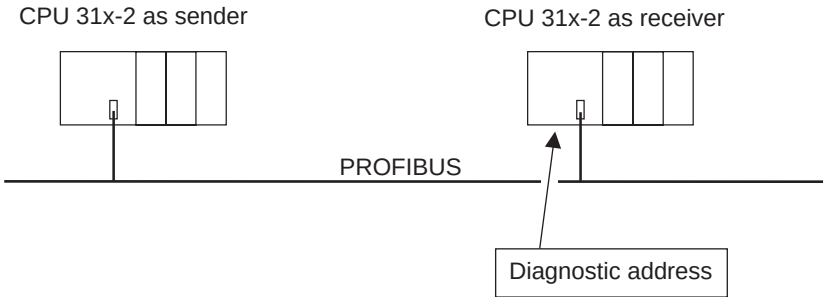


Figure 10-4 Diagnostic address for the receiving node with direct data exchange

In this figure, you see that for configuration in the receiver, you define a diagnostic address that is assigned to the receiver. The receiver obtains information about the status of the sender 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 10-11 Reading out diagnostic data in the master system, using STEP 5 and STEP 7

PLC with DP master	Blocks or registers in STEP 7	Application	Further Information
SIMATIC S7/M7	"DP slave diagnostics" register	Displaying slave diagnostic data as plain text on a STEP 7 user interface	Found under the keyword *Hardware diagnostics* in the STEP 7 Online Help and in the *Programming STEP 7* 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 system status list ID W#16#00B4 and read out the SSL of the slave CPU.	*System and Standard Functions* Reference Manual
	SFB 54 "RALRM"	Reading additional interrupt information from a DP slave or a centralized module from the relevant OB.	*System and Standard Functions* Reference Manual

PLC with DP master	Blocks or registers in STEP 7	Application	Further Information
	SFC 59 “RD_REC”	Reading data records of the S7 diagnosis (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 under http://www.ad.siemens.de/simatic-cs, Article ID 387 257
SIMATIC S5 with IM 308-C operating as DP master	FB 192 “IM308C”	Reading slave diagnostic data (stored in the data area of the user program)	Manual *Distributed I/O System ET 200*
SIMATIC S5 with S5-95U PLC operating as DP master	FB 230 “S_DIAG”		

Example of reading slave diagnostic data, using FB 192 "IM 308C"

Here you will find 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 as DP master uses page frame 0 to 15 (number 0 of IM 308-C).
- The DP slave has the PROFIBUS address 3.
- Slave diagnostics data should be stored in DB 20. Here you can also use any other data block.
- Slave diagnostic data has a length of 26 bytes.

STEP 5 user program

```
STL                                  Explanation
       :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 diagnosis
GCGR   :       KM 0                  //not evaluated
TYP    :       KY 0, 20              //S5 data area: DB 20
STAD   :       KF +1                 //Diagnostic data as of 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

For this **STEP 7** user program it is assumed that:

- 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                                    Explanation
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

With CPU 31x-2 you assign diagnostic addresses for the PROFIBUS DP. Make sure DP diagnostic addresses are assigned once to the DP master and to the DP slave during configuration.

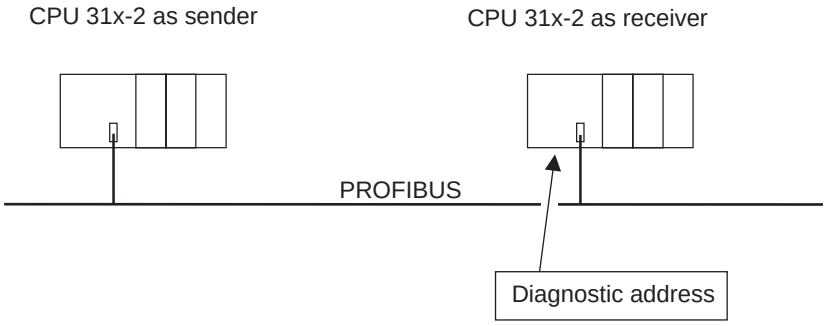


Figure 10-5 Diagnostic addresses for DP masters and DP slaves

Description of DP master configuration	Description of DP slave configuration
During configuration of the DP master, you assign two different diagnostic addresses for an I-slave: one diagnostic address for Slot 0 and one diagnostic address for Slot 2. The two addresses have the following functions: • The diagnostic address for slot 0 reports in the master all events relating to the complete slave (node representative), e.g. node failure. • The diagnostic address for slot 2 is used to report events that affect 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 on the status of the DP slave or a bus interruption.	During configuration of the DP slave, you also specify a diagnostic address assigned to the DP slave (in the associated project of the DP slave). 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 a bus interruption.

Event recognition

The table below shows how CPU 31x-2 operating as DP slave recognized operating state transitions or data exchange interruptions.

Table 10-12 Event recognition of CPUs 31x-2 operating as DP slave

Event	What happens in the DP slave?
Bus failure interrupt (short-circuit, connector unplugged)	• 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 OB122 (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: STOP → RUN	• 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 you how you can, for example, evaluate RUN-STOP transitions of the DP master in the DP slave (see also the previous table).

Table 10-13 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: • 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

10.6.3 Interrupts on the DP Master

Interrupts with S7 DP master

Process interrupts by I-Slave with SFC 7

In the CPU 31x-2 operated as a DP slave, you can trigger a user-defined process interrupt from the DP master from the user program.

When you call SFC 7 "DP_PRAL", you trigger an OB40 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 freely programmed as required. The *System Software for S7-300/400 - System and Standard Functions* Reference Manual contains a detailed description of SFC 7 "DP_PRAL".

Setting user-defined interrupts by I-Slaves with the SFB 75

In the CPU 31x-2 operated as a DP slave, you can trigger user-defined interrupts from the DP master from the user program. 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.

Interrupt-specific additional information may be sent at the same time. You can read all 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 the device-specific diagnostic data of CPU 31x-2. You must post-process the relevant diagnostic events in the DP master's user program.

Note

Before you can evaluate diagnostic and process interrupts using the device-specific diagnostics function on another DP master, you must make sure that:

The DP master is able to store the diagnostic messages, i.e. the diagnostic messages should be stored in a ring buffer on the DP master. For example, if the DP master can not store diagnostic messages, only the last incoming diagnostic message would be stored.

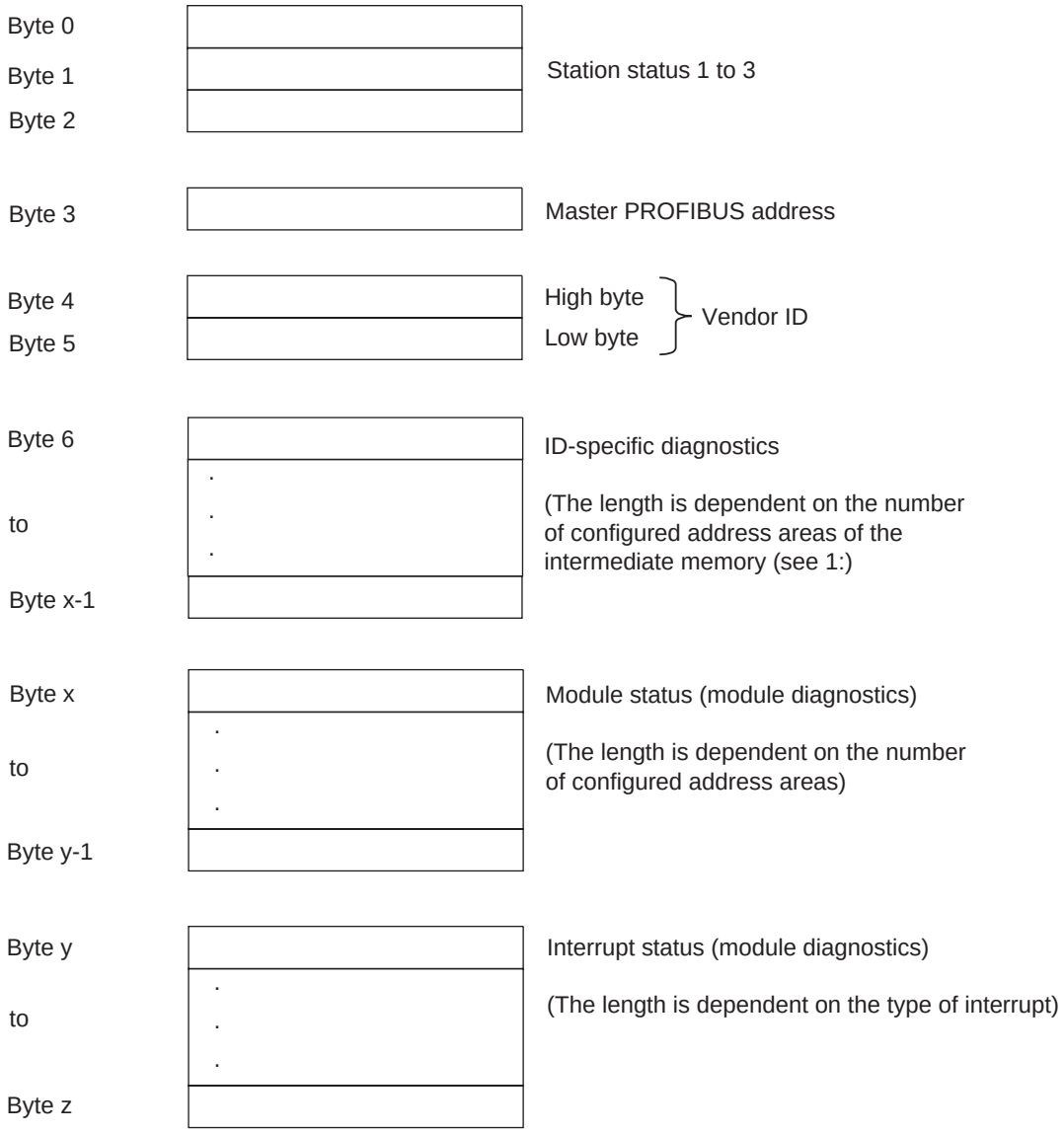
In your user program, you must query the relevant bits in device-specific diagnostic data. Here you must take the PROFIBUS DP cycle time into account, for example, to be able to query these bits at least once and in synchronism to bus cycle time.

With an IM 308-C operating as DP master you cannot utilize process interrupts in device-specific diagnostics, because only incoming events are reported rather than outgoing events.

10.6.4 Structure of the Slave Diagnostic Data when the CPU is used as an Intelligent Slave

Structure of the diagnostics message frame:

The figure below shows the structure of the diagnostics message frame 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 10-6 Structure of slave diagnostic data

Station Status 1

Table 10-14 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 RUN to STOP 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 10-15 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 "FREEZE".
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 10-16 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 10-17 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 10-18 Structure of the manufacturer ID (byte 4 and 5)

Byte 4	Byte 5	Vendor ID for the CPU
80_H	EE_H	CPU 315-2 DP
80_H	$F0_H$	CPU 317-2 DP
80_H	$D0_H$	313C-2-DP
80_H	$D1_H$	314C-2-DP
80_H	$F1_H$	317-2 PN/DP

Module diagnostics

Module diagnostics indicate the configured address area of intermediate memory that has received an entry.

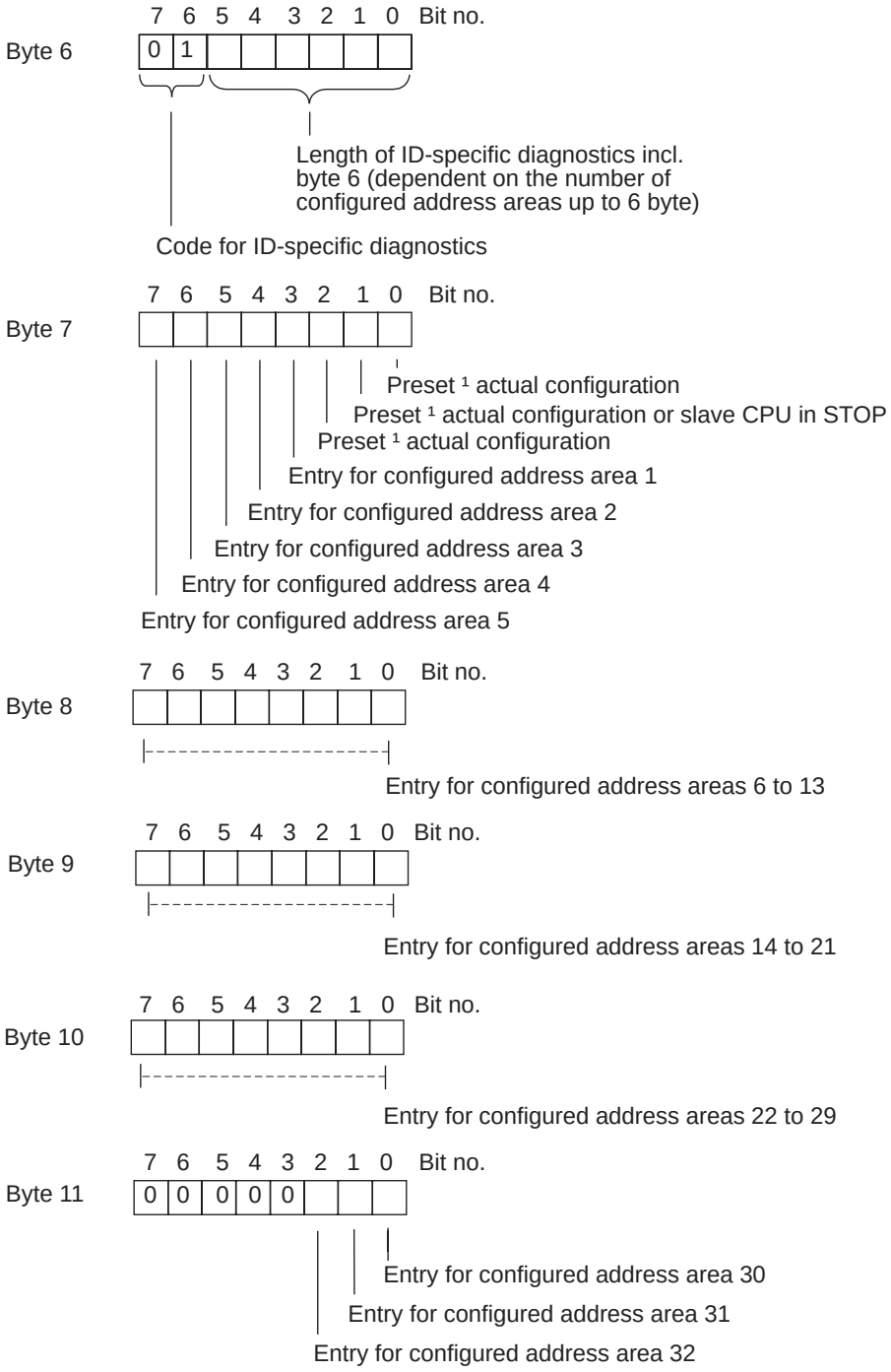


Figure 10-7 Structure of module diagnostics of CPU 31x-2

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.

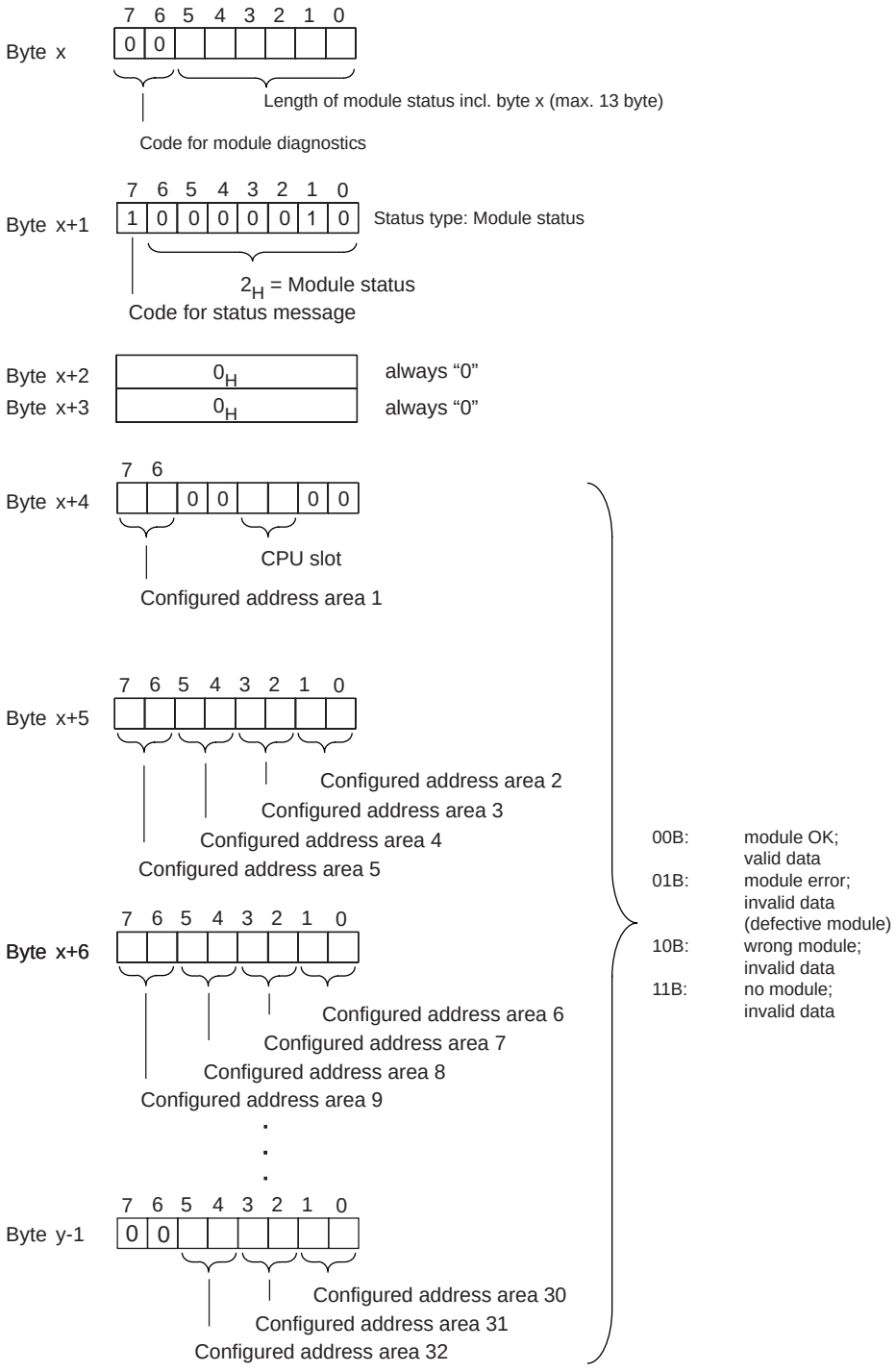
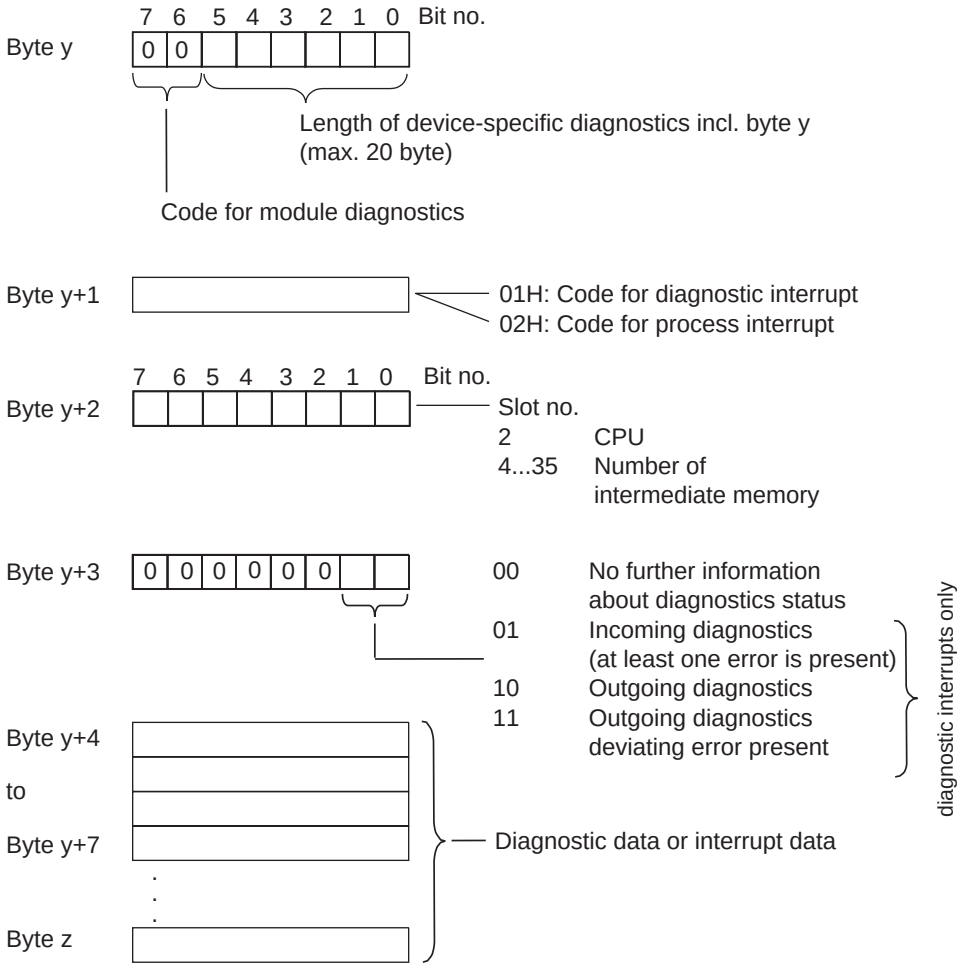


Figure 10-8 Structure of the module status

Interrupt status

The interrupt status of module diagnostics provides details on a DP slave. The maximum length of module diagnostics starting at byte y is 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 10-9 Structure of the interrupt status:

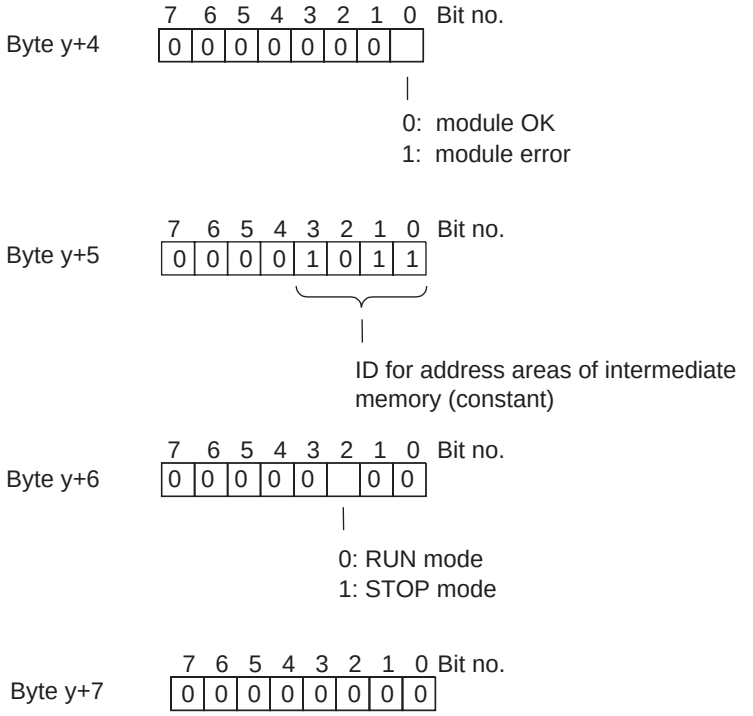
Structure of the interrupt data for a process interrupt (from byte y+4)

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 were 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 10-10 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)

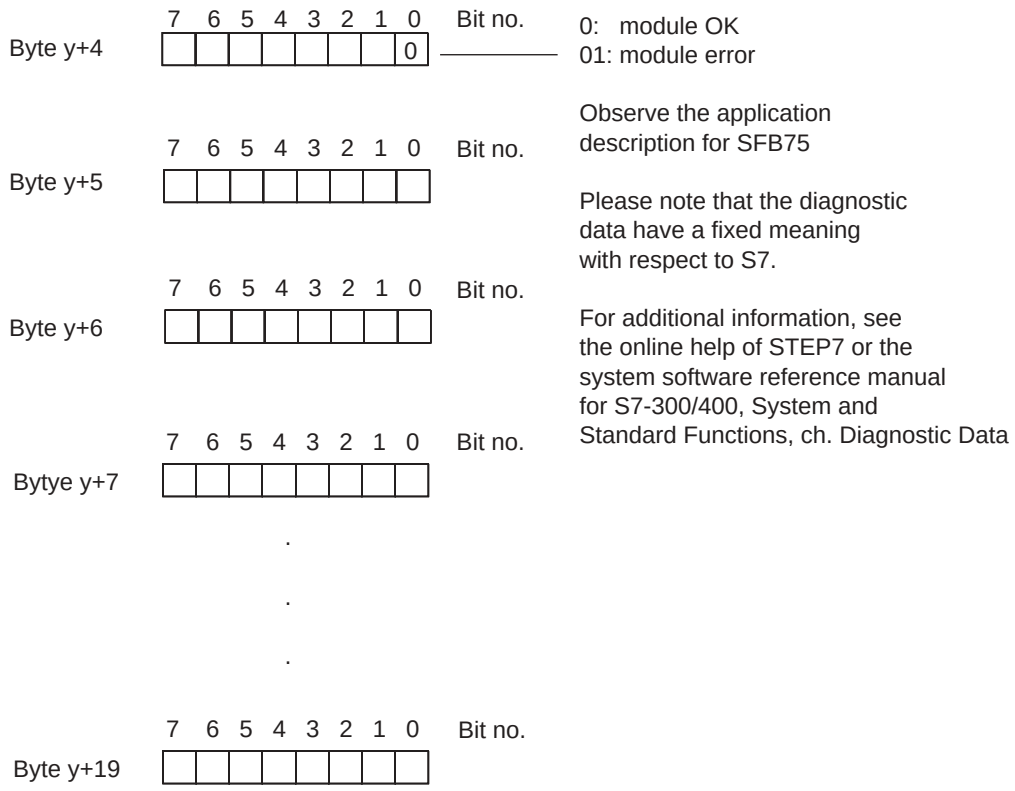


Figure 10-11 Bytes y+4 to y+7 for the diagnostic interrupt (SFB 75)

Appendix

A

A.1 General Rules and Regulations for S7-300 Operation

Introduction

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.

Warning

You must observe at the basic rules for electrical installation if you want your S7-300 to operate free of trouble.

EMERGENCY-OFF devices

EMERGENCY-OFF devices to IEC 204 (corresponds to VDE 113) must remain effective in all operating modes of the plant or system.

Start-up of the system after specific events

The following table shows you what you have to observe when starting up a plant again following specific events.

Table A-1 Start-up of the system after specific events

If there is...	What must not happen ...
Restart following a voltage dip or power failure,	no dangerous operating states may occur. If necessary, force EMERGENCY-OFF.
Start-up after releasing the EMERGENCY OFF device:	An uncontrolled or undefined start-up must be avoided.

Mains voltage

The following table shows you what to watch with respect to the mains voltage.

Table A-2 Mains voltage

In the case of ...	is ...
For stationary systems or systems without all-pole mains disconnect switch	Installation of a mains disconnect switch or a fuse in the building installation system.
For load power supplies, power supply modules	The set rated voltage range must correspond to the local power supply voltage.
For 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 in connection with the 24 VDC power supply.

Table A-3 Protection against external electrical interference

In the case of ...	Measures to take	
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 with an S7-300 installation	the plant or system is connected to a protective conductor for the suppression of electromagnetic interference.
Supply/signal/bus cables	The conductor routing and installation is correct.
Signal and bus cables	a cable/conductor break does not result in 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 via 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.

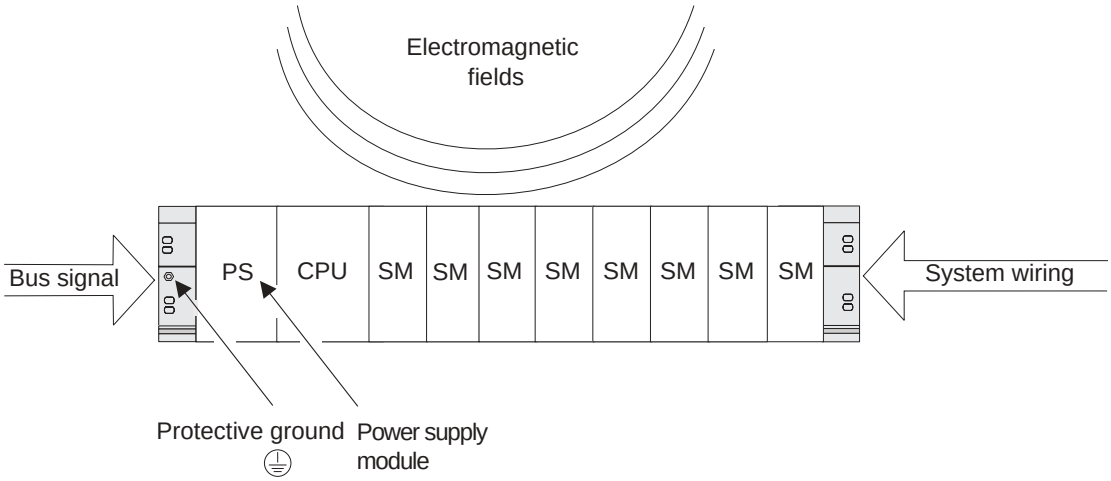


Figure A-1 Possible paths of electromagnetic interference

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

If you comply with theses five basic rules ...

you can ensure EMC in many cases!

Rule 1: Large-area grounding

When you install the automation equipment, make sure that surfaces of inactive metal parts are well bonded to chassis ground (see the following sections).

- 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.

Rule 2: Proper cable routing

Ensure proper cable routing when you wire your system (see the section below on *Indoor/outdoor cable routing*).

- 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).

Rule 3: Mounting the cable shielding

Take care that all cable shielding is properly fastened (refer to the section on *Shielding of cables*).

- 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.

Rule 4: Special EMC measures

Some special applications might require special EMC measures (refer to the section on *How to protect digital output modules against inductive surge voltage*).

- 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 .

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.

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.

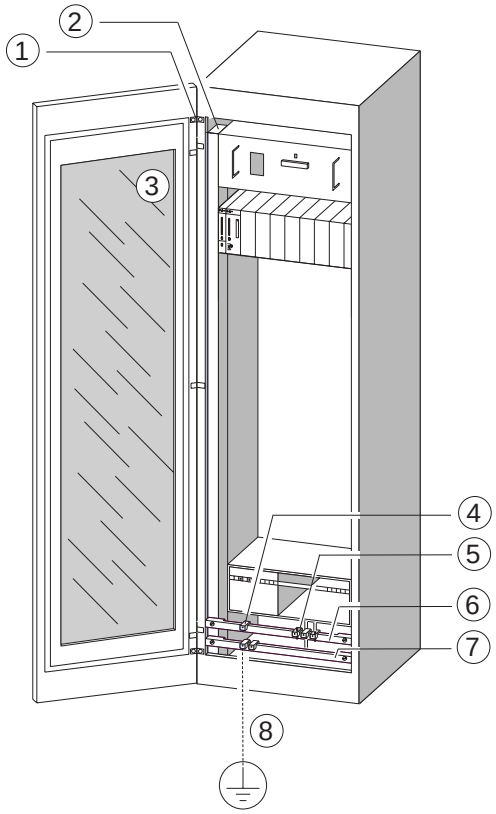


Figure A-2 Example of an EMC compatible cabinet installation

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 protective conductor bar and 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.

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.

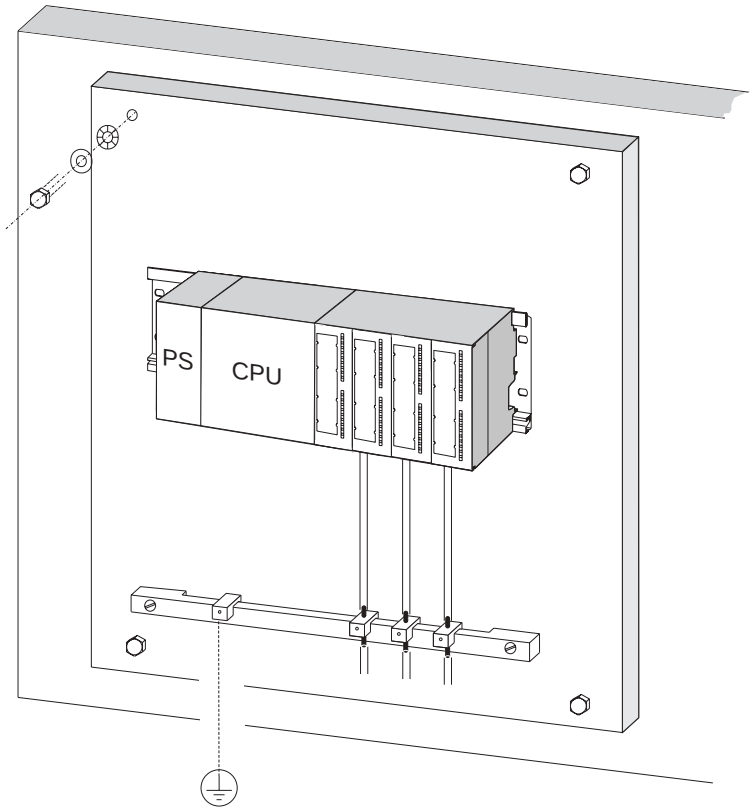


Figure A-3 Example of EMC compatible wall-mounting

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.

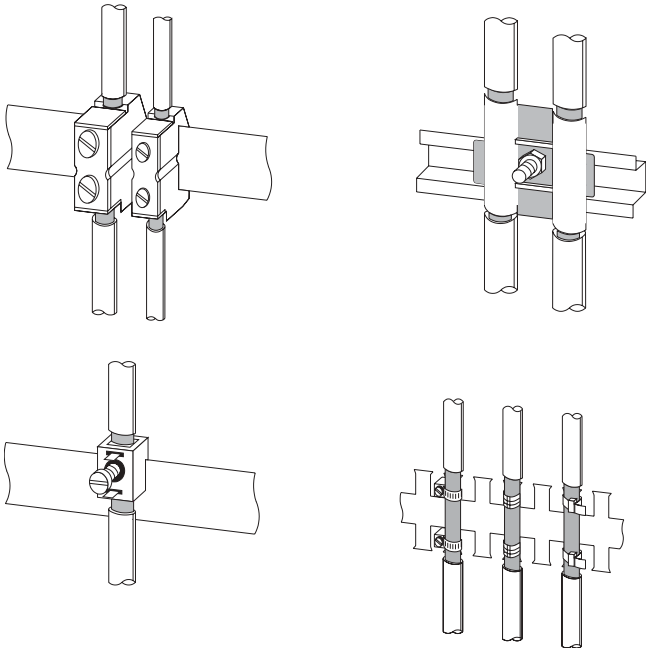


Figure A-4 Mounting cable shielding

A.2.7 Potential differences

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 mm²). 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).

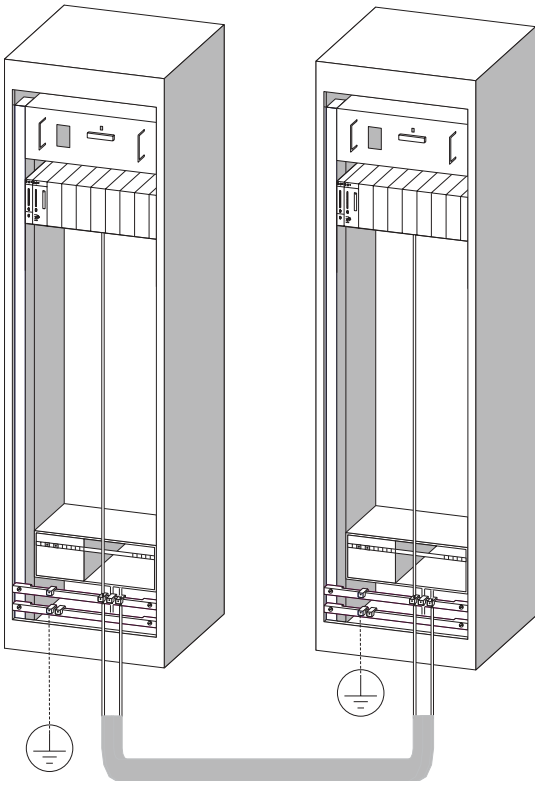


Figure A-5 Equipotential bonding

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 10-7 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 zones 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	Lightning protection zone 1
• Rooms and/or	Lightning protection zone 2
• Devices	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.

Block diagram of the lightning protection zones

The figure below shows a block diagram of the lightning protection zone concept for a detached building.

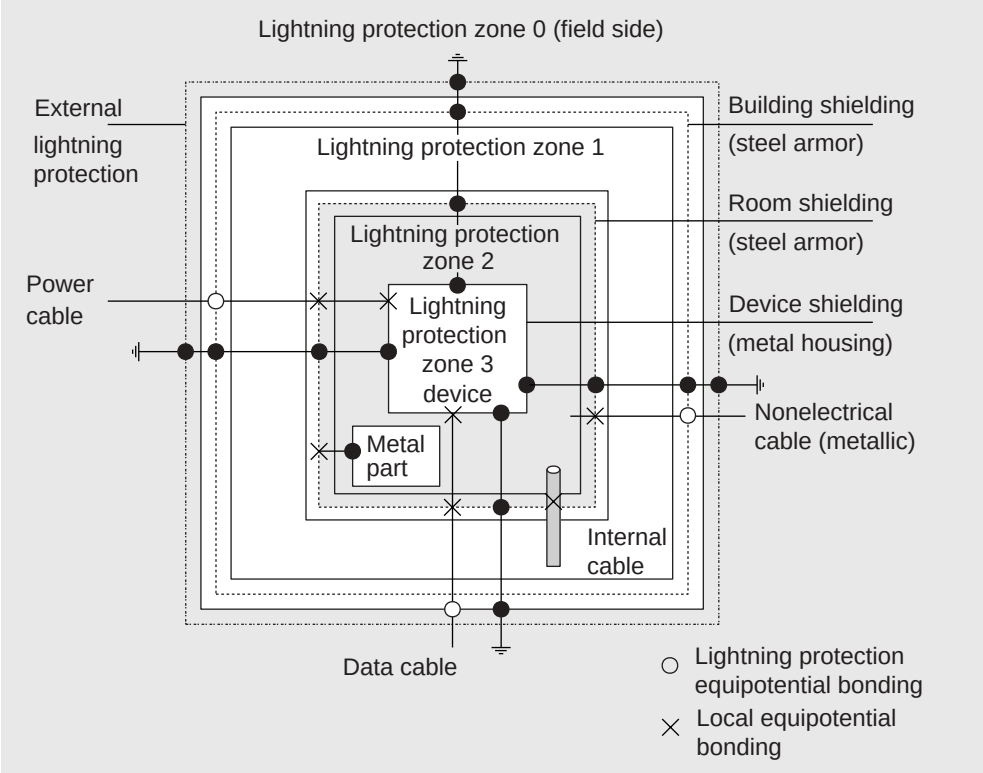


Figure A-6 Lightning protection zones of a building

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*
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*

Consec. no.	Cables for ...	... ... equip transition point 0 <-> 1 with:		Order number
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	DEHNguard 275 surge arresters Phase L to N	900 600* 5SD7 030
		1 x	DEHNgap C, N-PE surge arrester, 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 conductor 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 protection Type FDK 2 60 V	919 993*
5	Outputs of digital modules 24 V	1 x	Low-voltage surge arrester	919 991*

Consec. no.	Cables for ...	... ... equip transition point 1 <-> 2 with:		Order number
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	Surge arrester Blitzductor CT, type MD 12 V	919 506* and 919 541*

* You can order these components directly from:
DEHN + SÖHNE
GmbH + Co. KG
Elektrotechnische Fabrik
Hans-Dehn-Str. 1
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	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	DEHNguard 275 surge arresters Phase L to N	900 600* 5SD7 030
		1 x	DEHNgap C, N-PE surge arrester, 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 conductor 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*

Consec. no.	Cables for ...	... ... equip transition point 2 <-> 3 with:		Order number
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*

* You can order these components directly from:
DEHN + SÖHNE
GmbH + Co. KG
Elektrotechnische Fabrik
Hans-Dehn-Str. 1
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:

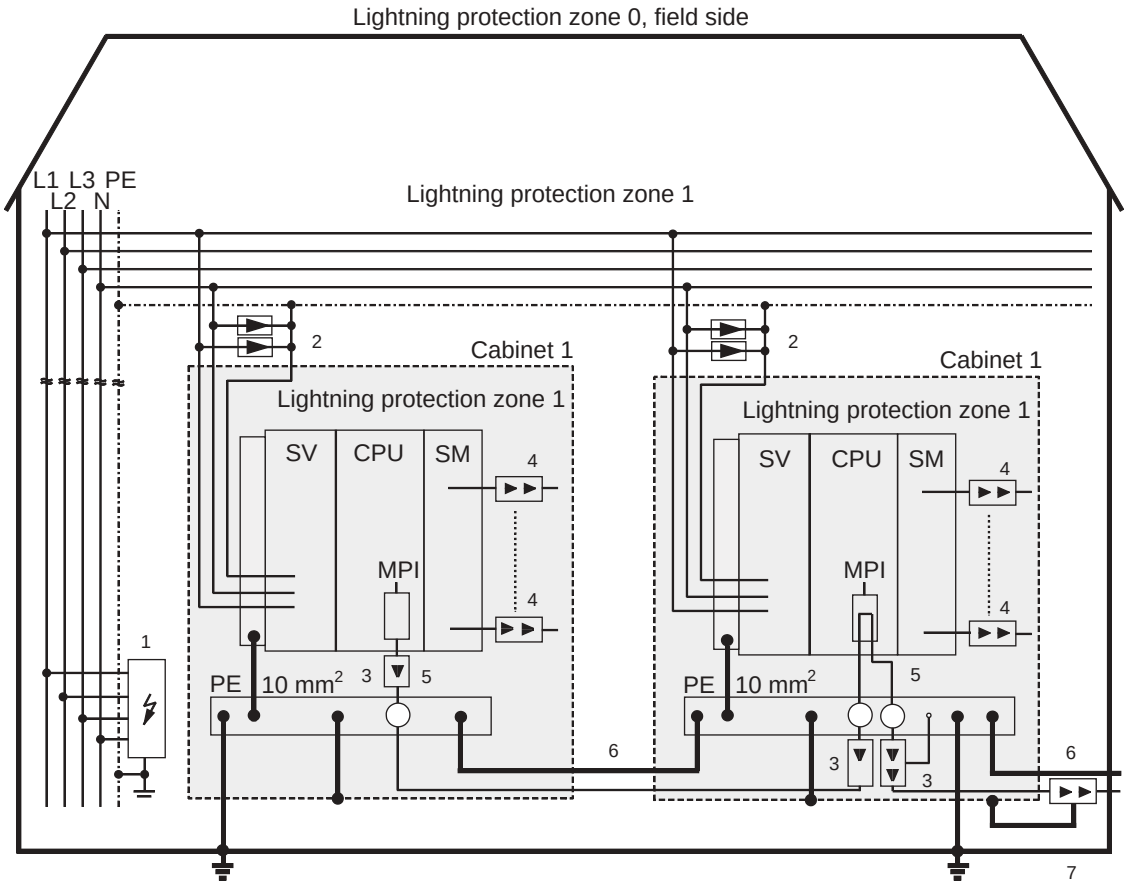


Figure A-7 Sample circuitry for networked S7-300 PLCs

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 arrestor, depending on the mains system, e.g. TN-S system: 1 piece DEHNbloc/3, Order No.: 900 110* and 1 piece 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 pieces DEHNguard 275; Order No.: 900 600*	High-voltage surge protection at transition 1 <-> 2
3	Surge arrester, Blitzductor CT 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

* You can order these components directly from:
DEHN + SÖHNE
GmbH + Co. KG
Elektrotechnische Fabrik
Hans-Dehn-Str.

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

The figures illustrates an output circuit requiring additional overvoltage protectors.

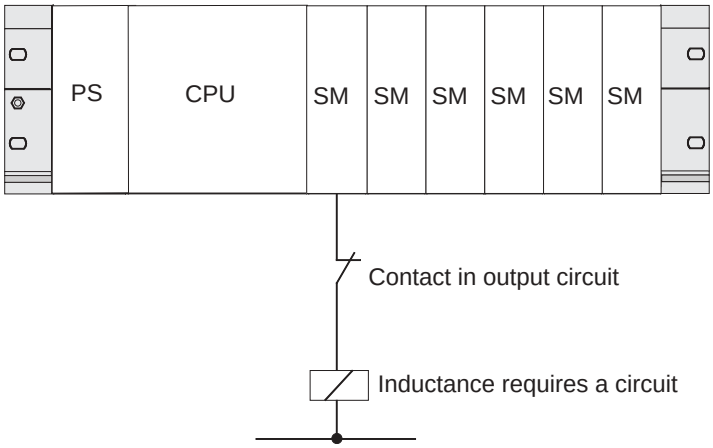


Figure A-8 EMERGENCY-OFF relay contact in the output circuit

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.

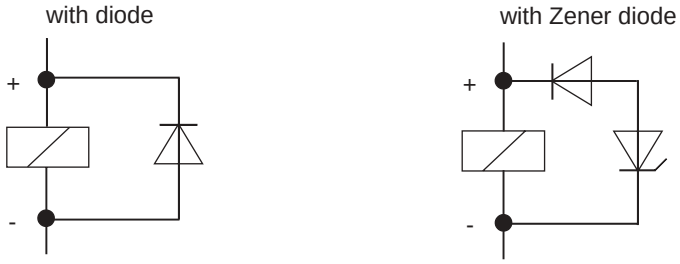


Figure A-9 Circuit for coils operated with DC voltage

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.

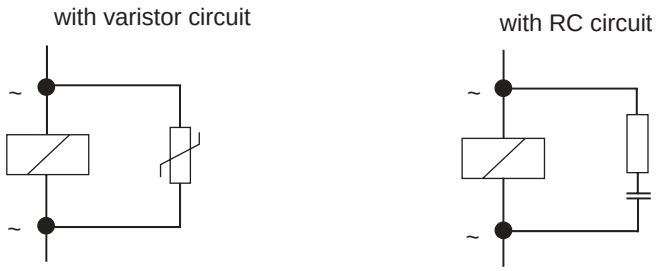


Figure A-10 Circuit for coils operated with AC voltage

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 (watchdog 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.

A.5 Technical support

SIMATIC Technical Support

You can reach the Technical Support for all A&D products

- Via e-mail:
- Phone: 49 (0) 180 5050 222
- Fax: +49 (0) 180 5050 223

Additional information about our Technical Support can be found on the Internet at

www.siemens.com/automation/service

Service & Support on the Internet

In addition to our documentation service, you can also access our complete knowledge base online on the Internet.

http://www.siemens.com/automation/service&support

There you can find:

- Up-to-date product information (News), FAQs (Frequently Asked Questions), Downloads, Tips and Tricks.
- The Newsletter provides latest information on your products.
- The Knowledge Manager helps you find the documents you need.
- Users and specialists from around the world share their experience and knowledge in the Forum.
- You can find your local service partner for Automation & Drives in our Partner Database.
- Information relating to onsite service, repairs, spare parts and lots more is available to you in the "Services" section.

Further support

If you still have questions about how to use the products described in this manual, please contact your local Siemens dealer.

http://www.siemens.com/automation/partner

Training center

We can provide training courses to help you get started with your S7-300 PLC. Please contact your local Training Center or the Central Training Center in Nuremberg, D-90327, Germany

Tel: +49 (911) 895-3200

http://www.sitrain.com

See also

Preface

Glossary

B

Accumulator

The --> CPU uses the accumulator registers as intermediate memory for load, transfer, comparison, calculation and conversion operations.

Address

The address represents the ID for a specific address or address range. Example: Input I 12.1; Memory bit Word MW25; Data block DB3.

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.

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 back-up memory provides a back-up of memory areas for the --> CPU without a back-up 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.

CbA

Concept for implementing modular, distributed automation applications based on open standards for data processing and data communications. Component based Automation is an extension of Totally Integrated Automation (TIA).

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!

Code block

A SIMATIC S7 code block contains part of the **STEP 7** user program. (In contrast: A --> Data Block (DB) only contains data.)

Communication processor

Communication processors are modules used for bus connections and point-to-point communication.

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 (e.g. up/down count).

CP

--> Communication processor

CPU

Central Processing Unit = central module of S7 PLCs, consisting of a controller and mathematical unit, memory, operating system and an interface for a programming device.

Cycle time

The cycle time represents the time a --> CPU requires to run through the --> user program once.

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.

Diagnostics

--> System diagnostics

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 via diagnostic interrupts.

DP master

A --> master which behaves in accordance with EN 50170, Part 3 is known as a DP master.

DP master

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 for isolated I/O is electrically isolated; e.g. by optocouplers, relay contact or transformer. I/O circuits can be connected to a common potential.

Error display

One of the possible responses of the operating system to a --> runtime error is to display the error. The other possible responses are: --> error response in the user program, CPU 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

Response to a --> runtime error. Possible operating system reaction: PLC transition to STOP mode, call of an OB in which the user can program a specific reaction or error display.

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.

FB

--> Function block

FC

--> 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, byte, word or double word units.

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 is used to assign fixed values to certain variables from a user program or CPU (including I/O).

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 is a --> code block that contains no --> 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 that contains no --> 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 consists of a number of CPUs exchanging data via global data communication, used as follows:

- A CPU broadcasts a GD packet to the other CPUs.
- A CPU sends and receives a GD packet from another CPU.

The GD ID identifies the GD circuit.

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 more --> GD objects transmitted in a single message frame.

Global data

Shared 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 procedure used to transfer --> global data between CPUs (without CFBs).

Ground

Chassis ground is the totality of all the interconnected passive parts of a piece of equipment on which dangerous fault-voltage cannot occur.

Ground

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).

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.

GSD file

The Device Master File (GSD file) stores all slave-specific properties. The GSD file format is specified in EN 50170, Volume 2, PROFIBUS.

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 input/output and in/out parameters as well as local block data.

Interface, MPI-capable

--> MPI

Interrupt

The CPU's --> 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, delay

--> Interrupt, delay

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, diagnostics

--> Diagnostic Interrupt

Interrupt, process

--> Process interrupt

Interrupt, status

A status interrupt can be generated by a DPV1 slave and causes OB55 to be called on the DPV1 master. For detailed information on OB55, 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 OB57 can be found in the *Reference Manual "System Software for S7-300/400: System and Standard Functions*"

Interrupt, watchdog

A watchdog interrupt is generated periodically by the CPU in a configurable time pattern. A corresponding --> OB will be processed.

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

--> Data, temporary

MAC address

Address to differentiate different nodes connected to a common communication medium (here: Industrial Ethernet). The MAC address is an e-address of the safety layer. The physical address is not identical to the network address or the protocol address which is an address of the communications layer.

Master

Masters in possession of the --> Token can send/request data to/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 an --> 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 MPI represents the SIMATIC S7 programming interface. It enables multiple-node operation (PGs, text-based displays, OPs) on one or several PLCs. Every node is identified by its unique address (MPI address).

MPI address

--> MPI

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.

Non-isolated

The reference potential of the control and on-load power circuits for non-isolated I/O is electrically interconnected.

OB

--> Organization blocks

OB priority

The CPU --> operating system distinguishes between different priority classes, e.g. 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

SIMATIC S7 PLCs know the following operating states: STOP, --> START-UP, RUN.

Operating system of 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 parameters 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**, e.g. modification of input delay parameters of a digital signal input module.

PG

--> Programming device

PLC

A PLC in the context of SIMATIC S7 --> is a programmable logic controller.

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. The PLC has a computer structure; it consists of the --> CPU (Central Processing Unit) with memories, I/O modules and internal bus system. The I/O and the programming language are oriented to control engineering needs.

PLC

--> PLC

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.

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 DP

The PLC distributes digital, analog and intelligent modules, and a wide range of field devices to EN 50170, Part 3, e.g. drives or valve blocks, to processes at external locations - across distances of up to 23 km.

The modules and field devices are connected to the programmable controller via the PROFIBUS-DP field bus and addressed in the same way as centralized I/Os.

PROFInet

Standard published by the Profibus User Organization (PNO) to define a cross-vendor communication and engineering model.

PROFInet devices

A PROFInet device contains the PNO-PN master stack V2.0 and must be able to be operated on the Ethernet. A PROFInet device may also have a PROFIBUS connector as a master and a proxy PROFInet device for PROFIBUS devices.

Programming device

Basically speaking, PGs are compact and portable PCs which are suitable for industrial applications. They feature a special hardware and software configuration for operation on SIMATIC PLCs.

RAM

RAM (Random Access Memory) is a semiconductor read/write memory.

RAM

Work memory is a RAM memory in the --> CPU accessed by the processor during user program execution.

Reduction factor

The reduction rate determines the send/receive frequency for --> GD packets on the basis of the CPU cycle.

Reference ground

--> Ground

Reference potential

Voltages of participating circuits are referenced to this potential when they are viewed and/or measured.

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 markers, 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

Runtime error

Errors occurred in the PLC (that is, not in the process itself) during user program execution.

Segment

--> Bus segment

SFB

--> System function block

SFC

--> System function

Signal module

Signal modules (SM) form the interface between the process and the PLC. Input and output modules can be digital (input/output module, digital) or analog I/O modules. (input/output module, analog)

Slave

A slave can only exchange data on --> Master request.

STARTUP

A START-UP routine is executed at the transition from STOP to RUN mode. Can be triggered by the --> mode selector switch or after power on, or by an operator action on the programming device. An S7-300 performs --> a restart.

STEP 7

Programming language for the creation of user programs for SIMATIC S7 PLCs.

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).

System diagnostics

System diagnostics refers to the detection, evaluation and signaling of errors which occur within the PLC, for example, program errors or module errors. System errors can be indicated via LED display 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, as required, 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, as required, 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 (e.g. communication buffers).

System status list

The SSL contains data describing the actual status of an S7300. You can always use this list to obtain an overview of:

- the S7-300 structure
- 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

--> 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 (e.g. start).

Time-of-day interrupt

➔ Interrupt, time-of-day

Token

Bus access rights

Transmission rate

Data transfer rate (in bps)

Varistor

Voltage-dependent resistor

Watchdog interrupt

--> Interrupt, watchdog

Ungrounded

Having no direct electrical connection to ground

User memory

The user memory contains --> code and --> data blocks 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

The SIMATIC system distinguishes between the CPU --> operating system and user programs. The latter are created with --> -->STEP 7 programming software, using optional programming languages (LAD and STL). User programs are stored in code blocks. Data is stored in data blocks.

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