

SIEMENS

SIMATIC

S7-300 Programmable Controller

Hardware and Installation

Manual

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

Edition 10/2001
A5E00105492-01

Safety Guidelines

This manual contains notices intended to ensure personal safety, as well as to protect the products and connected equipment against damage. These notices are highlighted by the symbols shown below and graded according to severity by the following texts:



Danger

indicates that death, severe personal injury or substantial property damage will result if proper precautions are not taken.



Warning

indicates that death, severe personal injury or substantial property damage can result if proper precautions are not taken.



Caution

indicates that minor personal injury can result if proper precautions are not taken.

Caution

indicates that property damage can result if proper precautions are not taken.

Note

draws your attention to particularly important information on the product, handling the product, or to a particular part of the documentation.

Qualified Personnel

Only **qualified personnel** should be allowed to install and work on this 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.

Correct Usage

Note the following:



Warning

This device and its components may only be used for the applications described in the catalog or the 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 safely if it is transported, stored, set up, and installed correctly, and operated and maintained as recommended.

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

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A5E00105492



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Preface

1

Purpose of the Manual

This manual gives you all information you require to configure, mount, wire, network and commission an S7-300 PLC.

Basic knowledge required

Basic requirement for comprehension of the topics in this manual is general knowledge of automation and control engineering.

Scope of the Manual

This manual applies to S7-300 PLCs, assembled with one of the CPUs described in the *CPU Data* Reference Manual.

Approvals

The product series SIMATIC S7-300 is approved by:

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

CE Label

Series SIMATIC S7-300 products are compliant with the following EC Guidelines and safety requirements:

- EC Guideline 73/23/EWE "Low-voltage Guideline"
- EC Guideline 89/336/EEC "EMC Guideline"

C-Tick-Mark
















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

Standards



The SIMATIC S7-300 product series is compliant with the requirements and criteria for IEC 61131-2.

Documentation required

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

<p>Reference manual “CPU Data”</p> <ul style="list-style-type: none">  “CPU Data CPU 312 IFM to 318-2 DP”  “CPU Data CPU 312 C to 314C-2 PtP/DP” 	<p>Operation, functions and technical specifications of the CPU</p>
<p>“Technological Functions” Manual</p> <ul style="list-style-type: none">  Manual  Examples 	<p>Description of the individual technological functions:</p> <ul style="list-style-type: none"> - positioning - counting - point-to-point-link - control <p>The CD contains examples on the technological functions.</p>
<p>Installation manual</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">You are reading this manual</p> <p>→  Manual</p>	<p>Configuration, installation, wiring, networking and commissioning description of the S7-300</p>
<p>Reference manua “module data”</p> <ul style="list-style-type: none">  Manual 	<p>Function description and technical specifications for the signal modules , power supply modules and the interface modules</p>
<p>Operating list</p> <ul style="list-style-type: none">  “CPU 312 IFM, 314 IFM, 313, 315, 315-2 DP, 316-2 DP, 318-2 DP”  “CPUs 312 C bis 314C-2 PtP/DP” 	<p>List of stored intructions of the CPUs and their execution times.</p> <p>List of executable blocks (OBs/SFCs/SFBs) and their execution times .</p>
<p>Getting Started</p> <ul style="list-style-type: none">  “CPU 31xC: positioning with analog output”  “CPU 31xC: positioning with digital outputs”  “CPU 31xC: count”  “CPU 31xC: point-to-point-link”  “CPU 31xC: control”  “CPU 31xC”  “S7 300” 	<p>Using concrete examples, Getting Starteds take you through the individual steps of commissioning up to a functioning application.</p>

In addition to this package, you require the following manuals:

<p>Manual “Integrated function CPU 312 IFM/314 IFM”</p> <p> Manual order number: 6ES7398-8CA00-8BA0</p>	<p>Description of the technological functions of the CPUs 312 IFM/314 IFM.</p>
<p>Reference manual “system software for S7-300/400 system and standard functions”</p> <p> Reference manual Part of the STEP 7 documentation package with the order number: 6ES7810-4CA05-8BR0</p>	<p>Description of the SFCs, SFBs, OBs and CPUs. You can also find the description in the STEP 7 Online Help</p>

Further Support

Please contact your Siemens partner at your local Siemens office if you have any queries about the products described in this manual.

<http://www.ad.siemens.de/partner>

Training Center

We offer corresponding S7-300 PLC courses that can help you to get started.

Please contact your local Training Center or the Central Training Center in Nuremberg, D-90327, Germany

Phone +499 (911) 895-3200..

<http://www.sitrain.com>

SIMATIC documentation on the Internet

Public documentation is found on the Internet URL:

<http://www.ad.siemens.de/support>

Use the quick search of the Knowledge Manager to find your required documentation. For queries and suggestions relating to documentation you can refer to the "Documentation" conference in our Internet Forum.

SIMATIC Customer Support Hotline

World-wide available 24 hours:

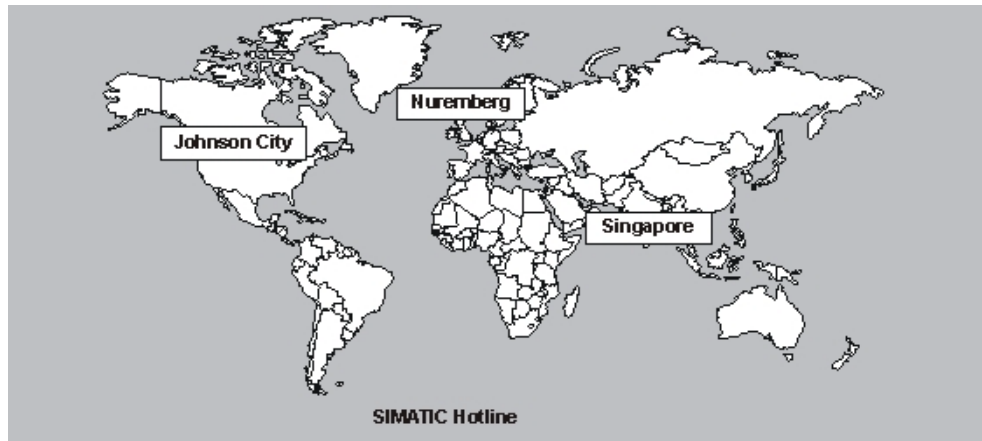


Figure 1-1 SIMATIC Customer Support Hotline

<p>World-wide (Nuremberg) Technical Support (Free Contact) Local time: Mo.-Fr. 7:00 to 17:00 Phone: +49 (180) 5050 222 Fax: +49 (180) 5050 223 E-mail: techsupport@ad.siemens.de GMT: +1:00</p>	<p>World-wide (Nuremberg) Technical Support (charged, only with SIMATIC Card) Local time: Mo.-Fr. 0:00 to 24:00 Phone: +49 (911) 895-7777 Fax: +49 (911) 895-7001 GMT: +1:00</p>	
<p>Europe / Africa (Nuremberg) Authorization Local time: Mo.-Fr. 7:00 to 17:00 Phone: +49 (911) 895-7200 Fax: +49 (911) 895-7201 E-mail: authorization@nbgm.siemens.de GMT: +1:00</p>	<p>America (Johnson City) Technical Support and Authorization Local time: Mo.-Fr. 8:00 to 19:00 Phone: +1 423 262 -2522 Fax: +1 423 262 -2289 E-mail: simatic.hotline@sea.siemens.com GMT: -5:00</p>	<p>Asia / Australia (Singapore) Technical Support and Authorization Local time: Mo.-Fr. 8:30 to 17:30 Phone: +65 740 -7000 Fax: +65 740 -7001 E-mail: simatic.hotline@sea.siemens.com.sg GMT: +8:00</p>
<p>German and English language spoken at SIMATIC Hotlines. Additional languages spoken at the Authorization Hotline are French, Italian and Spanish.</p>		

Service & Support on the Internet

We offer you our complete knowledge base online on the Internet as a supplement to our documentation.

<http://www.ad.siemens.de/support>

There you can find:

- Up-to-date product information (What's new), FAQs (Frequently Asked Questions), Downloads, Tips and Tricks.
- Our newsletter always provides you with the latest information on your products.
- The Knowledge Manager finds the documents you require.
- Users and specialists all over the world share their experience in our Forum.
- You can find your local service partner for Automation & Drives in our Partner Database.
- Information relating to on-site service, repairs, spare parts and lots more is available to you in the "Service" section.

Quick Guide

2


2.1 Quick Guide: selecting and arranging

In this Quick Guide ...

you can find - based on the conditions and requirements for your S7-300 system application - a 'signpost' leading you through the S7-300 documentation.

The place of S7-300 in S7 Technology

Table 2-1 S7-300 in S7 Technology

S7-200	S7-300	S7-400	C7
Fast and versatile Micro-PLC	Fast, high-performance and versatile Compact PLC (CPUs 31xC with integrated functionality)	Fast, high-performance, rugged and versatile Power PLC with high-performance communication capabilities	Compact and compatible Complete PLC
-	Available Documentation 	-	-

Selection and Configuration

Table 2-2 Ambient influence on the PLC

Information on ...	is available in ...
What provisions do I have to make for PLC installation space?	Chapter <i>Configuring</i> ; <i>Mounting dimensions of modules and mounting</i> ; <i>Mounting profile rails</i> , in the <i>installation manual</i>
How do environmental conditions influence the PLC?	<i>Appendix of the Installation Manual</i>

Table 2-3 Potential isolation

Information on ...	is available in ...
Which modules can I use if it is required to isolate the potential of specific sensors/actuators?	Chapter <i>Configuring; Electrical assembly, Protective measures and Grounding</i> , in the <i>Installation Manual</i> Reference Manual <i>Module Specifications</i>
When is it required to isolate the potential of specific modules? How do I wire that?	Chapter <i>Configuring; Electrical assembly, Protective measures and Grounding</i> , in the <i>Installation Manual</i> Chapter <i>Wiring</i> , in the <i>Installation Manual</i>
When is it required to isolate the potential of specific stations? How do I wire that?	Chapter <i>Configuring; Configuring subnets</i> , in the <i>Installation Manual</i> Chapter <i>Wiring</i> , in the <i>Installation Manual</i>

Table 2-4 Communication between sensors/actuators and the PLC

Information on ...	is available in ...
Which module is suitable for my sensor/actuator?	for CPU: Reference Manual <i>CPU Data</i> for signal modules: Reference Manual <i>Module Data</i>
How many sensors/actuators can I connect to the module?	for CPU: Reference Manual <i>CPU Data</i> for signal modules: Reference Manual <i>Module Data</i>
How do I wire the sensors/actuators to the PLC using front connectors?	Chapter <i>Wiring; Wiring front connectors</i> , in the <i>Installation Manual</i>
When do I require expansion modules (EG), and how are they connected?	Chapter <i>Configuring, optional expansions and networking</i> , in the <i>Installation Manual</i>
How do I mount modules on module racks/profile rails?	Chapter <i>Mounting; Mounting modules on profile rails</i> , in the <i>Installation Manual</i>

Table 2-5 Application of central and distributed I/O

Information on ...	is available in ...
Which range of modules do I want to use?	for central I/O / expansion modules (EGs): Reference Manual <i>Module data</i> for distributed I/O / PROFIBUS-DP: Manual of the respective peripheral device, e.g. <i>Manual ET 200B</i>

Table 2-6 Configuration consisting of the Central Unit (CU) and Expansion Modules (EMs)

Information on ...	is available in ...
Which mounting racks / profile rails are suited best for my application?	Chapter <i>Configuring</i> , in the <i>Installation Manual</i>
Which Interface modules (IM) do I need for connecting EMs to the CPU?	Chapter <i>Configuring, Arranging modules on multiple module racks</i> , in the <i>Installation Manual</i>
How do I configure the power supply (PS) performance?	Chapter <i>Configuring</i> , in the <i>Installation Manual</i>

Table 2-7 CPU performance

Information on ...	is available in ...
Which is the most adequate memory setup for my application?	Reference manual <i>CPU Data</i>
How do I install and remove Micro Memory Cards?	Chapter <i>Commissioning; Removing/Installing Micro Memory Cards, in the Installation Manual</i>
Which CPU meets my requirements on performance ?	<i>Instruction List</i> ; Reference Manual <i>CPU Data</i>
How long are CPU response and processing times?	Reference manual <i>CPU Data</i>
Which technological functions are implemented?	Manual <i>Technological functions</i>
How can I use these functions?	Manual <i>Technological functions</i>

Table 2-8 Communications

Information on ...	is available in ...
Which principles do I have to take into account?	Manual <i>Communication with SIMATIC</i>
Which options and resources does the CPU offer?	Reference manual <i>CPU Data</i>
How do I optimize communication with the help of communication processors (CPs)?	the respective device Manual
Which communication network is most suitable for my application?	Chapter <i>Configuring; Configuring subnets, in the Installation Manual</i> Manual <i>Communication with SIMATIC</i>
How do I network the specific modules?	Chapter <i>Configuring and wiring, in the Installation Manual</i>

Table 2-9 Software

Information on ...	is available in ...
Which software do I require for my S7-300 system?	Chapter <i>Technical data</i> ; Reference Manual <i>CPU data</i>

Table 2-10 Supplementary features

Information on ...	is available in ...
How do I implement operator control and monitoring? (Human Machine Interface)	for text displays: the respective device manual for operator panels: the respective device manual for WinCC: the respective device manual
How can I integrate process control modules?	for PCS 7: the respective device manual
What are the options of redundant and fail-safe systems?	Manual <i>S7-400H - Redundant systems</i> ; Manual <i>Fail-safe systems</i>

Cross-reference

Please note that you can also download respective current manuals from our public Internet URL. Details are found in the *Preface*.

2.2 Quick Guide: Installation

In this Quick Guide

In this Quick Guide we show you the basic procedures for configuring, mounting, wiring and networking your SIMATIC S7 system, modules and module racks.

How to successfully install a SIMATIC S7 system

Install an S7 system as follows:

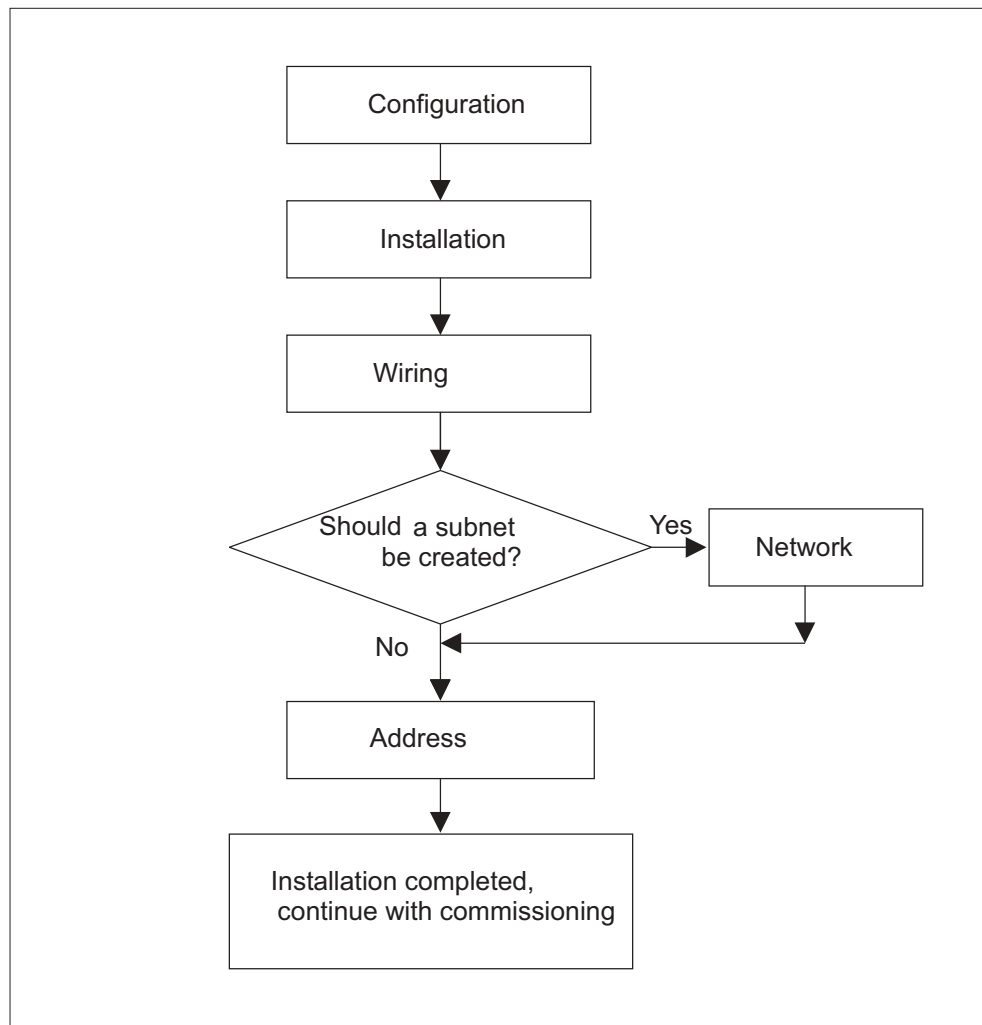


Figure 2-1 Installing a SIMATIC S7 system

Basic rules

In view of the many and versatile applications of an S7 system, this chapter can only cover the basics on its electrical configuration. You must keep at least to these basic rules if you want your S7 system to operate free of trouble.

Changing the configuration of an existing SIMATIC S7 system

Proceed as described above if you want to change an existing system configuration.

When retrofitting signal modules, also proceed in a configuring - mounting - wiring - etc. sequence. In this case, however, you only have to consider information that is relevant to the new module.

Cross-reference

Also note the description of specific module in the manual: *SIMATIC S7-300 PLCs, Module Data Reference Manual*.

Product overview

3

3.1 Product overview

In this chapter

we shall introduce the major components for your S7-300 configuration.

S7-300 Configuration

An S7-300 consists of the following modules:

- Power supply (PS)
- CPU
- Signal modules (SM)
- Function modules (FM)
- Communication processors (CP)

Multiple S7-300 CPUs can communicate with each other and with SIMATIC S7 PLCs across PROFIBUS cable.

You require a programming device (PG) to program the S7-300 PLC. Interconnect the PG and the CPU with a PG cable.

The figure below shows you a possible configuration, consisting of two S7-300 PLCs.

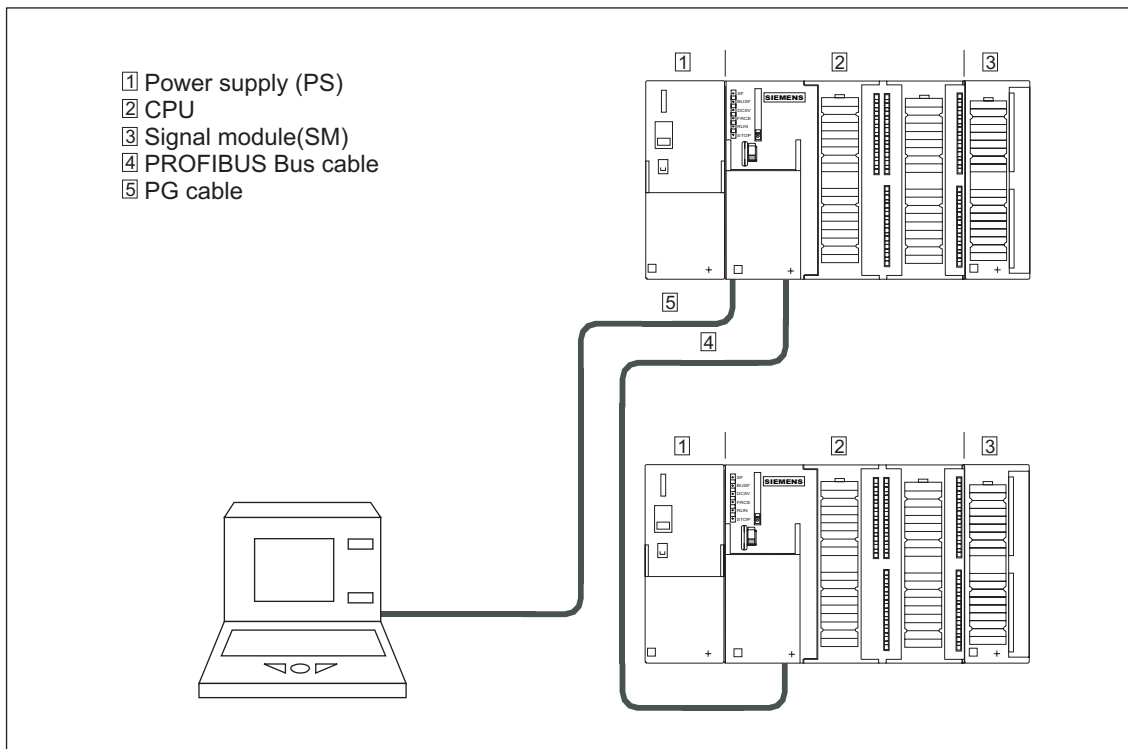


Figure 3-1 S7-300 modules

S7-300 PLCs can be installed horizontally or vertically. The following ambient air temperatures are permissible:

- horizontal installation: from 0 °C to 60 °C
- vertical installation: from 0 °C to 40 °C

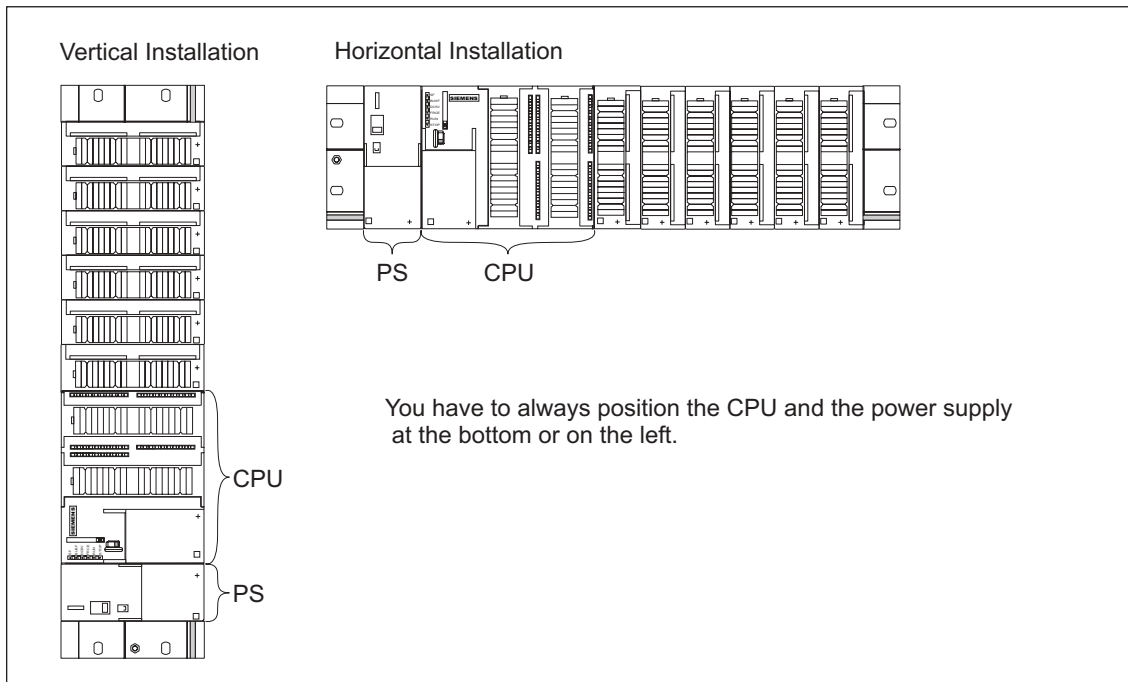
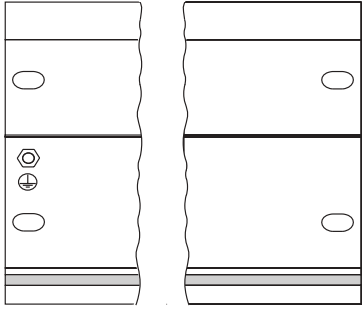
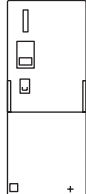


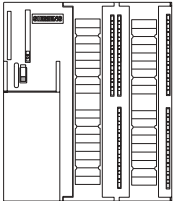
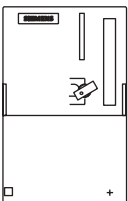
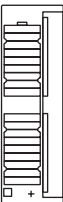
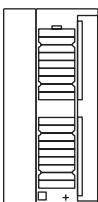
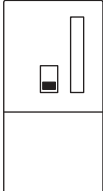
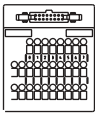
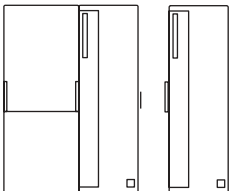
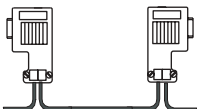
Figure 3-2 Horizontal and vertical installation of an S7-300

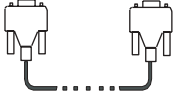

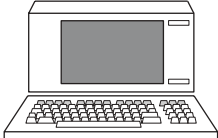
S7-300 modules

You can choose from a number of modules to install and commission an S7-300 PLCs. The table below shows the major modules and their function.

Table 3-1 S7-300 modules

Components	Function	Illustration
Profile rail Accessory: Shielding element	... is the module rack for an S7-300	
Power supply (PS)	... converts mains voltage (120/230 VAC) to 24 VDC operating voltage for the supply of the S7-300 and 24 VDC load circuits	

Components	Function	Illustration
<p>CPU</p> <p>Accessory: Front connectors (for CPUs with integrated I/O)</p>	<p>... executes the user program; 5-V supply for the S7-300 backplane bus; communicates with other MPI network nodes via MPI interface.</p> <p>Additional properties of specific CPUs:</p> <ul style="list-style-type: none"> • DP master in a PROFIBUS subnet • DP slave in a PROFIBUS subnet • Technological functions • Point-to-point communication 	 
<p>Signal modules (SM)</p> <p>(Digital input modules, digital output modules, digital I/O modules, analog input modules, analog output modules, analog I/O modules)</p> <p>Accessory: Front connectors</p>	<p>... adapt different process signal levels to the S7-300</p>	
<p>Function modules (FM)</p> <p>Accessory: Front connectors</p>	<p>... for time-critical process signal processing tasks with high memory load, e.g. positioning or controlling</p>	
<p>Communication processor (CP).</p> <p>Accessory: Connecting cable</p>	<p>... relieves the CPU of communication load, e.g. CP 342-5 DP connection to PROFIBUS-DP</p>	
<p>SIMATIC TOP connect</p> <p>Accessory: Front connector module with ribbon cable terminals</p>	<p>... for wiring of digital modules</p>	
<p>Interface module (IM)</p> <p>Accessory: Connecting cable</p>	<p>... interconnects the individual tiers of an S7-300</p>	
<p>PROFIBUS cable with bus connector</p>	<p>... interconnects nodes on an MPI or PROFIBUS subnet</p>	

Components	Function	Illustration
PG cable	... interconnects CPU and PG/PC	
RS485 Repeater	... for the amplification of signals in an MPI or PROFIBUS subnet and for interconnecting segments of an MPI or PROFIBUS subnet	
Programming device (PG) or PC with the STEP 7 software package	... for configuring, programming and testing the S7-300	

Configuring

4

4.1 In this Chapter

In this chapter

we show you,

- how to configure your mechanical assembly,
- how to configure your electrical assembly,
- what you need to consider for networking.

Manuals for further details

For information on network topics we recommend the Manual *Communication with SIMATIC*. This manual contains important notes on networking for SIMATIC professionals as well as the basics for newcomers.

In the appendix you can find ...

- Information on ambient conditions (Appendix: *Ambient Conditions*)
- Information on special protective measures (Appendix: *Electrical protective measures*); e.g. protection against inductive surge voltage, lightning, etc.

4.2 Basics



Warning

Open components

S7-300 modules are open components. That means, you must always install the S7-300 in cubicles, cabinets or electrical operating rooms accessible only with the help of a key or tool. Only trained or authorized personnel is allowed access to these cubicles, cabinets or electrical operating rooms.



Caution

Depending on the field of application, 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 guidelines. This Chapter and the Appendix *General rules and regulations on S7-300 operation* provides an overview of the most important rules you need to take into consideration for the integration of S7-300 in a plant or system.

CPU and expansion device (ED)

An S7-300 PLC consists of a central unit (CU) and – if required – one or multiple expansion devices (EDs).

The module rack containing the CPU is referred to as the central unit (CU). Module racks equipped with modules form the expansion devices (EDs) connected to the system's CU.

When should I use expansion devices?

You can use EDs if the number of CU slots is insufficient for your application.

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

Module racks

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

Horizontal and vertical installation

You can optionally install your S7-300 in horizontal or vertical position.

CPU and power supply must always be installed to the left side or at the bottom.

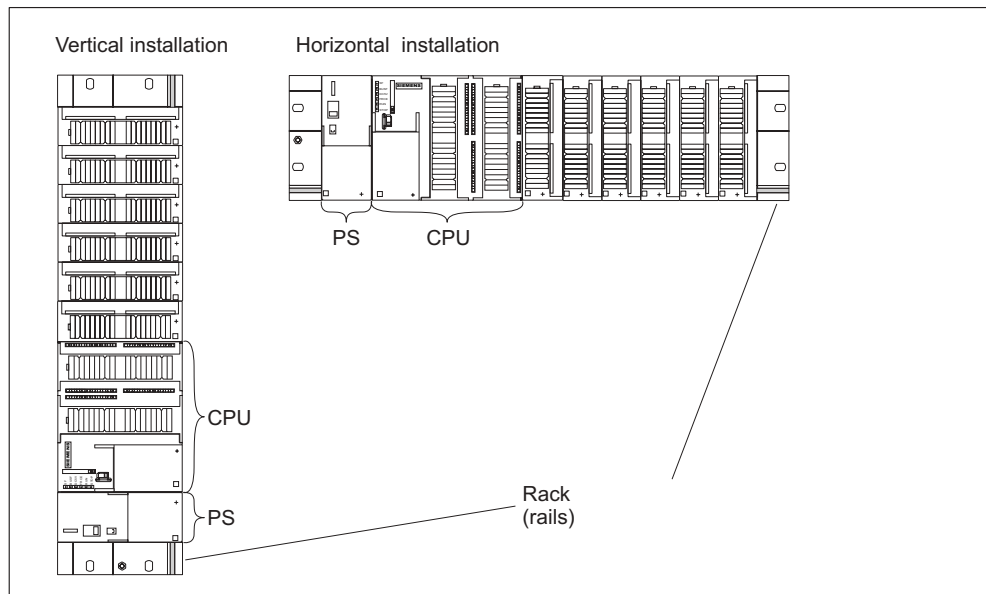


Figure 4-1 Horizontal and vertical installation

Further information on ...

- the selection and dimensions of profile rails (module racks) is found in Chapter *Module dimensions*.
- connections and interfaces (IMs) are found in Chapter *Arranging modules on multiple module racks*.
- the most important rules on S7-300 operation are found in the Appendix *General rules and regulations on S7-300 operation*.

4.3 Component dimensions

Length of the profile rails

The following profile rails are available.

Table 4-1 Profile rails - Overview

Profile rail length	usable length for modules	Order No.
160 mm	120 mm	ES7 390-1AB60-0AA0
482.6 mm	450 mm	ES7 390-1AE80-0AA0
530 mm	480 mm	ES7 390-1AF30-0AA0
830 mm	780 mm	ES7 390-1AJ30-0AA0
2,000 mm	cut to length if required	ES7 390-1BC00-0AA0

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

Installation 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 312C, 312 IFM, 313, 314, 315, 315-2 DP, 316-2 DP	80 mm
CPU 313C, 313C-2 DP, 313C-2 PtP, 314C, 314C-2 DP, 314C-2 PtP	120 mm
CPU 314 IFM, 318-2 DP	160 mm
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 terminal module**: 185 mm
- Maximum mounting depth: 130 mm
- Maximum mounting depth of CPU 31xC, including the plugged DP connector with chamfered cable guide: 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 respective manuals.

Shielding terminal module

If you use a shielding terminal module, the dimension specifications apply from the lower edge of the module.

The direct contact of the shielding terminal module to the profile rail makes it easy for you to connect all shielded cables of S7 modules to ground.

- Width of the shielding terminal module: 80 mm
- Mountable shielding terminals per shielding terminal module: 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

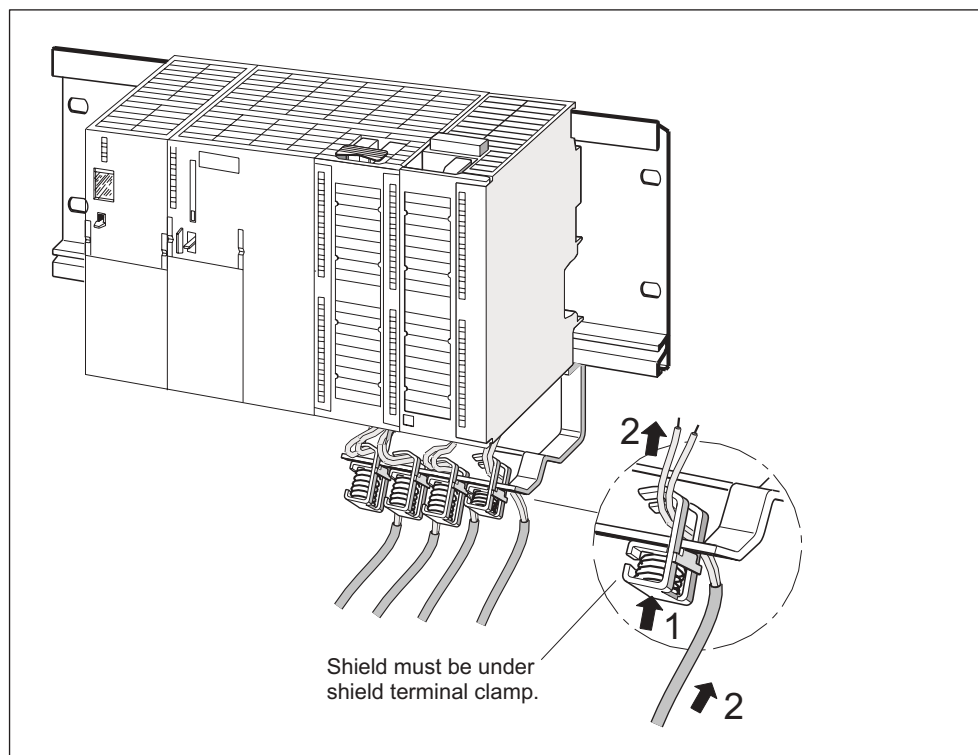


Figure 4-2 Shielding terminal module

Rules: Clearance

You must maintain the clearance as shown in the figure in order to provide module installation space and to ensure elimination of heat generated by the modules.

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

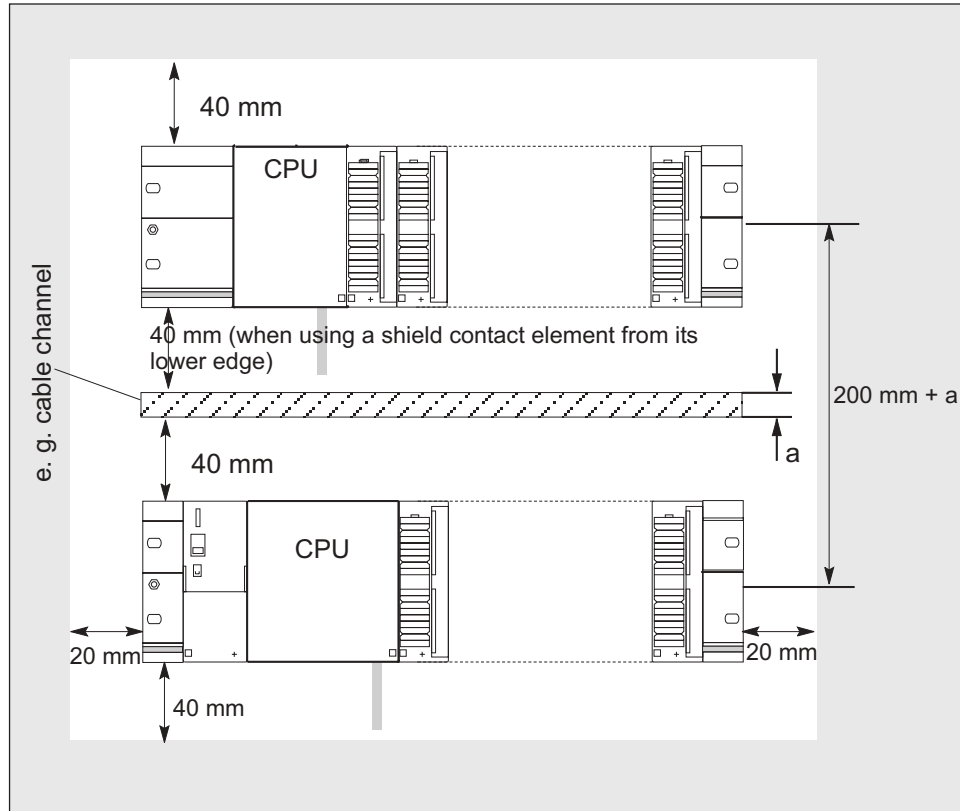


Figure 4-3 Clearance

4.4 Arranging modules on a single module rack

One or multiple module racks?

The answer to this query is based on the nature of your application. Reasons for using a single module rack could be:

- Compact, space-saving module application
- Central module application
- Low volume of signals to be processed

Possible reasons for a distribution to multiple module racks:

- High volume of signals to be processed
- No more slots available

Tip: If you choose installation on a single module rack, insert a dummy module to the right side of the CPU (Order No.: 6ES7 370-0AA01-0AA0). This gives you the option of inserting a second module 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 module 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 side of the CPU.
- The total current load on the S7 backplane bus of all modules mounted on a single module rack must not exceed
 - 1.2 A (except with CPU 312C or CPU 312 IFM)
 - 0.8 A with CPU 312C or CPU 312 IFM

The power consumption of modules ...

can be found in their technical data, e.g. *S7-300 Module Data Reference Manual*.

Example:

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

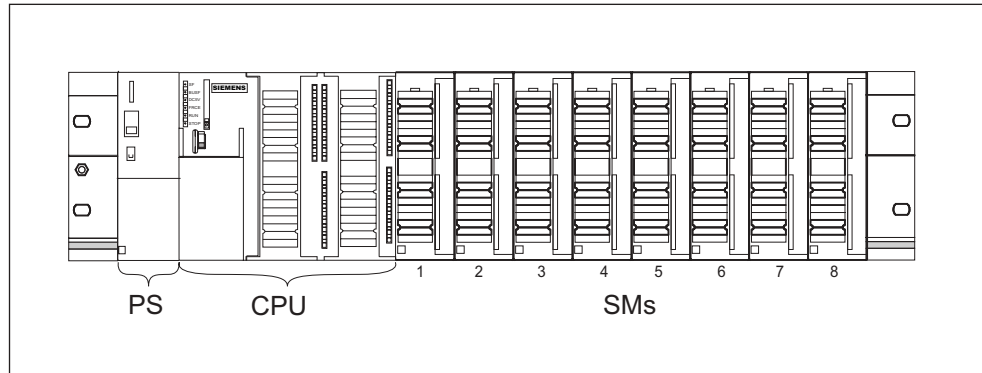


Figure 4-4 Module rack with eight signal modules

4.5 Arranging modules on multiple module racks

Exceptions

CPU 312 IFM, 312C and 313 can only be used for a **single-rack** module assemblies!

Prerequisite: Interface modules

Interface modules (IM) connecting the S7-300 backplane bus to the next module rack are required for assemblies on multiple module racks. The CPU is always located on rack 0.

Table 4-4 Interface modules - Overview

Characteristics	Dual- and multiple-line assembly	Low-cost 2-line assembly
Send IM in module rack 0	IM 360 Order No.: 6ES7 360-3AA01-0AA0	IM 365 Order No.: 6ES7 365-0AB00-0AA0
Receive IM in module rack 1 to 3	IM 361 Order No.: 6ES7 361-3CA01-0AA0	IM 365 (hardwired to send IM 365)
Maximum number of expansion devices	3	1
Length of the 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 (hardwired)
Remarks	-	Module rack 1 can only receive signal modules; total current load is limited to 1.2 A, whereby the maximum for module rack 1 is 0.8 A These restrictions do not apply for operation with interface modules IM 360/IM 361

Rules: Arranging modules on multiple module racks

The following rules apply to the arrangement of modules on multiple racks:

- The interface module is always installed in slot 3, to the left of the first signal module.
- No more than 8 modules (SM, FM, CP) are permitted per rack. These modules are always located to the right side of the interface modules.
- The number of modules (SM, FM, CP) is limited by the permissible current load on the S7-300 backplane bus. Total current consumption per line must not exceed 1.2 A (see Technical data of modules).

Rules: Interference-proof installation of the connection

Special shielding and grounding measures are not required if you interconnect the CU and ED using suitable interface modules (Send IM and Receive IM). However, make sure that

- all module racks are interconnected with low impedance,
- the module racks of a grounded assembly are grounded in a star pattern,
- the contact springs of the module racks are clean and not bent in order to ensure interference current diversion.

Example of a full assembly

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



Figure 4-5 Full assembly

4.6 Selection and installation of cabinets

Necessity of cabinets

You can install the S7-300 in a cabinet for operation in larger plants or if ambient interference or contamination is to be expected.

For compliance with UL/CSA standard it is required, amongst other things, to install components in cabinets.

Selecting and dimensioning of cabinets

Note the following criteria when selecting and dimensioning cabinets:

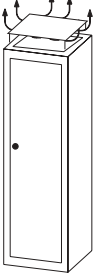
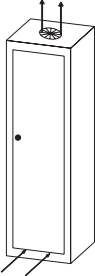
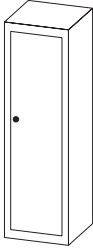

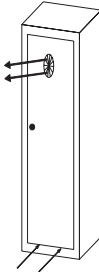
- Ambient conditions at the cabinet's place of installation
- The specified mounting clearance for module racks (profile rails)
- Total power loss of all components in the cabinet

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

Important 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
				

Open cabinets		Closed cabinets		
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: <ul style="list-style-type: none"> • 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

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.

Details on power dissipation ...

is found in the Siemens catalogs NV21 and ET1.

Cabinet dimensions

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

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



Warning

Modules are liable to get damaged if exposed to inadmissible ambient temperatures.

Permissible ambient temperatures ...

are found in the Appendix *Ambient Conditions*.

4.7 Sample application: Selecting a cabinet

Introduction

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

Installation

The following device configuration should be installed in a cabinet:

- 1 central device 150 W
- 2 expansion devices, each with 150 W
- 1 load power supply unit, 200 W under full load

This results in a total power loss of 650 W.

Power loss dissipated

The diagram in the figure below shows guide values for the permissible ambient air 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 module racks (profile rails).

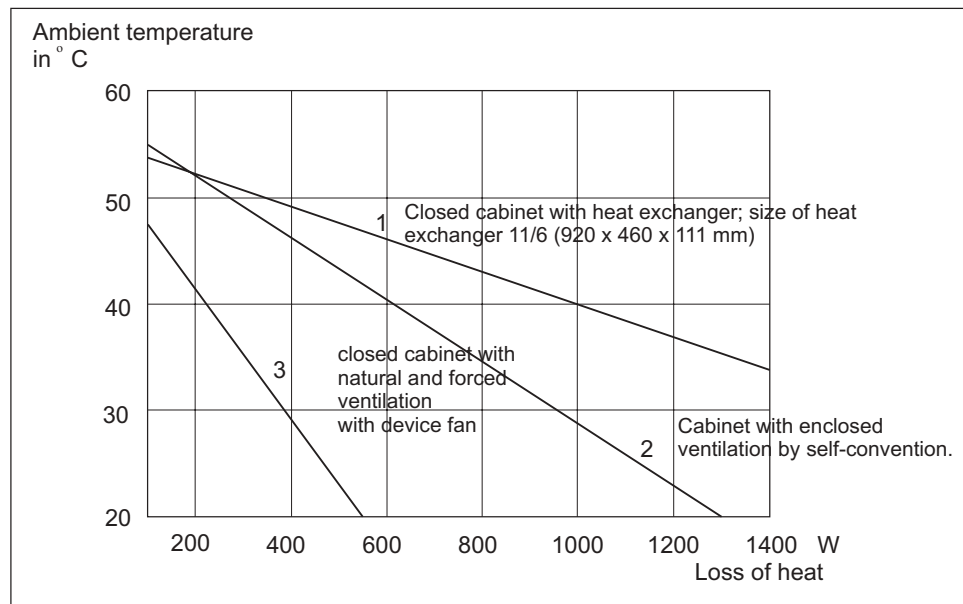


Figure 4-6 Power loss dissipated

Result:

The table below shows the ambient air temperatures at a total power loss of 650 W, as a result of the figure above:

Table 4-6 Cabinet selection

Cabinet design	Maximum permissible ambient temperature
Closed, with natural convection and forced convection (curve 3)	Operation not possible
Open, with enclosed ventilation (curve 2)	approx. 38 °C
Closed, with heat exchanger (curve 1)	approx. 45 °C

For a vertical installation of the S7-300 you can choose between the following cabinet types:

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

4.8 Electrical assembly, protective measures and grounding

4.8.1 Grounding conception and overall structure

Introduction

Below you can find information on the overall structure of an S7-300 operated on a grounded power supply (TN-S network). The following aspects are covered:

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

In view of the many and versatile S7-300 applications, this chapter can only describe the basic rules on its electrical configuration. You must observe at least these basic rules if you want your S7-300 to operate free of trouble.

Definition: Grounded power supply (PEN)

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.

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: <ul style="list-style-type: none"> • 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	Galvanic isolation by transformer mandatory

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

Further information on protective measures ...

e.g. EMC/lightning protection is found in the Appendix.

4.8.2 S7-300 installation with grounded reference potential

Introduction

In an S7-300 configuration with grounded reference potential occurring interference current is dissipated to the ground conductor/ to ground. A configuration with grounded reference potential is possible with following CPUs:

- CPU 312 IFM and CPUs 31xC
(internally hardwired)
- CPU 313, 314, 314 IFM, 315, 315-2 DP, 316-2 DP, 318-2 DP
(bridged terminals M and functional ground)

Connection block diagram

The figure below shows an S7-300 assembly with CPU 313, 314, 314 IFM, 315, 315-2 DP, 316-2 DP, 318-2 DP and grounded reference potential. If you want to ground reference potential, you must not remove the bridge on the CPU between the M terminal and functional ground.

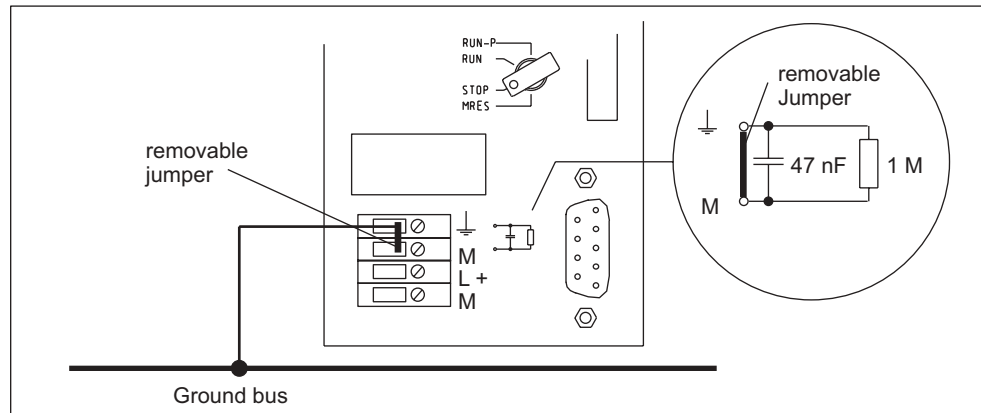


Figure 4-7 S7-300 configuration with grounded reference potential

4.8.3 S7-300 assembly with floating reference potential (not CPU 312 IFM and CPU 31xC)

Introduction

In an S7-300 installation with floating reference potential, occurring interference current is dissipated to the ground conductor/ to ground via an RC combination integrated in the CPU. A configuration with grounded reference potential is possible with following CPUs:

CPU 313, 314, 314 IFM, 315, 315-2 DP, 316-2 DP, 318-2 DP.

Application

In larger plants it might be required to install the S7-300 with floating reference potential because of short-circuit to ground monitoring. This is the case, for example, in chemical industry and power stations.

Connection block diagram

The figure below shows an S7-300 assembly with CPU 313, 314, 314 IFM, 315, 315-2 DP, 316-2 DP, 318-2 DP and floating reference potential. If you do not want to ground reference potential, remove the jumper on the CPU between the M terminal and functional ground. If the jumper is not installed, the reference potential of the S7-300 is connected internally to the protective conductor over an RC network and the profile rail. This discharges radio-frequency interference current and avoids static charge.

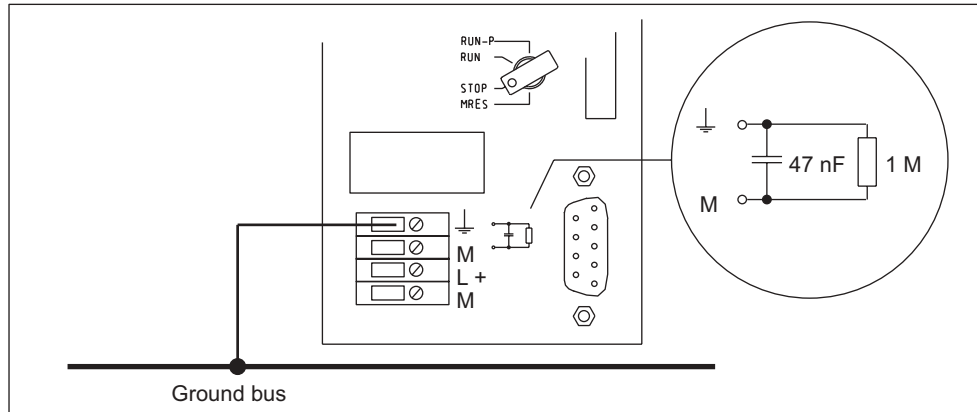


Figure 4-8 S7-300 configuration with floating reference potential

Note

Floating potential installation of an S7-300 with CPU 312 IFM or CPU 31xC is not possible.

4.8.4 Isolated or non-isolated modules?

Isolated modules

In configurations with isolated modules, the reference potentials of the control circuit (M_{internal}) and load circuit (M_{external}) are electrically isolated (see Figure).

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 conception

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

Example:

The figure below shows a sample configuration: One CPU 31xC or 312 IFM with isolated modules.

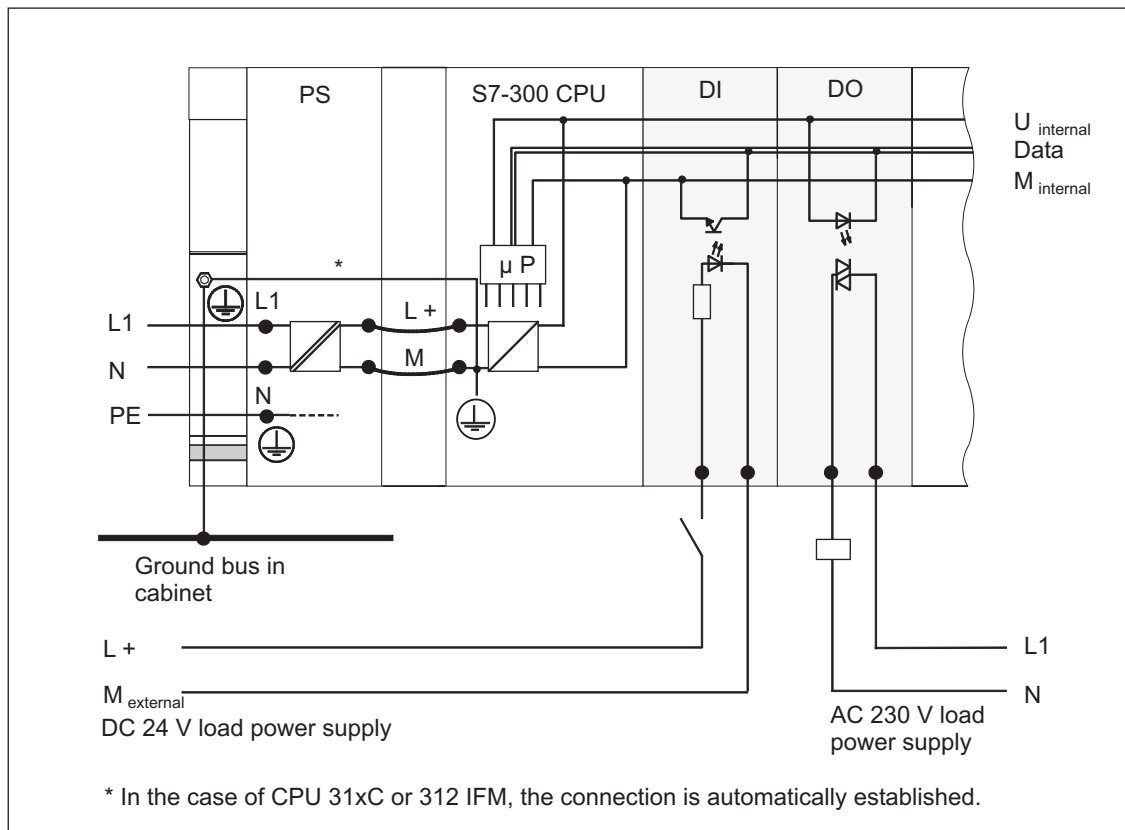


Figure 4-9 Configuration with isolated modules

Non-isolated modules

In configurations with non-isolated modules, the reference potentials of the control circuit (M_{internal}) and load circuit (M_{external}) are not electrically isolated (see the figure below).

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.

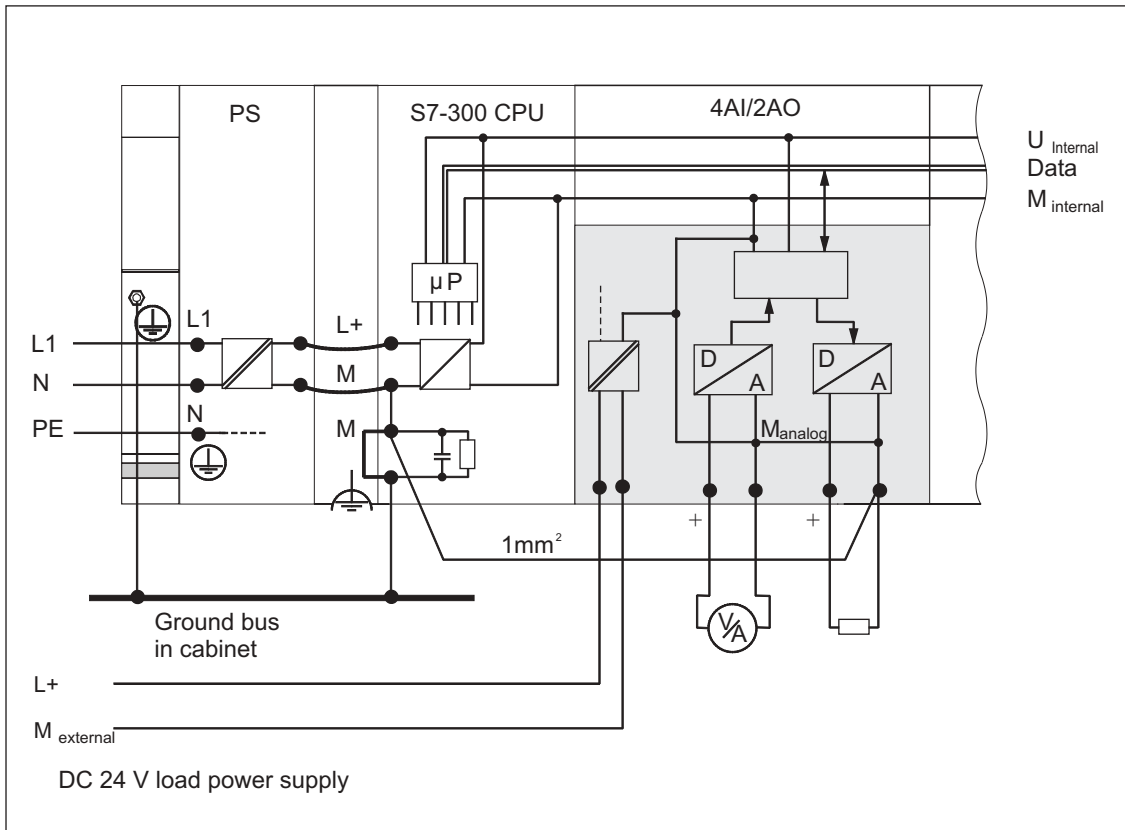


Figure 4-10 Configuration with non-isolated modules

4.8.5 Grounding

Bonding

Low-resistance connections to ground reduce the risk of electric shock in case of 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, as well as 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
Module rack / profile rail	Connection to central ground with cable of minimum cross-section of 10 mm ² , if the profile rails are not installed in the cabinet and not interconnected with larger metallic parts.
Module	None
I/O Device	Grounding via Schuko plug
Sensors and actuators	Grounding in accordance with regulations applying to the system

Rule: Ground the 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 conductor,
- if analog signals (some mA or μ A) are transmitted,
- or if foil shielding is used (static shielding).

Note

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

Caution



Always avoid the flow of operating current to ground.

Details on cable shielding and equipotential bonding ...

are found in the Appendix under the same topic.

Rule: Ground the load circuits

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

Tip:

If you want to localize a short 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).

This tip does not apply to CPUs 31xC and 312 IFM, because these cannot be operated ungrounded.

Connecting the reference potential of the load voltage

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	Remarks
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 operation of CPU31xC and 312 IFM is not possible

4.8.6 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.

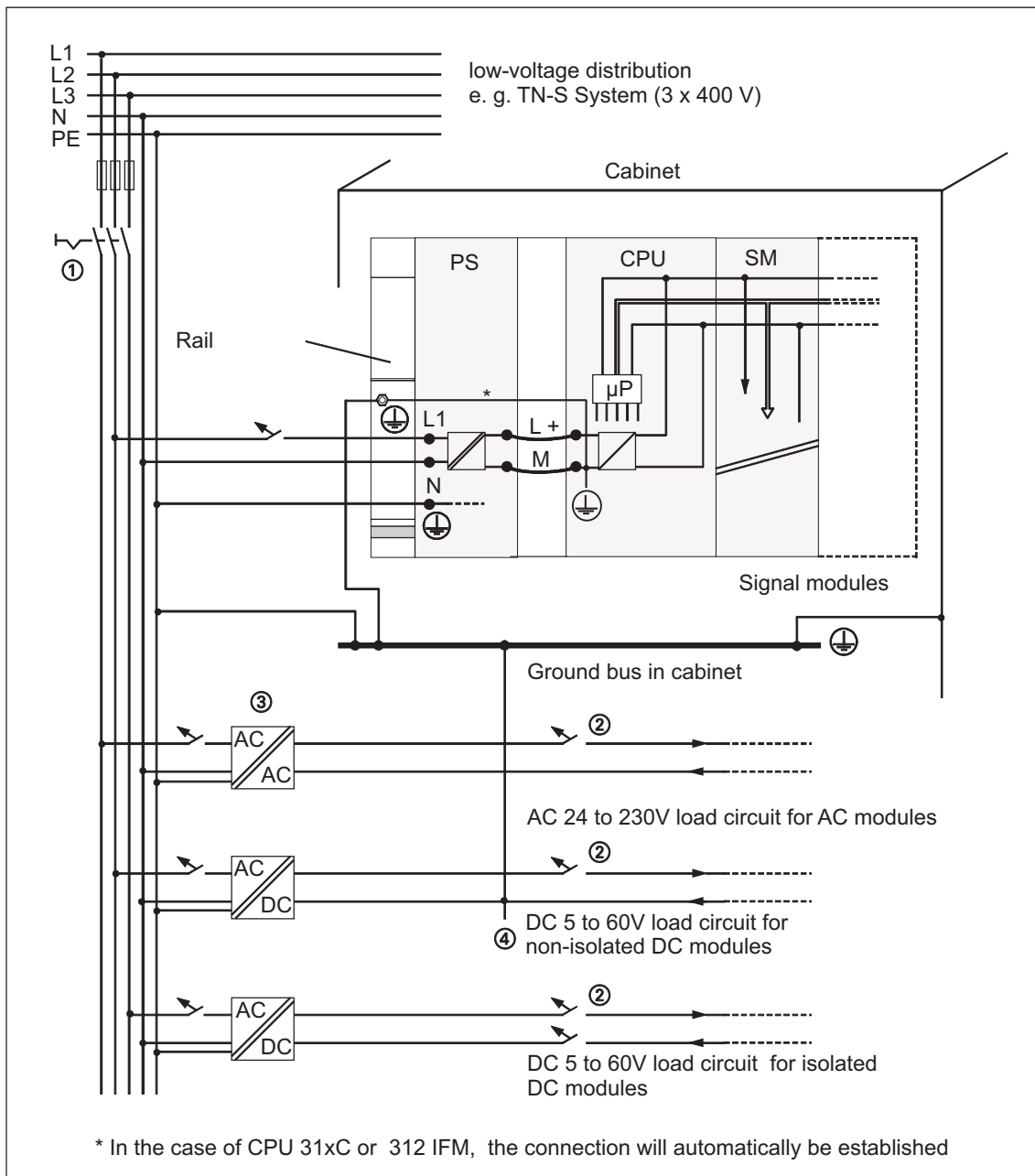


Figure 4-11 Grounding conception S7-300 with CPU 31xC

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.

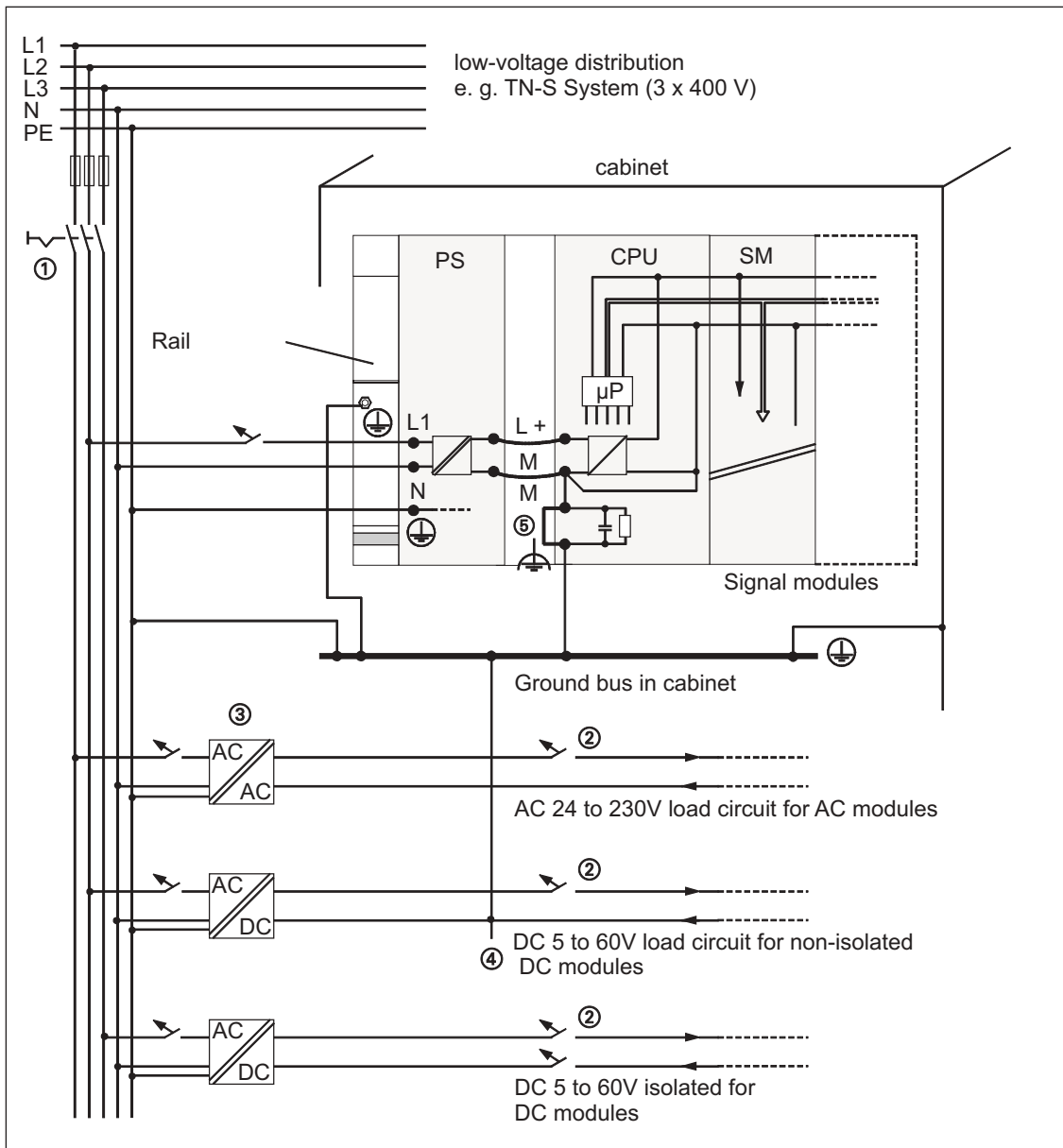


Figure 4-12 Grounding conception S7-300 (not with CPU 31xC)

4.9 Selecting the load power supply unit

Load power supply unit

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

Characteristics

Below we have listed the properties of load power supply units required in specific cases of application for the selection of load power supply units.

Table 4-10 Characteristics of load power supplies

Characteristics of the load power supply	Mandatory for ...	Remarks
Protective separation	Modules requiring voltage supplies of ≤ 60 VDC or ≤ 25 VAC. 24 VDC load circuits	These characteristics apply to Siemens power supplies of the series PS 307 and to SITOP power (series 6EP1).
Output voltage tolerances: 20.4 V to 28.8 V 40.8 V to 57.6 V 51 V to 72 V	24 VDC load circuits 48 VDC load circuits 60 VDC load circuits	-

Requirements

The DC load power supply must meet following requirements:

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.

How to determine load current

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

In case of 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 unit from PS 307

The figure below shows the overall S7-300 configuration (load power supply unit and grounding conception), 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 displayed does not correspond with the physical arrangement; it was merely selected to give you a clear overview.

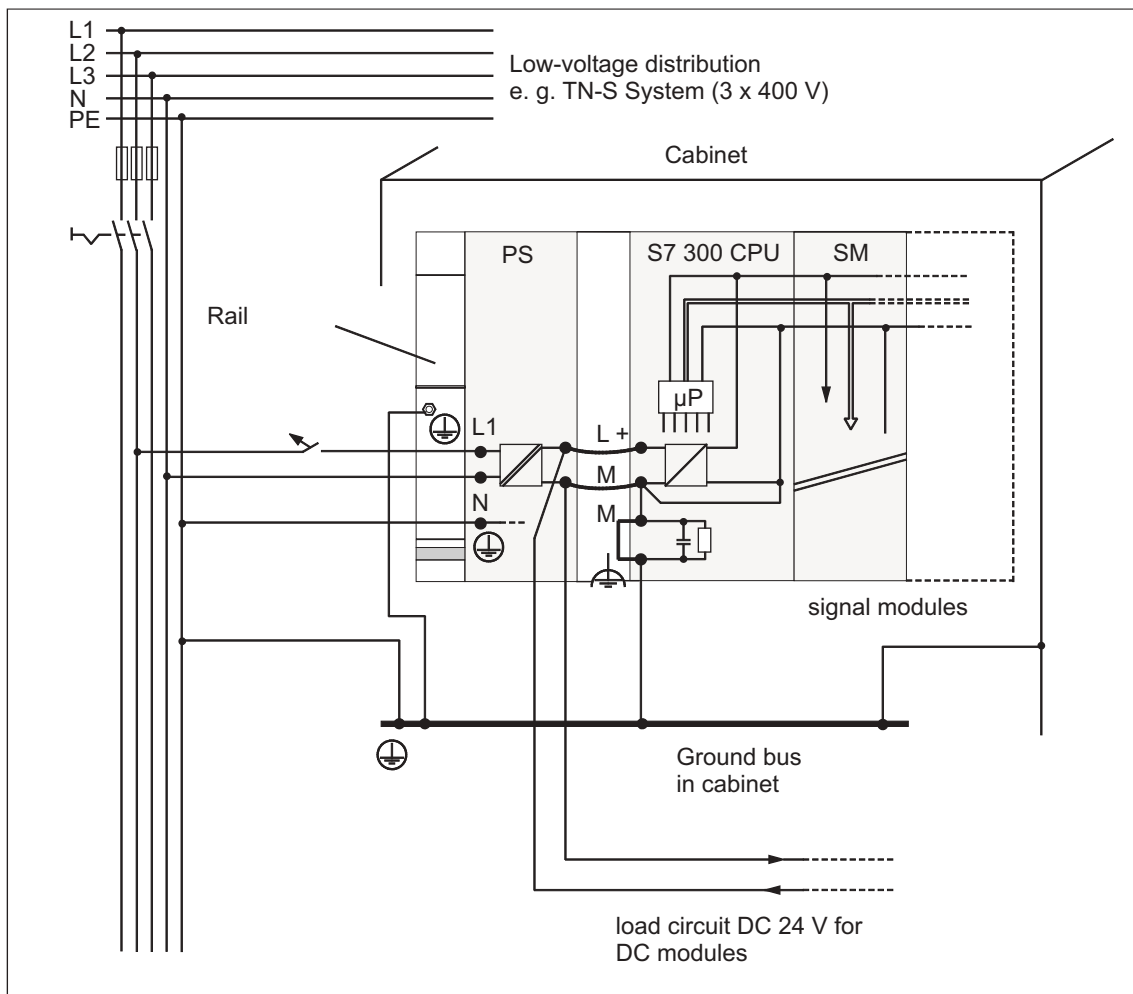


Figure 4-13 Example: S7-300 with load power supply from PS 307

4.10 Configuring a subnet

4.10.1 Expansion and networking options

Subnets

SIMATIC offers the following subnets, according to different automation levels (process, cell, field and actuator/sensor level):

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

Multi Point Interface (MPI)

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

All S7-300 CPUs are equipped with this interface.

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.

PROFIBUS

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

PROFIBUS is available in two versions:

1. PROFIBUS-DP fieldbus for fast cyclic data exchange, and PROFIBUS-PA for the intrinsically safe area.
2. The cell level as PROFIBUS (FDL or PROFIBUS-FMS) for fast data exchange with communication partners equipped with equal rights.

CPUs 31xC with suffix "DP" are equipped with a 2nd interface, namely a PROFIBUS-DP interface.

However, you can also implement PROFIBUS-DP and PROFIBUS-FMS with communication processors (CP).

Point-to-point communication (PtP)

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

For this type of communication you require PtP communication processors (CP).

CPUs 31xC with suffix "PtP" are equipped with a 2nd interface, namely a PtP interface.

Industrial Ethernet

Industrial Ethernet in an open multivendor communication system represents the SIMATIC network on process and cell level. Industrial Ethernet is suitable for fast and high-volume data exchange and offers offsite networking options via gateway. With S7-300 CPUs, you can implement Industrial Ethernet connections only with the help of communication processors.

Actuator/Sensor Interface (ASI)

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.

Same configuration for MPI and PROFIBUS-DP

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.

For reference literature ...

we especially recommend the manual *Communication with SIMATIC*.

4.10.2 Basics

MPI, PROFIBUS-DP, PtP

Since these subnets are the most commonly used for S7-300 CPUs, we shall take a closer look at them.

Declaration: Device = Node

In the following, all networked devices 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 permissible line length, depending on the transmission rate.

Transmission rate

These maximum transmission rates are possible:

- MPI
 - 12 Mbps with CPU 318-2 DP
 - 187.5 Kbps with all other CPUs
- PROFIBUS-DP: 12 Mbps
- PtP:
 - Half duplex: 38.4 Kbps
 - Full duplex: 19.2 Kbps

Number of nodes

Maximum possible number of nodes per subnet:

Table 4-11 Subnet nodes

Parameter	MPI	PROFIBUS-DP	PtP
Number	127	126 ¹⁾	2
Addresses	0 to 126	0 to 125	-
Remarks	Default: 32 addresses Reserved are: <ul style="list-style-type: none"> • address 0 for PG • address 1 for OP 	of those: <ul style="list-style-type: none"> • 1 Master (reserved) • 1 PG connection (address 0 reserved) • 124 slaves or other masters 	-

1) Note 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 4-12 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 MPI/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 \geq 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 4-13 MPI addresses of CPs/FMs in an S7-300

Options	Example:		
<p>Example:</p> <p>An S7-300 CPU and 2 CPs in one unit.</p> <p>You have two options for assigning MPI addresses of CPs/FMs installed in one unit:</p>			
	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 CP MPI addresses in your configuration according to the following pattern: MPI address CPU; MPI address +1; MPI address +2. (Default)	MPI address	MPI address +1	MPI address +2

Options	Example:
Special features: CPU 318-2 DP	This CPU uses only one MPI address, including the CPs connected.

Recommendations for the MPI address n

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.

Recommended MPI address n

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 optical waveguide?

Use optical waveguides instead of copper conductors if you want your fieldbus to cover greater distances regardless of the transmission rate and be insensitive to external noise fields.

Equipotential bonding

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.

Also note ...

the section referring to communication in the respective CPU manual.

4.10.3 Interfaces

MPI interface

MPI (Multi Point Interface) represents the CPU's interface to the PG/OP or for MPI subnet communication. Every CPU is equipped with an RS485 **MPI interface**.

The typical (default) transmission rate is 187.5 Kbps. For S7-200 communication you must set 19.2 Kbps. Other transmission rates are not possible.

The CPU automatically broadcasts its bus parameter configuration (e.g. transmission rate) via MPI interface. This means that a programming device, for example, can automatically "hook up" to an MPI subnet.

Note

You may only connect one PG to the MPI subnet in run mode. You must not connect other nodes (e.g. OP, PP, TD, ...) to the MPI subnet, because due to line noise you might lose global data packets or transmitted data.

PROFIBUS-DP interface

The PROFIBUS-DP interface is mainly used to connect distributed I/O. PROFIBUS-DP allows you to create large subnets. The maximum possible PROFIBUS transmission rate is 12 Mbps. The CPU broadcasts its bus parameter configuration (e.g. transmission rate) via PROFIBUS-DP interface. This means that a programming device, for example, can automatically "hook up" to a PROFIBUS-DP subnet. In your configuration you can specify to disable bus parameter broadcasting. CPUs 313C-2 DP and 314C-2 DP are equipped with a second interface, an RS485 **PROFIBUS-DP interface** that you can configure as master or slave.

PtP interface

At the CPU's PtP interface you can connect devices equipped with a serial port, e.g. barcode readers, printers, ..., (non-Siemens devices). Here, you can operate with transmission rates in full duplex mode (RS422) up to 19.2 Kbps, and in half duplex mode (RS485) up to 38.4 Kbps. CPUs 313C-2 PtP and 314C-2 PtP are equipped with a second interface, namely a **PtP interface** (Point-to-Point, 15-pin). The following PtP communication drivers are implemented in these CPUs:

- ASCII driver
- 3964 (R) protocol
- RK512 (only CPU 314C-2 PtP)

Which devices can I connect to which interface?

Table 4-14 Connectable Devices

MPI	PROFIBUS-DP	PtP
<ul style="list-style-type: none"> PG/PC OP/PP/MP S7 controllers with MPI interface S7-200 (Note: only 19.2 Kbps) 	<ul style="list-style-type: none"> Other DP masters and DP slaves Actuators/Sensors S7 controllers with PROFIBUS-DP interface PG/PC OP/PP/MP 	<ul style="list-style-type: none"> Devices with serial port e.g.: barcode readers, printers, etc. CPUs 31xC with PtP interface Communication processors (CPs) for PtP of PG/PCs and S7 controllers

Further information

Further information on specific connections is found in the *Communication with SIMATIC* manual. Details on PtP communication are also found in the *Technological Functions* manual.

4.10.4 Network components

PROFIBUS bus cable

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

Table 4-15 Available bus cables

Bus cable	Order No.
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 properties of these bus cables.

Table 4-16 Properties of PROFIBUS cables

Properties	Values
Impedance level	approx. 135 Ω to 160 Ω (f = 3 MHz to 20 MHz)
Loop resistance	\leq 115 Ω /km
Effective capacitance	30 nF/km
Attenuation	0.9 dB/100 m (f = 200 kHz)
Permissible conductor cross-sections	0.3 mm ² to 0.5 mm ²
Permissible cable diameter	8 mm \pm 0.5 mm

Wiring 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 4-17 Marginal conditions for wiring interior bus cables

Characteristics	Condition
Bending radius (one-off)	\geq 80 mm (10 x d_A)
Bending radius (multiple times)	\geq 160 mm (20 x d_A)
Permissible temperature range during installation	-5 °C to +50 °C
Shelf and stationary operating temperature range	-30 °C to +65 °C

Cross-reference

If you want to use optical waveguide cables for PROFIBUS, you can find further information on this topic in the Manual SIMATIC NET, PROFIBUS Networks.

RS485 bus connector

Table 4-18 Bus connectors

Type	Order No.
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), 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 the 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 200C)
- RS485 Repeater.

RS485 Repeater

Table 4-19 RS485 Repeater

Type	Order No.
RS485 Repeater	6ES7 972-0AA00-0XA0

Purpose

An RS485 repeater amplifies data signals on bus lines and interconnects bus segments.

You require this RS485 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 segmentThe maximum cable lengths for RS485 Repeaters ...

... is found in the Chapter *Cable lengths*.

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 RS485 repeaters corresponds to the cable length of a segment (see the following Chapter). Please note that these maximum cable lengths only apply if no other node is interconnected between the two RS485 repeaters. You can connect up to nine RS485 repeaters in series.

Please note that you have to add the RS485 repeater when you determine the number of nodes in your subnet, even if it is not assigned its own MPI/PROFIBUS address.

Technical data and installation instructions are found ...

... in the RS485 Repeater product information.

PG patch cord

Table 4-20 PG patch cord

Type	Order No.
PG patch cord	6ES7 901-4BD00-0XA0

Stub cables

If you do not want to install the bus cable directly in the bus connector (for example, when using an L2 bus terminal), you must take into account the maximum length possible for the stub cable.

Up to 3 Mbps you can use a PROFIBUS cable with bus connector for your connection.

Use the patch cord to connect the PG or PC when operating above 3 Mbps. In your bus assembly you can use multiple PG patch cords with this order no. Do not use other types of stub cables.

The maximum cable lengths for PG patch cords ...

... is found in the Chapter *Cable lengths*.

4.10.5 Cable length

MPI Subnet Segment

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

Table 4-21 Permissible cable lengths in an MPI subnet segment

Transmission rate	S7-300 CPUs (without CPU 318-2 DP) (non-isolated MPI interface)	CPU 318-2 DP (isolated MPI interface)
19.2 Kbps	50 m	1,000 m
187.5 Kbps		
1.5 Mbps	-	M 200
3.0 Mbps		M 100
6.0 Mbps		
12.0 Mbps		

Segment in the PROFIBUS Subnet

The cable length in a segment of a PROFIBUS subnet depends on the transmission rate.

Table 4-22 Permissible cable lengths in an MPI subnet segment

Transmission rate	Maximum cable length in a segment
9.6 Kbps to 187.5 Kbps	1,000 m
500 Kbps	M 400
1.5 Mbps	M 200
3 Mbps to 12 Mbps	M 100

Longer cable lengths

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

Length of the stub cables

If you do not want to install the bus cable directly in the bus connector (for example, when using an L2 bus terminal), you must take into account the maximum length possible for the stub cable.

The following table lists the maximum permissible lengths of stub cables per segment:

Table 4-23 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 assembly you can use multiple PG patch cords with this order no. Do not use other types of stub cables.

4.10.6 Network samples

Example: MPI subnet

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

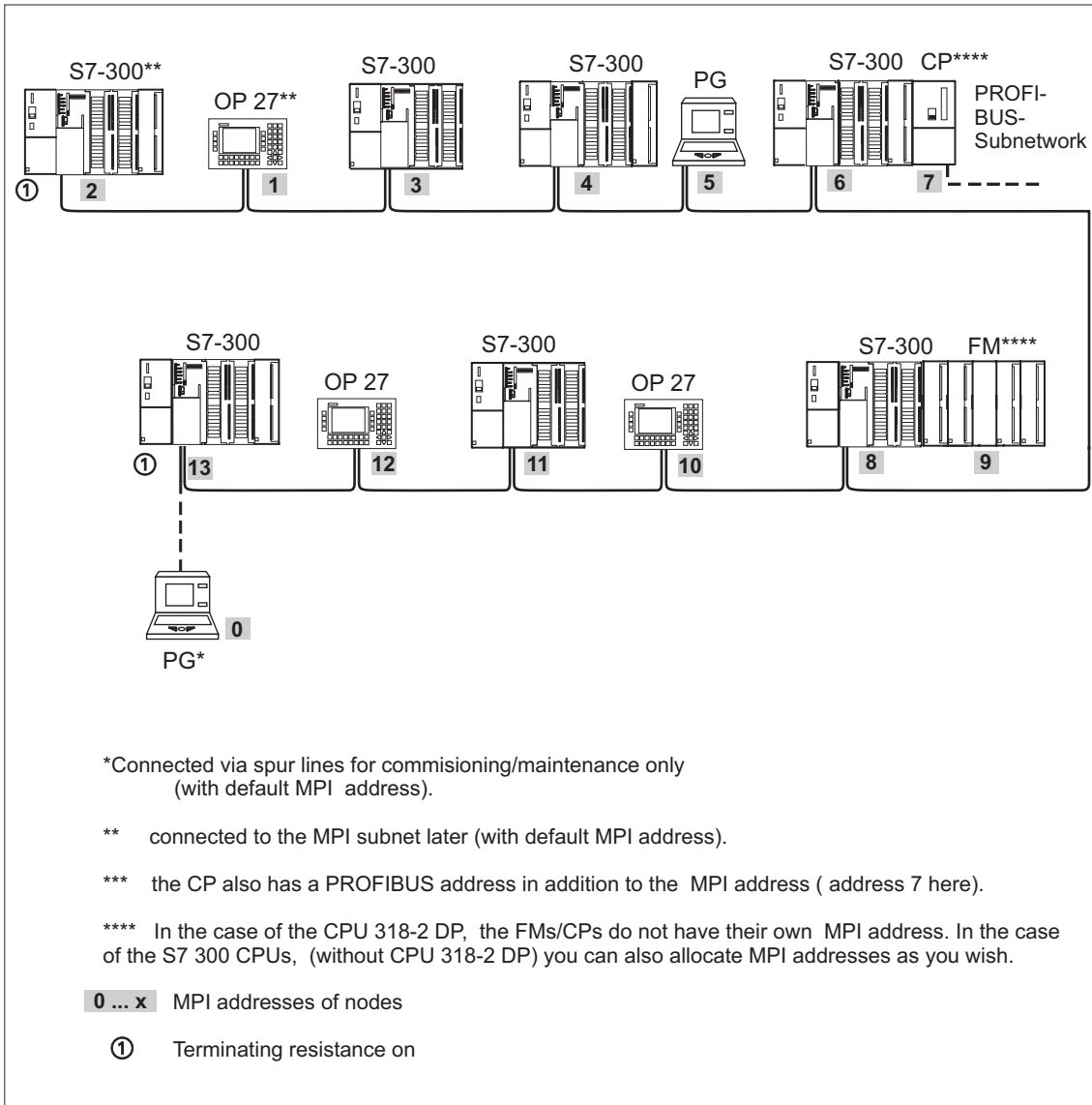


Figure 4-14 Example of an MPI subnet

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 RS485 repeaters

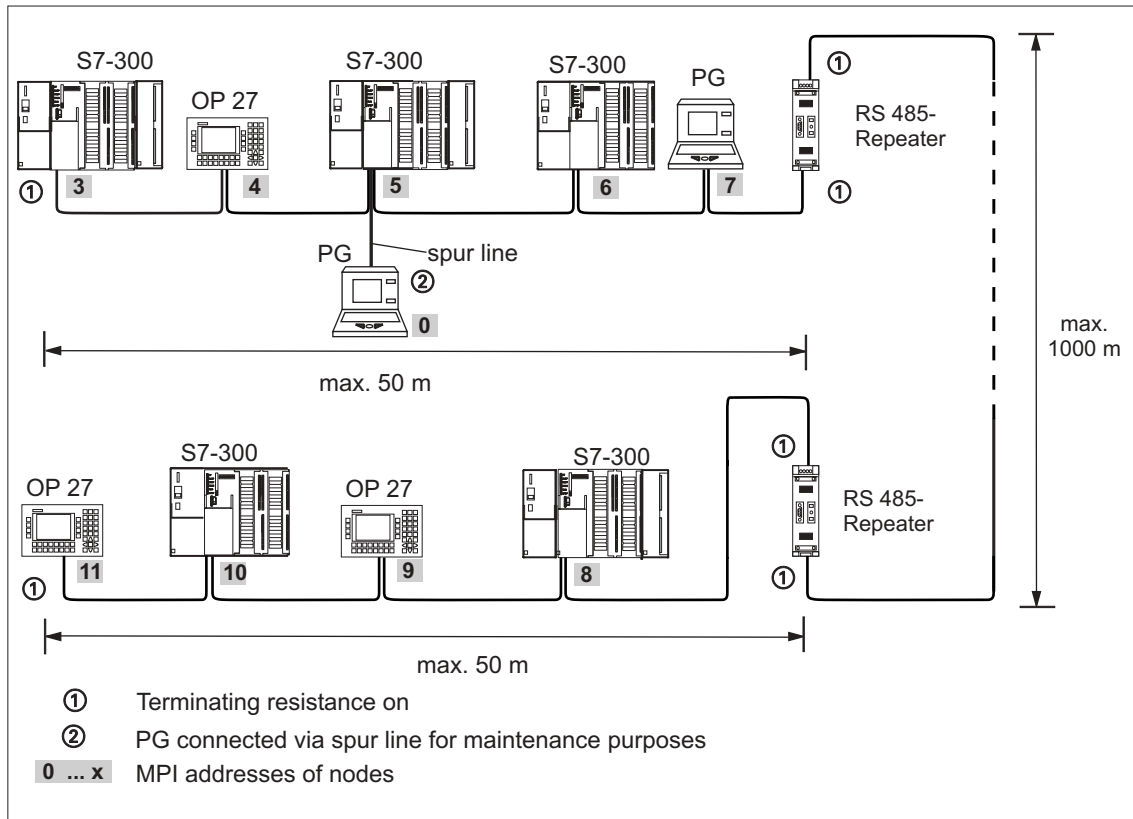


Figure 4-15 Example: Maximum distances in the MPI subnet

Example: PROFIBUS subnet

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

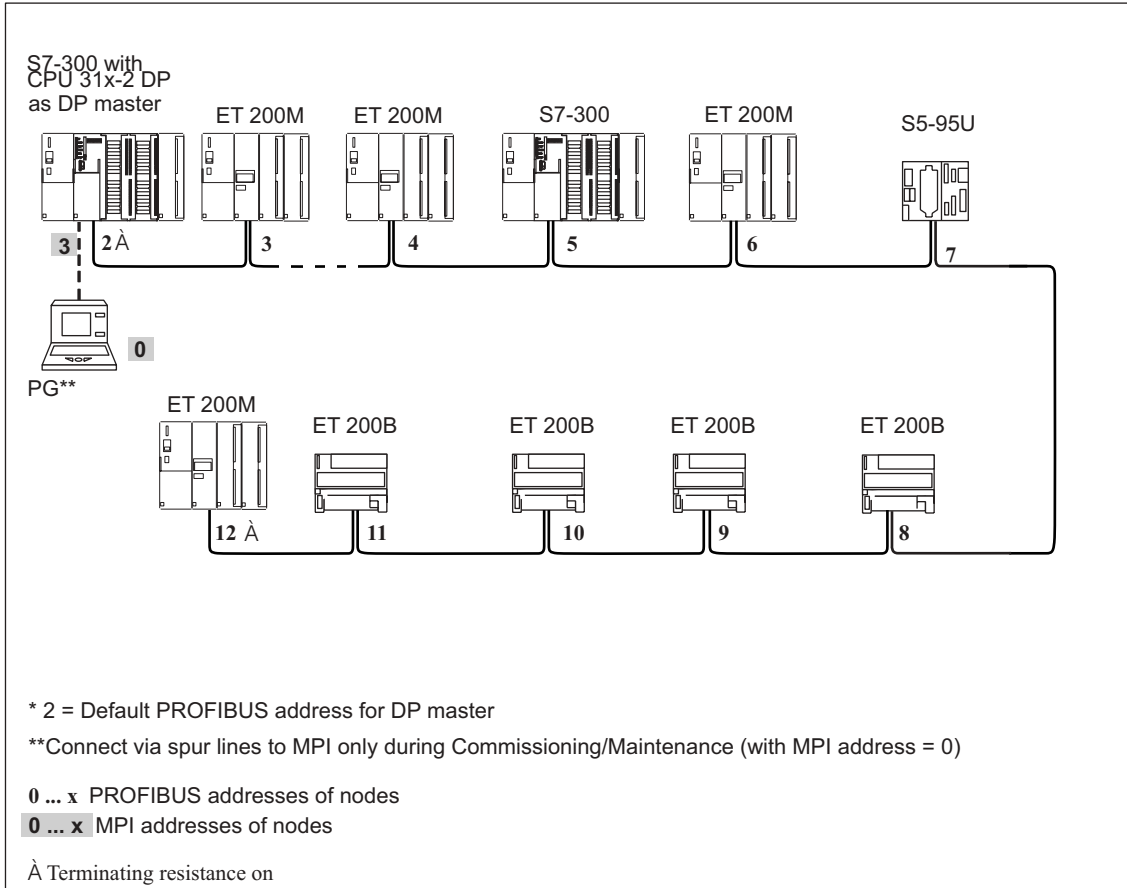


Figure 4-16 Example of a PROFIBUS Subnet

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.

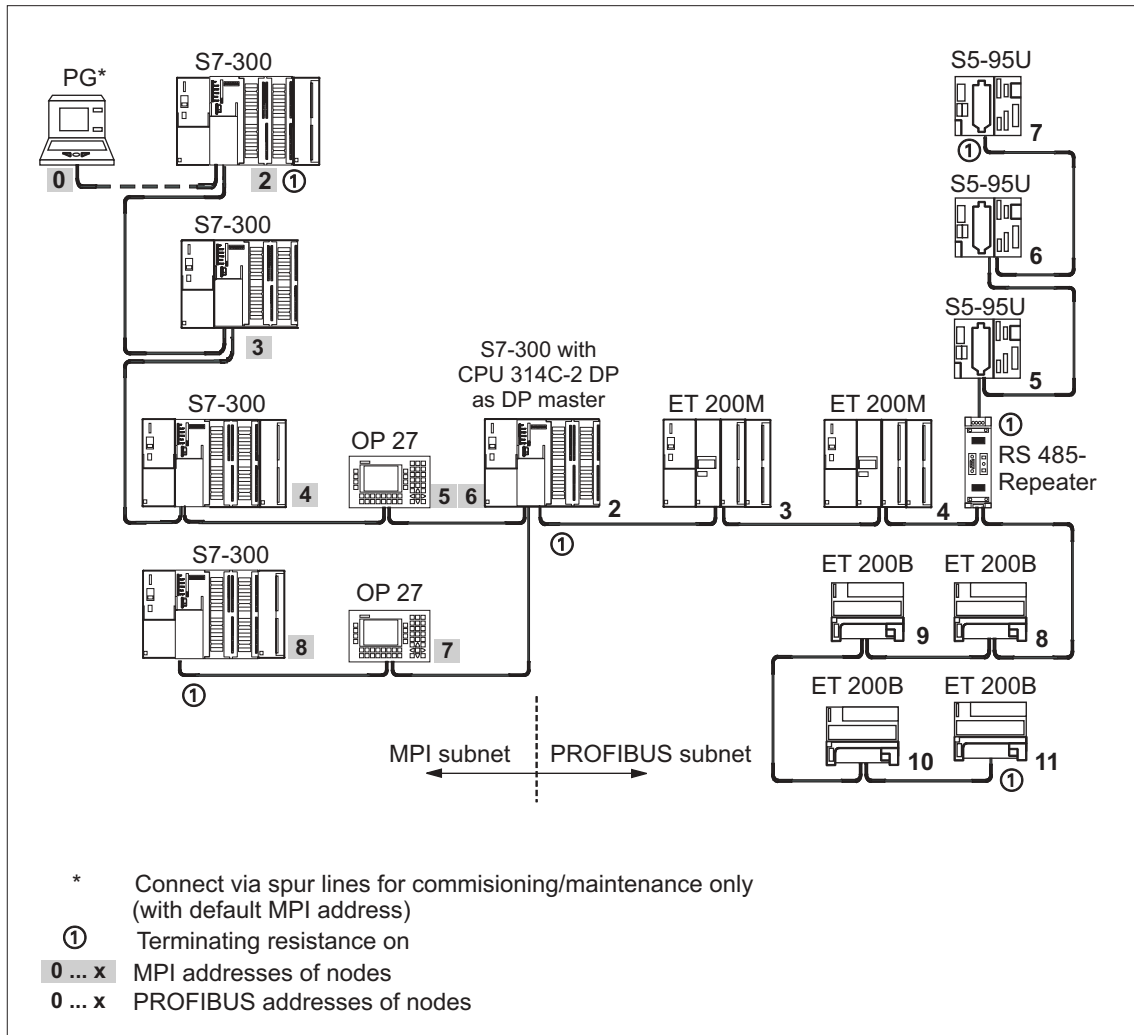


Figure 4-17 Example: CPU 314C-2 DP as MPI and PROFIBUS node

Example: PG access across network boundaries (routing)

With a programming device you can access all modules across network boundaries.

Prerequisites

- You must be using STEP 7 Version 5.0 or later.
- 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.

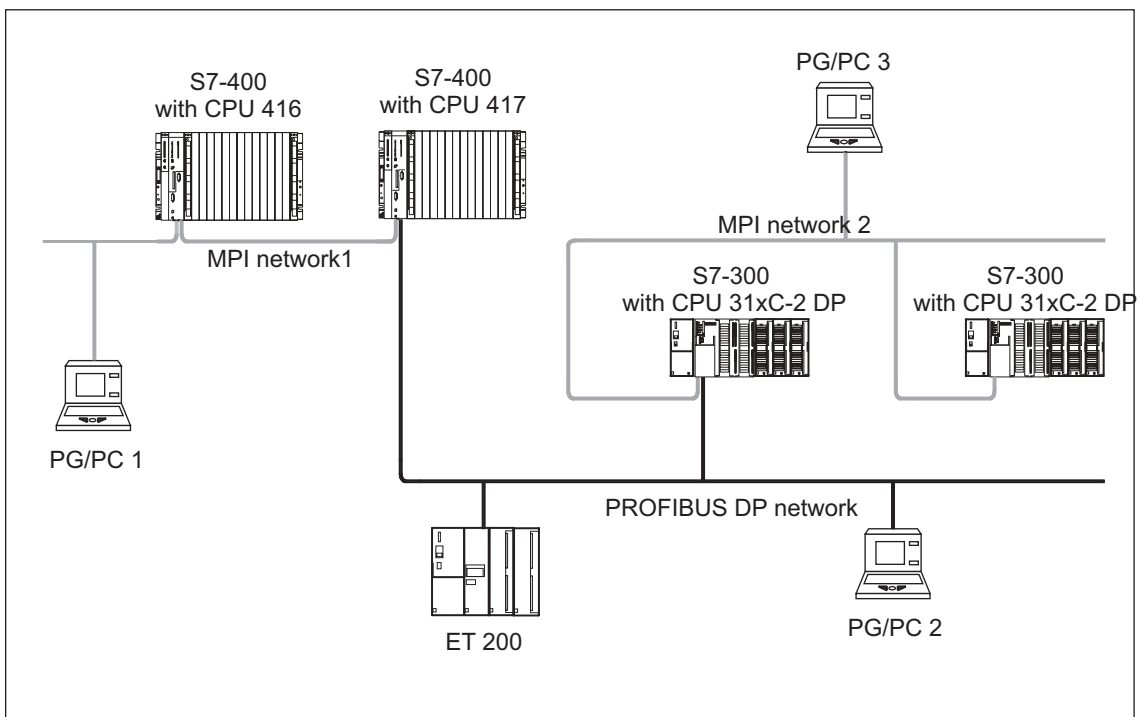


Figure 4-18 Example of PG access across network boundaries (routing)

Information on routing is found in the ...

- CPU Manual.
- In the *Communication with SIMATIC* manual.

To use the routing function, you must always configure your CPU 31xC as master; this feature is not available with an I-Slave configuration!

Example: Terminating resistor in the MPI subnet

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

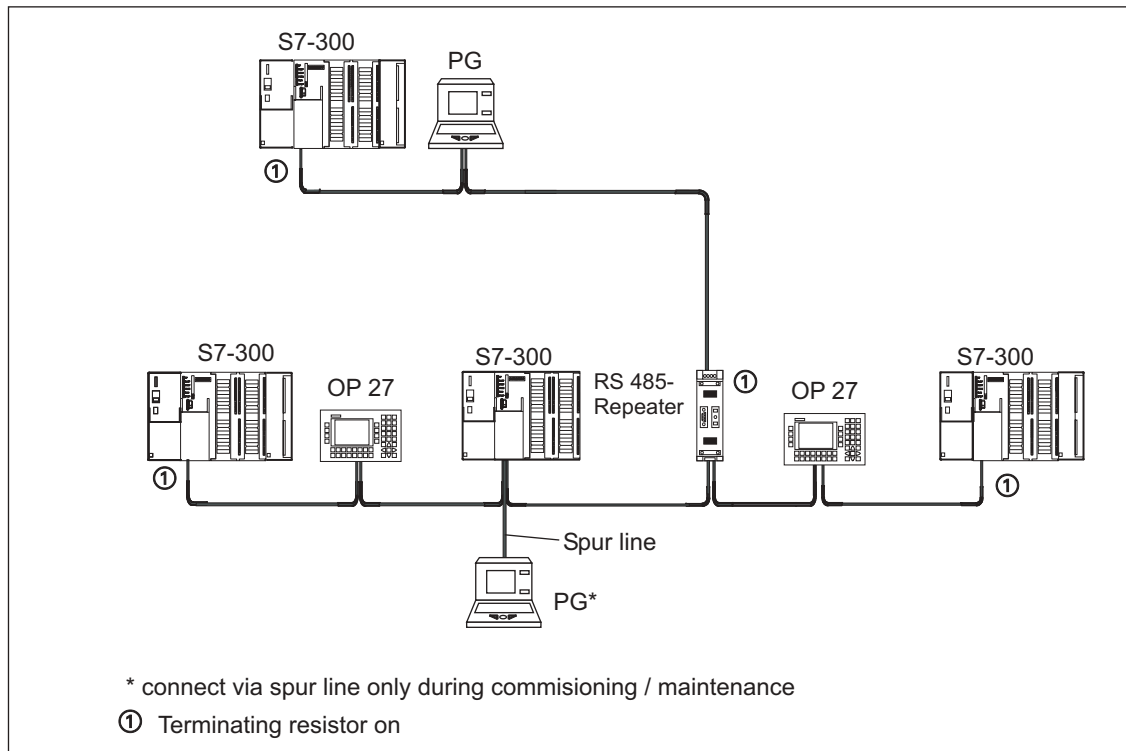


Figure 4-19 Activation of the terminating resistors in an MPI subnet



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.

As an alternative, you can also use the PROFIBUS Terminator as active bus termination.

Installation

5

5.1 Installation

In this chapter

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

Note

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

Open components

S7-300 modules are "Open Components" according to IEC 61131-2 and EC Guideline 73/23/EEC (Low-Voltage Guideline), 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	Description
CPU	1 x Slot number label	For assigning slot numbers
	2 keys (not CPU 31xC)	The key is used for operating the CPU's mode selector switch
	Inscription labels	for the MPI address and Firmware Version (all CPUs) for the inscription of integrated I/Os (only CPU 312 IFM, 314 IFM and 31xC) Tip: Templates for labeling strips can be obtained from the internet at http://www.ad.siemens.de/cs info under article ID 406745.
Signal module (SM) Function Module (FM)	1 bus connector	For electrical interconnection of modules
	1 labeling strip	for labeling module I/Os Tip: Templates for labeling strips can be obtained from the internet at http://www.ad.siemens.de/cs info 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 can be obtained from the internet at http://www.ad.siemens.de/cs info 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

Tools and material required

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 profile rail to length	measuring tape, hacksaw
scribing and drilling holes on the 2-m profile rail	calliper gauge, scribing iron, center punch, drill with a diameter of 6.5 mm, drilling machine
screw-mounting the profile 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 profile rail	screwdriver with 3.5 mm blade width (cylindrical design)

5.2 Installing the profile rail

Introduction

Profile rails are available in two versions:

- Ready-to-use, in four standard lengths (with 4 bores for fixing screws and 1 ground conductor bolt)
- 2-m profile rail
This can be reduced as desired for subnet configuration with special lengths. It has no holes for fixing screws and no ground conductor bolt.

Prerequisite

You must prepare the 2-m profile rail for mounting.

Preparing the 2-m profile rail for mounting

1. Cut the 2-m profile 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 profile 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 profile 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.

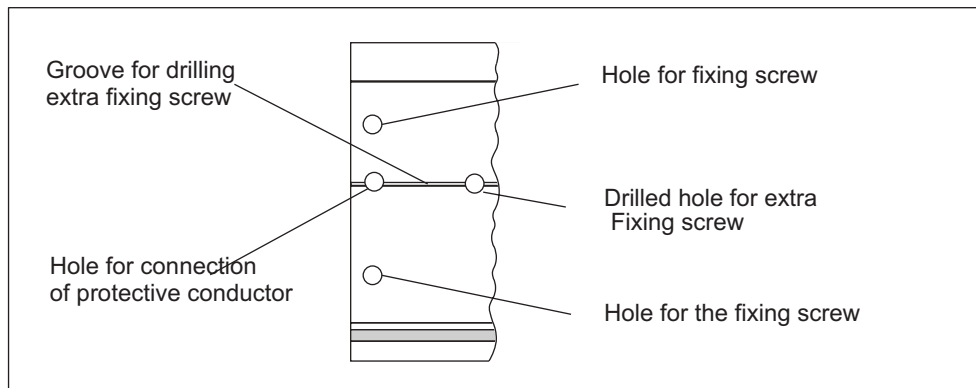


Figure 5-1 Holes for mounting the 2-m profile rail

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" profile rail			2-m profile 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

You can use the following type of screw to mount the profile rails:

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

Mounting the profile rail

1. When you mount the profile 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 profile rail (M6 screws).

Note

Take care to create a low-impedance connection between the profile 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.

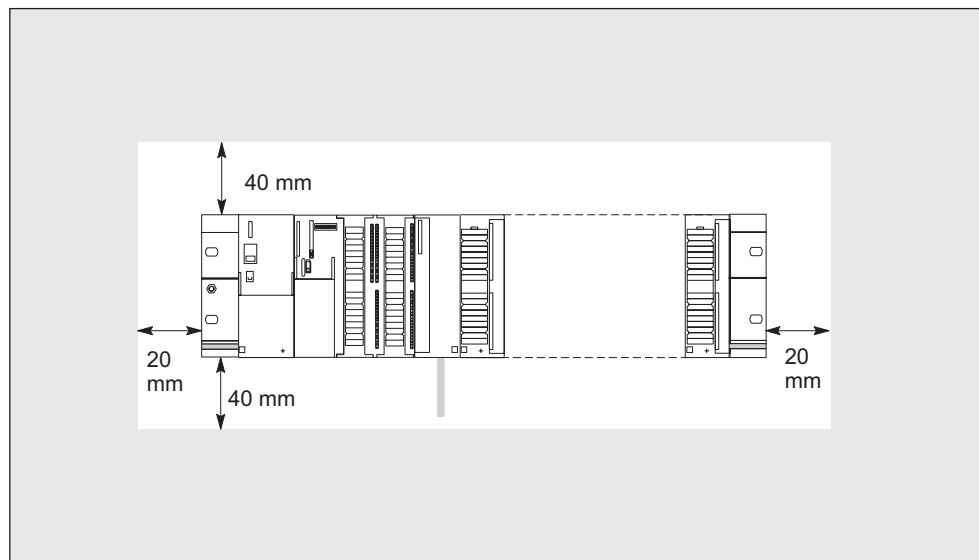


Figure 5-2 Free space required for an S7-300 installation

5.3 Installing modules on the profile rail

Prerequisite

- Your S7-300 PLC is fully configured.
- The profile rail is installed.

Order of the modules

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

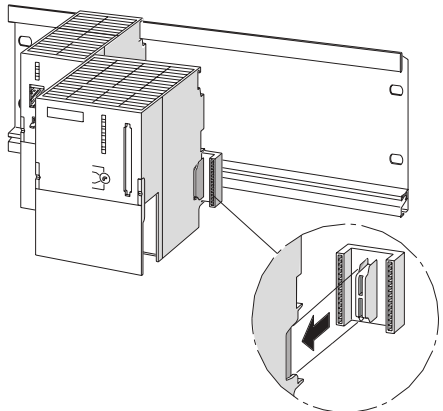
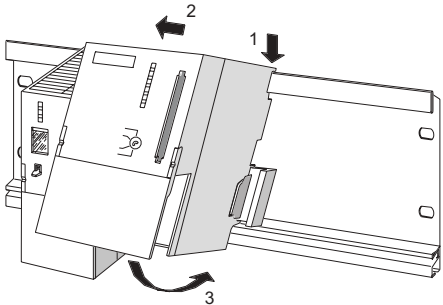
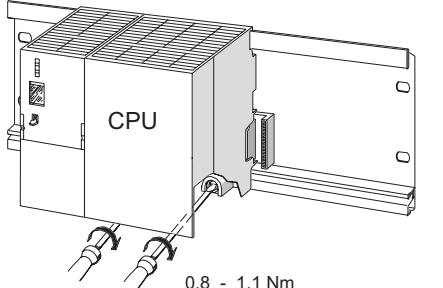
1. Power supply module
2. CPU
3. signal modules, function modules, communication modules, interface modules

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 specifications Reference Manual*.

Steps of installation

The specific steps for module installation are described below.

<p>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.</p> <ul style="list-style-type: none"> • Always start at the CPU when you plug in the bus connectors. Here, take 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. 	
<p>2. Suspend all modules in their specified sequence onto the rail (1), slide them up to the module on the left (2), then swing them down (3).</p>	
<p>3. Screw-fasten all modules, tightening the screws with a torque of 0.8 N/m to 1.1 N/m.</p>	

Inserting the key

After you have mounted all modules, insert the key into the S7-300 CPU's mode selector switch (not with CPU 31xC).

5.4 Label the modules

Assigning slot numbers

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	Remarks
1	Power supply (PS)	–
2	CPU	–
3	Interface module (IM)	To the right of the CPU
4	1st signal module	To the right of the CPU or IM
5	2nd signal module	–
6	3rd signal module	–
7	4th signal module	–
8	5th signal module	–
9	6th signal module	–
10	7th signal module	–
11	8th signal module	–

Inserting slot numbers

1. Hold the corresponding slot number in front of the respective 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.

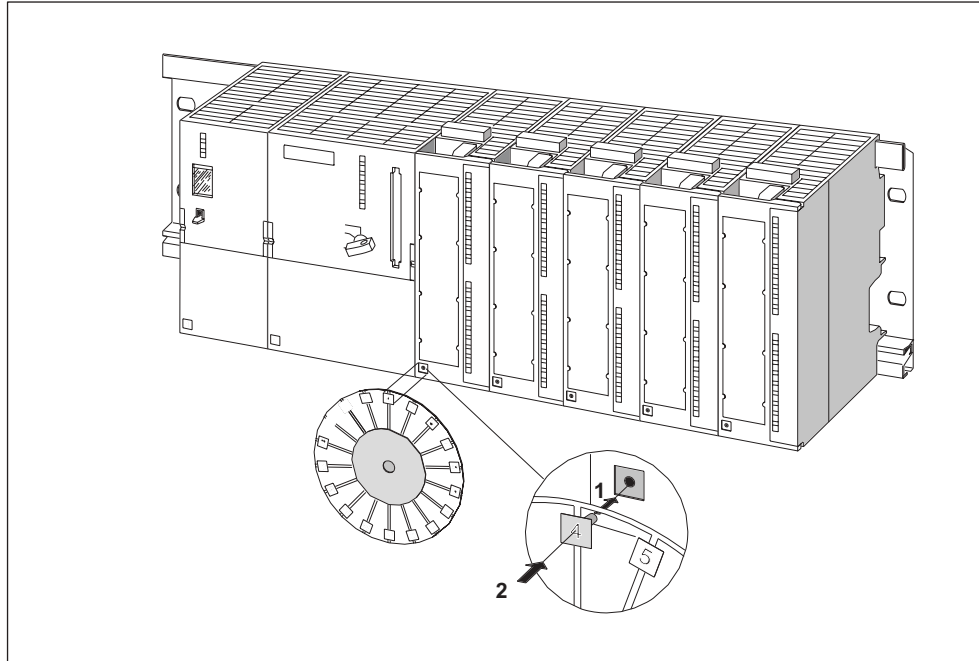


Figure 5-3 Inserting slot numbers in modules

Wiring

6

6.1 Wiring

In this chapter

we shall explain the procedures for wiring an S7-300.

Accessories required

To wire the S7-300, you require the accessories listed in the table below.

Table 6-1 Wiring accessories

Accessories	Description
Connection comb (included with the PS)	for the connection between the power supply module and the CPU (not CPU 31xC)
Front connector	for the connection of system sensors/actuators to the S7-300
Labeling strips	for labeling the module I/Os
Shielding element, shielding terminals (matching the shielding diameter)	for connecting cable shielding

Tools and material required

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

Table 6-2 Tools and material for wiring

You require ...	for ...
bonding the protective conductor to the profile rail	Wrench Protective conductor cable (cross-section $\geq 10 \text{ mm}^2$) 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 $3 \times 1.5 \text{ mm}^2$ 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 cable 0.25 mm^2 to $0.75/1.5 \text{ mm}^2$ If required, shielded cables If required, wire end ferrules to DIN 46228

Brief overview of the power supply module and CPU

Table 6-3 Conditions for wiring the PS and CPU

Connectable cables	to PS and CPU
solid conductors	No
flexible conductors	
• Without wire end ferrule	0.25 mm^2 to 2.5 mm^2
• With wire end ferrule	0.25 mm^2 to 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
Diameter of the conductor insulation	max. 3.8 mm
Stripped length	11 mm
Wire end ferrules to DIN 46228	
• Without insulating collar	Version A, 10 mm to 12 mm length
• With insulating collar	Version E, up to 12 mm length

Brief overview of front connectors

Table 6-4 Wiring conditions for front connectors

Connectable cables	Front connector	
	20-pin	40-pin
solid conductors	No	No
flexible conductors <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 0.25 mm² to 0.75 mm² Potential supply: 1.5 mm²
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	<ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 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 Bonding the protective conductor to the profile rail

Prerequisite

The profile rail is fixed to the mounting surface.

Connecting the protective conductor

1. Connect the protective conductor to the rail, using the M6 protective conductor bolt.

Minimum cross-section of the protective conductor: 10 mm².

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

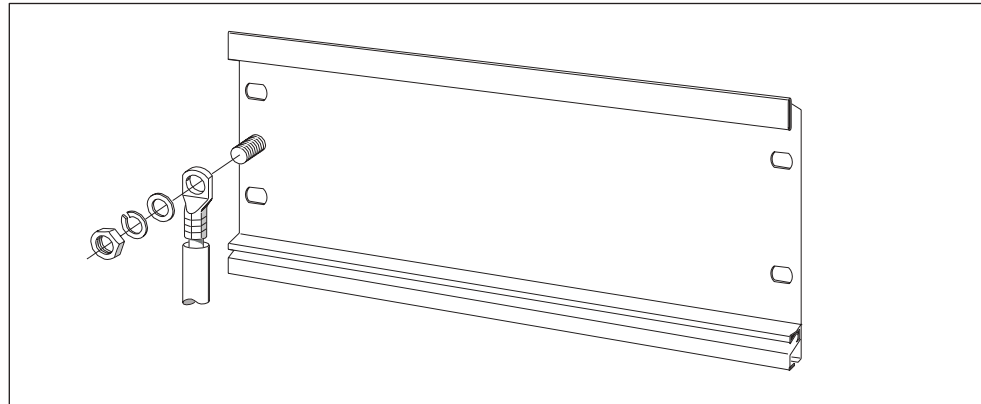


Figure 6-1 Bonding the protective conductor to the profile rail

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 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 to see whether the selector switch is set to the correct mains voltage.

You can change the selector switch setting as follows:

1. Remove the protective cap with the help of a screwdriver (1).
2. Set the selector switch to your mains voltage (2).
3. Replace the cover.

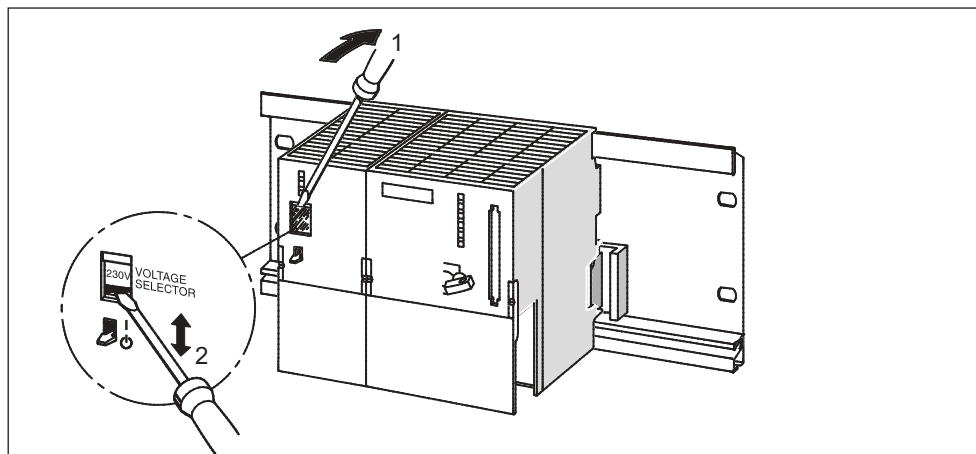


Figure 6-2 Setting the mains voltage selector switch for the PS 307

6.4 Wiring the power supply module and the CPU

Prerequisite

The modules are mounted on the profile rail.

Connecting comb (not for CPU 312 IFM and CPU 31xC)

You can connect some of the CPUs to the PS 307 power supply module using the connection comb included with the module.

PS and CPU wiring

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

On CPUs 31xC the power supply plug is removable.

Warning

Unintentional contact with live conductors is possible if the power supply module and any additional load power supplies are switched on. Always wire the S7-300 with the power turned off!

1. Open the front panel to the PS 307 power supply module and CPU.
2. Open the strain relief clamp 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 clamp again.
5. **You have two options of wiring the CPU, depending on which one you are using:**
 - **CPU 312 IFM and CPUs 31xC:** Strip the connecting leads for the CPU power supply to a length of 11 mm. Connect the lower terminals M and L+ of PS 307 to terminals M and L+ of the CPU.
 - **CPU 313/314/314 IFM/315/315-2 DP/316-2 DP/318-2 DP:** Insert the connection comb and screw-tighten it.

6. Close the front panel.

The figure below illustrates the procedures described above.

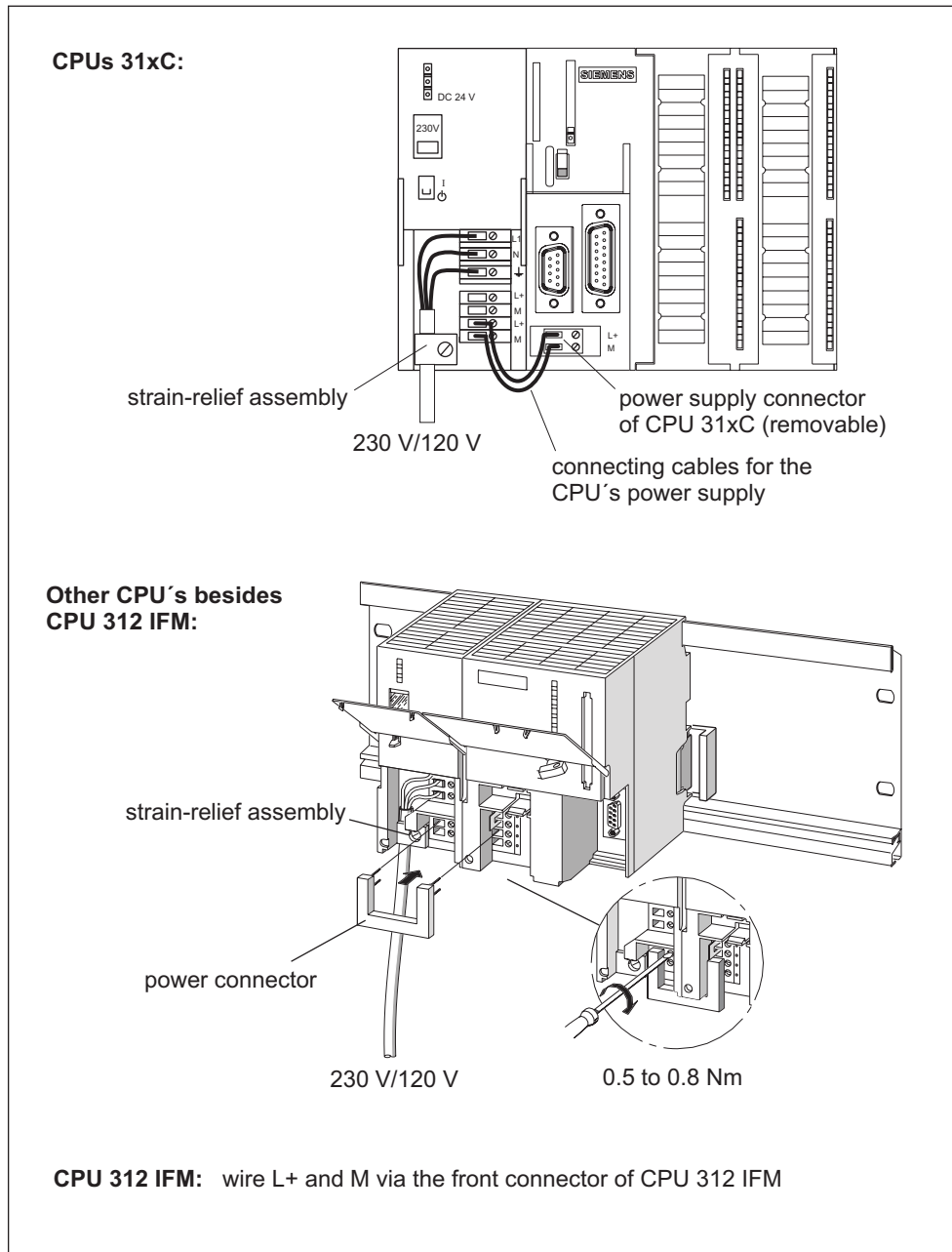


Figure 6-3 Wiring the power supply module and the CPU

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.

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 CPU 312 IFM	6ES7 392-1AJ00-0AA0	6ES7 392-1BJ00-0AA0
Signal modules (32-channel) CPUs 314 IFM and 31xC	6ES7 392-1AM00-0AA0	6ES7 392-1BM01-0AA0

Termination with 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.

Tip:

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

Prerequisite

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

Preparing the front connector and the cables



Warning

Unintentional contact with live conductors is possible if the power supply module and any additional load power supplies are switched on.
Always wire the S7-300 with the power turned off!

1. Open the front panel (1).
2. Move the front connector into wiring position (2).
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.
3. Strip the leads to a length of 6 mm.
4. Crimp on the cable end sleeves, e.g. for terminating 2 conductors on 1 terminal.

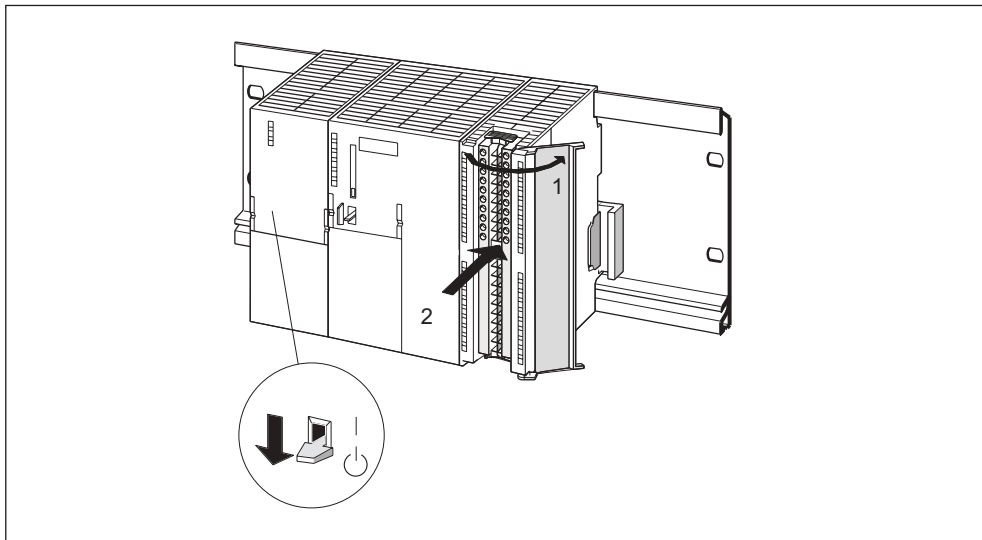
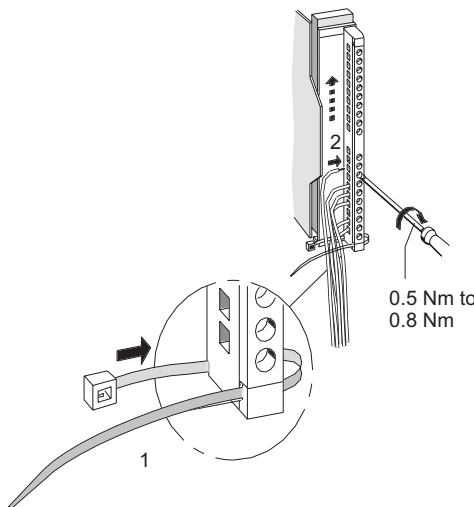
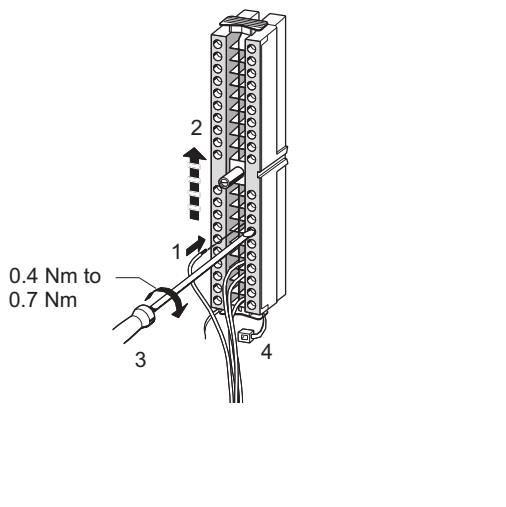


Figure 6-4 Move the front connector into wiring position

Wiring the front connector

Table 6-6 Wiring front connectors

Step	20-pin front connector	40-pin front connector
1.	Thread the cable strain relief into the front connector.	–
2.	Do you want to exit the cables at the bottom of the module?	
	<p>If yes: Starting at terminal 20, work your way down to terminal 1.</p> <p>If not: Starting at terminal 1, work your way up to terminal 20.</p>	<p>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.</p> <p>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.</p>
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 cable strain-relief assembly tight. Push in the strain relief retainer to the left to improve utilization of the available cable space.	
–	 <p>0.5 Nm to 0.8 Nm</p>	 <p>0.4 Nm to 0.7 Nm</p>

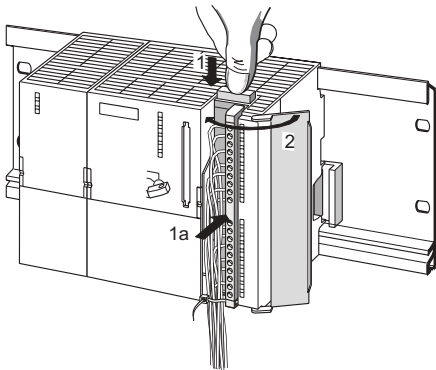
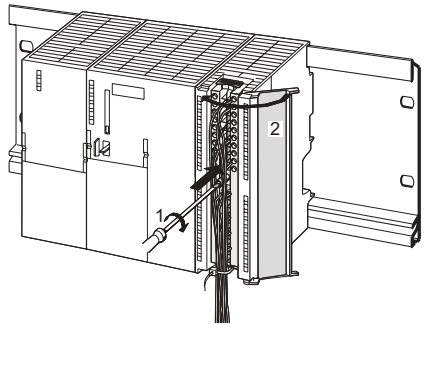
6.6 Inserting front connectors into modules

Prerequisite

The front connectors are completely wired as described in the Chapter *Wiring front connectors* .

Inserting the front connector

Table 6-7 Inserting the front connector

Step	with 20-pin front connector	with 40-pin front connector
1.	<p>Push in the unlocking mechanism on top of the module (1).</p> <p>Hold the unlocking mechanism in this position and insert the front connector into the module (1a).</p> <p>Provided the front connector is seated correctly in the module, the unlocking mechanism automatically returns to initial position when you release it.</p>	<p>Screw-tighten the fixing screw in the center of the connector (1).</p> <p>This pulls the front connector completely into contact with the module.</p>
<p>Note</p> <p>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.</p>		
2.	Close the front panel (2).	
—		

6.7 Labeling the module I/Os

Introduction

The assignment of module I/Os to the sensors/actuators of your system is recorded on labeling strips.

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

Table 6-8 Assigning labeling strips 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 and inserting labeling strips

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

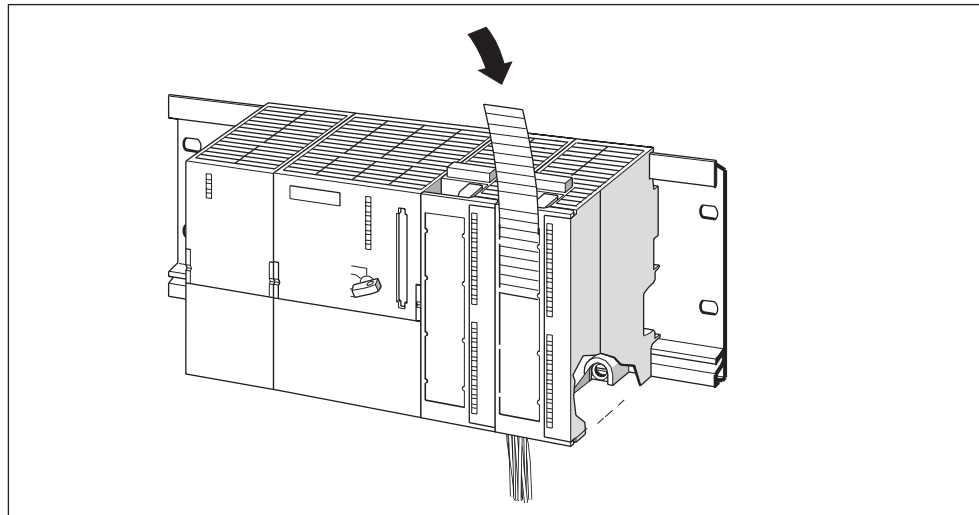


Figure 6-5 Slide the labelled strips into the front panel

Tip:

Templates for labeling strips can be obtained from the internet at <http://www.ad.siemens.de/csinfo> under article ID 406745.

6.8 Connecting shielded cables to the shielding contact element

Application

Using 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 profile rail.

Design of the shielding contact element

The shielding contact element consists of:

- a bracket for screw-mounting (with two screws) it onto the profile 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 6-9 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.

Mounting the shielding contact element

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 edge "a" of the bracket (see the Figure below). Push the shield terminal down and swing it into the desired position. The two rows of the shielding contact element allow you install a maximum of 4 shielding terminals.

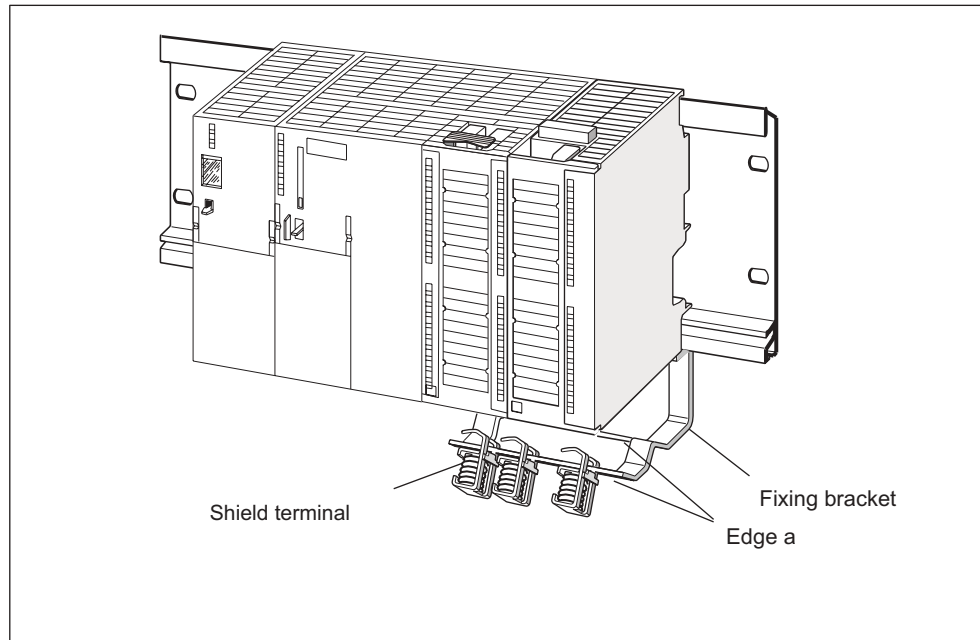


Figure 6-6 Shielding contact element underneath two signal modules

Terminating 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 contact clamp. Push the shielding clamp 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.

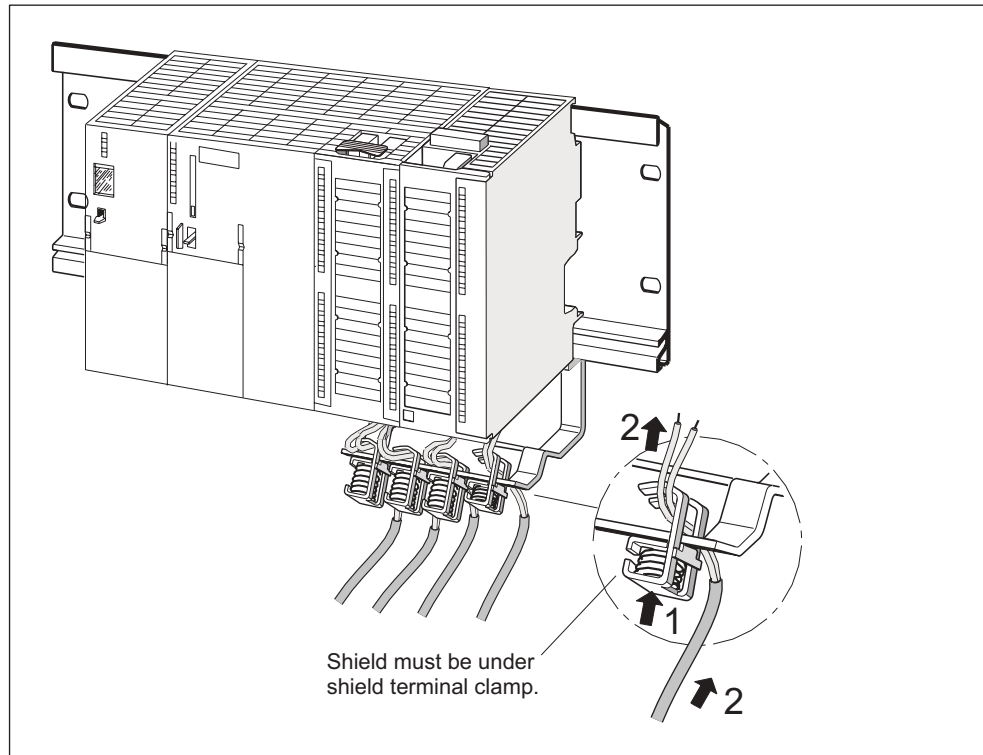


Figure 6-7 Connecting 2-wire cables to the shielding contact element

Tip:

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 contact element.

6.9 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 is found in the article below.

Wiring the bus cable to the bus connector

Bus connector with screw terminals:

1. Strip the bus cable.
Details on stripped lengths are found in the product information included 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.

Fast Connect bus connector:

1. Strip the bus cable.
Details on stripped lengths are found in the product information included with the bus connector.
2. Open the bus connector's cable strain relief.
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. Take care that the bare shielding contacts the shielding contact surface.

Note

For CPU 31xC you must use a 90° bus connector.

Inserting the bus connector into the 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 at the beginning or at the end of a segment, you have to enable the terminating resistor (Switch position "ON" see figure below).

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 stations where the terminating resistor is active.

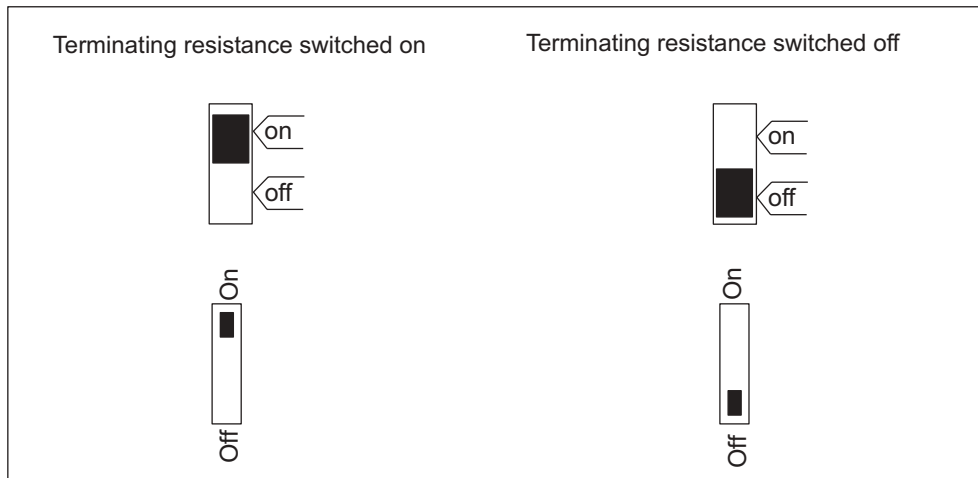


Figure 6-8 Bus connector: Enabled and disabled terminating resistor

Removing 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.

Addressing

7

7.1 Addressing

In this chapter

shows you the options of addressing specific module channels.

Slot-based addressing

Slot-based addressing is the default setting, that is, *STEP 7* assigns each slot number a defined module start address.

User-defined addressing

With user-defined addressing, you can assign any module address from the address area managed by the CPU. User-defined addressing for S7-300 PLCs is only possible with CPUs 315, 315-2 DP, 316-2 DP and 318-2 DP as well as CPUs 31xC.

7.2 Slot-defined addressing of modules

Introduction

In slot-based addressing (default addressing), 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 module racks and the optional slots with their module start addresses. The input and output addresses for I/O modules start from the same module start address.

Note

With CPU 314 IFM and CPUs 31xC you cannot insert a module in module rack 3, slot number 11. The address area is reserved for the integrated I/O.

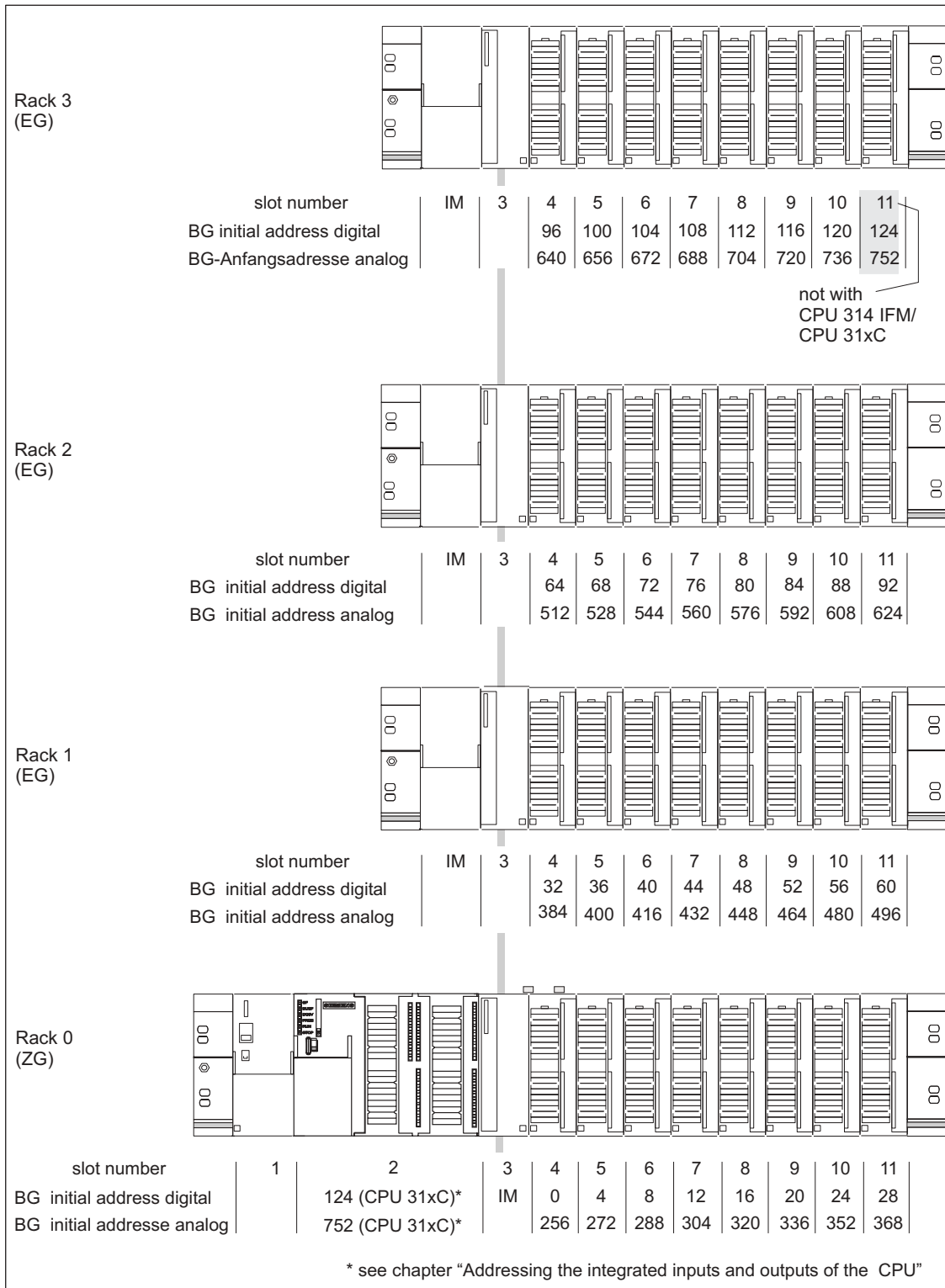


Figure 7-1 S7-300 slots and the corresponding module start addresses

7.3 User-defined addressing of modules

Possible with?

User-defined addressing is only supported by CPUs 315, 315-2 DP, 316-2 DP and 318-2 DP, as well as CPUs 31xC.

User-defined addressing

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 respective S7-300 configuration.

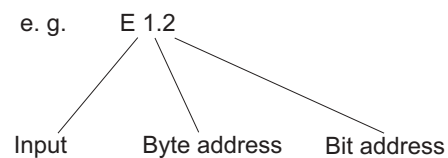
7.4 Addressing signal modules

Introduction

This section shows you how to address signal modules. You need this information in order to be able to address the channels of the signal 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.



The byte address depends on the module start address.

The bit address is the number printed on the module.

If the first digital module is inserted in slot 4 its default start address is 0. The start address of any further digital modules is incremented by 4 per slot (see the Figure in Chapter *Slot-based Addressing of Modules*).

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

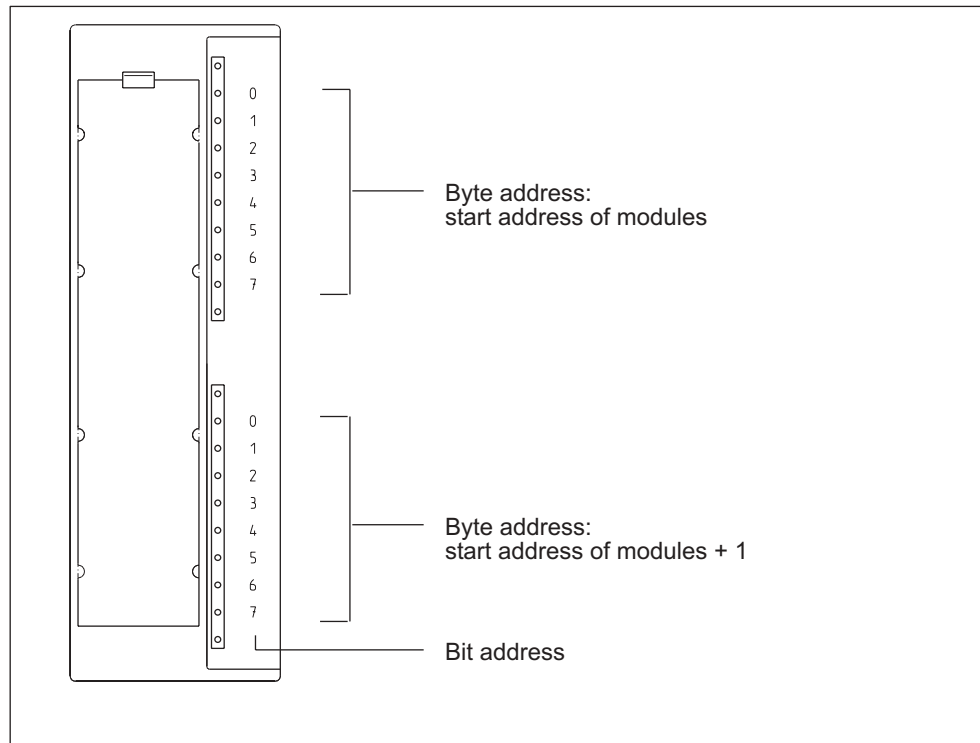


Figure 7-2 Addresses of the I/O of digital modules

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.

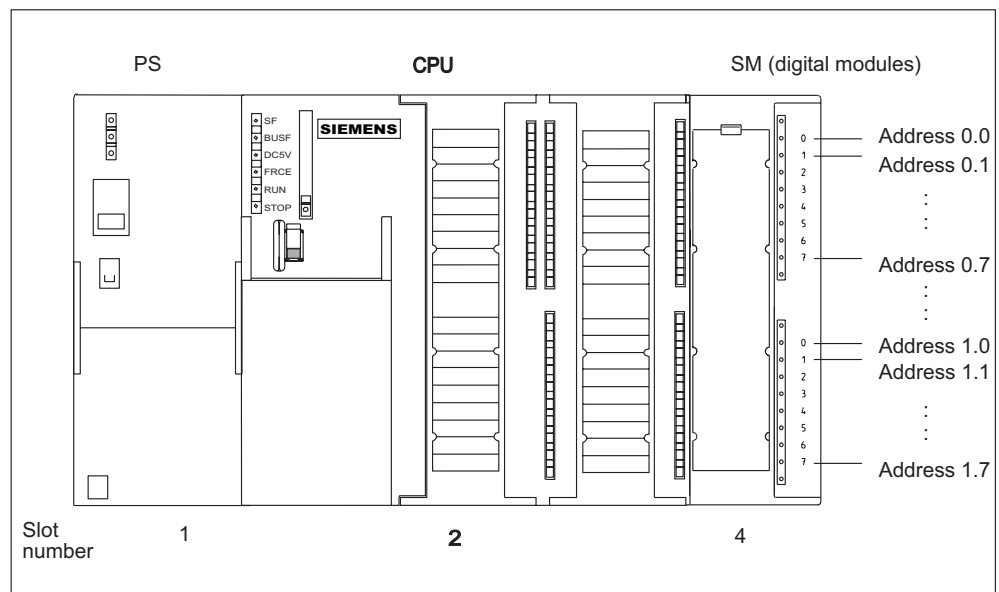


Figure 7-3 I/O Addresses of a digital module in Slot 4

Addresses of the 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.

If the first digital module is inserted in slot 4 its default start address is 256. The start address of any further analog modules is incremented by 16 per slot (see the Figure in Chapter *Slot-based Addressing of Modules*).

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.

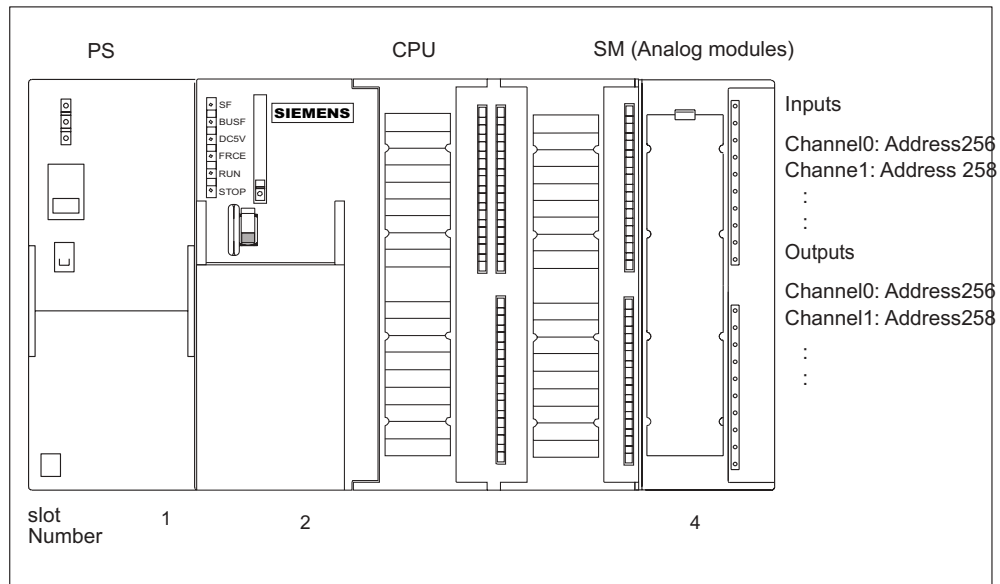


Figure 7-4 I/O addresses of an analog module in Slot 4

7.5 Addressing the integrated I/O of the CPU

CPU 312 IFM

The following addresses are assigned to the integrated I/O of CPU 312 IFM:

Table 7-1 Integrated I/O of CPU 312 IFM

Inputs/Outputs	Addresses	Remarks
10 digital inputs	124.0 to 125.1 of those are 4 Inputs for integrated functions: 124.6 to 125.1	Optional utilization of Inputs for integrated functions: <ul style="list-style-type: none"> Counting Frequency measurement Interrupt input Refer to the Manual <i>Integrated functions</i>
6 digital outputs	124.0 to 124.5	–

CPU 314 IFM

The following addresses are assigned to the integrated I/O of CPU 314 IFM:

Table 7-2 Integrated I/O of CPU 314 IFM

Inputs/Outputs	Addresses	Remarks
20 digital inputs	124.0 to 126.3 of those are 4 Inputs for integrated functions: 126.0 to 126.3	Optional utilization of Inputs for integrated functions: <ul style="list-style-type: none"> • Counting • Counting A/B • Frequency measurement • Positioning • Interrupt input Refer to the Manual <i>Integrated functions</i>
16 digital outputs	124.0 to 125.7	–
4 analog inputs	128 to 135	–
1 analog output	128 to 129	–

CPU 312C

The following addresses are assigned to the integrated I/O of CPU 312C:

Table 7-3 Integrated I/O 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.
6 digital outputs	124.0 to 124.5 of those are 2 Inputs for technological functions: 124.0 to 124.1	Optional technological functions: <ul style="list-style-type: none"> • Counting • Frequency measurement • Pulse width modulation

CPU 313C

The following addresses are assigned to the integrated I/O of CPU 313C:

Table 7-4 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: <ul style="list-style-type: none"> • 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/DP

The following addresses are assigned to the integrated I/O of CPU 313C-2 PtP/DP:

Table 7-5 Integrated I/O 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: <ul style="list-style-type: none"> • 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/DP

The following addresses are assigned to the integrated I/O of CPU 314C-2 PtP/DP:

Table 7-6 Integrated I/O 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: <ul style="list-style-type: none"> • 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	

Remarks

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

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

7.6 Consistent data

Consistent data

The table below shows what you have to take into account for communication in a DP master system if you want to transfer I/O areas with "Total length" consistency.

CPUs 315-2 DP, 316-2 DP CPU 318-2 DP (Firmware version < V 3.0)	CPU 318-2 DP (Firmware version ≥ V 3.0)	CPUs 31xC
Even if they exist in the process image, consistent data is not automatically updated.	You can choose whether or not to update the address area of consistent data in the process image.	The address area of consistent data in the process image is automatically updated.
To read and write consistent data, you must use SFC14 and 15.	To read and write consistent data, you can also use SFC14 and 15. If the address area of consistent data is not in the process image, you must use SFC14 and 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 In this Chapter

In this chapter

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.

Always note ...

the information on commissioning in the description of your system elements and devices.

8.2 Commissioning procedure

Software requirements

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

- STEP 7 as of V 5.1 + SP 2 for CPUs 31xC
- STEP 7 as of V 5.x for all other CPUs

Prerequisites for commissioning

- S7-300 is installed
- S7-300 is wired
- With networked S7-300:
 - MPI/PROFIBUS addresses are configured
 - The segments are terminated with active terminating resistors

Recommended procedure - Part I: Hardware

Due to the modular structure and many expansion options, an S7-300 can be quite extensive and complex. It is therefore inappropriate to initially start up an S7-300 with multiple module 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 - Part I: Hardware

Tasks	Remarks	Information is found in ...
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: By redirecting output data of your outputs to a data block, you can check the status of the outputs at any time	-
Preparing the CPU	Connecting the PG	in the Chapter <i>Connecting the PG</i>
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.	in Chapter <i>Initial Power On</i>
	Check the LED displays on both modules.	in Chapter <i>Testing Functions, Diagnostics and Fault Elimination</i>
Initialize the CPU and check the LEDs	-	in Chapter <i>Resetting CPU memory</i>
CU: commission all other modules	Insert further modules into the CU and commission them in succession.	Reference Manual <i>Module Specifications</i>
Expansion Device (ED): Connecting	If required, interconnect the CU and the EDs: Insert only one Send IM into the CU and the matching receiver IM into the ED.	Chapter <i>Mounting</i>
ED: Commissioning	Insert further modules into the EDs and commission them in succession.	See above.

Recommended procedure - Part II: Software

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

Tasks	Remarks	Information is found in ...
<ul style="list-style-type: none"> Switch on the PG and start SIMATIC Manager Download the configuration and the program to the CPU 	-	in the <i>STEP 7 Programming Manual</i>
Testing the I/Os	<p>Helpful functions are here:</p> <ul style="list-style-type: none"> Monitoring and controlling of variables Testing with program status Force Controlling outputs in Stop mode (PA isolation) <p>Tip: If you connect switches to the inputs, you can include the signal lines in your test.</p>	<ul style="list-style-type: none"> in the <i>STEP 7 Programming Manual</i> in Chapter <i>Testing Functions, Diagnostics and Fault Elimination</i>
Commission PROFIBUS-DP or other networks	-	in Chapter <i>Commissioning PROFIBUS-DP</i>
Connect the outputs	Commissioning the outputs successively.	-



Danger

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

Reaction 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 is found in the chapters describing the respective modules.
- If required, remove specific modules to trace the error.

Important notes are also found ...

in Chapter *Testing Functions, diagnostics and fault elimination*

8.3 The 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 respective topic.

Module racks

Points to be examined	refer to the Installation Manual; Chapter ...	refer to the Reference Manual; Chapter ...
Are the profile rails mounted firmly to the wall, in the frame or in the cabinet?	4; 5	-
Have you maintained free space required?	4; 5	-
Are the cable ducts installed properly?	4	-
Is the air convection OK?	4	-

Conception of grounding and chassis ground

Points to be examined	refer to the Installation Manual; Chapter ...	refer to the Reference Manual; Chapter ...
Have you established a low-impedance connection (large surface, large contact area) to local ground?	4, Appendix	-
Are all module racks (profile rails) properly connected to reference potential and local ground (galvanic connection or isolated operation)?	4; 6; Appendix	-
Are all grounding points of galvanically connected modules and of the load power supply units connected to reference potential ?	4; Appendix	-

Module installation and wiring

Points to be examined	refer to the Installation Manual; Chapter ...	refer to the Reference Manual; Chapter ...
Are all modules properly inserted and screwed in?	5	-
Are all front connectors properly wired, plugged, screw-tightened or latched to the correct module?	5; 6	-

Mains voltage

Points to be examined	refer to the Installation Manual; Chapter ...	refer to the Reference Manual; Chapter ...
Is the correct mains voltage set for all component?	6	Module Data: 2

Power supply module

Points to be examined	refer to the Installation Manual; Chapter ...	refer to the Reference Manual; Chapter ...
Is the mains plug wired correctly?	6	-
Is mains voltage connected?	-	-

8.4 Insert the backup battery or rechargeable battery

Exceptions

- **CPUs 31xC** are maintenance-free and do not require a backup battery or rechargeable battery.
- **CPU 312 IFM** is not equipped with a backup battery or rechargeable battery (it is not buffered).
- **CPU 313** does not require a rechargeable battery because it is not equipped with a real-time clock.

Inserting the backup/rechargeable battery

Insert a backup/rechargeable battery in the CPU as follows:

Note

Do not insert the backup battery in the CPU until after POWER ON.
If you insert the backup battery before POWER ON, the CPU requests initialization.

1. Open the front panel of the CPU.
2. Plug the connector of the backup/rechargeable battery into the corresponding socket in the battery compartment of the CPU. The notch on the connector must show towards the left hand side.
3. Insert the backup/rechargeable battery into the battery compartment of the CPU.
4. Close the front panel of the CPU.

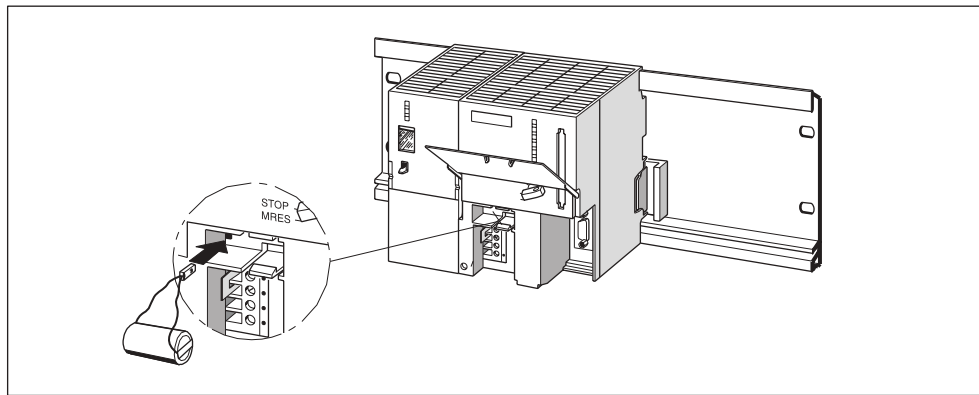


Figure 8-1 Insert a backup battery into CPUs 313/314

8.5 Inserting or replacing a Memory Card or Micro Memory Card

Exceptions

You cannot insert a memory card into the CPUs 312 IFM and 314 IFM (314-5AE0x). These CPUs are equipped with an integrated FEPRM load memory.

Inserting/replacing a Memory Card

Note

If you insert the memory card in a CPU mode other than STOP, the CPU will go into STOP mode and the STOP LED will flash at 2-second intervals to request initialization.

1. Set the CPU to STOP mode.³¹
2. Is a Memory Card inserted? If yes, ensure that the MMC is not accessed by read/write operations. If required, disconnect all communication connections or switch to POWER OFF state. Now, remove the Memory Card from the CPU 31x module slot.
3. Insert the ("new") Memory Card into the CPU 31x module slot. Please note that the insertion marking on the memory card points to the marking on the CPU 31x (see the figure below).
4. Reset the memory of CPU 31x (refer to Chapter *Commissioning modules, Resetting CPU memory*)

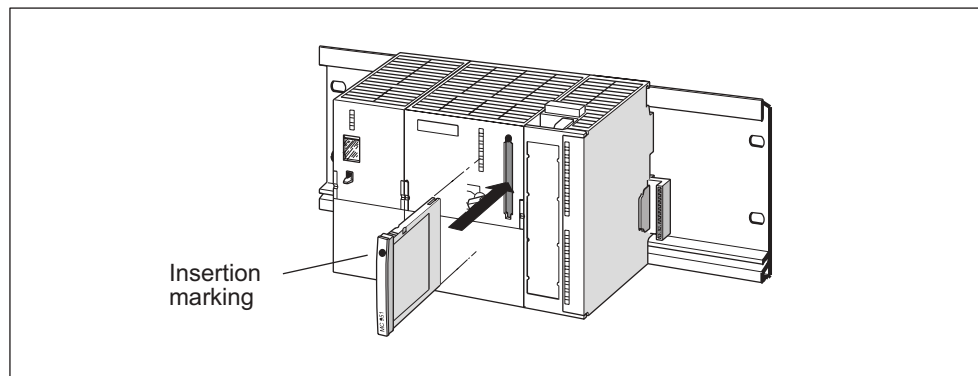


Figure 8-2 Inserting the Memory Card in the CPU31x

Inserting and removing a Memory Card (FEPRM) in POWER OFF Mode

If you remove a memory card in POWER OFF mode and insert another memory card with identical contents, the following happens after POWER ON:

CPU 318-2 (buffered)	CPUs 312 IFM to 316-2 DP
The CPU 318--2 goes into STOP mode and requests memory reset.	The CPU switches to the mode it was in prior to POWER OFF, that is, RUN or STOP.

Inserting/replacing a SIMATIC Micro Memory Card (MMC)

Note

Loading the user program and, therefore, operation of a CPUs 31xC is only possible if an MMC is inserted.

Removal of the MMC causes CPU 31xC to go into STOP mode and request memory reset.



Caution

Data on a SIMATIC Micro Memory Card can be corrupted if you remove the card during write access. In this case you might have to insert the MMC memory in your PG to delete it, or you format the card in the CPU.

Never remove an MMC in RUN mode. Always remove it in power off or CPU STOP state, when the PG does not write access the card. Disconnect the communication lines if you cannot safely exclude active write access functions from the PG (e.g. load/delete function block).

1. Set the CPU 31xC to STOP mode.
2. Is an MMC inserted?
 - If yes, make sure that no PG write access functions (e.g. load block) are active. If you cannot ensure this state, disconnect all communication lines of the CPU. Now, push in the ejector and remove the MMC.
 - In order to make it possible for you to remove the Micro Memory Card we have equipped the module slot socket with an ejector (refer to the Reference Manual *CPU Data*, figure in Chapter *Elements and Assembly of the CPU*).
 - Use a small screwdriver or pen to remove the MMC.
3. Insert the ("new") MMC into the MMC slot with the chamfered edge of the MMC pointing to the ejector.
4. Insert the MMC under slight pressure into the CPU 31xC until it latches.
5. Reset the memory of CPU 31xC (refer to Chapter *Commissioning Modules, Resetting CPU memory*)

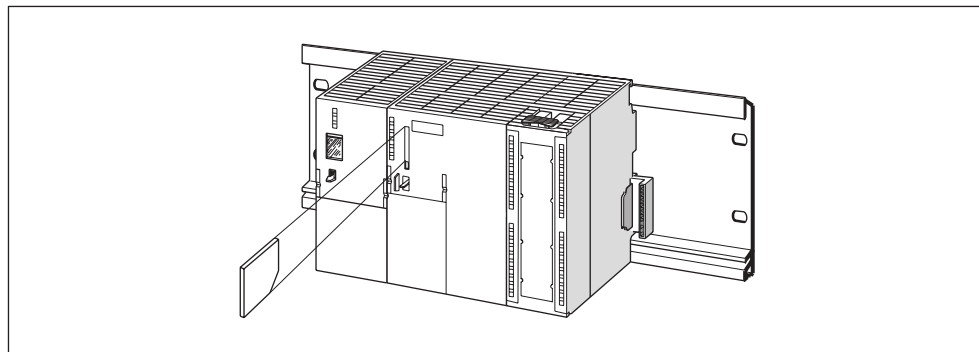


Figure 8-3 Inserting the Memory Card in the CPU31xC

Inserting/Removing an MMC in POWER OFF mode

If you replace the MMC in POWER OFF mode, CPUs 31xC

- will recognize a physically identical MMC with changed content

- a new MMC with content identical to the old MMC

After POWER ON, they request memory reset.

Also refer to the CPU Data Manual, Chapter *Structure and Communication Functions of CPU 31xC*, section *SIMATIC Micro Memory Card (MMC)*.

8.6 Commissioning modules

8.6.1 Connecting the PG

Prerequisite

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

Cable length

For information on possible cable lengths refer to the Chapter *Configuring; Cable Lengths*.

Connecting a PG to an S7-300

1. Connect the PG with a patch cable to the MPI of the CPU.

Alternatively, you can produce the connecting leads with PROFIBUS cable and bus connectors yourself (refer to Chapter *Wiring, Connecting Bus Connectors*).

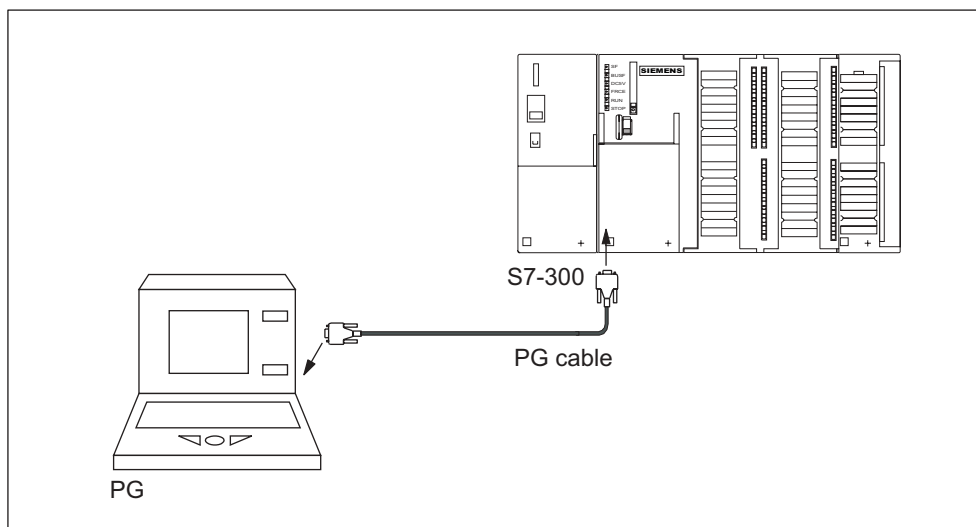


Figure 8-4 Connecting the PG to an S7-300

Connecting the PG to Several Nodes

Stationary PG

1. Use bus connectors to connect a stationary PG in the MPI subnet to the other nodes of the MPI subnet.

The figure below shows the interconnection of two networked S7-300s interconnected with bus connectors.

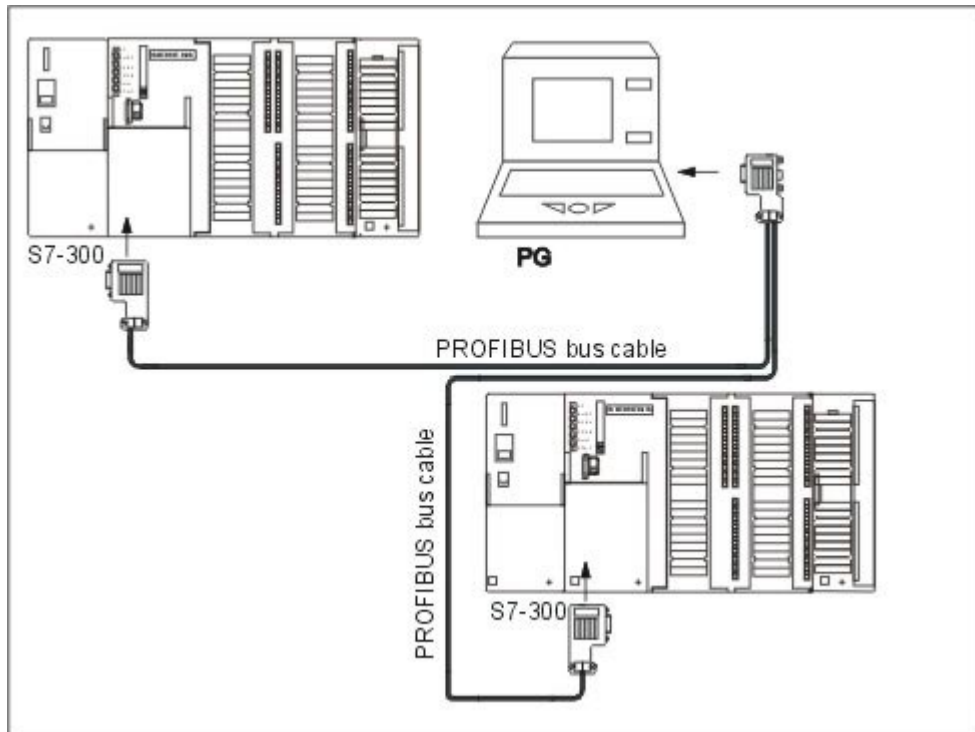


Figure 8-5 Connecting a PG to multiple S7-300 PLCs

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.

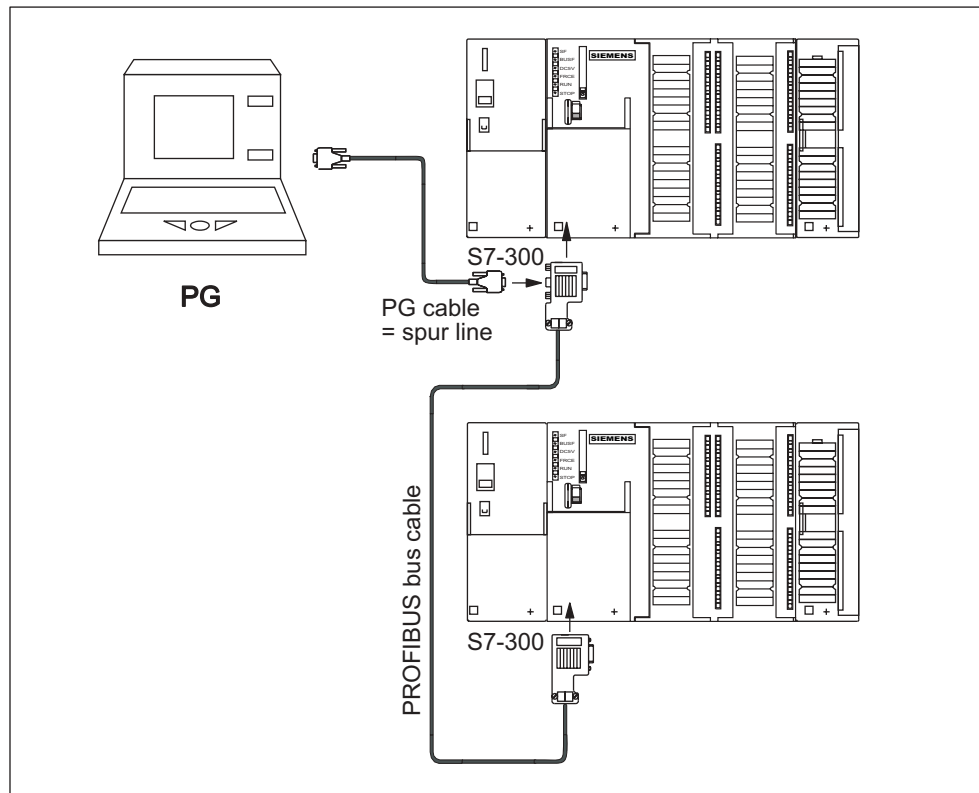


Figure 8-6 Connecting a PG to a subnet

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.

Connecting PGs to ungrounded nodes of an MPI subnet (not with CPUs 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.

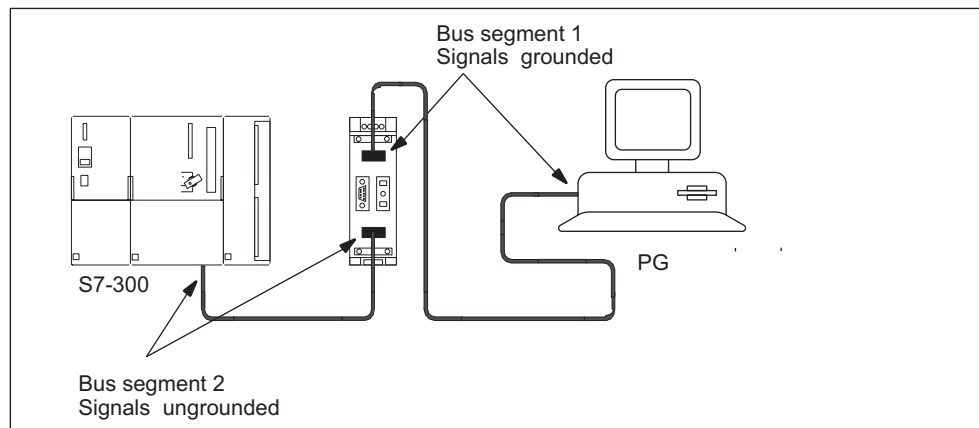


Figure 8-7 PG connected to an ungrounded S7-300

8.6.2 Initial power on

Prerequisites

- The S7-300 is installed and wired.
- A SIMATIC MMC is inserted in the S7-300 with CPU 31xC.
- The mode selector switch is set to STOP.

Initial Startup of CPUs 31x

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.

The BATF LED is lit if the backup battery is missing in the CPU (not with CPU 312 IFM, since not buffered).

Note

If you insert a Memory Card and a backup battery before power is on, the CPU also requests a memory reset after startup.

Initial Startup of CPUs 31xC

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.

8.6.3 Resetting CPU memory

When do you reset CPU memory?

You must reset 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	Remarks
The Memory Card or MMC has been replaced.	not with CPU 312 IFM / 314 IFM (314-5AE0x)
RAM error in CPU	–
Main memory too small, that is not all user program blocks on a Memory Card or MMC could be loaded.	CPU with inserted 5-V FEPRM Memory Card (not CPU 31x) With these causes the CPU requests one memory reset. After that, the CPU ignores the contents of the memory card, enters the error reasons in the diagnostics buffer and goes to STOP. You can erase or reprogram 5-V FEPRM Memory Card in the CPU.
Attempts to load faulty blocks; e.g. if the wrong instruction was programmed.	CPU 31xC with inserted MMC: Continuous request to reset memory. Additional information on MMC behavior after memory reset is found in the Reference Manual <i>CPU Data</i> , Chapter <i>memory Conception</i> .

How to reset memory

There are two ways of resetting CPU memory:

Memory reset with the mode selector switch	Memory reset with PG
... is described in this Chapter.	... only possible if the CPU is in STOP mode (see <i>STEP 7 Online Help</i>).

CPU memory reset with the mode selector switch

The table below shows the steps required for resetting CPU memory.

Table 8-4 Procedure for CPU memory reset

Step	Resetting CPU memory
1.	Turn the key to STOP position
2.	Turn the key to the MRES position and push it in 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 switch back to the MRES position and push it in within three seconds. Keep it in this position 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 only required if the user want to reset CPU memory, without being requested by the CPU to reset memory (slow flashing of the STOP LED). Memory reset requested by the CPU itself is started by briefly turning the mode selector switch to MRES position.

The figure below shows the sequence of operation.

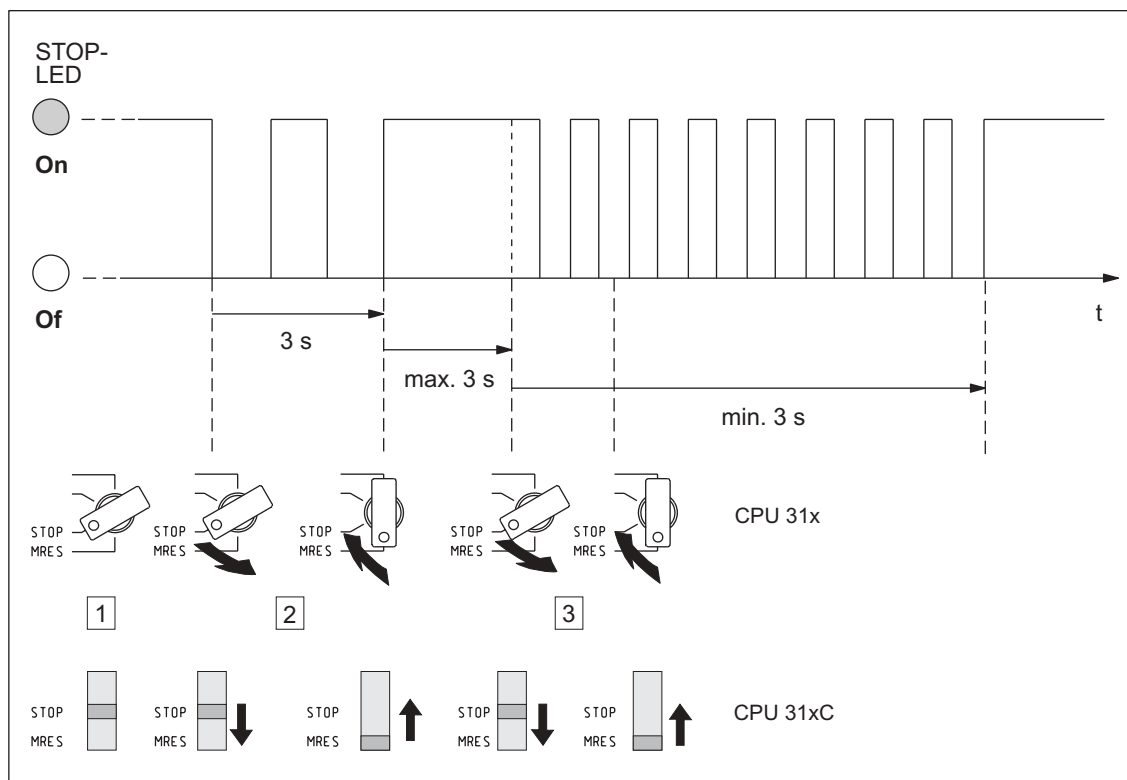


Figure 8-8 Sequence of operation for resetting CPU memory with the mode selector switch

In specific cases you might have to format the MMC if the CPU requests memory reset again after a successful reset. Refer to the CPU Data Manual, Chapter

Structure and Communication Functions, SIMATIC Micro Memory Card (MMC), section on Formatting an MMC on Memory Reset.

Is the STOP LED not flashing during memory reset?

What do I have to do if the STOP LED is not flashing during memory reset or if other LEDs are lit (Exception: BATF-LED)?

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

Cold restart with CPU 318-2 DP

With a CPU 318-2DP you can also perform a cold start instead of resetting the memory.

Cold start means:

- The data blocks in the working memory created by SFC 22 are deleted. The remaining data blocks have the default value from load memory.
- The process image as well as all timers, counters and memory bits are reset - irrespective of whether they were configured as retentive.
- OB 102 is processed.
- The process image of the inputs is read before the first instruction in OB1 is executed.

Step	Performing a Cold Start
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.	Within 3 seconds you must turn the switch to the RUN position. During Startup the RUN LED flashes at 2 Hz.

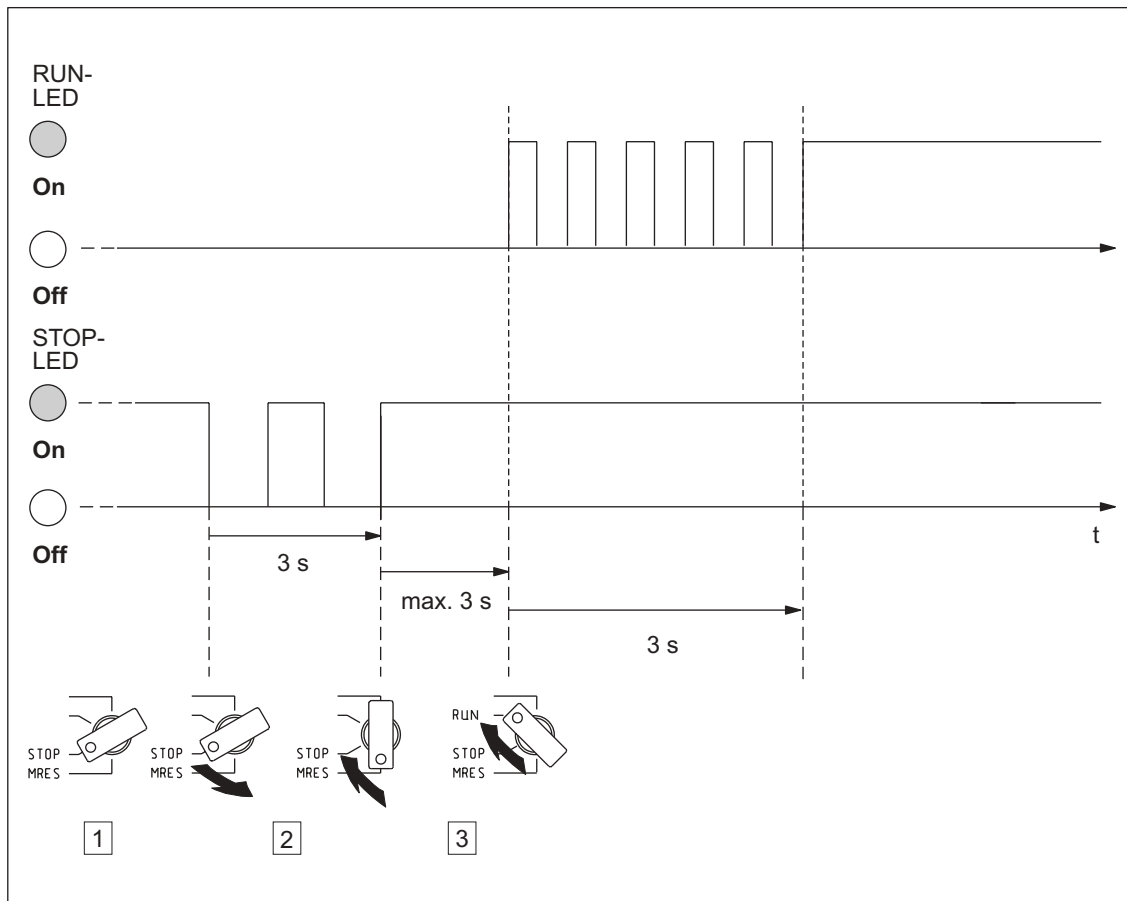


Figure 8-9 Sequence of operation for cold start with the mode selector switch (CPU 318-2DP only)

What happens in the CPU during memory reset?

Table 8-5 Internal CPU events on memory reset

Event	CPU 313 / 314 / 314 IFM (314-5AE10) / 315 / 31x-2 DP / CPU 31xC	CPU 312 IFM / 314 IFM (314-5AE0x)
CPU activities	1.	The CPU deletes the complete user program in main memory and RAM load memory.
	2.	The CPU deletes the retentive data.
	3.	The CPU tests its own hardware.
	4.	If a Memory Card or an MMC is inserted, the CPU copies its runtime relevant data to main memory. Tip: If the CPU cannot copy the data on Memory Card or MMC and requests memory reset: <ul style="list-style-type: none"> Remove the Memory Card or MMC Resetting CPU memory Read the diagnostic buffer.

Event	CPU 313 / 314 / 314 IFM (314-5AE10) / 315 / 31x-2 DP / CPU 31xC	CPU 312 IFM / 314 IFM (314-5AE0x)
Memory contents after reset	The status of CPU memory space is "0". If a Memory Card or MMC has been inserted, the user program is transferred again to main memory.	The user program is loaded back into the RAM from the integrated retentive EPROM of the CPU.
What's left?	Data in the diagnostics buffer. You can read the diagnostic buffer with the PG (see <i>STEP 7 Online Help</i>).	
	The MPI parameters (MPI address and highest MPI address, transmission rate, configured MPI addresses of CPs/FMs in an S7-300).	
	The contents of the operating hours counter (not for CPU 312 IFM).	

Special feature: MPI parameters

MPI parameters hold a special position when memory is reset. The table below describes MPI parameters remaining valid after memory reset.

Memory reset ...	MPI parameters
with inserted Memory Card (MMC)	... located on the memory card or on the integrated FEPRM of the CPU are valid. If this location does not contain parameter data (SDB), the previously set parameters stay valid.
With integrated FEPRM load memory (CPU 312 IFM / 314 IFM (314-5AE0x))	
Without Memory Card (MMC)	... are retained and valid.

CPU 312 IFM and 314 IFM: Erasing the integrated EPROM

If you wish to erase the contents of the integrated EPROM, proceed as follows:

1. Use menu command **View > online** to open the online window for viewing an open project
or
open the window **Available nodes** with a click on the **Available nodes** toolbar button or select the menu command **PLC > Show available nodes**.
2. Select the MPI number of the target CPU (double-click).
3. Select the **Modules** container.
4. Select the menu item **Edit > Select all**.
5. Then select the menu command **File > Delete** or press the DEL key. This deletes all selected blocks from target memory.
6. Select the MPI number of the target CPU.
7. Select the menu command **PLC > Copy RAM to ROM**.

These commands delete all blocks online and overwrite the EPROM with the blank contents of the RAM.

8.6.4 Starting SIMATIC Manager

Introduction

SIMATIC Manager is a GUI for online/offline editing of S7 objects (projects, user programs, blocks, HW 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 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 respective 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.

8.6.5 Monitoring and controlling I/Os

The tool "Monitoring and Controlling a Variable"

The STEP 7 tool "Monitoring and Controlling a Variable" lets you

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

create a variable table

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

- in the LAD/FBD/STL Editor via menu item **PLC > Monitor/control variable**
This table is also available directly online
- in SIMATIC Manager with open **Blocks** container 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 operand to be monitored or controlled (e.g. inputs, outputs) occupies one row.

The meaning of the VAT columns is as follows:

Column text	This field ...
Operand	contains the absolute address of the variable
Symbol	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: <ul style="list-style-type: none"> • 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
Control value	is used to enter the new variable value (control value)

Monitoring variables

You have two options of 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**

Controlling variables

To control variables, proceed as follows:

1. Left-click the field **Control value** of the respective variable.
2. Enter the control value according to the data type.
3. To update control values once, select the menu item **Variable > Enable control values**.

or

Enable control values permanently via menu item **Variable > Control**.

4. In the **Monitor** test function, verify the control value entry in the variable.

Is the control value valid?

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

Only valid control 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 controlling" determines the time for assigning the control values to the variables to be controlled.

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 controlling" determines whether to assign control values once or permanently to the variable to be controlled.

You can customize the trigger points using the tool "Monitor and control 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 value** or **Variable > Monitor** have the same effect, namely a single update.
- If "Trigger condition for controlling" is set to **once**, the menu items **Variable > Update control value** or **Variable > Control** have the same effect, namely a one-time assignment.
- If trigger conditions are set to **permanent**, the said menu items have different effects as described above.
- If monitoring and controlling 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 the VAT

1. After you abort or complete 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 the 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 respective 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 control variables it is required to establish a connection to the respective 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 (HW 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. Menu item PLC > Connect to ... > Available CPU ... is used to establish a connection to any CPU available on the network.

Controlling outputs in CPU STOP mode

The function **Enable PO** switches off output disable for the peripheral outputs (PO), thus enabling control 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 control, or activate the window containing the corresponding VAT.
2. To control the PO of the active VAT, select the CPU connection in menu command **PLC > Connect to ...** .
3. Use menu command **PLC > Mode** to open the **Mode** dialog and switch the CPU to STOP mode.
4. Enter your values in the "Control value" column for the PO you want to control.
Example:
PO: POB 7 control 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. Control the PO via menu item **Variable > Enable control 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.

8.7 Commissioning PROFIBUS-DP

8.7.1 Commissioning PROFIBUS-DP

Prerequisites

Prerequisite 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 respective DP slave).
- Software requirements are shown in the table below, depending on the CPU:

Table 8-6 Software requirements

CPU	Software required
315-2 DP	as of <i>STEP 7 V 3.1</i> as of <i>COM PROFIBUS V 3.0</i>
316-2 DP	as of <i>STEP 7 V 5.x</i>
318-2 DP	as of <i>COM PROFIBUS V 5.0</i>
313C-2DP	as of <i>STEP 7 V 5.1 + SP 2</i>
314C-2DP	as of <i>COM PROFIBUS V 5.0</i>

DP address areas of the CPUs

Table 8-7 DP address areas of the CPUs

Address area	315-2 DP 313C-2 DP 314C-2 DP	316-2 DP	318-2 DP
DP address area for I/Os	1024 bytes	2048 bytes	8192 bytes
Number of those in the I/O process image	Bytes 0 to 127	Bytes 0 to 127	Byte 0 to 255 (default), configurable up to byte 2047

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 respective node (LADDR parameter of SFC13). The DP diagnostic addresses are specified in your configuration. If you do not specify any DP diagnostic addresses, *7 STEP 7* assigns these DP diagnostic addresses, starting at the highest byte address downwards .

With CPU 31xC-2DP as master/ CPUx>=3 as master with DPV1 configuration you assign two different diagnostic addresses to S7 slaves:

- Diagnostic address of the slave (address for slot 0)
At this address all slave events are reported in the DP master (station representative), e.g. station 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.

8.7.2 Commissioning the CPU as DP Master

Prerequisites for commissioning

- The PROFIBUS subnet has been configured.
- The DP slaves are ready for operation (see relevant DP slave manual).
- An MPI/DP interface as DP interface must be configured accordingly (only CPU 318-2).
- 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 a CPU 31x-2 DP/31xC-2 DP a DP Slave?

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

Commissioning

Commission CPU 31x-2 DP/31xC-2 DP as DP master in the PROFIBUS subnet as follows:

1. Download the PROFIBUS subnet configuration (preset configuration) you have created in *STEP 7* from the PG to CPU 31x-2 DP/31xC-2 DP.
2. Switch on all of the DP slaves.
3. Switch CPU 31x-2 DP/31xC-2 DP from STOP to RUN mode.

Startup of CPU 31x-2 DP/31xC-2 DP as DP Master

On startup, CPU 31x-2 DP/31xC-2 DP compares the preset configuration of your DP master systems to the actual configuration.

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

If the preset configuration \neq to the actual configuration, the configuration of parameter **Startup if preset configuration \neq actual configuration** determines the Startup behavior of the CPU.

Startup with preset configuration \neq actual configuration = yes (Default setting)	Startup with preset configuration \neq actual configuration = no
CPU 31x-2 DP/31xC-2 DP switches to RUN mode. (BUSF LED flashes if any of the DP slaves cannot be addressed)	CPU 31x-2 DP/31xC-2 DP remains in STOP mode. On expiration of the Monitoring time for parameter transfer to modules the BUSF LED starts flashing. 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 <i>STEP 7</i> .

Recognizing the operating state of DP Slaves (Event recognition)

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

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)	<ul style="list-style-type: none"> 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 \rightarrow STOP	<ul style="list-style-type: none"> 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 \rightarrow RUN	<ul style="list-style-type: none"> 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 OB 82 and 86. 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.

Equidistance

As of *STEP 7 V 5.x* you can configure equidistant lengths for PROFIBUS subnet bus cycles. Details on equidistance are found in the *Step 7 Online Help*.

Startup of the DP master system

CPU 315-2 DP / 316-2 DP / 31xC-2 DP is DP master	CPU 318-2 DP is DP master
Customize the Startup monitoring time for DP slaves in parameter Monitoring time for parameter transfer to modules .	Customize the Startup monitoring time for DP slaves in parameters Monitoring time for parameter transfer to modules and Module reports ready .
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

With CPU 31x-2 DP/31xC-2 DP do not set "126" as PROFIBUS address.

8.7.3 Commissioning the CPU as DP slave

Prerequisites for commissioning

- The DP master is configured and programmed.
- If the MPI/DP interface of CPU 318-2 DP is to be operated as DP interface, you must configure the interface accordingly.
- You must program and configure CPU 31x-2 DP/31xC-2 DP as DP slave prior to commissioning. That is, in *STEP 7* you must:
 - "switch 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.

GSD Files

When working on an IM 308-C or non-Siemens system, you require a GSD file in order to be able to configure CPU 31x-2 DP/31xC-2 DP as DP slave in a DP master system.

COM PROFIBUS as of V 4.0 includes this GSD file.

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

- Internet URL <http://www.ad.siemens.de/csi/gsd>
- or
- via modem from the **SSC (Interface Center)** Fürth, Germany; Phone number (0911) 911/737972

Configuration and parameter assignment message frame

STEP 7 supports you in configuring/programming CPU 31x-2 DP/31xC-2 DP.

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 CPU 31x-2 DP/31xC-2 DP as 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.

Startup of CPU 31x-2 DP/31xC-2 DP as DP slave

When the CPU 31x-2 DP/31xC-2 DP is switched to RUN, two 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 CPU 31x-2 DP/31xC-2 DP as DP slave recognizes operating mode transitions or data exchange interrupts.

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)	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 OB 82 and 86. 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. To do so, you must enable these functions when configuring the CPU as a DP slave in *STEP 7*. This is not required for CPU 300 C.

Note

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

Data Transfer via Intermediate Memory

CPU 31x-2 DP/31xC-2 DP as DP slave provides an intermediate memory for PROFIBUS-DP communication. All data exchange between the CPU as DP slave and the DP master takes place via this intermediate 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.

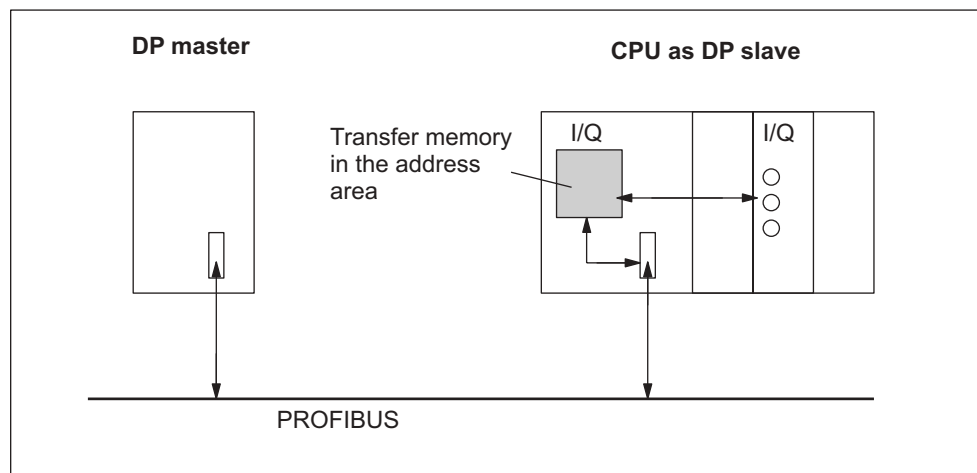


Figure 8-10 Intermediate memory in CPU 31x-2 DP/31xC-2 DP as DP Slave

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				In the DP Master CPU			
L	2						
T	MB	6					
							Data pre-processing in the DP Slave
L	IB	0					
T	MB	7					
L	MW	6					Passing data to the DP master
T	PQW	310					
				L	PIB	222	// processing data received in the DP Master
				T	MB	50	
				L	PIB	223	
				L	B#16#3		
				+	I		
				T	MB	51	
				L	10		//Data pre-processing in the 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	


```

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

```

Working with intermediate 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 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 intermediate memory addresses taken from the DP address area of CPU 31x-2 DP/31xC-2 DP.

Addresses assigned to intermediate memory cannot be assigned again to I/O modules of CPU 31x-2 DP/31xC-2 DP. When using consistent data areas in intermediate memory, note the section on *Consistent Data* in Chapter *Addressing*.

S5 DP Master

When exchanging consistent data with IM 308-C operating as DP master and CPU 31x-2 DP/31xC-2 DP as DP slave, note that:

You must program FB192 in IM 308-C to enable exchange of consistent data between a DP master and the DP slave. FB192 reads or outputs CPU 31x-2 DP/31xC-2 DP data only in a single continuous block.

S5-95 as DP Master

Bus parameters of an AG S5-95 operated as DP master must also be set in CPU 31x-2 DP/31xC-2 DP operating as 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

With CPU 31x-2 DP/31xC-2 DP do not set "126" as PROFIBUS address.

8.7.4 Direct data exchange

Prerequisite

In 7 STEP 7 V 5.x or later, you can configure "Direct data exchange" for PROFIBUS nodes. CPUs 31x-2 DP/31xC-2 DP can participate in direct data exchange both as sending or receiving station.

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 respective peripheral input addresses, specify which address area of the receiving station is to receive data requested from the sending station.

A CPU 31x-2 DP/31xC-2 DP can operate as:

- 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. In the figure, all DP masters DP slaves are a CPU 31x-2 DP/31xC-2 DP respectively. Note that other DP slaves (ET 200M, ET 200X, ET 200S) can only operate as sending station.

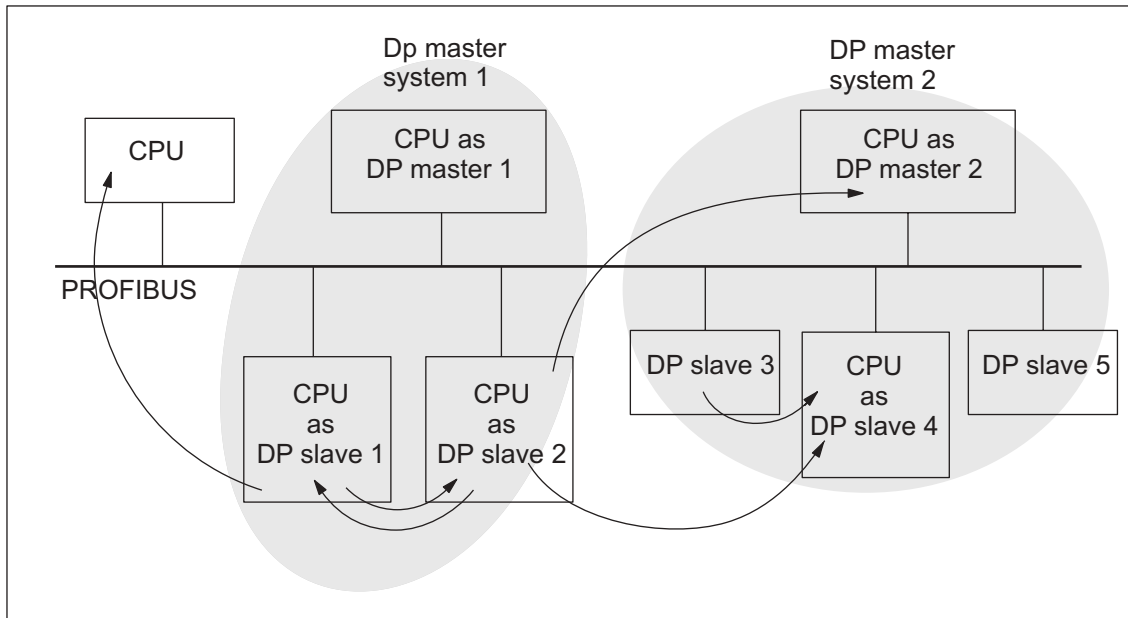


Figure 8-11 Direct Data Exchange with CPUs 31x-2 DP/31xC-2 DP

9.1 In this Chapter

Maintenance = operating system backup/update, replacement of modules and fuses

S7-300 is a maintenance-free PLC.

Therefore, maintenance is to be considered as:

- Backup of the operating system on Memory Card (MC) or Micro Memory Card (MMC)
(depending on the CPU type)
- Operating system update from MC or MMC
- Replacement of modules
- Replacement of the backup/rechargeable battery (not with CPU 312 IFM and CPU 31xC)
- Replacement of the fuses in digital output modules

In this chapter

we show you how to backup or update your operating system and to replace modules, the backup/rechargeable battery and the 120/230 VAC fuse of the digital output module.

9.2 Operating System Backup

In which situations should I backup the operating system?

For example, you should backup the operating system of your system CPU if you want to replace it with a standby CPU and ensure that the operating system is identical in the replacement CPU.

It is also highly recommended to generate a backup copy of the operating system for emergency situations.

Which CPUs allow me to backup the operating system?

You can backup the operating system as of the following CPU versions:

CPU	Order No.	Firmware	Required MC/MMC
313	as of 6ES7313-1AD03-0AB0	as of V 1.0.0	MC \geq 1 Mbyte
314	as of 6ES7314-1AEx4-0AB0	as of V 1.0.0	MC \geq 1 Mbyte
314 IFM	as of 6ES7314-5AE10-0AB0	as of V 1.1.0	MC \geq 2 Mbyte
315	as of 6ES7315-1AF03-0AB0	as of V 1.0.0	MC \geq 1 Mbyte
315-2 DP	as of 6ES7315-2AFx3-0AB0	as of V 1.0.0	MC \geq 2 Mbyte
316-2 DP	as of 6ES7316-2AG00-0AB0	as of V 1.0.0	MC \geq 2 Mbyte
312C	as of 6ES7312-5BD00-0AB0	as of V 1.0.0	MMC \geq 2 Mbyte
313C	as of 6ES7313-5BE00-0AB0	as of V 1.0.0	MMC \geq 2 Mbyte
313C-2DP	as of 6ES7313-6CE00-0AB0	as of V 1.0.0	MMC \geq 4 Mbyte
313C-2 PtP	as of 6ES7313-6BE00-0AB0	as of V 1.0.0	MMC \geq 2 Mbyte
314C-2DP	as of 6ES7314-6CF00-0AB0	as of V 1.0.0	MMC \geq 4 Mbyte
314C-2PtP	as of 6ES7314-6BF00-0AB0	as of V 1.0.0	MMC \geq 2 Mbyte

A backup of the operating system is **not** possible with CPU 318-2 DP.

Operating system backup on Memory Card or Micro Memory Card

How to backup the operating system:

Table 9-1 Backup of the operating system on MC or MMC

Step	Action required	CPU Response
1.	Insert a new Memory Card or Micro Memory Card into the CPU.	The CPU requests memory reset
2.	Turn the mode selector switch to MRES position and hold it there.	-
3.	POWER OFF / POWER ON. Hold the mode selector switch in MRES position until the STOP, RUN and FRCE LEDs start flashing.
4.	Mode selector switch to STOP position.	-

Step	Action required	CPU Response
5.	Mode selector switch briefly to MRES position, then let it return to STOP.	<ul style="list-style-type: none"> • The CPU starts backup of the operating system to MC/MMC. • All LEDs are lit during backup. • The STOP LED flashes to indicate successful backup. The CPU requests memory reset.
6.	Remove the Memory Card or Micro Memory Card.	-

9.3 Updating the Operating System

In which situations should I update the operating system?

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

Where do I get the latest version of the operating system?

You can obtain the latest operating system versions from your Siemens partner or from the Internet (Siemens Homepage; Automation and Drives, Customer Support).

Tip: Backup your operating system before you update it

Backup your existing operating system to an empty MC/MMC before you start the update (see previous Chapter). This allows you to reload the "old" operating system in case you meet any problems.

Updating the Operating System

How to update the operating system (OS):

Table 9-2 Operating system update with MC/MMC

Step	Action required	CPU Response
1.	Using STEP 7 and your programming device, transfer the update files to an empty MC/MMC.	-
2.	Remove the backup/rechargeable battery from respective CPUs.	-
3.	Switch off the CPU power supply and insert the MC/MMC that contains the OS update.	-
4.	POWER ON.	<ul style="list-style-type: none"> • The CPU automatically recognizes the MC/MMC and the OS update and then starts the update. • All LEDs are lit during OS update. • The STOP LED starts flashing on successful OS update. The CPU requests memory reset.
5.	Switch off the CPU power supply and remove the MC/MMC that contains the OS update.	-
6.	Reinsert the backup/rechargeable battery into the respective CPUs.	-

9.4 Module replacement

Rules for Installation and Wiring

The table below draws your attention to 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 profile rail	from 0.8 N/m to 1.1 N/m		from 0.8 N/m to 1.1 N/m
• Connecting cables	from 0.5 N/m to 0.8 N/m		–
POWER OFF when replacing the ...	Yes		No
S7-300 operating mode when replacing ...	–		STOP
Load voltage OFF when replacing the ...	Yes		Yes

Initial Situation

The module you want to replace is installed and wired. You want to install a new module of the same type.



Warning

Disturbances can corrupt data if you insert or remove S7-300 modules while data is transferred via MPI.

Do not replace S7-300 modules while there is data traffic on the MPI.

If you are not certain whether or not data transfer is active on the MPI, unplug the connector on the MPI before you replace the module.

Removing a 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 (5) with one hand, with the other hand pull out the front connector at the grips (5a).	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.	

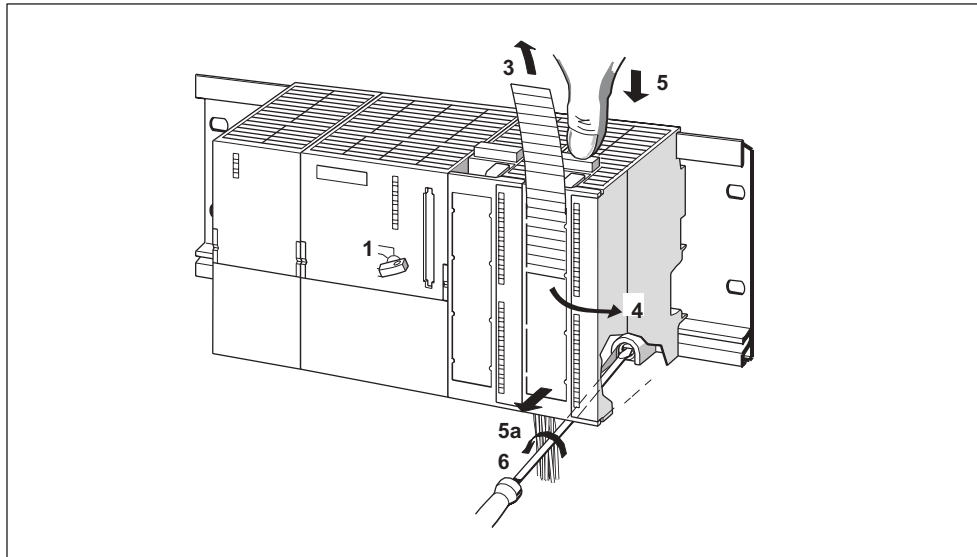


Figure 9-1 Unlocking the front connector and removing the module

Removing the front connector coding pin from the module

Before you start installation of the new module, remove the upper part of the front connector coding pin from this module (see the figure below).

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

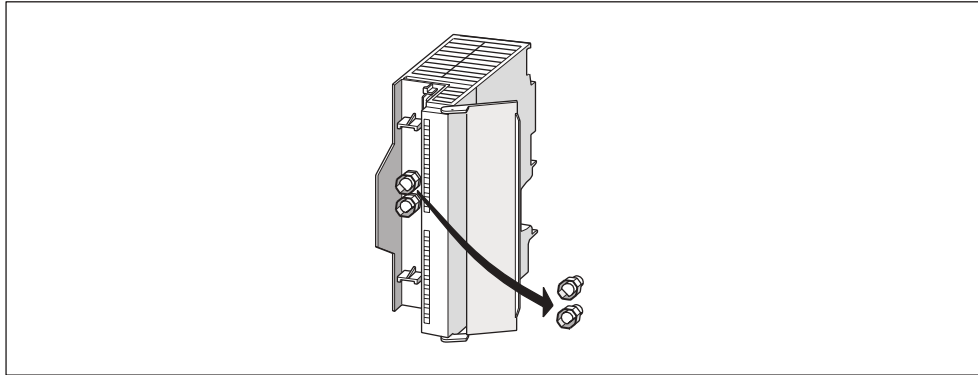


Figure 9-2 Removing the front connector coding pin

Installing a new module

Install the new module as follows:

1. Insert the new module of the same type and swing it down into place.
2. Screw-tighten the module.
3. Slip the labeling strip of the removed module into its guide on the new module.

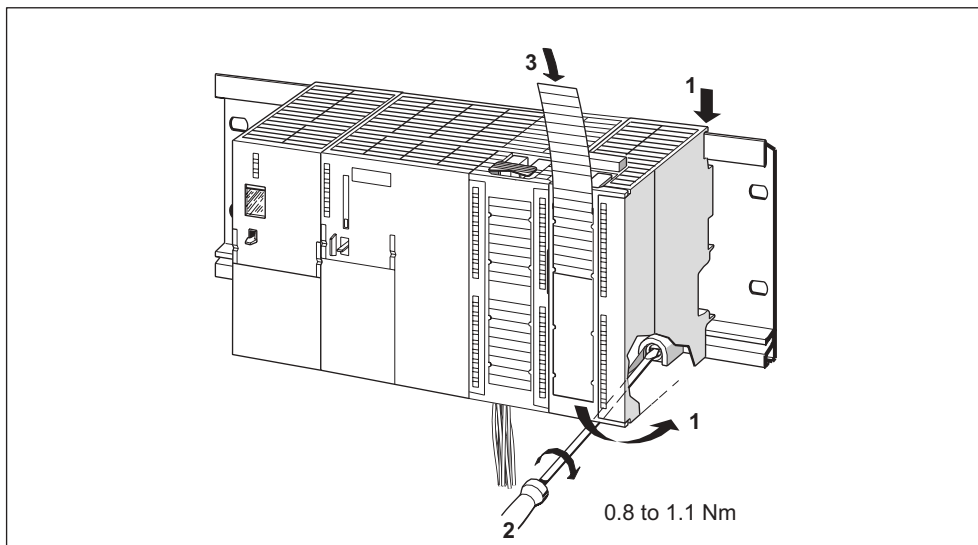


Figure 9-3 Installing a new module

Removing the Front Connector Coding

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. Set the CPU to RUN mode again.

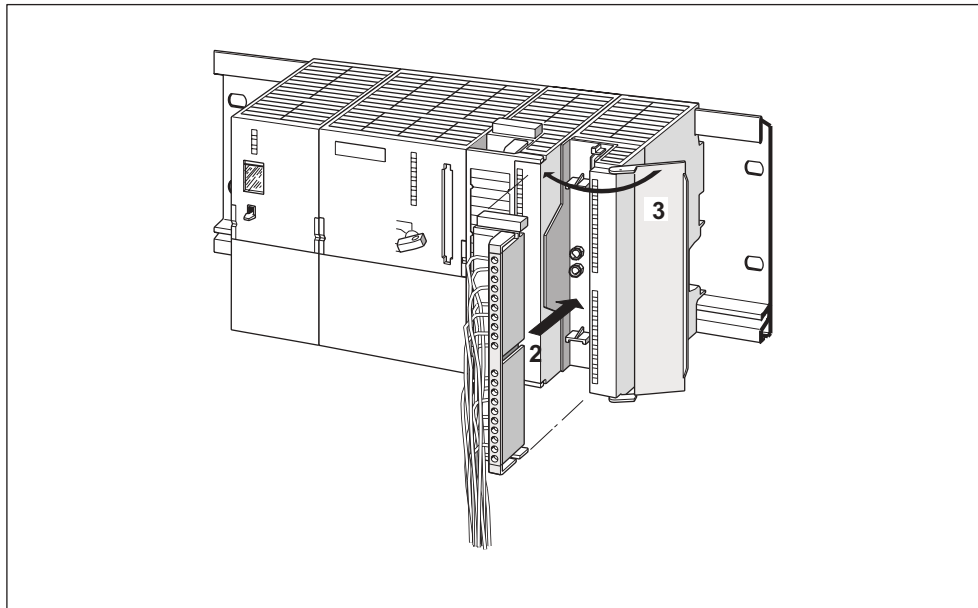


Figure 9-4 Inserting the front connector

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).

9.5 Replacing the backup/rechargeable battery (not CPU 312 IFM and CPUs 31xC)

Replacing the backup battery or the rechargeable battery

Always replace the backup/rechargeable battery in POWER ON state of the CPU, in order to avoid data loss in internal memory or stopping the real-time clock.

Note

Data in internal main memory will be lost if you replace the backup battery in POWER OFF state of the CPU.

Always replace the backup battery in POWER ON state!

Replace the backup/rechargeable battery as follows:

Step	CPU 313/314	CPU 314 IFM/315/315-2 DP/ 316-2 DP/318-2 DP
1.	Open the front panel of the CPU.	
2.	Pull the backup battery/accumulator out of the compartment with a screwdriver.	Pull the backup/rechargeable battery out of the compartment with its cable.
3.	Plug the connector of the new backup/rechargeable battery into the corresponding socket in the battery compartment of the CPU. The notch on the battery connector must show towards the left hand side.	
4.	Insert the new backup/rechargeable battery into the battery compartment of the CPU.	
5.	Close the front door of the CPU.	

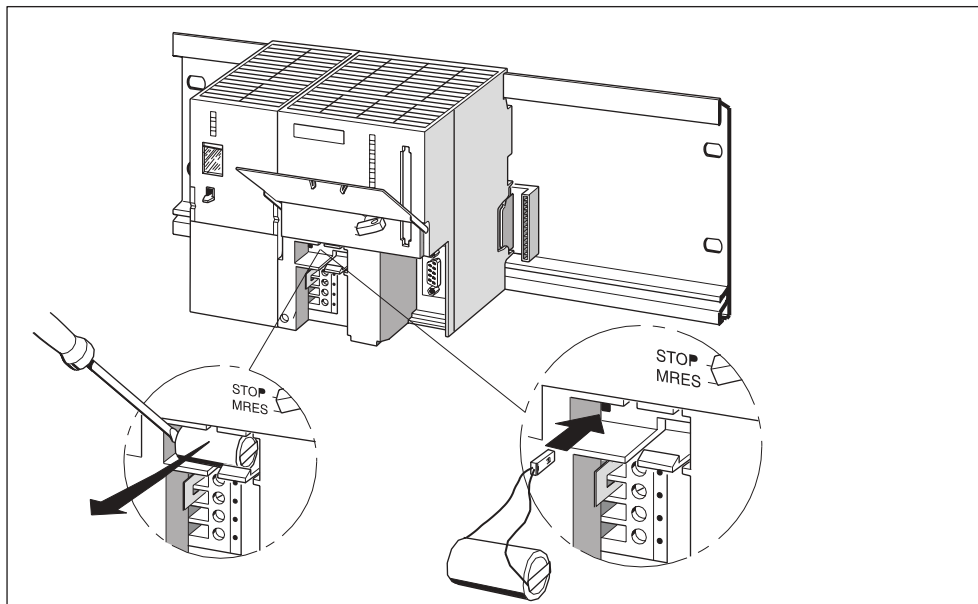


Figure 9-5 Replacing the backup battery in CPU 313/314

How often do I have to replace it?

Backup battery: We recommend an annual replacement

Rechargeable battery: Never needs to be replaced.

Disposal

Note your local regulations/guidelines on battery disposal.

Storing backup batteries

Store backup batteries in a dry and cool place.

The shelf life of backup batteries is five years.



Warning

If heated or damaged, backup batteries can ignite or explode and cause severe burning injury.

Store backup batteries in a dry and cool place.

Rules for the handling of backup batteries

To avoid risk of danger when handling backup batteries, note the following rules:



Warning

Improper handling of backup batteries can cause injuries and property damage. Improperly handled backup batteries can explode and cause severe burns.

Do not

- charge
 - heat up
 - incinerate
 - drill through
 - squash
 - short-circuit backup batteries.
-

Rules for handling the rechargeable battery

Do not charge rechargeable batteries in devices other than the CPU. The rechargeable battery must always be charged in the CPU, in POWER ON state of the CPU.

9.6 Digital output module AC 120/230 V: 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 × A 120 230 V

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 can cause injuries and property damage.

Beware of dangerous live voltage > 25 VAC or > 60 VDC underneath the cover at the right hand side of the module.

Always unplug the front connector or disconnect the module's power supply before you open these covers.



Warning

Improper handling of front connectors can cause injuries and property damage.

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.

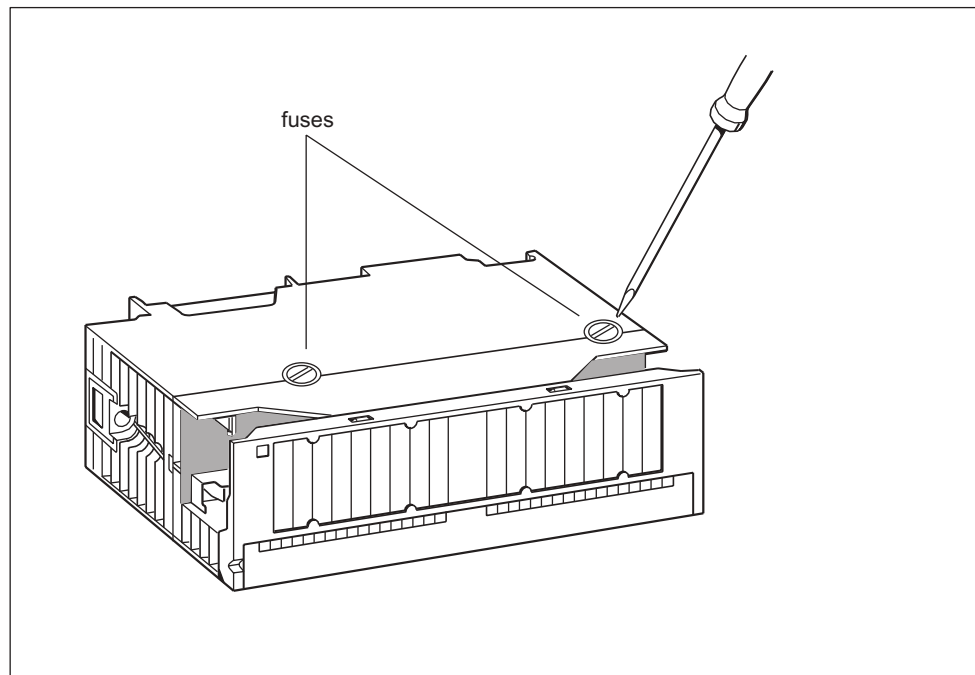


Figure 9-6 Location of fuses in the digital output module 120/230 VAC

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.
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 In this Chapter

Introduction

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 respective hardware/software manuals.

10.2 Overview: Testing functions

Software testing functions: Monitoring and controlling of variables, single-step mode

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

- Monitoring and controlling 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 permissible 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

Can cause severe injury or even death and damage to assets.

When executing the force functions, improper handling can be extremely hazardous to life or health of persons or can cause damage to the machine or the plant as a whole. Please adhere to the safety notice in the *STEP 7 Manuals*.



Danger

Forcing with S7-300 CPUs (without CPU 318-2 DP)

Force values of the **input** process image can be overwritten by write instructions (e.g. T EB x, = E x.y, copying with SFC etc.), peripheral read instructions (e.g. L PEW x) in the user program and by write functions of the PG/OP! **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!

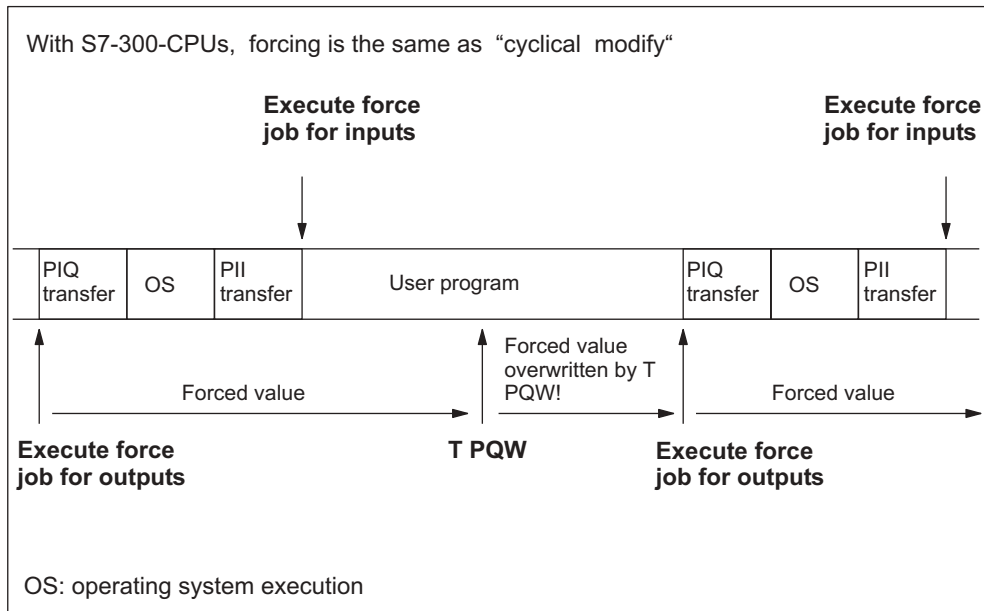


Figure 10-1 Principle of Forcing with S7-300 CPUs (all CPUs except 318-2 DP)

Differences between Forcing and Controlling of Variables

Table 10-1 Differences between Forcing and Controlling of Variables

Characteristics/Function	Forcing with CPU 318-2 DP and S7-400	Forcing with S7-300 without 318-2 DP	Controlling Variables
Memory bit (M)	Yes	-	Yes
Timers and counters (T, C)	-	-	Yes
Data Blocks (DB)	-	-	Yes
Inputs and outputs (I, Q)	Yes	Yes	Yes
Peripheral Inputs (PI)	Yes	-	-
Peripheral Outputs (PO)	Yes	-	Yes
User program can overwrite control/force values	-	Yes	Yes
Maximum number of force values	256	10	-

Cross-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

Introduction

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.

Errors during **operation** are almost always a result of faults or damage to the hardware.

Types 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 two 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:

- Green LEDs report regular operation (e.g. supply voltage is applied).
- Yellow LEDs indicate special operating states (e.g. "Force" is active).
- Red LEDs report errors (e.g. bus error)

A flashing LED also indicates a special event (e.g. memory reset).

Cross-reference

Notes on diagnostics with LEDs are found in the Chapter below.

Notes on diagnostics of I/O modules capable of diagnostics are found in the respective 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.

Diagnostic-capable 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 sample above.

Diagnostics with System Functions

The four most important options of 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 SFC13 "DPNRM_DG"

Every DP slave provides slave diagnostic data according to EN 50 170 Volume 2, PROFIBUS. You can use SFC13 "DPNRM_DG" to read these diagnostic data. Error information is stored in hex code. Refer to the respective 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 SFC59 "RD_REC"

You can use SFC59 "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 diagnostic-capable 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 SFC6 "RD_SINFO"
- Error information is also found in the start information of the respective error OB.

You can use SFC6 "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 Startup OB that was last called.

10.4 Diagnostic options with STEP 7

The "Hardware diagnostics" function

Localize the cause of a module error by viewing the online information on the module. You can localize 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 symbols 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.

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/Os, memory bits, counters, timers and blocks).

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

10.5 Diagnostics with LEDs

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. Here you can find, for example, the number of the matching error OB. You can prevent the CPU from switching to STOP mode by generating this OB.

CPU status and error displays

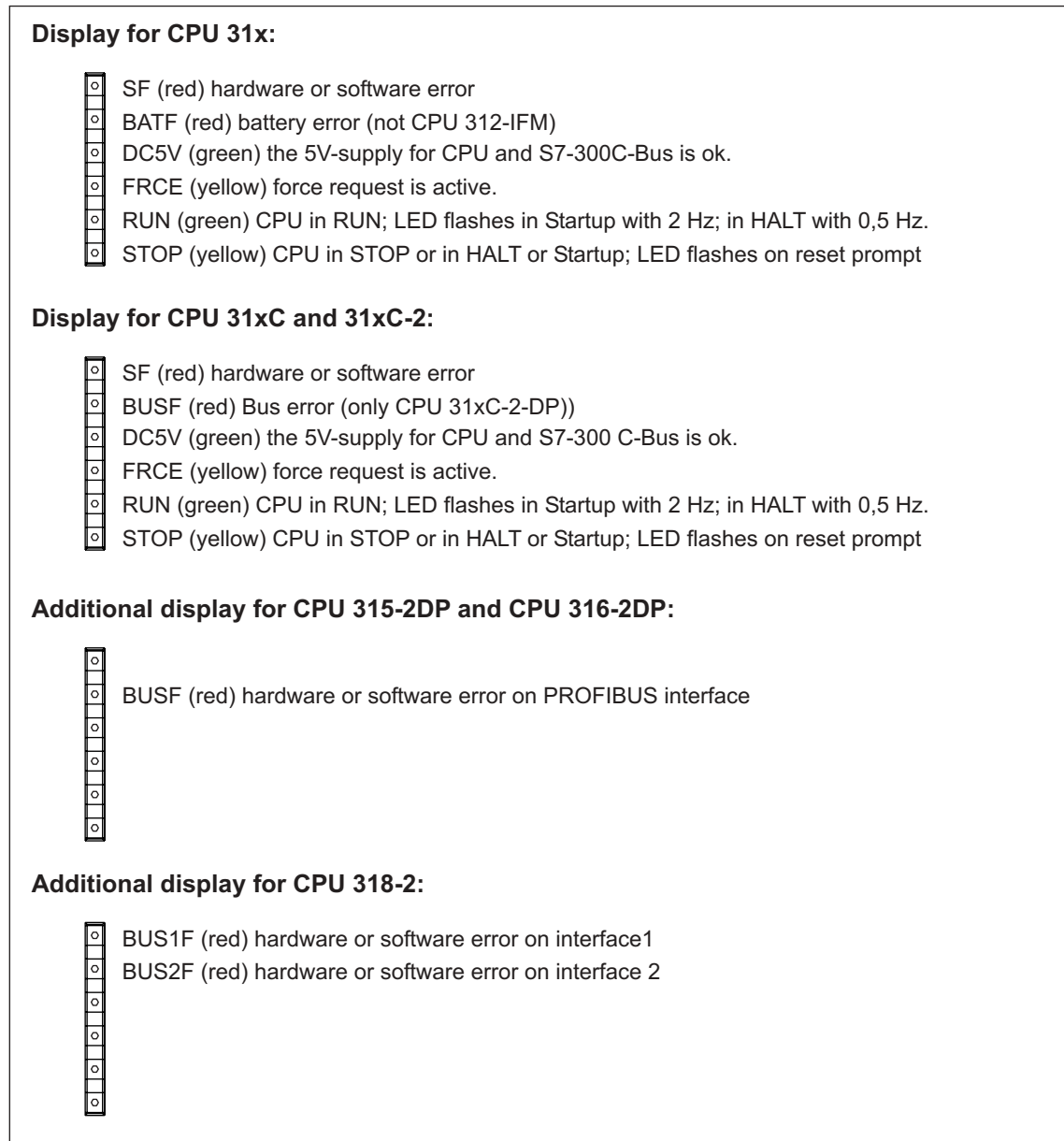


Figure 10-2 Status and error displays of 31xC CPUs

Status and error displays of all CPUs

Table 10-2 Status and error displays

LED					Description
SF	5 VDC	FRCE	RUN mode	STOP	
LED off	LED off	LED off	LED off	LED off	CPU power supply missing. Remedy: Check whether the power supply module is connected to mains and switched on. Check whether the CPU is connected to the power supply module and switched on.
LED off	On	X (see the description)	LED off	On	The CPU is in STOP mode. Remedy: Start the CPU.
On	On	X	LED 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	LED off	Flashes (0.5 Hz)	The CPU requests memory reset.
X	On	X	LED off	Flashes (2 Hz)	The CPU executes memory reset.
X	On	X	Flashes (2 Hz)	On	The CPU is in Startup mode.
X	On	X	Flashes (0.5 Hz)	On	The CPU was halted by a programmed break point. For details refer to the Programming Manual <i>Programming with STEP 7</i> .
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 <i>Programming with STEP 7</i> .

Description of status X:

This status is irrelevant for the current CPU function.

Table 10-3 Evaluation of the SF LED (Software error)

Possible Errors	Reaction of the CPU	Remedies
TOD interrupt is enabled and triggered. However, a matching block is not loaded.(Software/ configuration error)	OB 85 call. CPU goes into STOP if OB 85 is not loaded.86	Loading OB 10 or 11 (CPU 318-2 only) (OB number can be viewed in the diagnostic buffer).
Start time of the enabled TOD interrupt was jumped, e.g. by advancing the internal clock.	OB 80 call. CPU goes into STOP if OB 80 is not loaded.	Disable the TOD interrupt before you set the time-of-day with SFC29.
Delay interrupt triggered by SFC 32. However, a matching block is not loaded. (Software/ configuration error)	OB 85 call. CPU goes into STOP if OB 85 is not loaded.	Loading OB 20 or 21 (CPU 318-2 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)	OB 85 call. CPU goes into STOP if OB 85 is not loaded.	Loading OB 40 or 41 (CPU 318-2 only) (the OB number can be viewed in the diagnostic buffer).
Attempt to access a missing or faulty module. (Software or hardware error)	OB 85 call. CPU goes into STOP if OB85 is not loaded or, with loaded OB 80, if the cycle time is exceeded a second time without having been retriggered.	Generate OB 85, the start information of the OB contains the address of the respective module. Replace the respective module or eliminate the program error.
The cycle time was exceeded. Probably too many interrupt OBs called simultaneously.	OB 80 call. CPU goes into STOP when OB 80 is not loaded or called twice.	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 <ul style="list-style-type: none"> • Block not loaded • Wrong block number • Wrong timer/counter number • Read/write access to wrong area • etc. 	OB 121 call. CPU goes into STOP if OB 121 is not loaded.	Eliminate the programming error. The STEP 7 testing function helps you to localize the error.
I/O access error An error has occurred when module data was accessed	OB 122 call. CPU goes into STOP if OB 122 is not 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.	OB 87 call. CPU goes into STOP if OB 87 is not loaded.	Check global data communication in STEP 7. If required, correct the DB size.

Table 10-4 Evaluation of the SF LED (Hardware error)

Possible Errors	Reaction 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 diagnostic-capable module reports a diagnostic interrupt.	OB 82 call. CPU goes into STOP if OB 82 is not loaded. ⁸⁶	Reaction 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 OB 85, 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 goes into STOP if the OB is not loaded.	Generate OB 85, the start information of the OB contains the address of the respective module. Replace the respective module, tighten the plug or eliminate the program error.
Faulty Memory Card.	The CPU goes into STOP mode and requests memory reset.	Replace the Memory Card, reset CPU memory, transfer the program again and set the CPU to RUN mode.

Tip: You can use SFC 39 to disable all interrupts and asynchronous error events.
 Tip on OB 32 and OB 35: You can set the times in watchdog OB 32 and OB 35, starting from 1 ms.

Note

The shorter the selected watchdog interrupt period, the more likely is it that watchdog interrupt errors will occur. You must take into account the operating system times of the CPU in question, the user program runtime as well as cycle time extension, for example, by active PG functions.

Cross-reference

Details on the OBs and on SFCs required for their evaluation is found in the *STEP 7 Online Help* and in the *Manual System Software for S7-300/400 - System and Standard Functions*.

Status and error display of DP-capable CPUs

Table 10-5 The BUSF, BUSF1 and BUSF2 LEDs

LED					Description
SF	5 VDC	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 318-2 DP. Remedy: Refer to the table below
On	On	-	X	On/ flashes	Error at the second PROFIBUS-DP interface of CPU 318-2 DP. Remedy: Refer to the table below

Description of status X: The status of the LED can be On or Off. However, this status is irrelevant for the current CPU function. For example, the Force states On or Off do not influence the STOP status of the CPU.

Table 10-6 BUSF LED is lit

Possible Errors	Reaction of the CPU	Remedies
<ul style="list-style-type: none"> Bus fault (hardware fault). DP interface error. Different transmission rates in multiple DP master mode. 	Call of OB 86 (when CPU is in RUN mode). CPU goes into STOP if OB 86 is not loaded.86	<ul style="list-style-type: none"> 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	Reaction of the CPU	Remedies
The CPU is DP master: <ul style="list-style-type: none"> Failure of a connected station At least one of the configured slaves cannot be accessed. 	Call of OB 86 (when CPU is in RUN mode). CPU goes into STOP if OB 86 is not loaded.86	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 DP slave: Wrong CPU 31xC configuration. Possible causes: <ul style="list-style-type: none"> The response monitoring time has expired. PROFIBUS DP communication is interrupted. Wrong PROFIBUS address. 	Call of OB 86 (when CPU is in RUN mode). CPU goes into STOP if OB 86 is not loaded.86	<ul style="list-style-type: none"> 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.

10.6 Diagnostics of DP CPUs

10.6.1 Diagnostics of DP CPUs operating as DP master

Diagnostics evaluation in the user program

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

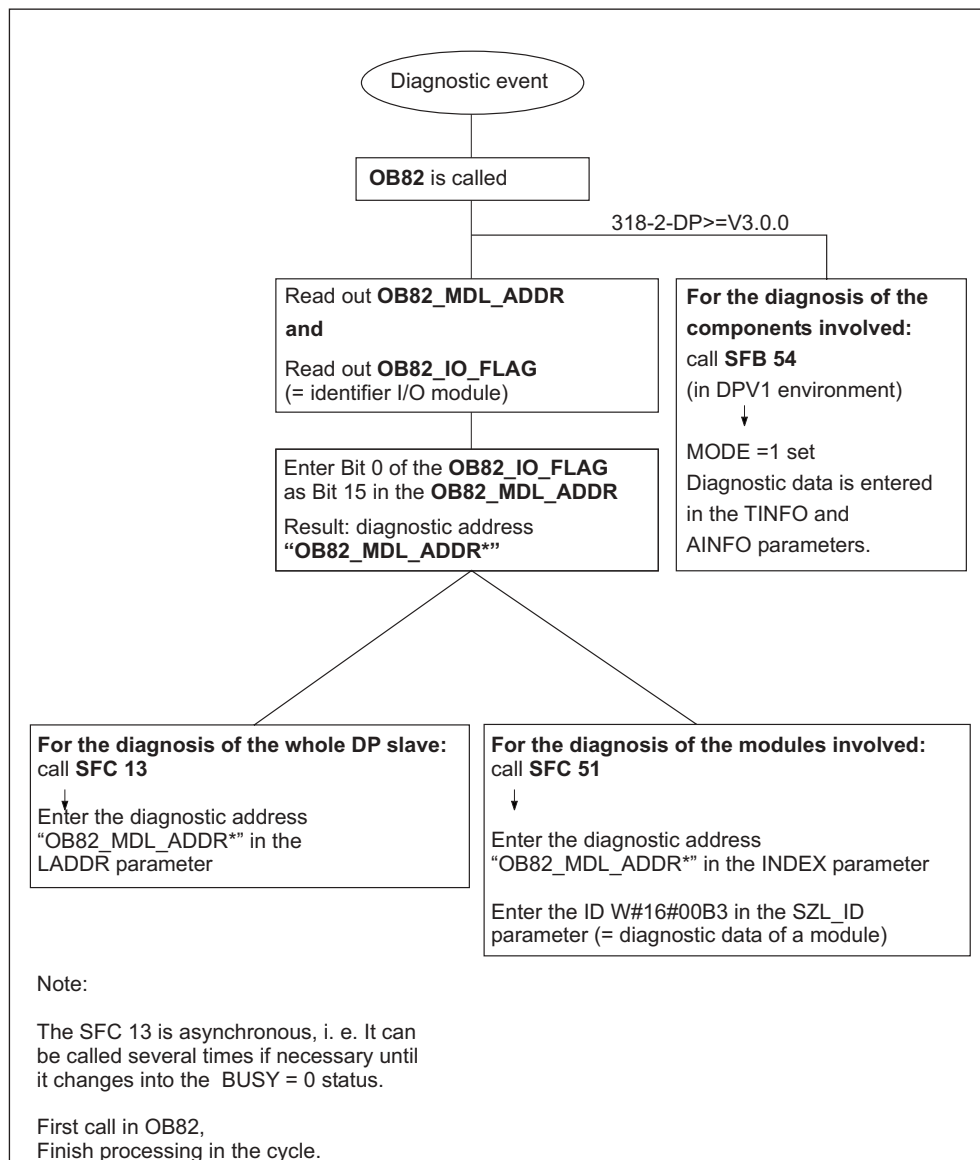


Figure 10-3 Diagnostics with CPU 31x-2 (315-2-DP as of 315-2AF03)

Diagnostic Addresses

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

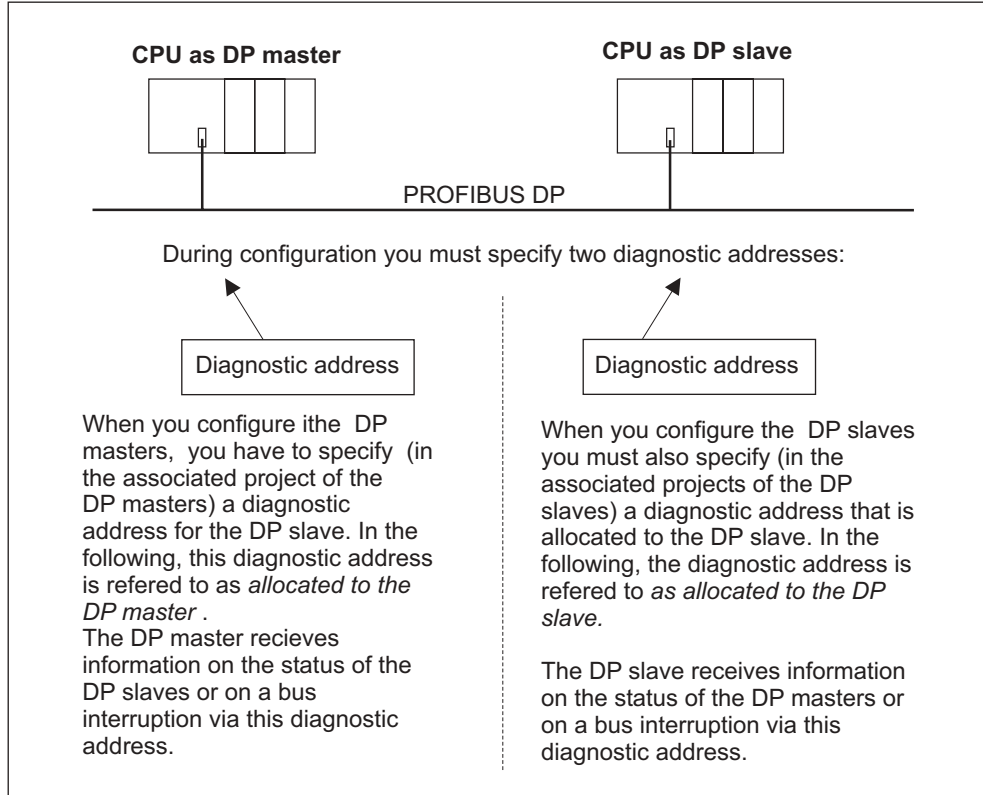


Figure 10-4 Diagnostic addresses for DP masters and DP slaves

Special features of CPUs 31xC-2DP

With CPUs 31xC-2DP operating as master, assign two different diagnostic addresses to one I-Slave, one diagnostic address to slot 0 and one diagnostic address to slot 2. These two addresses have the following functions:

- The diagnostic address for slot 0 reports in the master all events relating to the complete slave (station representative), e.g. station failure.
- The diagnostic address for slot 2 is used to report events at this slot, that is, with the CPU operating as I-Slave it reports the diagnostic interrupts for operating state transitions.

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 10-8 Event recognition of CPU 31x-2 operating as DP master

Event	What happens in the DP Slave?
Bus failure interrupt (short-circuit, connector unplugged)	<ul style="list-style-type: none"> • Call of OB 86 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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)

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 10-9 Evaluating RUN to STOP transitions of the DP slave in the DP master

In the DP Master	In the DP Slave (CPU 31x-2DP)
Diagnostic addresses: (Example) Master diagnostic address = 1023 Slave diagnostic address = 1022	Diagnostic addresses: (Example) Slave diagnostic address = 422 Master diagnostic address = irrelevant
The CPU calls OB 82 with the following information: <ul style="list-style-type: none"> • OB 82_MDL_ADDR:=1022 • OB82_EV_CLASS:=B#16#39 (incoming event) • OB82_MDL_DEFECT: = Module error <p>Tip: The CPU diagnostic buffer also contains this information</p> <p>In the user program you should also include SFC13 "DPNRM_DG" for reading out DP slave diagnostic data.</p>	← CPU: RUN -> STOP The CPU generates a DP slave diagnostics message frame

10.6.2 Diagnostics of DP CPUs operating as DP Slave

Reading 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

You assign a diagnostic address to the receiving station when directly exchanging data:

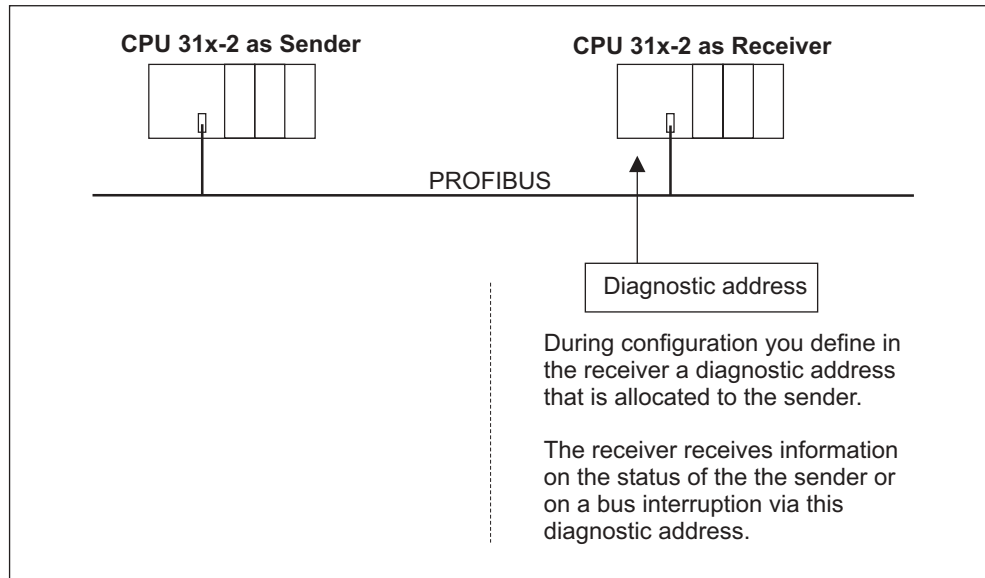


Figure 10-5 Diagnostic address for the receiving station with direct data exchange

Reading Out the Diagnostic Data

The table below shows you how the various DP master system can read diagnostic information from a slave.

Table 10-10 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 <i>Hardware diagnostics</i> in the STEP 7 Online Help and in the <i>Programming STEP 7 Manual</i>
	SFC 13 "DP NRM_DG"	Reading slave diagnostic data (store in the data area of the user program)	System and Standard Functions <i>Reference Manual</i>
	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 <i>Reference Manual</i>
	SFC 59 "RD_REC"	Read out data records of the S7 diagnosis (store in the data area of the user program)	System and Standard Functions <i>Reference Manual</i>
	FB 125/FC 125	Evaluating slave diagnostic data	On the Internet URL 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 (store in the data area of the user program)	Manual <i>Distributed I/O System ET 200</i>
SIMATIC S5 with S5-95U PLC operating as DP master	FB 230 "S_DIAG"		

Example of reading slave diagnostic data, using FB192 "IM 308C"

Here you will find an example of how to use FB192 to read out DP slave diagnostic data in the 192 **STEP 5** user program.

Agreement for the STEP 5 user program

For this **STEP 5** user program we agree:

- 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			Description
	:A	DB 30	
	:SPA	FB 192	
Name	:IM308C		
DPAD	:	KH F800	Default address area of IM 308-C
IMST	:	KY 0, 3	//IM no. = 0, PROFIBUS address for 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 dataword 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. reading slave diagnostic data is similar with SFC 13.

Agreement for the STEP 7 user program

For this **STEP 7** user program we agree:

- Diagnostic data for the input module at address 200_H is to be read.
- Data record 1 is to be read out.
- Data record 1 is to be stored in DB 10.

STEP 7 User Program

STL	Description
CALL SFC 59	
REQ :=TRUE	//Request to read
IOID :=B#16#54	//Identifier of the address area, here the I/O input
LADDR:= W#16#200	//Logical address of the module
RECNUM :=B#16#1	//Data record 1 is to be read
RET_VAL :=MW2	//An error code is output if an error occurs
BUSY :=MO.0	//Read operation not finished
RECORD :=P# DB10.DBX 0.0 BYTE 240	//DB 10 is target area for the read data record 1

Note

data is only returned to the target area if BUSY is reset to 0 and if no negative RET_VAL has occurred.

Diagnostic Addresses

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

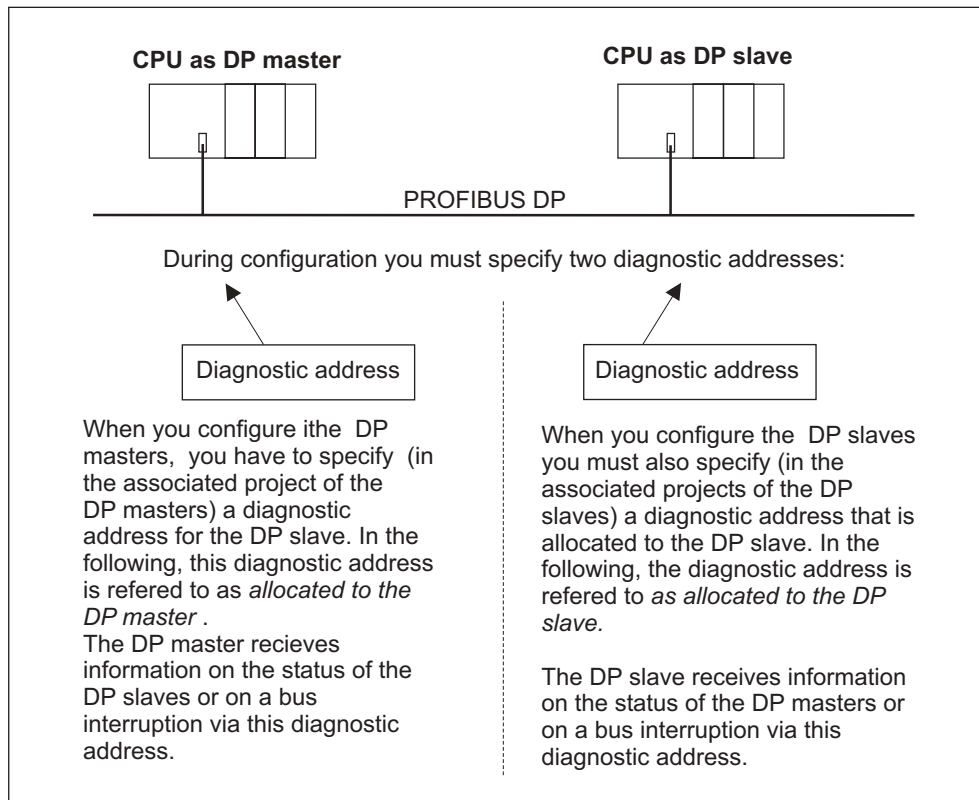


Figure 10-6 Diagnostic addresses for DP masters and DP slaves

Special features of CPUs 31xC

With CPUs 31xC you assign two different diagnostic addresses to the slave, namely one diagnostic address for slot 0 and one for slot 2. These two addresses have the following functions:

- The diagnostic address for slot 0 reports in the master all events relating to the complete slave (station representative), e.g. station failure;
- The diagnostic address for slot 2 is used to report events at this slot, that is, with the CPU operating as I-Slave it reports the diagnostic interrupts for operating state transitions.

Event recognition

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

Table 10-11 Event recognition of CPUs 31x-2 operating as DP slave

Event	What happens in the DP Slave?
Bus failure interrupt (short-circuit, connector unplugged)	<ul style="list-style-type: none"> • Call of OB 86 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	<ul style="list-style-type: none"> • Call of OB 82 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	<ul style="list-style-type: none"> • 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 10-12 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	Diagnostic addresses: (Example) Slave diagnostic address = 422 Master diagnostic address = irrelevant
CPU: RUN " STOP	→ The CPU calls OB 82 with the following information: <ul style="list-style-type: none"> • OB 82_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 at the DP master

Interrupts with S7/M7 DP masters

With the CPU 31x-2 as a DP slave, you can trigger a process interrupt with the DP master from the user program. By calling SFC7 "DP_PRIN", you will trigger an OB 40 in the user program of the DP master. You can forward interrupt information to the DP master in a double word with the SFC7. This information can be evaluated in OB 40 in the OB40_POINT_ADDR variable. You will find detailed information on SFC 7 "DP_PRIN" in the reference manual *System software for S7-300/400 - System and standard functions*.

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

In order to be able to evaluate diagnostic interrupts and process interrupts via device-specific diagnostic data when operating with a different DP master, note that:

The DP master should be able to store the diagnostic messages, that is, in its ring buffer. 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 slave diagnostic data

Structure of slave diagnostic data

The figure below shows the structure of the diagnostics message frame for slave diagnostics.

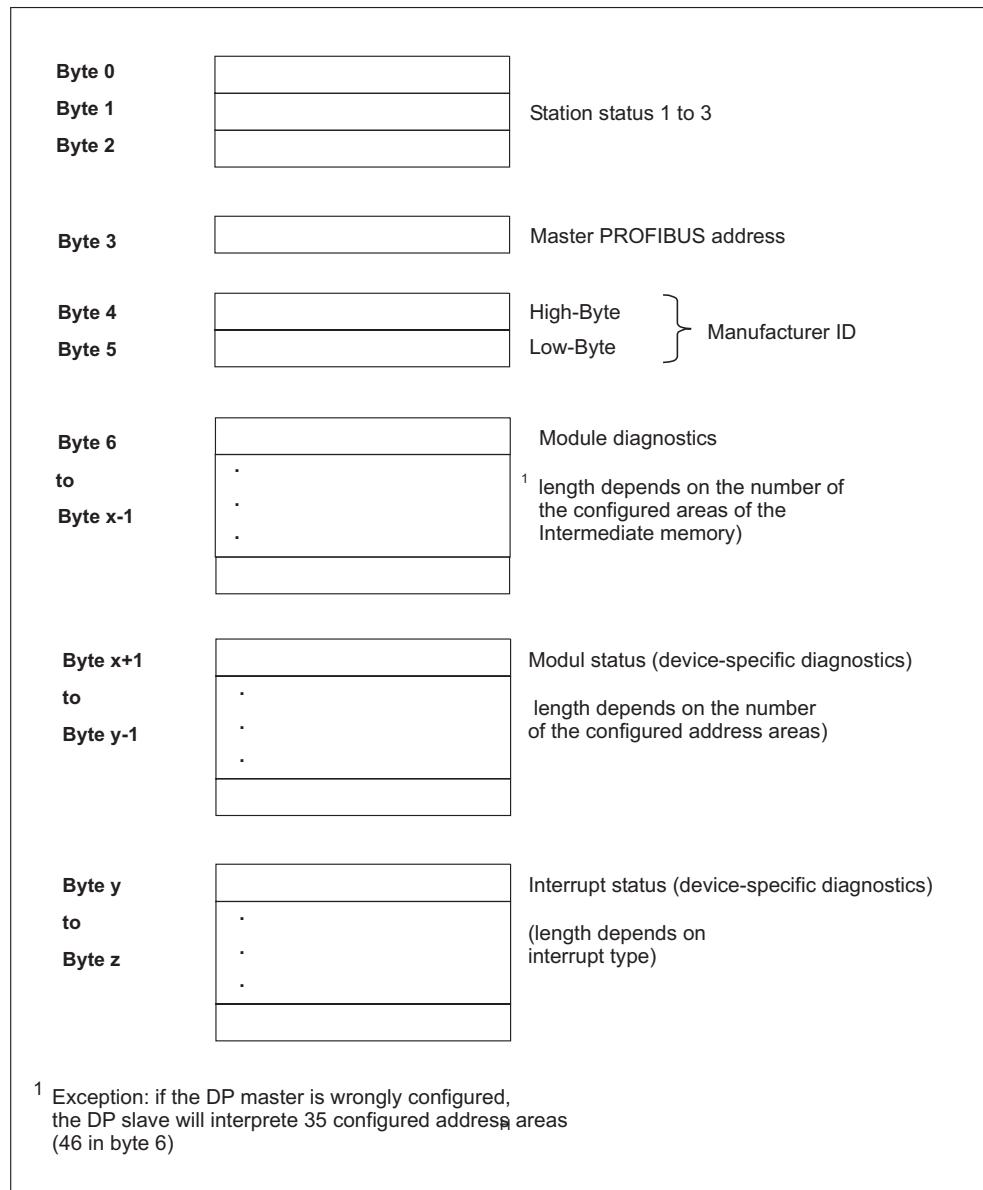


Figure 10-7 Structure of slave diagnostic data

Station status 1

Table 10-13 Structure of station status 1 (Byte 0)

Bit	Description	Remedy
0	1: DP slave cannot be addressed by DP master.	<ul style="list-style-type: none"> 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.	<ul style="list-style-type: none"> Wait for the slave to complete startup.
2	1: Configuration data sent by DP master to the DP slave is inconsistent with slave configuration.	<ul style="list-style-type: none"> Was the software set for the correct station type or DP slave configuration?
3	1: Diagnostic interrupt, generated by CPU RUN to STOP transition 0: Diagnostic interrupt, generated by CPU STOP to RUN transition	<ul style="list-style-type: none"> You can read the diagnostic data.
4	1: Function not supported; e.g. changing the DP address at software level	<ul style="list-style-type: none"> Check configuration data.
5	0: This bit is always "0".	<ul style="list-style-type: none"> -
6	1: DP slave type inconsistent with software configuration.	<ul style="list-style-type: none"> 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.	<ul style="list-style-type: none"> The bit is always 1 if, for example, you are currently accessing the DP slave via PG or a different DP master. <p>The configuring master's DP address is located in the "Master PROFIBUS address" diagnostics byte.</p>

Station Status 2

Table 10-14 Structure of Station Status 2 (Byte 1)

Bit	Description
0	1: The DP slave requires new parameters and configuration.
1	1: A diagnostic message was received. The DP slave cannot resume operation until the error has been cleared (static diagnostic message).
2	1: This bit is always "1" if a DP slave exists with this DP address.
3	1: The watchdog monitor is enabled on this DP slave.
4	1: DP slave has received control command "FREEZE".
5	1: DP slave has received control command "SYNC".
6	0: This bit is always "0".
7	1: DP slave is disabled, that is, it has been excluded from cyclic processing.

Station Status 3

Table 10-15 Structure of Station Status 3 (Byte 2)

Bit	Description
0 to 6	0: These bits are always "0"
7	1: The DP slave is out of memory for received diagnostic messages. 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 10-16 Structure of the Master PROFIBUS address (byte 3)

Bit	Description
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

Manufacturer ID

The manufacturer ID contains a code specifying the DP slave's type.

Table 10-17 Structure of the manufacturer ID (byte 4 and 5)

Byte 4	Byte 5	Manufacturer ID for
80 _H	2F _H	CPU 315-2-DP
80 _H	6F _H	CPU 316-2-DP
80 _H	7F _H	CPU 318-2
80 _H	DO _H	313C-2-DP
80 _H	D1 _H	314C-2-DP

Module diagnostics

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

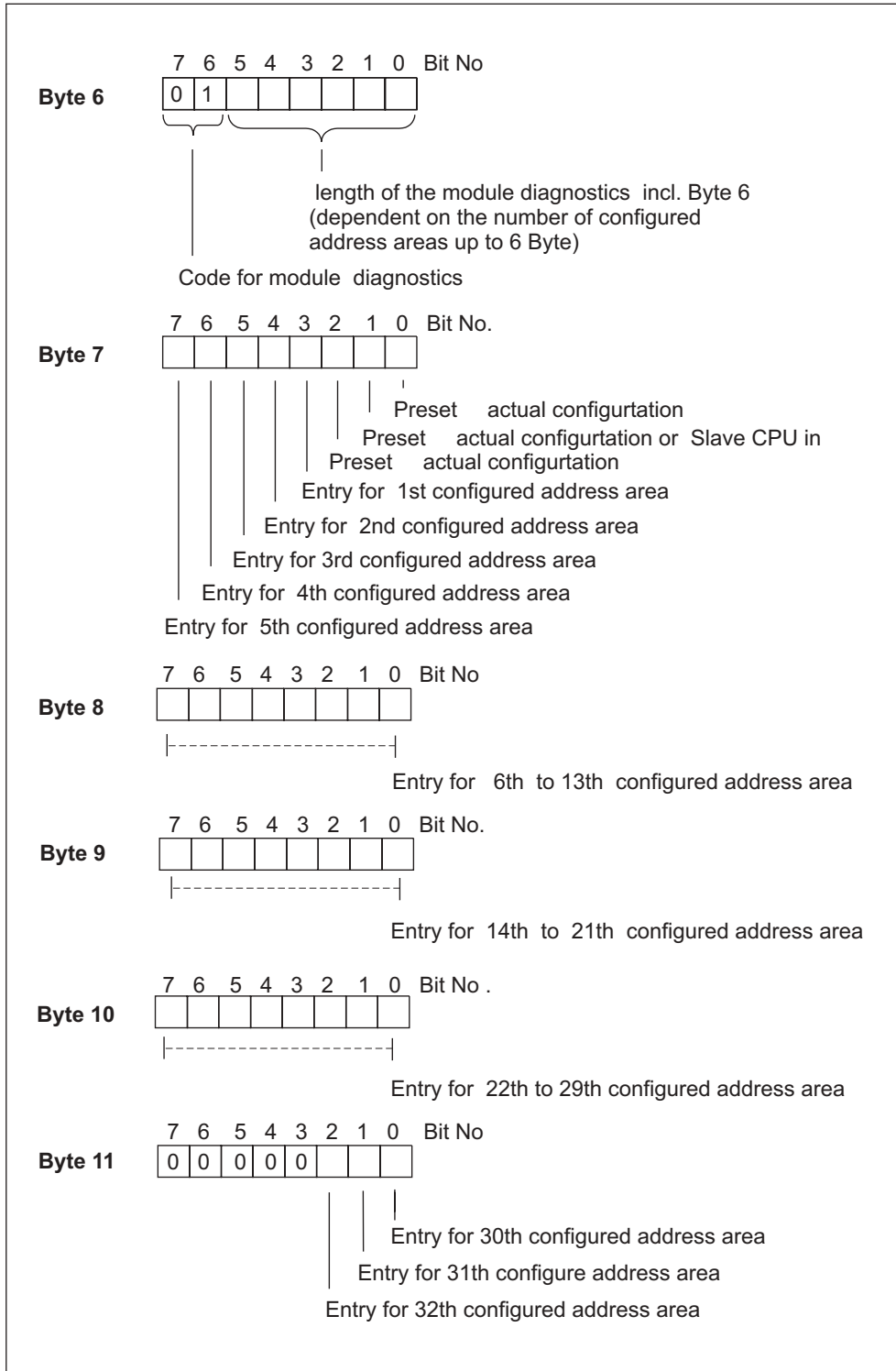


Figure 10-8 Structure of module diagnostics of CPU 31x-2

Module status

Module status returns the status of configured address areas and provides details on the configuration of module diagnostics. Module status starts with module diagnostics and consists of a maximum of 13 bytes.

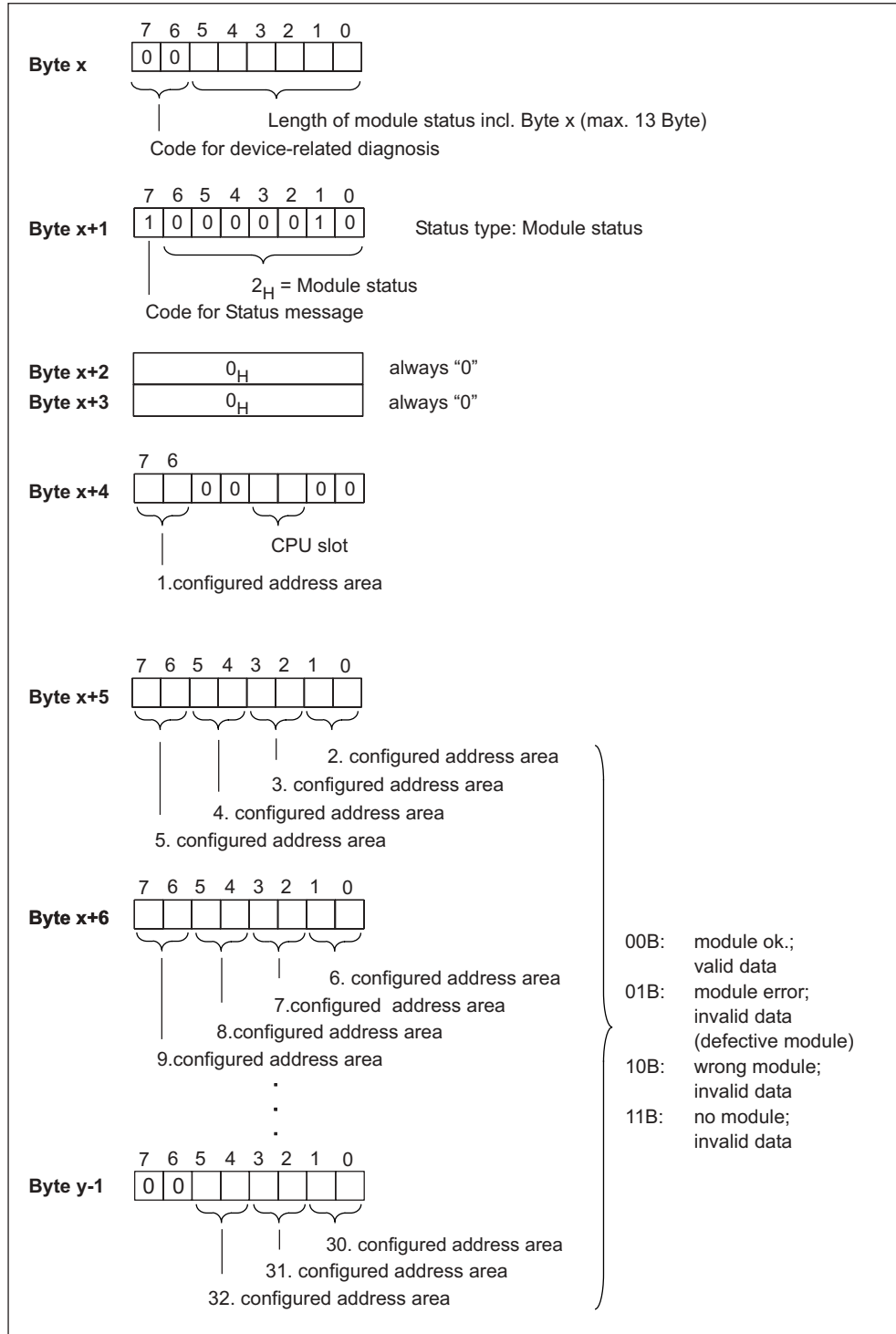


Figure 10-9 Structure of the module status

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 intermediate memory.

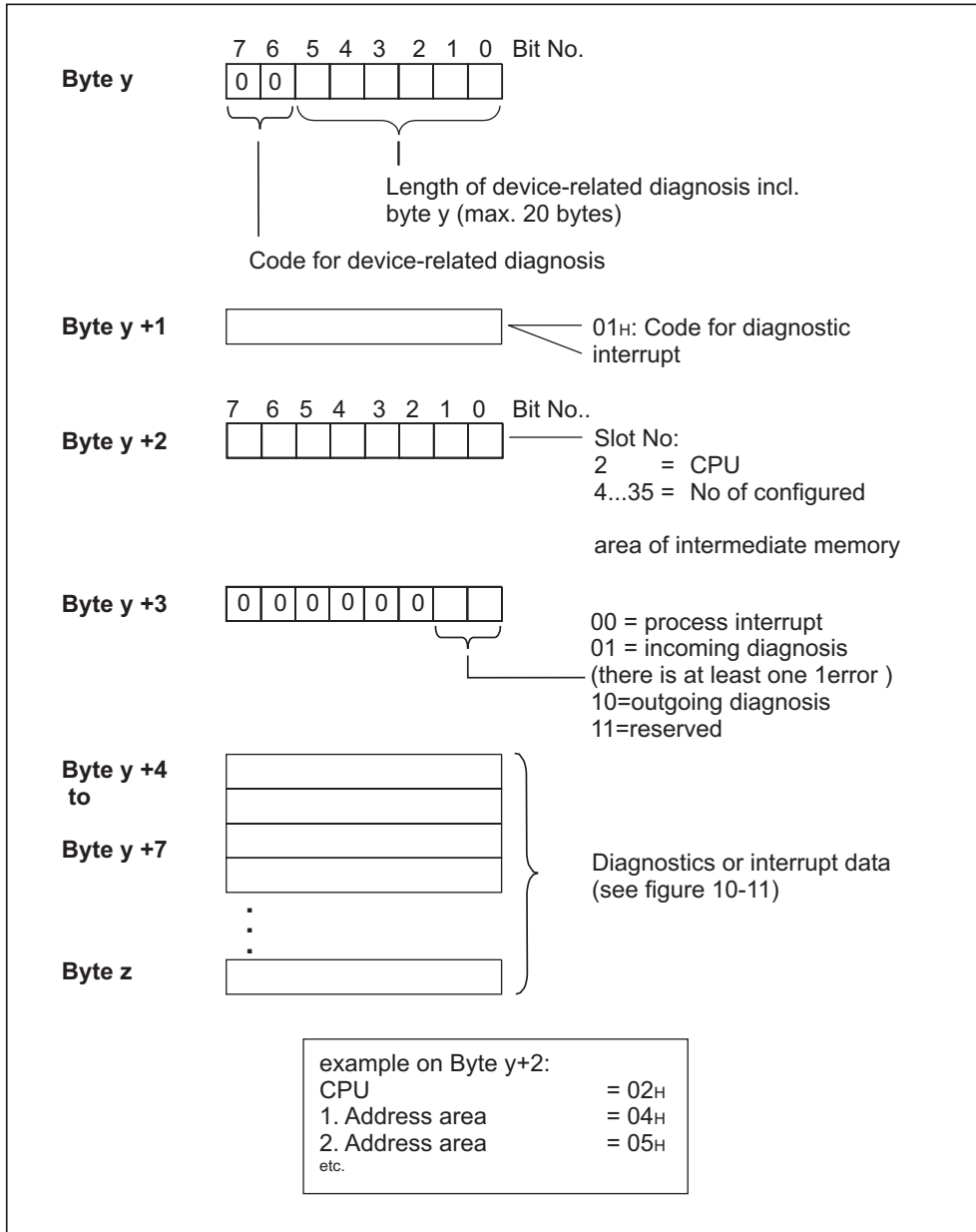


Figure 10-10 Structure of the interrupt status for CPU 31xC

As of byte y+4

The significance of the bytes following byte y+4 depends on byte y+1 (see previous figure).

Byte y+1 contains the code for diagnostic interrupt (01 _H)	Byte y+1 contains the code for process interrupt (02 _H)
The diagnostic data contain 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.	You can program 4 bytes of interrupt information for the process interrupt. You pass these four bytes in STEP 7 to the master using SFC 7 "DP_PRAL" .

Bytes y+4 to y+7 for diagnostic interrupts

The figure below shows the structure and content of byte y+4 to y+7 for diagnostic interrupts. 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).

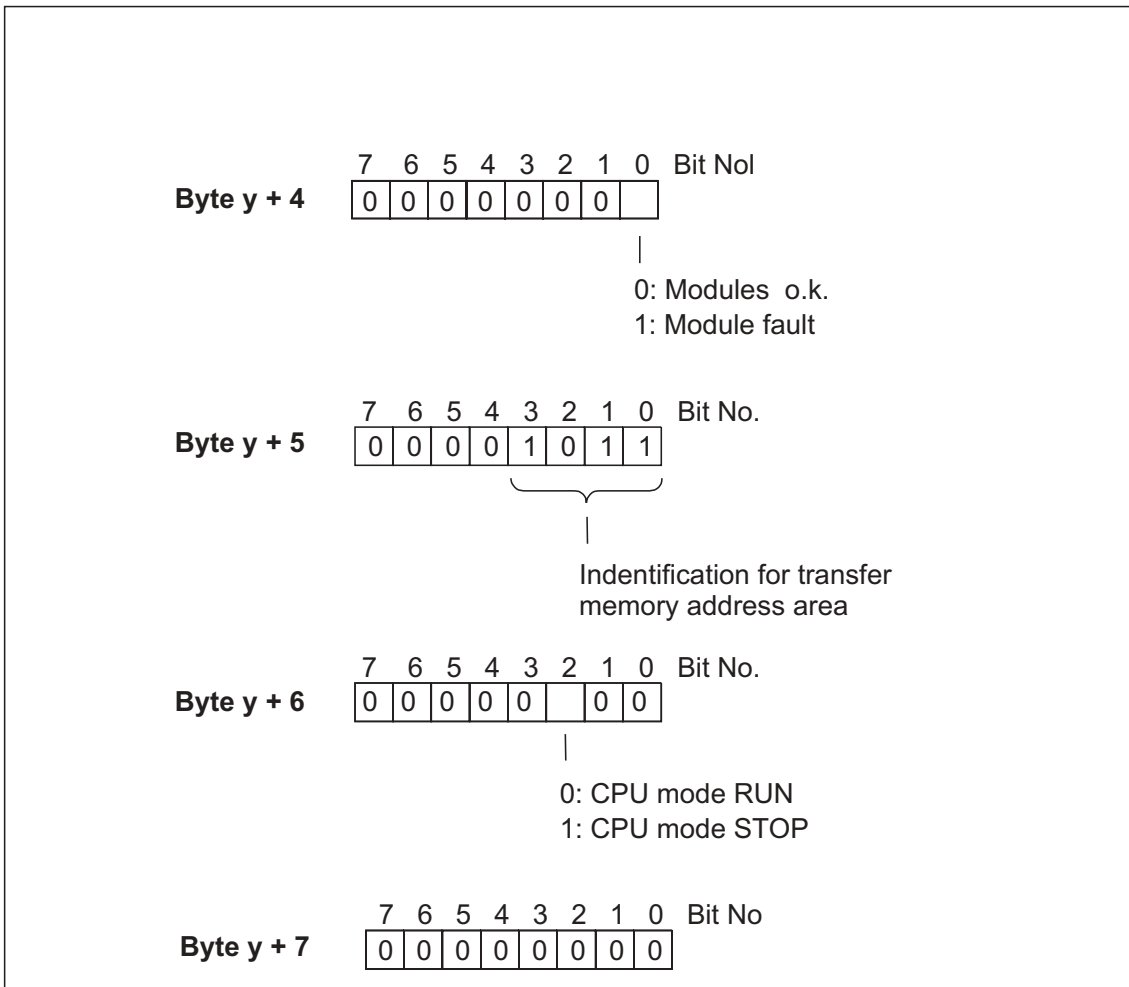


Figure 10-11 Byte y+4 to y+7 for Diagnostic/Process interrupts

11.1 Installation

11.1.1 General rules and regulations for S7-300 operation

Introduction

In view of the many and versatile S7-300 applications, this chapter can only describe the basic rules on its electrical configuration. You must observe at least these basic rules 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.

Startup 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 11-1 Startup 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.
Startup after releasing the EMERGENCY OFF device:	An uncontrolled or undefined startup must be avoided.

Mains voltage

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

Table 11-2 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 permissible 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 11-3 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 11-4 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.

Information on EMC and surge protection ...

is found in the following Chapters.

11.2 protection against electromagnetic interference

11.2.1 Basic points for system installations conforming with EMC requirements

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 under consideration of all possible interference sources.

Possible effects of interference

Electromagnetic noise 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.

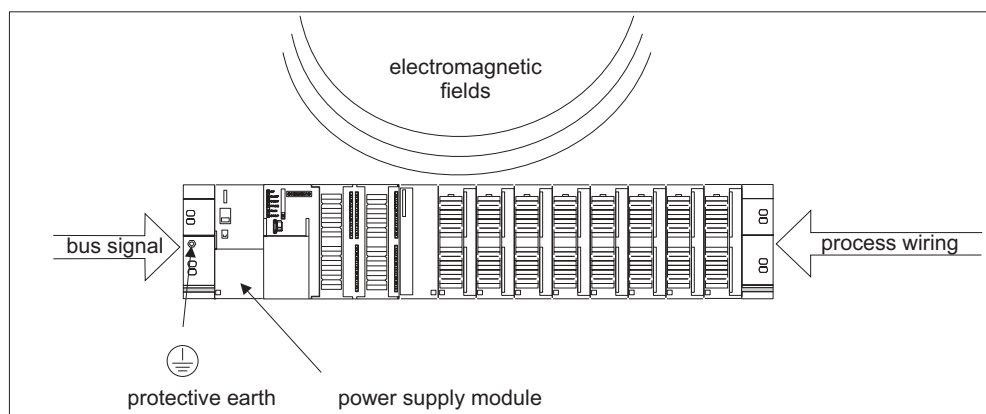


Figure 11-1 Possible paths of electromagnetic interference

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 11-5 Coupling mechanisms

Coupling mechanisms	Cause	Typical interference sources
Galvanic coupling	Galvanic or mechanical coupling always occurs when two circuits use one common cable.	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • Neighboring transmitters (e.g. radio phones) • Sparking (sparkplugs, collectors of electrical motors, welding devices)

11.2.2 Five basic rules for insuring EMC

If you conform with these five basic rules ...

you can insure 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 is highly corrosive and is therefore less suitable for ground bonding.
- Create a central connection between chassis ground and the equipotential busbar/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 beams, 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 busbar 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 busbar 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*).

- Install equipotential busbars of sufficient size if potential differences exist or are to be expected between equipment of your system.
- 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.

11.2.3 EMC compatible installation of PLC**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 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).

11.2.4 Examples of an EMC compatible installation

Introduction

Below you can find two examples of an EMC compatible PLC installation.

Sample 1: EMC compatible 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.

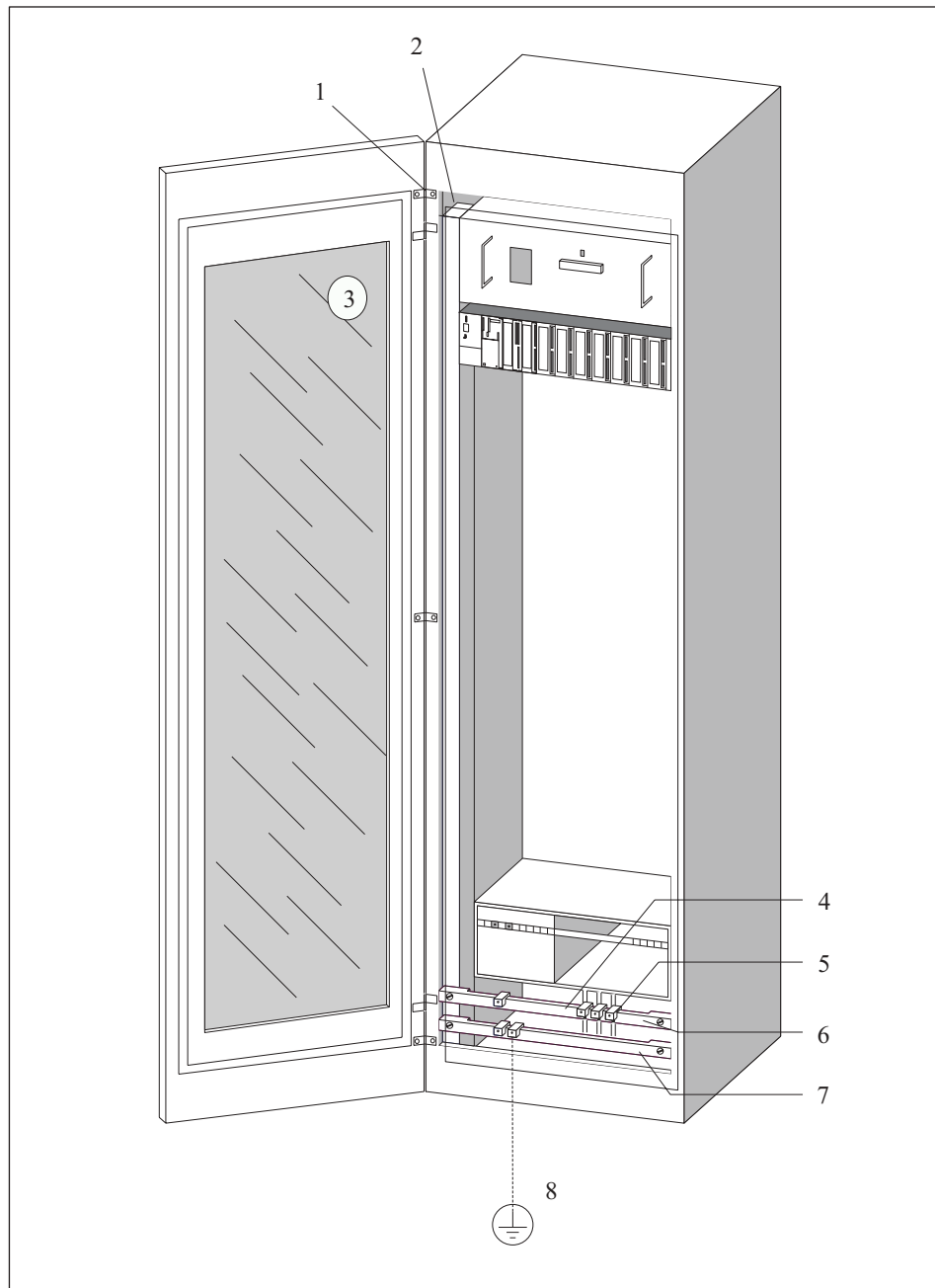


Figure 11-2 Example of an EMC compatible cabinet installation

Keys for sample 1

The numbers in the following list refer to the numbers in the figure above.

Table 11-6 Keys for sample 1

No	Description	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 profile rail	The mounting bar and module 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 busbar 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 busbar	Interconnect the shielding busbar on a large surface with the supporting bars (metal-to-metal connection). The cable shielding is terminated on the busbar.
7	Protective conductor busbar	Interconnect the protective conductor busbar on a large surface with the supporting bars (metal-to-metal connection). Interconnect the protective conductor busbar and the protective ground system, using a separate cable (minimum cross-section 10 mm ²).
8	Cable to the protective ground system (equipotential ground)	Interconnect the cable on a large area with the protective ground system (equipotential ground).

Example 2: EMC compatible wall mounting

When operating your S7 in a low-noise environment that conform with permissible 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 busbar for connecting your cable shielding. This shielding busbar can also be used as protective conductor busbar.

Note the following points on frame-/wall-mounting:

- 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 conductor busbar.
- Always touch-protect live mains conductors.

The figure below shows an example of EMC compatible wall-mounting of an S7.

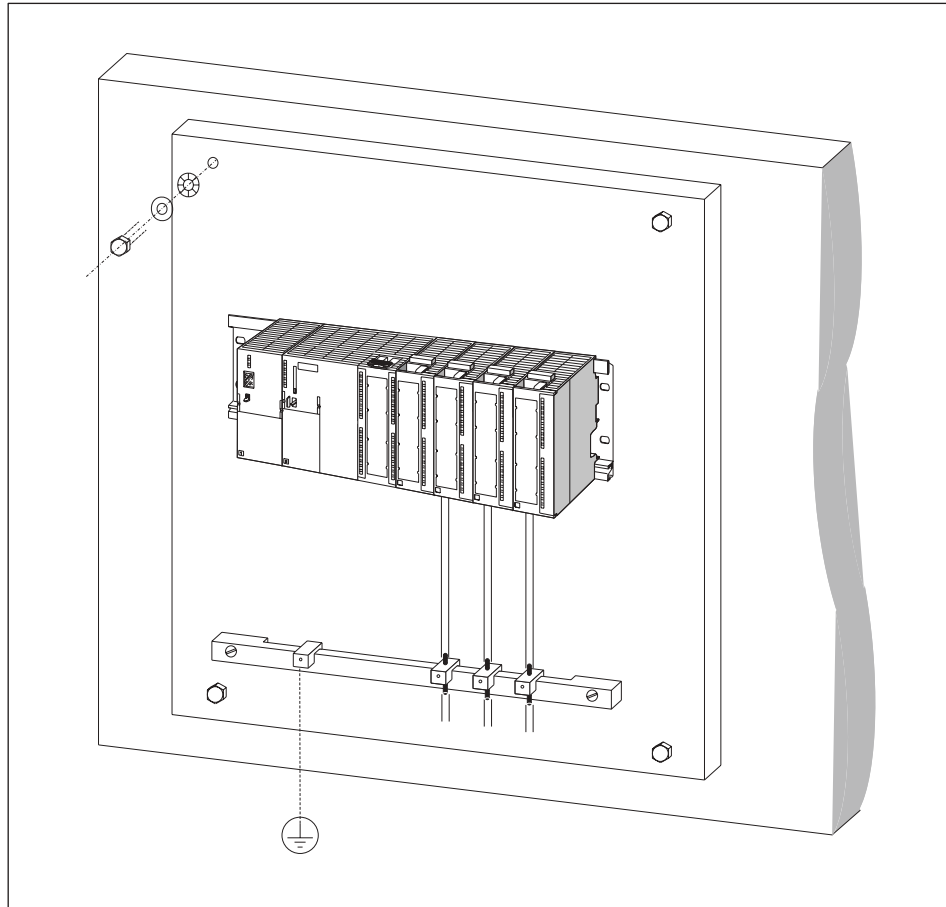


Figure 11-3 Example of EMC compatible wall-mounting

11.2.5 Shielding of cables

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 busbar. 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 of mounting shielded cables, using cable clamps.

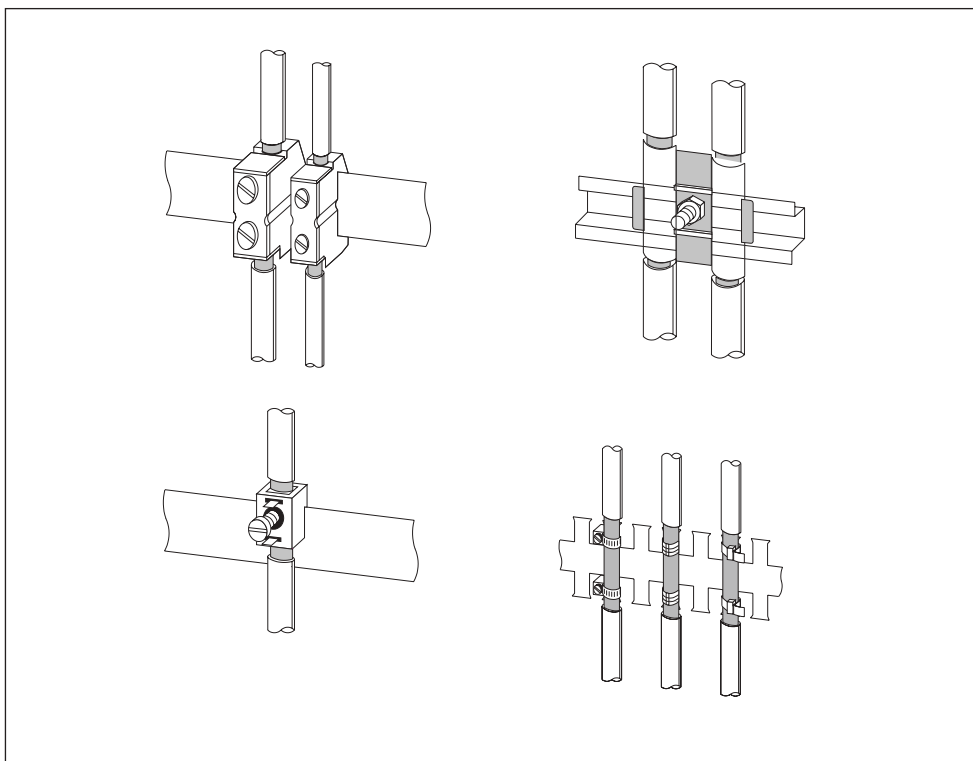


Figure 11-4 Mounting cable shielding

11.2.6 Equipotential bonding

Potential differences

Potential differences can occur between separate system elements. This can result in high equipotential currents, e.g. if the cable shielding is terminated at both ends and grounded to different system components.

The cause of potential difference can be differences in the power supplies.



Warning

Cable shielding is not suitable for equipotential bonding. Always use the prescribed cables (e.g. with a cross-section of 16mm²). When installing MPI/DP networks, provide a sufficient conductor cross-section. Otherwise, interface hardware might get damaged or even be destroyed.

Equipotential conductor

To reduce potential differences and ensure proper functioning of your electronic equipment, you must install equipotential conductors.

Note the following points on the use of equipotential conductors:

- The lower the impedance of an equipotential 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 additionally installed equipotential conductor must not exceed 10% of the shielding impedance.
- The cross-sectional dimension of an equipotential conductor must be sufficient to handle the maximum equipotential current flow. Practical and proven equipotential conductor cross-section is 16 mm².
- Always use equipotential conductors made of copper or galvanized steel. Always connect the cables on a large surface to the equipotential busbar/protective conductor and protect it against corrosion.
- Route your equipotential conductor to minimize the area between the equipotential conductor and signal lines as far as possible (see the figure below).

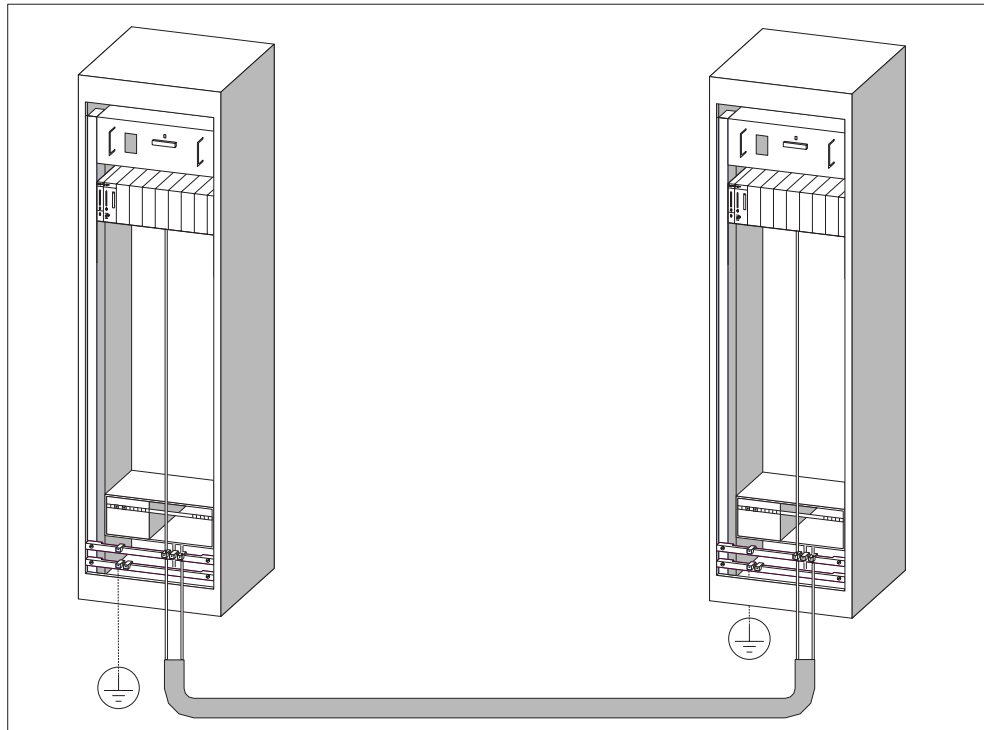


Figure 11-5 Equipotential bonding

11.2.7 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. Read off the guidelines to be observed from column 3 (Run ...).

Table 11-7 Cable routing inside buildings

Cables for ...	and cables for ...	Run ...	
<ul style="list-style-type: none"> • 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) 	<ul style="list-style-type: none"> • 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	
	<ul style="list-style-type: none"> • 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)
	<ul style="list-style-type: none"> • DC and AC voltage (> 400 V), unshielded 		<p>inside cabinets:</p> <p>In separate bundles or cable ducts (no minimum clearance necessary)</p> <p>outside cabinets:</p> <p>On separate cable racks with a clearance of at least 10 cm</p>

Cables for ...	and cables for ...	Run ...
<ul style="list-style-type: none"> • DC voltage (> 60 V and ≤ 400 V), unshielded • AC voltage (> 25 V and ≤ 400 V), unshielded 	<ul style="list-style-type: none"> • 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) 	<p>In separate bundles or cable ducts (no minimum clearance necessary)</p>
	<ul style="list-style-type: none"> • DC voltage (> 60 V and ≤ 400 V), unshielded • AC voltage (> 25 V and ≤ 400 V), unshielded 	<p>In common bundles or cable ducts</p>
	<ul style="list-style-type: none"> • DC and AC voltage (> 400 V), unshielded 	<p>inside cabinets: In separate bundles or cable ducts (no minimum clearance necessary)</p> <p>outside cabinets: On separate cable racks with a clearance of at least 10 cm</p>
<p>DC and AC voltage (> 400 V), unshielded</p>	<ul style="list-style-type: none"> • 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) 	<p>inside cabinets: In separate bundles or cable ducts (no minimum clearance necessary)</p> <p>outside cabinets: On separate cable racks with a clearance of at least 10 cm</p>
	<ul style="list-style-type: none"> • DC and AC voltage (> 400 V), unshielded 	<p>In common bundles or cable ducts</p>
<p>ETHERNET</p>	<p>ETHERNET</p>	<p>In common bundles or cable ducts</p>
	<p>Others</p>	<p>In separate bundles or cable ducts with a clearance of at least 50 cm</p>

11.2.8 Outdoor cable routing

Rules for EMC compatible cable routing

The same EMC compatibility rules apply both for indoor and outdoor routing of cables. The following also applies:

- Running cables on metal cable trays.
- Galvanic 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.

Additional information on lightning protection ...

is found in the following Chapters.

11.3 Lightning and surge protection

11.3.1 Overview

In the following sections ...

we show you solutions for the protection of your S7-300 against damage as a result of surge voltage.

Overview

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.

11.3.2 Lightning protection zone conception

Principally of the Lightning protection zone conception to IEC 61312-1/DIN VDE 0185 T103

The principle of the lightning protection zone conception states that the volume to be protected against overvoltage, for example, a manufacturing hall, is subdivided into lightning protection zones in accordance with EMC guidelines (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 <ul style="list-style-type: none"> • Buildings • Rooms and/or • Devices 	Lightning protection zone 1 Lightning protection zone 2 Lightning protection zone 3

Effects of the Lightning Strike

Direct lightning strikes occur in lightning protection zone 0. Lightning strike generates high-energy electromagnetic fields which can be reduced or eliminated from one lightning protection zone to the next by suitable lightning protection elements/measures.

Overvoltage

In lightning protection zones 1 and higher, a lightning strike might additionally cause overvoltage as a result of switching operations, coupling etc.

Block diagram of the lightning protection zones

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

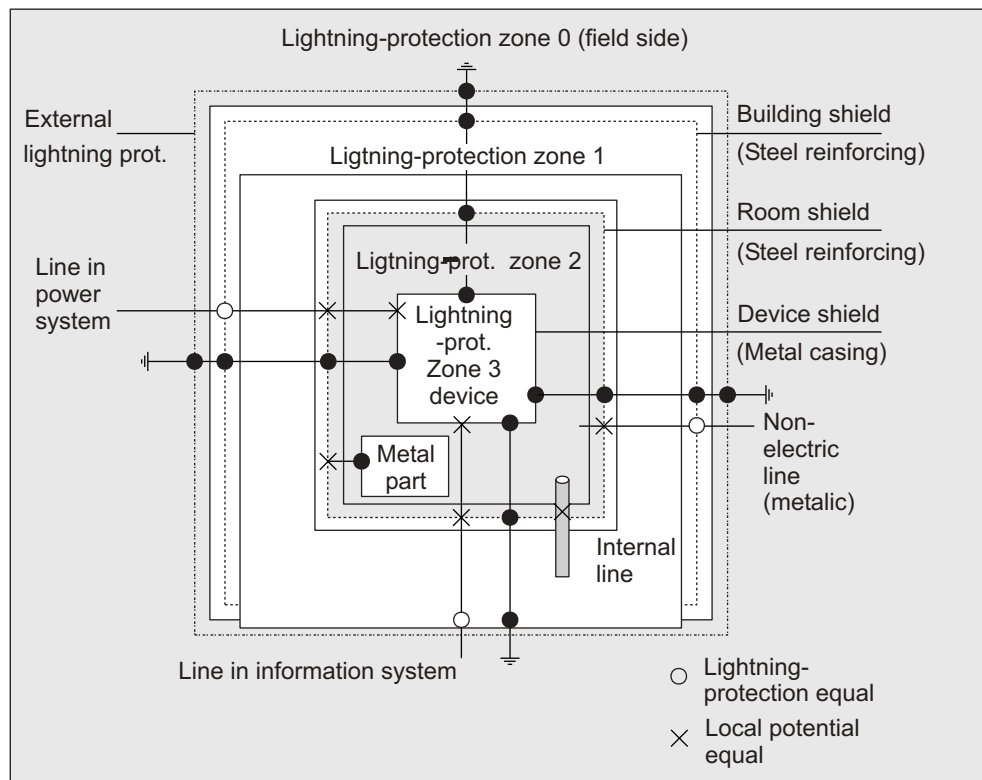


Figure 11-6 Lightning protection zones of a building

Principle of the transition points between lightning protection zones

At the transition points between lightning protection zones, you must take measures to prevent surges being conducted downstream.

The principle of the lightning protection zone conception 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 system.

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).

11.3.3 Rules for the transition point between lightning protection zones 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 optical waveguides 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 11-8 High-voltage protection of cables with the help of surge protection equipment

Ser. No.	Cables for equip transition point 0 <-> 1 with:		Order No.
1	3-phase TN-C system	1 piece of	DEHNbloc/3 lightning conductor, phase L1/L2/L3 to PEN	900 110* 5SD7 031
	3-phase TN-S system	1 piece of	DEHNbloc/3 lightning conductor, phase L1/L2/L3 to PE	900 110* 5SD7 031
		1 piece of	DEHNbloc/1 lightning conductor, N to PE	900 111* 5SD7 032
	3-phase TT system	1 piece of	DEHNbloc/3 lightning conductor, phase L1/L2/L3 to N	900 110* 5SD7 031
		1 piece of	DEHNgap B/n N-PE lightning conductor, N to PE	900 130*
	AC TN-S system	2 pieces of	DEHNbloc/1 lightning conductor, phase L1 +N to PE	900 111* 5SD7 032
	AC TN-C system	1 piece of	DEHNbloc/1 lightning conductor, phase L to PEN	900 111* 5SD7 032
	AC TT system	1 piece of	DEHNbloc/1 lightning conductor, phase to N	900 111* 5SD7 032
1 piece of		DEHNgap B/n N-PE lightning conductor, N to PE	900 130*	
2	24 VDC Power Supply	1 piece of	Blitzductor VT Lightning conductor, type A D 24 V -	918 402*
3	MPI bus cable, RS485, RS232 (V.24)	1 piece of	Blitzductor CT lightning conductor, type B	919 506* and 919 510*
4	Inputs/outputs of digital modules 24 V		DEHNrail 24 FML	909 104*
5	24 VDC power supply module	1 piece of	Blitzductor VT lightning conductor, type AD 24 V -	918 402* 900 111* 5SD7 032
6	Inputs/outputs of digital modules and 120/230 VAC power supply	2 pieces of	DEHNbloc/1 lightning conductor	900 111* 5SD7 032
7	Inputs/outputs of analog modules up to 12 V +/-	1 piece of	Blitzductor CT lightning conductor, type B	919 506* and 919 510*

* You can order these components directly at:

DEHN + SÖHNE
GmbH + Co. KG
Elektrotechnische Fabrik
Hans-Dehn-Str. 1
D-92318 Neumarkt

11.3.4 Rules for the transition points 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 11-9 Low-voltage protection for lightning protection zones 1 <-> 2

Ser. No.	Cables for equip transition point 1 <-> 2 with:		Order No.
1	3-phase TN-C system	3 pieces of	DEHNguard 275 surge arresters	900 600* 5SD7 030
	3-phase TN-S system	4 pieces of	DEHNguard 275 surge arresters	900 600* 5SD7 030
	3-phase TT system	3 pieces of	DEHNbloc/275 surge arrester, phase L1/L2/L3 to N	900 600* 5SD7 030
		1 piece of	DEHNgap C N-PE surge arrester, N to PE	900 131*
	AC TN-S system	2 pieces of	DEHNguard 275 surge arresters	900 600* 5SD7 030
	AC TN-C system	1 piece of	DEHNguard 275 surge arresters	900 600* 5SD7 030
	AC TT system	1 piece of	DEHNguard 275 surge arrester, phase L to N	900 600* 5SD7 030
1 piece of		DEHNgap C, N-PE surge arrester, N to PE	900 131*	
2	24 VDC Power Supply	1 piece of	Blitzductor VT, type AD 24 V -	918 402*
3	Bus cable			
	<ul style="list-style-type: none"> • MPI, RS485 • RS232 (V.24) 	1 piece of	<ul style="list-style-type: none"> • Blitzductor CT surge arrester, type MD/HF • per conductor pair surge arrester Blitzductor CT Typ ME 15 V 	919 506* and 919 570* 919 506* and 919 522*
4	Inputs of digital modules DC 24 V	1 piece of	Low-voltage surge arrester, type FDK 2 60 V	919 993*
5	Outputs of digital modules 24 V	1 piece of	Low-voltage surge arrester	919 991*
6	Inputs/outputs of digital modules	2 pieces of	Surge arrester	
	• 120 VAC		• DEHNguard 150	900 603*
	• 230 VAC		• DEHNguard 275	900 600*
7	Inputs of analog modules up to 12 V +/-	1 piece of	Blitzductor CT surge arrester, 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 11-10 Low-voltage protection for lightning protection zones 2 <-> 3

Ser. No.	Cables for equip transition point 2 <-> 3 with:		Order No.
1	3-phase TN-C system	3 pieces of	DEHNguard 275 surge arresters	900 600* 5SD7 030
	3-phase TN-S system	4 pieces of	DEHNguard 275 surge arresters	900 600* 5SD7 030
	3-phase TT system	3 pieces of	DEHNBloc/275 surge arrester, phase L1/L2/L3 to N	900 600* 5SD7 030
		1 piece of	DEHNgap C, N-PE surge arrester, N to PE	900 131*
	AC TN-S system	2 pieces of	DEHNguard 275 surge arresters	900 600* 5SD7 030
	AC TN-C system	1 piece of	DEHNguard 275 surge arresters	900 600* 5SD7 030
	AC TT system	1 piece of	DEHNguard 275 surge arrester, phase L to N	900 600* 5SD7 030
1 piece of		DEHNgap C, N-PE surge arrester, N to PE	900 131*	
2	24 VDC Power Supply	1 piece	Blitzductor VT, type AD 24 V -	918 402*
3	Bus cable			
	<ul style="list-style-type: none"> • MPI, RS485 • RS232 (V.24) 	1 piece of	<ul style="list-style-type: none"> • Blitzductor CT surge arrester, type MD/HF • per conductor pair Low-voltage protection FDK 2 12 V 	919 506* and 919 570* 919 995*
4	Inputs of digital modules			
	<ul style="list-style-type: none"> • 24 VDC 	1 piece of	Low-voltage protection, type FDK 2 60 V, on insulated profile rail	919 993*
		2 pieces of	Surge arrester	
	<ul style="list-style-type: none"> • 120 VAC • 230 VAC 		<ul style="list-style-type: none"> • DEHNrail 120 FML • DEHNrail 230 FML 	901 101* 901 100*
5	Outputs of digital modules 24 V	1 piece of	Low-voltage protection FDK 2 D 5 24	919 991*
6	Outputs of analog modules up to 12 V +/-	1 piece of	Low-voltage 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

11.3.5 Sample of a surge protection circuit for networked S7-300 PLCs

Sample circuit

The sample in the figure below shows you how install an effective surge protection for 2 networked S7-300 PLCs:

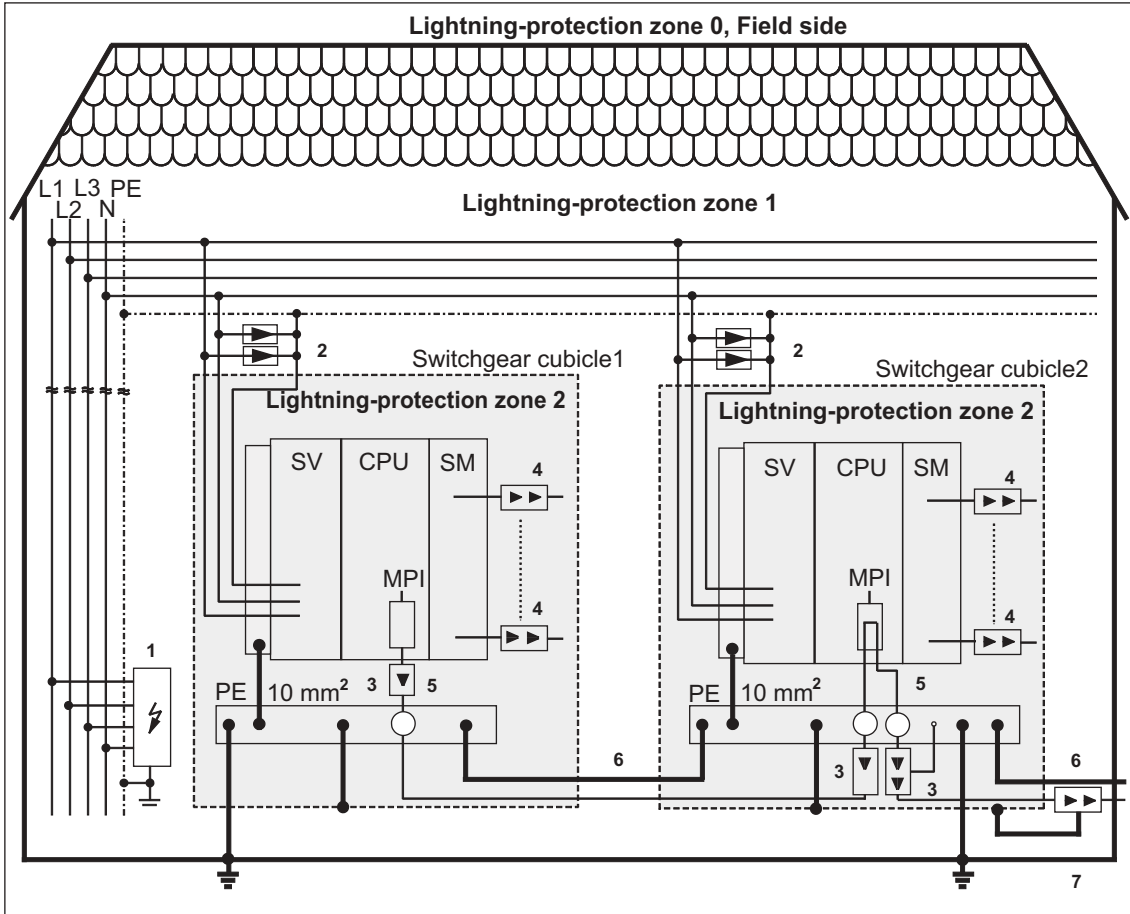


Figure 11-7 Sample circuitry for networked S7-300 PLCs

Components in previous figure 1-2

The table below explains consecutive numbers in the figure above:

Table 11-11 Example of a circuit conforming to lightning protection requirements (legend to previous figure)

Ser. No. from the previous figure	Components	Description
1	lightning arrester, 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 arrestors, 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 sq. 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. 1

11.3.6 How to protect digital output modules against inductive surge voltage

Inductive surge voltage

Overtoltage occurs when inductive devices are switched off. Examples are relay coils and contactors.

Integrated surge arrestor

S7-300 digital output modules are equipped with an integrated surge arrestor.

Additional Overtoltage 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 respective surge protection rating from the supplier of inductive devices.

Example:

The figure below shows an output circuit that requires additional surge arresters.

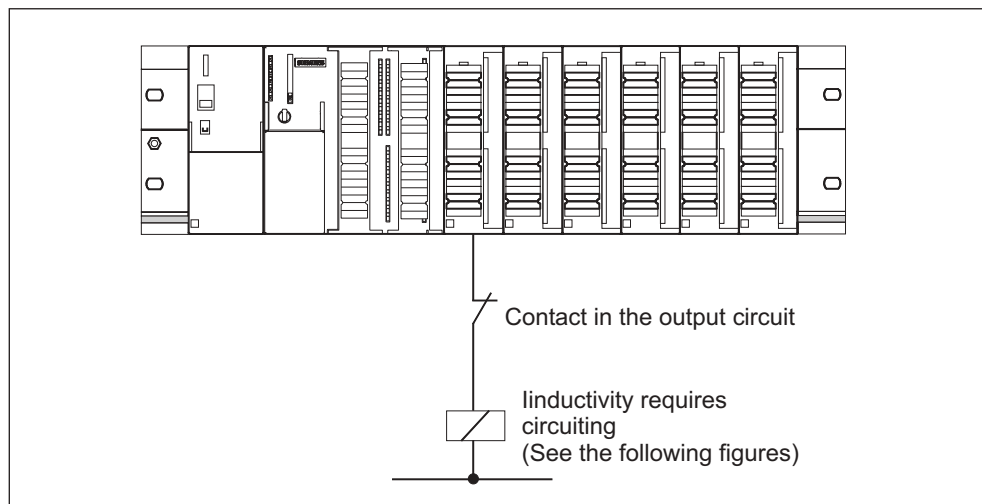


Figure 11-8 EMERGENCY-OFF relay contact in the output circuit

Circuit for coils operated with DC voltage

The figure below shows DC-operated coils equipped with diode or Zener diode circuit.

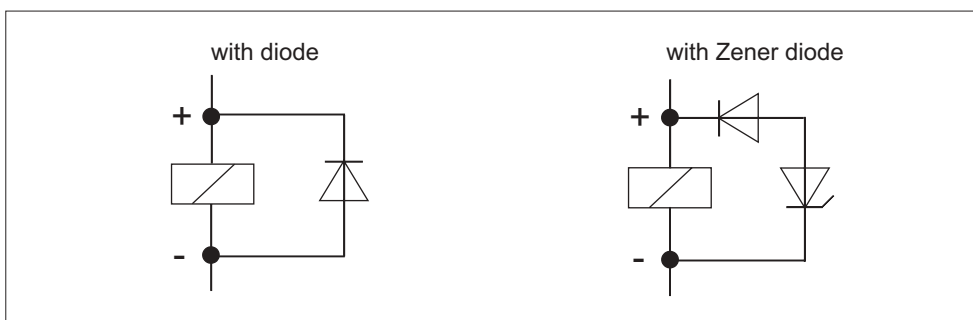


Figure 11-9 Circuit for coils operated with DC voltage

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.

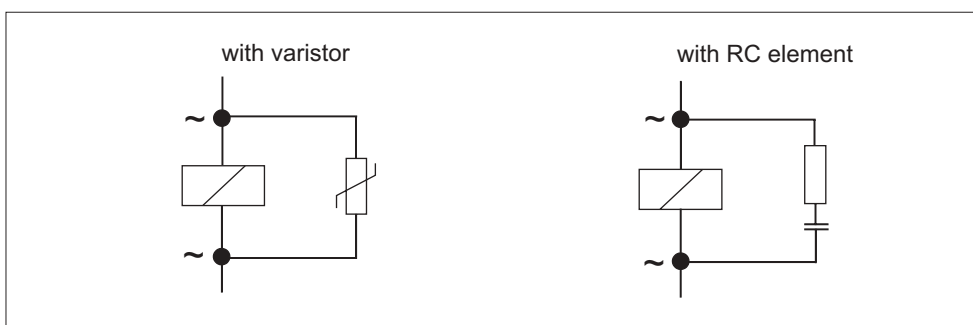


Figure 11-10 Circuit for coils operated with AC voltage

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.

11.4 Safety of electronic control equipment

Introduction

The notes below apply independent 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 in safety technology as basic measures. They prevent or rectify a large proportion of possible faults.

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. That is, additional measures (e.g. redundant configurations, tests, checksums etc.) must be implemented and certified for the control equipment (DIN VDE 0801). The prototype of the fail-safe PLC S5-95F was tested by TÜV (German Institute for Technological Surveillance), BIA and G EM III; several certificates have been granted. Thus, it is suitable in the same way as the previously tested fail-safe PLC S5-115F to control and monitor safety-relevant system areas.

Splitting the group into safety-relevant areas and areas which are not safety relevant

Most plants contain equipment performing safety-relevant operations (e.g. EMERGENCY-OFF switch, protective gates, two-hand controls). To avoid the need to examine the entire controller from the aspect of safety, **the controller is usually divided into an area that is safety-relevant and an area that is not safety-relevant**. In the non-safety-related area, no special demands are placed on the safety of the control equipment because any failure in the electronics will have no effect on the safety of the installation. In the safety-relevant area, however, it is only allowed to operate controllers or circuits compliant with corresponding regulations.

The following divisions are common in practical situations:

- For control equipment with few safety-related functions (e.g. machine controls)
The conventional PLC is responsible for machine control, whereas safety-related functions are implemented with a fail-safe mini PLC (e.g. S5-95F).
- For controllers with balanced areas (e.g. chemical installations, cable cars)
In this case also, the area that is not safety-relevant is controlled with a standard PLC, whereas a tested fail-safe controller (S7-400F, S7-400FH, S5-115F, or multiple S5-95F) controls the safety-relevant areas.
The entire installation is implemented with a fail-safe control system.
- For control equipment with mainly safety-relevant functions (e.g. burner control systems)
The entire control system is implemented with fail-safe technology.

Important Information

Even when electronic control equipment has been configured for maximum design safety - e.g. with a multi-channel structure - it is imperative conform with instructions given in the operating manual. Incorrect handling can render measures intended to prevent dangerous faults ineffective, or generate additional sources of danger.

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 operand or operand 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, so that they can be processed by the central processing unit, or convert digital values into analog manipulated variables.

Automation system

An automation system in the context of SIMATIC S7 --> is a programmable logic controller.

Backplane Bus

The serial backplane data bus supplies the power required by the modules. It is also used by the modules for communication. The connection between the modules is established by bus connectors.

Backup memory

This memory is used to backup memory areas of --> CPUs not equipped with a backup battery. A configurable number of timers, counters, memories and data bytes (retentive timers, counters, memories and data bytes) is backed up.

Bus segment

A bus segment is a self-contained section of a serial bus system. Bus segments are interconnected using repeaters.

Bus

A bus is a communication medium connecting several nodes. Data transmission can be serial or parallel across electrical conductors or optical waveguides.

Chassis ground

Chassis ground is the totality of all the interconnected inactive parts of a piece of equipment on which a hazardous touch voltage cannot build up even in the event of a fault.

Clock memories

Memories that can be used for clocking purposes in the user program (1 memory byte).

Note

Note in the case of S7-300 CPUs that the clock memory byte 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 blocks (DB) only contain data.)

Communication processor

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

Compress

The PG's online function "Compress" is used to align all valid blocks contiguously in the RAM of the CPU at the start of the user memory. This eliminates all gaps which arose when blocks were deleted or modified.

Configuration

Assignment of modules to racks/slots and (e.g. for signal modules) addresses.

Consistent data

Data whose contents are related and which should not be separated are known 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 by reading it out at two different times.

Counter

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 of an S7 PLC, consisting of the control and arithmetic unit, memory, operating system and a PG interface.

Cycle Time

The term cycle time describes the time required by a --> CPU for one --> user program execution.

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 while instance data blocks are assigned to a specific FB call.

Data, static

Static data is data which can only be used within a function block. The data is saved in an instance data block belonging to the function block. The data stored in the instance data block is retained until the next function block call.

Data, temporary

Temporary data is local data of a block that is stored in the L stack during block execution and no longer available after execution.

Delay Interrupt

--> Interrupt, Delay

Diagnostic buffer

The diagnostic buffer is a buffered memory area in the CPU in which diagnostic events are stored in the order of their occurrence.

Diagnostic Interrupt

Modules capable of diagnostic operations report detected system error events to the --> CPU, using diagnostic interrupts.

Diagnostics

--> System Diagnostics

DP master

A --> master which operates in accordance with EN 50170, Part 3 is referred to as a DP master.

DP Slave

A --> slave operated on PROFIBUS with PROFIBUS-DP protocol and in accordance with EN 50170, Part 3 is referred to as DP slave.

Equipotential bonding

Electrical connection (equipotential bonding conductor) which gives the bodies of electrical equipment and external conducting bodies the same or approximately the same potential, in order to prevent disturbing or dangerous voltages from being generated between these bodies.

Error display

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

Error handling via OB

When the operating system detects a specific error (e.g. access error with **STEP 7**), it calls a dedicated organization block (Error OB) that determines subsequent CPU response.

Error response

Response to a --> runtime error. The operating system can respond in the following ways: transition of the PLC to STOP mode, call of an organization block in which the user can program an error response or display.

External power supply

Power supply for the signal and function modules and the I/O connected to them.

FB

--> Function Block

FC

--> Function

Flash EPROM

FEPROMs are the same as electrically erasable EEPROMS in that they can retain data in the event of a power failure, but they can be erased much more quickly (FEPRoM = Flash Erasable Programmable Read Only Memory). They are used on --> Memory Cards.

Force

The "Force" function overwrites a variable (e.g. memory bit, output) with a value defined by the S7 user. At the same time, this variable is write protected, thus preventing modification by any other operation (including from the STEP 7 user program). The value is retained after the programming device is disconnected. The write protection can only be cleared with the "Unforce" function. The value specified in the user program is then written back to the variable. For example, during commissioning you can use the "Force" function to set specific outputs to "ON" state for an indefinite time, even if the user program is not logically linked (e.g. inputs are not wired).

Function block

According to IEC 1131-3, a function block is a --> code block that contains --> static data. An FB allows parameters to be passed in the user program. Function blocks are therefore suitable for programming complex functions, e.g. closed-loop controls, mode selections, which are repeated frequently.

Functional grounding

Grounding which has the sole purpose of safeguarding the intended function of the electrical equipment. Functional grounding short-circuits interference voltage which would otherwise have an impermissible impact on the equipment.

Function

According to IEC 1131-3, a function is a --> code block that contains no --> static data. A function allows parameters to be passed in the user program. Functions are therefore suitable for programming complex functions, e.g. calculations, which are repeated frequently.

Galvanically isolated

The reference potential of the control and on-load power circuits for isolated I/Os is galvanically isolated; e.g. by optocouplers, relay contact or transformer. I/O circuits can be connected to a common potential.

GD circuit

A GD circuit consists of a number of CPUs exchanging data by means of global data communication and which are used as follows:

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

A GD circuit is identified by a GD circuit number.

GD Element

A GD element is generated by assigning shared --> global data. It is identified by a unique global data ID in the global data table.

GD packet

A GD packet can consist of one or multiple --> GD elements transferred in a single message frame.

Global data communication

Global data communication is a procedure used for --> global data exchange between CPUs (no CFBs).

Ground (to)

To ground means to connect an electrically conducting component to the grounding electrode (one or more conducting components which have a very good contact with the earth) across a grounding system.

Ground

The conducting earth whose electrical potential can be set equal to zero at any point.

In the vicinity of grounding electrodes, the earth can have a potential different to zero. The term "reference ground" is frequently used to describe these circumstances.

GSD file (device master 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

A DB is automatically generated and assigned to every function block call in the **STEP 7** user program. The values of the input, output and in/out parameters are stored in the instance data block, together with local block data.

Interface, multipoint

--> MPI

Interrupt, delay

The delay interrupt belongs to one of the priority classes when processing programs in SIMATIC S7. It is started on expiration of a time generated in the user program. A corresponding organization block is then executed.

Interrupt, Diagnostics

--> Diagnostic Interrupt

Interrupt, Process

--> Process Interrupt

Interrupt, time-of-day

The time-of-day interrupt belongs to one of the priority classes when processing programs in SIMATIC S7. It is generated depending on a specific date (or daily) and time-of-day (e.g. 9:50 or hourly, or every minute). A corresponding organization block is then executed.

Interrupt, watchdog

A watchdog interrupt is generated periodically by the CPU in configurable time intervals. A corresponding --> organization block is then executed.

Interrupt

The CPU's --> operating system knows 10 different priority classes for controlling user program execution. e.g. process interrupts. When an interrupt is triggered, the operating system automatically calls an assigned organization block in which the user can program the desired response (for example in an FB).

Load memory

The load memory is part of the central processing unit. It contains objects generated by the programming device. It is implemented either as a plug-in memory card or a permanently integrated memory.

Local data

--> Data, temporary

Main memory

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

Master

Masters in possession of the --> Token can send/request data to/from other nodes (= active node).

Memory bits

Memory bits are part of the CPU's --> system memory. They store the intermediate results of calculations. They can be accessed in bit, byte, word or doubleword units.

Memory card

Memory cards are memory media in smart card format for CPUs and CPs. They are implemented as --> RAM or --> FEPRM.

Micro Memory Card (MMC)

Micro Memory Cards are memory media for CPUs and CPs. Its smaller dimensions form the only difference compared to the --> Memory Card.

Module parameters

Module parameters are values which can be used to control the response of the module. A distinction is made between static and dynamic module parameters.

MPI address

--> MPI

MPI

This interface is capable of multipoint communication (MPI). It forms part of the SIMATIC S7 PG interface. It also offers optional multiple node operation (PGs, text displays, operator panels) on one or several PLCs. Each node is identified by a unique address (MPI address).

Nesting depth

One block can be called from another by means of a block call. Nesting depth is defined 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/Os is electrically interconnected.

OB

--> Organization Blocks

OB priority

The CPU --> operating system distinguishes between different priority classes, e.g. cyclic program execution, program execution controlled by process interrupt. Each priority class is assigned --> organization blocks (OBs) in which the S7 user can program a response. The OBs have different standard priorities which determine the order in which they are executed or interrupted in the event that they are activated simultaneously.

Operating mode

SIMATIC S7 PLC operating modes are: STOP, --> START-UP, RUN.

Operating system of the CPU

The operating system of the CPU organizes all functions and processes of the CPU which are not associated with a special control task.

Organization Blocks

Organization blocks (OBs) represent the interface between the operating system of the CPU and the user program. The processing sequence of the user program is defined in the organization blocks.

Parameters, dynamic

Unlike static parameters, dynamic parameters of modules can be changed during operation by calling an SFC in the user program, for example limit values of an analog signal input module.

Parameters, static

Unlike dynamic parameters, static parameters of modules cannot be changed by the user program, but rather by changing the configuration in **STEP 7**, for example the input delay on a digital signal input module.

Parameters

1. Variable of a STEP 7 code block
 2. Variable for declaring module response (one or several per module).
- All modules are delivered with a suitable factory setting which can be changed in the configuration with **STEP 7**.
There are --> static parameters and --> dynamic parameters

PG

--> Programming Device

PLC

--> Programmable controller

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. If a priority class includes several OBs, they do not interrupt each other, but are executed sequentially.

Process Image

The process image is part of CPU --> system memory. At the start of cyclic program execution, the status of the signal module inputs is written to the input process image. At the end of cyclic program execution, the signal status of the output process image 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 is then processed, according to interrupt priority.

Product version

The product version differentiates between products which have the same order number. The product version is increased with each upwardly compatible function extension, production-related modification (use of new components) or bug-fix.

PROFIBUS-DP

The PLC distributes controls for digital, analog and intelligent modules as well as a wide range of field devices to EN 50170, part 3, for example, drives or valve blocks, to processes at external locations - even across distances exceeding 23 km.

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

Programmable controller

Programmable controllers (PLCs) are electronic controllers whose function is saved as a program in the control unit. The configuration and wiring of the unit are therefore independent of the function of the control system. 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/Os and the programming language are oriented to control engineering needs.

Programming device

Programming devices are essentially personal computers which are compact, portable and suitable for industrial applications. They are equipped with special hardware and software for SIMATIC PLCs.

RAM

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

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

Potential with reference to which the voltages of participating circuits are observed and/or measured.

Restart

When a central processing unit is started up (e.g. by switching the mode selector from STOP to RUN or by switching the power on), organization block OB 100 (complete restart) is executed before cyclic program execution commences (OB 1). On restart, the input process image is read in and the **STEP 7** user program is executed, starting at the first instruction in OB 1.

Retentivity

A memory area is retentive if its contents are retained even after a power failure and a change from STOP to RUN. The volatile area of memory bits, timers and counters is reset after a power failure and transition from STOP to RUN mode.

The following can be made retentive:

- Bit memories
- S7 timers
- S7 counters
- Data areas (only with Memory Card or integrated EPROM)

Runtime error

These are PLC errors occurring during user program execution (that is, not in the process itself).

Segment

--> Bus Segment

SFB

--> System function block

SFC

--> System function

Shared data

Shared data can be addressed from any --> code block (FC, FB, OB). In detail, this refers to memories M, inputs I, outputs Q, timers, counters and data blocks DB. Absolute or symbolic access can be made to shared data.

Signal module

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

Slave

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

Startup

RESTART mode is activated on a transition from STOP mode 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 developing user programs for SIMATIC S7 PLCs.

Substitute value

Substitute values are configurable values which output modules transmit to the process when the CPU switches to STOP mode.

In the event of an input 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 is the term used to describe the detection, evaluation and signaling of errors which occur within the programmable controller. Examples of such errors are program errors or module failures. System errors can be displayed with LED indicators or in **STEP 7**.

System function block

A System Function Block (SFB) is a --> function block integrated in the CPU operating system. If required, it can be called in the STEP 7 user program.

System function

A system function (SFC) is an integrated --> Function of the CPU. It can be called at any time in the STEP 7 user program.

System Memory

The system memory (RAM) is integrated on the central processing unit. System memory contains the operand areas (e.g. timers, counters, memory bits) as well as the data areas required internally by the --> operating system (e.g. buffers for communication).

System state list

The system status list contains data describing the current status of an S7-300. You can use it to gain an overview of the following at any time:

- The S7-300 configuration
- The current CPU configuration and the configurable signal modules
- Current status and processes in the CPU and configurable signal modules.

Terminating resistor

The terminating resistance is used to avoid reflections on data links.

Time-of-day interrupt

--> Interrupt, Time-of-day

Timer

--> Timers, Principle

Timers

Timers are part of CPU --> system memory. The contents of the "timer cells" are updated automatically by the operating system asynchronously to the user program. **STEP 7** instructions are used to define the exact function of the timer cells (for example on-delay) and initiate their execution (e.g. start).

Token

Access right on bus

Transmission rate

Rate of data transfer (bps)

Ungrounded

Having no galvanic connection to ground

User memory

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, user programs are always executed from --> CPU working memory.

User program

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

Varistor

Voltage-independent resistor

Watchdog Interrupt

--> Interrupt, Watchdog

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