SIEMENS

SIMATIC

SIMATIC S7-4100 Controller

System Manual

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6DL4160-2SD01-0XX0
6DL4163-1EX00-0XE0
6DL4163-5DX00-0XE0
6DL4160-1BF01-0XX0

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Legal information

Warning notice system

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

⚠ DANGER

indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠ WARNING

indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION

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

NOTICE

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

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

Qualified Personnel

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

Proper use of Siemens products

Note the following:

⚠ WARNING

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

Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

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

Siemens AG
Digital Industries
Postfach 48 48
90026 NÜRNBERG
GERMANY

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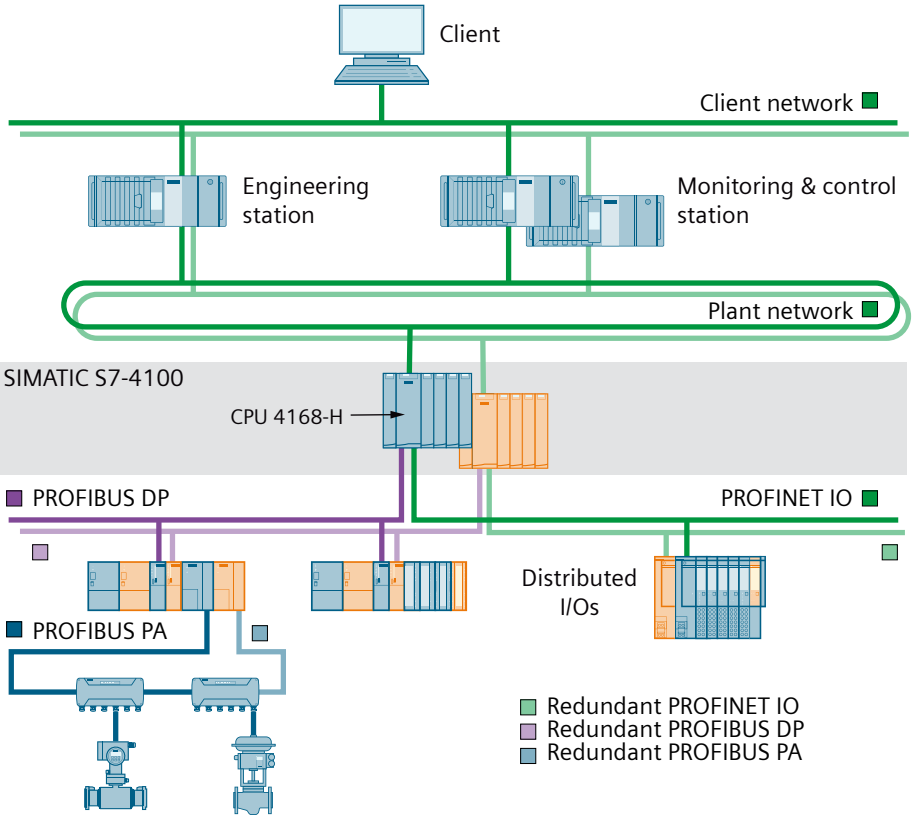
SIMATIC S7-4100 - System overview

1

Overview

SIMATIC S7-4100 is a controller that is specially designed for use with the SIMATIC PCS neo process control system. The controller adds compact and powerful components to the hardware portfolio of the process control system.
The central processing unit of the SIMATIC S7-4100 is the CPU 4168-H, which features SIMATIC technology.
Its mounting technology enables space-saving mounting of the CPU, the power supply module and up to 5 communications processors (CPs).
The controller can be connected to PROFINET IO/Industrial Ethernet and PROFIBUS DP via interfaces of the CPU or plug-in CPs.

The figure shows an example of a system configuration for integrating controllers with connected distributed I/O to the process control system. The components required for installation and operating the controller are described in the following.



Scope of this documentation

This document is valid for SIMATIC S7-4100.

Note

Classification of the documentation

The information in this documentation takes precedence over the information for the specific products. The statements in the product information always takes precedence over all other information.

Purpose of the documentation

This document contains information on the following topics:

- Planning
- Installing and connecting
- Commissioning
- Diagnostic options and service support
- Description of functions
- Technical specifications

Knowledge required

A basic knowledge of automation technology is required to understand the documentation.

Experience using computers or devices similar to PCs.

You can find information about the required Windows operating system for SIMATIC PCS neo in the SIMATIC PCS neo Readme.

Knowledge about the national and international standards applicable to the area of application

Read the notes highlighted as follows:

Note

A note contains important information on the product described, on the handling of the product or on the section of the documentation.

Features of the SIMATIC S7-4100

SIMATIC S7-4100 has the following features:

- Scalable CPU
- Modules in rugged design
- Compact modules with high packing density

- Optimal communication and networking options via PROFINET IO/Industrial Ethernet and PROFIBUS DP
- Optimum integration into the process control system
- Software-based parameter assignment of all modules
- Operation without fan

See also

Working with the SIMATIC S7-4100 controller (Page 35)

1.1 Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit
https://www.siemens.com/industrialsecurity.

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customer's exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under
https://www.siemens.com/cert.

1.1.1 Security concept

Note the security concept of PCS neo, see:
Link to the security concept of PCS neo (https://support.industry.siemens.com/cs/ww/en/view/109772128/en),

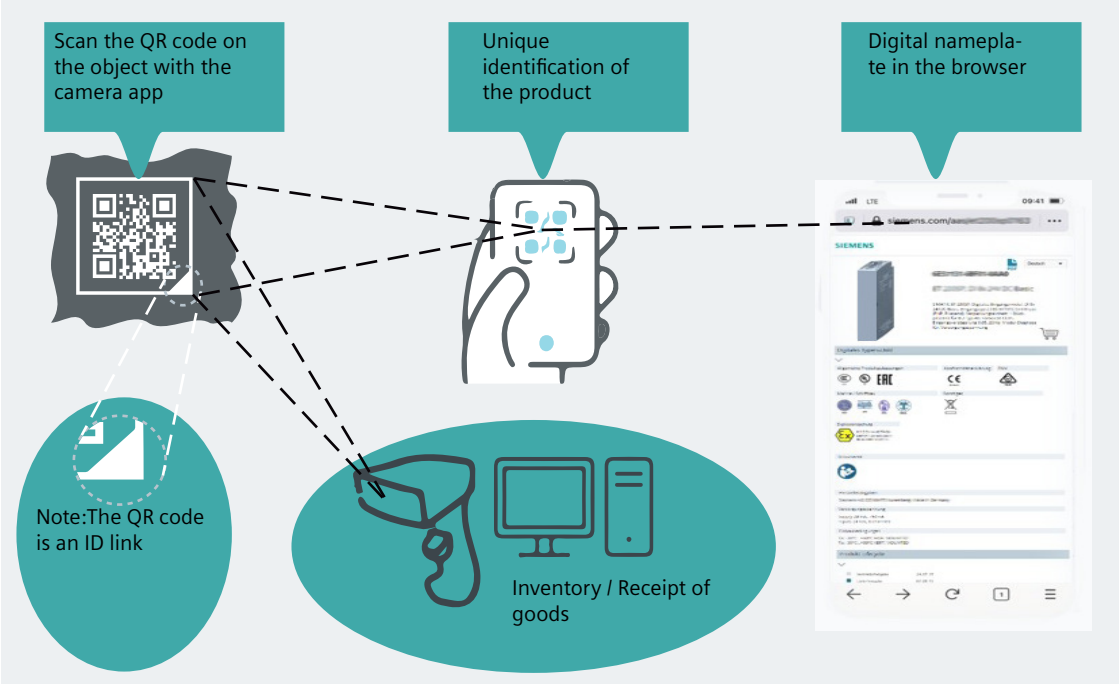
the contents of this manual in the section Security recommendations (Page 67)

as well as the PROFINET Security Guideline, see:

Link to the PROFINET Security Guideline (https://www.profibus.com/download/profinet-security-guideline)

1.2 Digital nameplate (QR code on the front)

Identification link --- Simple application



QR code

The QR code on the front of this product and on the packaging uniquely identifies the product.

The QR code is also an identification link to IEC 61406-1.

If you scan the QR code (e.g. with a smartphone) you directly open the digital nameplate.

Digital nameplate

The digital nameplate is:

- A contribution from SIEMENS to reduce the CO_2 footprint and to conserve resources.
- The efficient way to access the product information provided on the Internet. This information remains up-to-date over the entire product life cycle.
  For your plant documentation, you have the option of linking the download or downloading the following information:
  - Technical specifications
  - Certifications and Declaration of Conformity
  - Manufacturer information
  - Product identification
  - User documentation
  - Replacement
  - Responsive web design
  - Other information

1.3 Safety instructions

Safety notices on the use of the device

Note the following safety notices when setting up and operating the device and during all associated work such as installation, connecting up or replacing the device.

1.3.1 Important notes on using the device

Note

Module approvals

You can find the currently valid approvals on the nameplate of the respective product.

⚠ WARNING

Safety requirements for open type equipment

Death or serious physical injury or considerable damage to property can occur if appropriate measures are not taken.

The device including its components is considered "open type equipment" according to the following standards:

- IEC 61010-2-201

or

- UL 61010-2-201 / CSA C22.2 No. 61010-2-201.

To satisfy the specifications for safe operation with respect to mechanical strength, flame resistance, stability and protection against contact, you must ensure the following:

- This device must only be operated installed in enclosures, cabinets or electrical operation rooms inside a building.
- The enclosures, cabinets or electrical operation rooms ensure protection from electric shock and prevent the spread of fire.
  The requirements of mechanical strength are taken into account.
- The enclosure, cabinet or electrical operating rooms can only be accessed with a key or tool.
- The personnel have been trained accordingly or granted access permission.

NOTICE

Ambient temperature of more than 50 °C

If a device is operated at an ambient temperature of more than 50 °C, the device enclosure temperature can be above 70 °C.

The installation location of the device must therefore be in a restricted area accessible only to service engineers or operators who have been informed of the reason for the access restriction and the necessary security measures at an ambient temperature of more than 50 °C.

⚠ WARNING

Protection from conductive contamination

Protect the devices from conductive contamination. Note the ambient conditions in doing so.

You achieve the protection from conductive contamination, for example, by installing the devices into a control cabinet with the corresponding degree of protection.

1.3.2 Notes on use in hazardous areas

Note

Approval

You may use the device with device category 3G in hazardous areas of Zone 2.

You may only use the power supply module PS 4160-SD in the hazardous area (Zone 2). Note the following requirement on the supply voltage.

⚠ CAUTION

Supply voltage in the hazardous area - Zone 2

The supply voltage of the device must meet at least one of the following conditions:

- The supplied safety extra low voltage (SELV) with limited power (Limited Power Source, LPS) meets the following standards:
  - IEC 60950-1 / EN 60950-1 / VDE 0805-1

  or
  - IEC 62368-1 / EN 62368-1 / VDE 62368-1
- The power supply unit of the device complies with NEC Class 2 according to the National Electrical Code (r) (ANSI / NFPA 70).

When the device is connected to a redundant power supply (two separate power supply units), both units must meet these requirements.

⚠ WARNING

Explosion hazard due to pulling or plugging in Ex Zone 2

Pulling or plugging of components (modules and cables) is prohibited in Ex Zone 2.

The following applies in the safe area (area without combustible gas concentrations):

- Pulling or plugging of bus cables is permitted when the power supply is switched on.
- Installation in the bus module
  The following modules may be removed or installed when the power supply is switched on:
  - CPs
- Installation with U-connector
  Irrespective of the use, it is not permitted to pull or plug modules when the supply voltage is switched on.

⚠ WARNING

EXPLOSION HAZARD

You are not permitted to disconnect cables from the device or connect cables to the device in Ex Zone 2.

The following applies in the safe area (area without combustible gas concentrations):

Cables may be disconnected from the device or connected to the device.

WARNING

Unsuitable cables or connectors

Risk of explosion in hazardous areas

- Only use connectors that meet the requirements of the relevant type of protection.
- If necessary, tighten the connector screw connections, device fastening screws, grounding screws, etc. according to the specified torques.
- Close unused cable openings for electrical connections.
- Check the cables for a tight fit after installation.

WARNING

Unprotected cable ends

There is a risk of explosion due to unprotected cable ends in hazardous areas.

- Protect unused cable ends according to IEC/EN 60079-14.

WARNING

Improper laying of shielded cables

Compensating currents are an explosion hazard.

- Ground shielded cables that cross hazardous areas only at one end.
- If both ends are grounded, install an equipotential bonding conductor.

WARNING

Insufficient disconnection of intrinsically safe and not intrinsically safe circuits

Explosion hazard in hazardous areas

- When connecting circuits that are intrinsically safe or not intrinsically safe, ensure that galvanic isolation takes place properly while observing local regulations (e.g. IEC 60079-14).
- Note the device approvals in effect in your country.

WARNING

Missing equipotential bonding

If equipotential bonding is not installed in hazardous areas, there is a risk of explosion due to compensatory currents or sparks.

Make sure that equipotential bonding exists for the device.

WARNING

Degree of pollution

The device may only be operated in an environment with pollution degree 1 or 2 as specified in EN/ IEC 60664-1, GB/T 16935.1.

Cleaning

If you need to clean the product, use a dry ESD cleaning cloth (while adhering to ESD protection measures).

See also

Maintenance (Page 122)

1.3.3 Additional requirements for operation in hazardous areas as specified in ATEX / UKEX / IECEx / CCC-Ex

WARNING

Requirements for the cabinet/enclosure

To comply with EC Directive 2014/34 EU (ATEX 114) or the conditions of IECEx, this enclosure or cabinet must meet the requirements of at least IP54 (in compliance with EN 60529) according to EN 60079-7.

WARNING

Suitable cables for high temperature in hazardous area

Use heat-resistant cables when the ambient temperature exceeds 60 °C; these cables must be rated for an ambient temperature that is at least 20 °C higher. The cable entries used on the enclosure must meet the IP degree of protection as specified in EN IEC / IEC 60079-0, GB 3836.1.

WARNING

Explosion hazard through transient overvoltages

Take measures to prevent transient overvoltages of more than 40% of the rated voltage (for example, more than 119 V). This is guaranteed when you only operate devices with SELV (safety extra low voltage).

1.3.3.1 LAN (Local Area Network) connection

WARNING

LAN (Local Area Network) connection

A LAN or LAN segment with all its associated and networked devices should be completely integrated into a single low-voltage power distribution in a building. The LAN is configured either for "Environment A" as specified in IEEE802.3 or "Environment 0" as specified in IEC TR 62102.

Do not connect electrical connectors directly to a telephone network (Telephone Network Voltage) or a WAN (Wide Area Network).

1.3.4 Additional requirements for operation in hazardous areas as specified in UL HazLoc

WARNING

EXPLOSION HAZARD

You may only connect or disconnect cables carrying electricity when the power supply is switched off or when the device is in an area without inflammable gas concentrations.

This equipment is suitable for use in Class I, Division 2, Groups A, B, C and D or non-hazardous locations only.

The device is only suitable for use in Class I, Zone 2, Group IIC and in non-hazardous areas.

1.3.5 Additional requirements for operation in hazardous areas as specified in FM

WARNING

EXPLOSION HAZARD

You may only connect or disconnect cables carrying electricity when the power supply is switched off or when the device is in an area without inflammable gas concentrations.

This equipment is suitable for use in Class I, Division 2, Groups A, B, C and D or non-hazardous locations only.

The device is only suitable for use in Class I, Zone 2, Group IIC and in non-hazardous areas.

⚠ WARNING

EXPLOSION HAZARD

The equipment is intended to be installed within an ultimate enclosure. The inner service temperature of the enclosure corresponds to the ambient temperature of the module. Use installation wiring connections with admitted maximum operating temperature of at least 30 °C higher than maximum ambient temperature.

1.3.6 Installing and connecting

1.3.6.1 Damage caused by electrical fields or electrostatic discharge

Electrostatic sensitive devices (ESD) are individual components, integrated switches, modules or devices that can be damaged by electrostatic fields or electrostatic discharges.

NOTICE

Damage caused by electrical fields or electrostatic discharge

Electrical fields or electrostatic discharges can cause interferences through damaged individual components, integrated switches, modules or devices.

- Only package, store, transport or ship electronic components, modules or devices in their original packaging or using other suitable materials, such as conductive foam rubber or aluminum foil.
- Only touch the components, modules and devices when you are grounded through one of the following measures:
  - Wearing an ESD wristband
  - Wearing ESD shoes or ESD grounding straps in ESD areas with conductive flooring
- Only place electronic components, modules or devices on conductive surfaces (table with ESD mat, conductive ESD foam rubber, ESD packaging bags, ESD shipping containers).

⚠ WARNING

Cable cross-section

Insufficient cable cross-sections are a fire hazard.

The cables must be approved for the required current.

Observe the installation and setup instructions specified in DIN EN IEC 60079-14 as well as country-specific regulations when laying the cables and wiring.

Note

Repairing devices

Repair on site is not permitted.
In case of a fault, ship the device to your Siemens location for repair.

Repairs (Page 30)

WARNING

Impermissible accessories and spare parts

Risk of explosion in hazardous areas

- Only use original accessories and original spare parts.
- Observe all relevant installation and safety instructions described in the manuals for the device or supplied with the accessories or spare parts.

1.3.6.2 Installation

Observe the following during installation

DANGER

Explosion hazard

Ignitable sparks or impermissible surface temperatures may occur during installation under certain circumstances. Never carry out the installation under explosive conditions or in hazardous areas!

Observe the installation and setup instructions specified in DIN EN IEC 60079-14 as well as country-specific regulations.

1.3.7 Disassembly

WARNING

Improper removal

Improper removal can cause a risk of explosion in hazardous areas.

Observe the following for proper removal:

- Before you start with the removal, make sure that the supply voltage is switched off.
- Secure all remaining connectors so that they do not cause any damage as a result of removal if the supply voltage is inadvertently switched on.

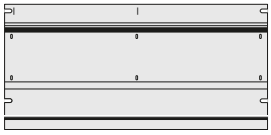
1.4 Basic components of the controller

1.4.1 Mounting rail

Definition

Used as the mounting platform for the SIMATIC S7-4100 controller.

Description



The mounting rails enable all versions for assembling the modules:

Design versions of the controller (Page 52)

The bottom part of the mounting rail is equivalent to a standard mounting rail (35 mm wide).

See also

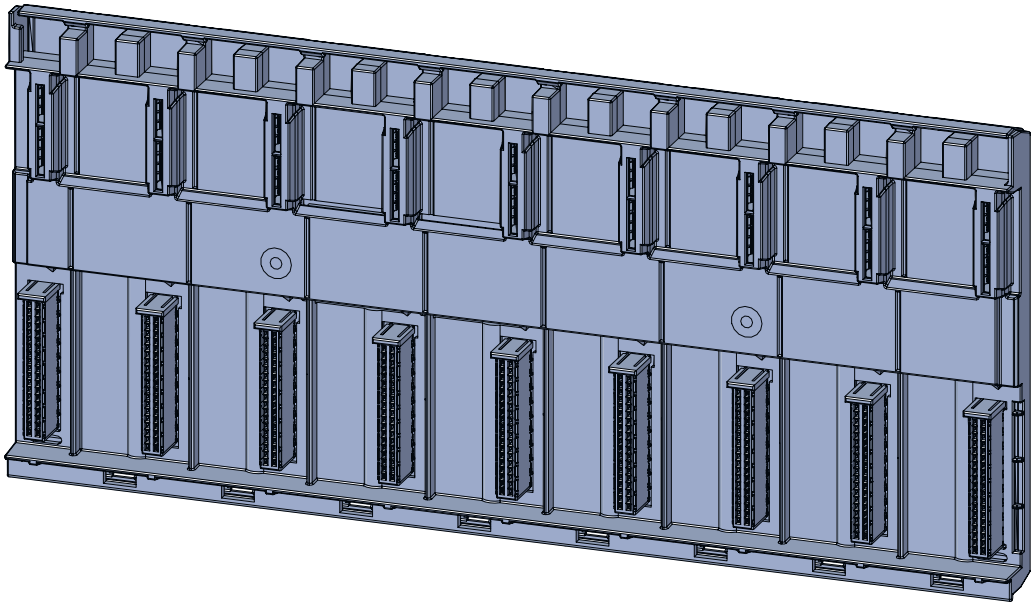
Components for the rack configuration (Page 168)

1.4.2 Bus module

Definition

Used for electrical and mechanical connection of all modules of a controller.

Description



The bus module is a component of the rack design.
It can be ordered separately (e.g. for designing a rack with two bus modules on a 19" mounting rail).
With the additional terminals required for the bus module, you can change a rack design with U-connectors to a rack design with bus modules.

The complete system functionality of the controller is only available in the design with a bus module.

Rack design with bus module (Page 53)

More information

- U-connector (Page 23)
- Labeling strips for slots are available:
  Components for the rack configuration (Page 168)

1.4.3 Terminal for bus module

Definition

Used for fastening and securing the bus modules on the mounting rail for a rack design with bus module.

Description

The terminal for the bus module is only required in the following cases:

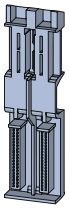
- When replacing the bus modules.
- Install bus module (assemble/create rack design with bus module).
  Make sure that the bus module is secured at both ends with a terminal for bus modules.

1.4.4 U-connector

Definition

Used for the electrical and mechanical connection between two modules.

Description



When assembling the controller, it is possible to establish the module connection between two modules with a U-connector.

More information

- Rack design with U-connector (Page 55)
- Labeling strips for slots are available:
  Components for the rack configuration (Page 168)

1.4.5 Power supply module

Definition

The power supply module converts the supply voltage into the secondary-side, internal system voltage of the controller.

Types of power supply modules (PS)

Information on the types of power supply modules: Power supply (Page 168)

Description

A power supply module supplies the system voltage regardless of the supply voltage.

The system voltage is forwarded via the bus module or a U-connector to the controller modules.

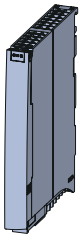
Note

Estimation of the power requirements

A power supply module provides the required power to supply all modules installed in the maximum configuration of the controller.

Therefore, an estimation of the power requirement is not necessary.

You can find information about the current consumption and power dissipation of the individual modules in the associated documentation in the technical specifications.



Total configuration with power supply modules

To increase availability, you can integrate up to two power supply modules in one controller.

Note the rules for the maximum configuration:

Maximum configuration (Page 55)

You can use power supply modules of different types for the configuration.

1.4.6 Device plug

Definition

Device plugs are the mechanical/electrical connectors for connecting the supply voltage to the power supply module.

Device plug

The device plug is part of the power supply module.

The device plugs are compatible with the device plugs of the SIMATIC S7-400 power supply: Type: 24 V DC or 120/230 V AC

When replacing the controller, the power supply plug can be plugged into a power supply module of the same type.

1.4.7 CPU

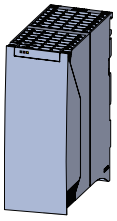
Definition

Used to execute the user program.

Description

Only the following CPU type is used for the SIMATIC S7-4100 controller:

CPU 4168-H for the SIMATIC S7-4100 controller.



The CPU has integrated interfaces for PROFINET IO/Industrial Ethernet and PROFIBUS DP.

Scalability

The functionality of the CPU can be scaled by the maximum number of licensed process objects (PO) that can be loaded.

Licensing for the number of process objects is saved to the SEC.

A System Expansion Card (SEC) is required to operate the CPU.

Note

SEC required

The SEC forms a unit with the CPU.

- The CPU cannot be operated without an SEC.
- A CPU with SEC only goes into RUN mode when a sufficiently large PO license is detected on the SEC.

- SECs with a different number of process objects are available for the CPU:
  System Expansion Cards (Page 167)

Note

Compatibility

The SECs are identical to the SECs used in the SIMATIC S7 CPU 410.

- Information about increasing the quantity structure
  Additional support (Page 31)
- Replacement
  Replacing the System Expansion Card (Page 137)

See also

Complete SIMATIC S7-4100 controller systems (Page 169)

1.4.8 CP

Definition

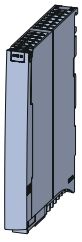
A CP is a module of the communication processor type for connecting the system to a communication network (e.g. PROFINET IO).

CP types (communication processor types)

Information on the types of communication processors: Communication (CPs) (Page 168)

Description

A CP exchanges the communication data with the CPU via the bus module or U-connector.



Total configuration with CP

You can integrate up to five CPs in one controller.

You can use CPs of different types for the configuration.

Note the rules for the maximum configuration:

Maximum configuration (Page 55)

1.4.9 Slot cover

Definition

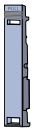
The slot cover protects a slot on the bus module without CP.

Requirement

Configuration with bus module

Description

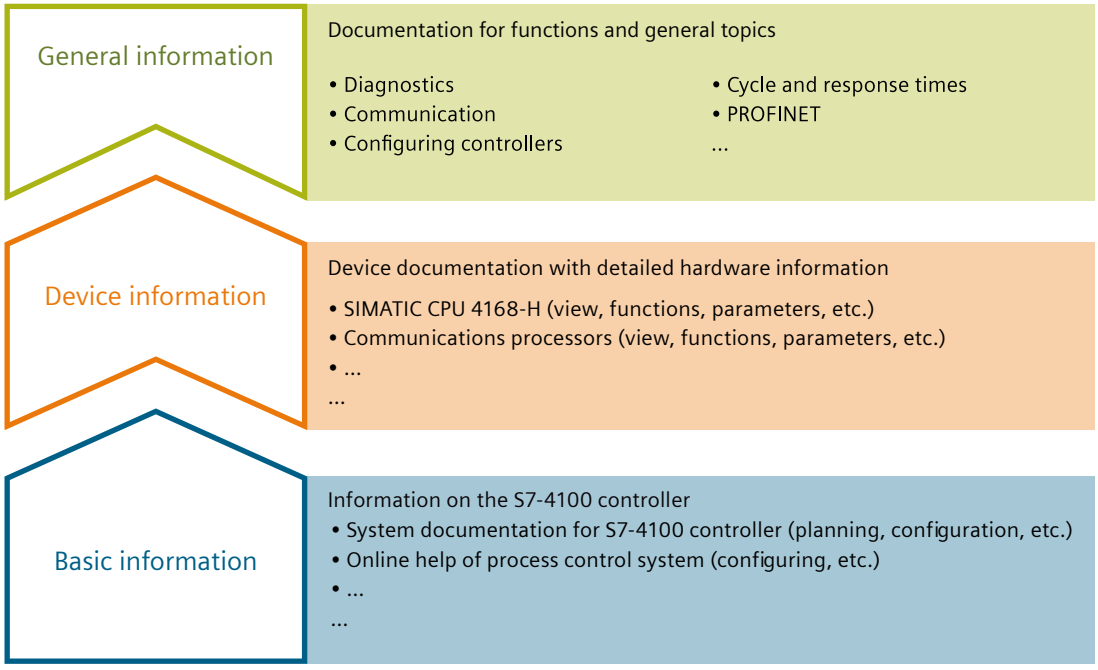
The slot cover is constructed as follows:



1.5 Additional information

1.5.1 Guide - SIMATIC S7-4100 documentation

The documentation for the SIMATIC S7-4100 controller is divided into 3 areas.



Basic information

The system documentation describes the mounting and wiring of the SIMATIC S7-4100 controller in detail.

Device information

Manuals include a compact description of the module-specific information, for example, properties, connection diagrams, technical specifications.

Comprehensive information

The cross-system documentation includes detailed descriptions on topics such as diagnostics, communication, standards, and general design guidelines.

Information about changes

Changes and amendments to the manuals are documented in a Product Information, if required.

Working with the PDF Reader

- **Cross references**
  Cross-references to other sections are frequently used in this manual. To return to the original page after jumping to a cross-reference, some PDF readers support the command <Alt>+<Left arrow>.
- **Search**
  To display all instances of a search term in a list, some PDF readers support the command <Ctrl>+<Shift>+<F>.

Working with the PUD Manager

- The PUD Manager is a tool for offline display of the documentation. By adding documentation packages, you expand and update the scope of your individual user documentation.
- You can more information on this topic on the Internet:
  PUD Manager (https://support.industry.siemens.com/cs/ww/en/view/109771768)

Conventions

The following terms are used synonymously in this documentation:

Term	Synonyms	Notes
CPU	Central unit	Unless otherwise stipulated, the term applies to the module as well as to the function of the module.
PN/IE interface	PROFINET interface; Ethernet interface	Interface for the connection to PROFINET/Ethernet. • Mostly referred to as PROFINET interface in the user interface. • PROFINET interface: With exclusive reference to the PROFINET IO system in this documentation. • Ethernet interface: – Mostly referred to as PROFINET interface in the user interface. – With exclusive reference to the Ethernet (Industrial Ethernet or LAN) in this documentation.
Module	Module, Product	Unless otherwise stipulated, applies to the hardware component of the controller described in the respective context (e.g. CPU or CP module, power supply module)
Device	Controller	Applies to the unit of all components that make up the specific design of the controller.
ES	Engineering Station	PC station, with installed project configuration software (e.g. configuration of the controller and the corresponding distributed I/O).

1.5.2 Approvals

You will find detailed information on standards and approvals in the section:

Standards and approvals (Page 159)

License conditions

For information on the open source software components used, please refer to the enclosed CD. "S7-4100 License Conditions".

Note

Open source software

The product contains open source software. Read the license conditions of the open source software carefully before using the product.

1.5.3 Firmware

Firmware

The firmware is signed.

The following applies for loading the firmware:

- The engineering station only loads released firmware on modules of the controller.
- The modules of the controller refuse to load manipulated or incorrect firmware.

More information on the firmware update is available under engineering in the online help.

Note on firmware/software support

Siemens only provides bug and security fixes for the last released firmware/software version. This means that Siemens only monitors the current firmware/software version for security vulnerabilities.

1.5.4 Repairs

If there is a fault, send the module to your Siemens location for repair. Repair on site is not possible.

Repair services (https://support.industry.siemens.com/cs/ww/en/sc/2154)

If you need replacement:
Spare part services (https://support.industry.siemens.com/cs/ww/en/sc/2110)

Decommissioning

Decommission the device according to the applicable guidelines to prevent access by unauthorized persons to confidential data in the device memory.

Restore the factory settings of the module:

- Reset to factory settings (Page 129)

Recycling and disposal

The products are low in harmful substances, can be recycled and meet the requirements of the WEEE Regulation 2012/19/EU "Waste electrical and electronic equipment".

Do not dispose of the products at public disposal sites. For environmentally compliant recycling and disposal of your electronic waste, please contact a company certified for the disposal of electronic waste or your Siemens representative.

Note the local regulations.

You can find information on product returns on the Internet pages of Siemens Industry Online Support:
Recycling and disposal (https://support.industry.siemens.com/cs/ww/en/view/109479891).

1.5.5 Additional support

If you have questions about the described products that are not answered in this documentation: Please contact your Siemens representative at the agencies and branch offices responsible for you.
You can find your contact at:

Contact partners (http://www.siemens.com/automation/partner)

The guide for technical documentation for the individual SIMATIC products and systems is available at:

Documentation (http://www.automation.siemens.com/simatic/portal/html_76/techdoku.htm)

You can find the online catalog and online ordering system at:

Catalog (http://mall.automation.siemens.com/)

Training center

We offer the following training courses to make it easier for you to get started using the SIMATIC automation system. Contact your regional training center or the central training center in Nuremburg, Germany:

Training (https://www.siemens.com/sitrain)

Technical Support

You can reach the Technical Support for all Industry Automation products via the web form for the support request
Support Request (http://www.siemens.de/automation/support-request)

You can more information on our Technical Support on the Internet at
Technical Support (http://support.automation.siemens.com).

Service & Support on the Internet

You can find our extensive documentation offer online on the Internet:

Service & Support (https://support.industry.siemens.com/cs)

There you will find:

- The newsletter that provides you continuously with the latest information on our products.
- The latest documents using our search function in Service & Support.
- A forum in which users and specialists worldwide are exchanging their experiences.
- Your contact person for automation and drive technology on site using our contact person database.
- Information about on-site service, repairs and spare parts. You will find a lot more information under the term "Services".
- Applications and tools for optimal use of the SIMATIC. For example, performance measurements for PROFINET IO and PROFIBUS DP are also published here.

SIMATIC NET glossary

The SIMATIC NET glossary describes terms that may be used in this document.

You will find the SIMATIC NET glossary in the Siemens Industry Online Support at the following address:

Link: (https://support.industry.siemens.com/cs/ww/en/view/50305045)

Register for individual notifications (Newsletter)

1. Open the web page of the product support: https://support.industry.siemens.com/cs/ww/en/ps (https://support.industry.siemens.com/cs/ww/en/ps)
2. Filter the products for which you want to receive notifications.
3. Click "Save filter".
4. Enter the filter name.
5. Click "Enable notification".
6. Click "Save filter".

Additional information on this:

- Quick start: Receive notifications (Newsletter) (https://support.industry.siemens.com/cs/): Individual notifications and filters (Newsletter)
- Helpful functions in Online Support (videos) (https://support.industry.siemens.com/cs/ww/en/sc/2063)

Always up to date with "mySupport"

In Industry Online Support, you can set "Filters" for various individual topics of interest (e.g. topics, configurations, products, etc.) or mark specific articles as "Favorites". To not have to check for yourself whether there is news or changes to these topics of interest, you can receive notifications from the Online Support, for example, by email.

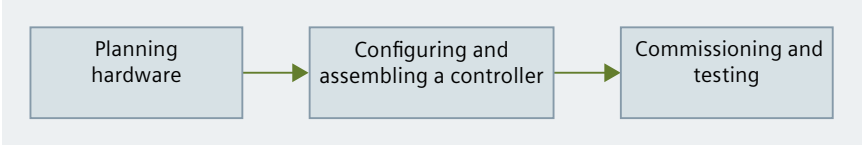
- You access this service on the following pages on the Internet (https://support.industry.siemens.com/cs/ww/en/my).
  You will find the following information in the header:
  - **Language**: Language selection for "mySupport" page
  - **Contact**: "Global and regional contacts"
  - **Help:** Help for "mySupport" page
  - **Support Request**: Requests submitted to technical specialists

Working with the SIMATIC S7-4100 controller

2

You need the following information to work with the SIMATIC S7-4100 controller:

SIMATIC S7-4100 - System overview (Page 9)



- The controller is scalable, allowing it to be adapted locally to individual needs (e.g. plant-specific configuration and licensing).
  Planning hardware (Page 37)
- You can execute the steps for configuration and installation simultaneously or in any order.
  Configuring and assembling a controller (Page 67)
- Successful engineering is a prerequisite for loading the controller.
  Commissioning the controller (Page 103)
- You evaluate status information for controller diagnostics. Servicing on the controller includes maintenance work and specific changes to the plant state.
  Running diagnostics and maintenance (Page 111)

Planning

3

3.1 Planning hardware

You need the following information for planning the controller.

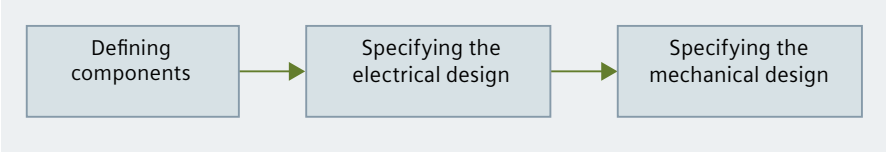
Notes on hardware planning (Page 39)

Determining requirements

Before you can plan the hardware, the following requirements must be clarified:

- Scope of performance (number of process objects)
- Required communication connections
- Required number and type of interfaces for the distributed I/O
- Operating environment (power supply, environment, etc.)
- National and international standards and directives

Defining components



- Specify the electrical design of the controller (power supply, network connections, time synchronization).
  Specifying the electrical design (Page 62)
- Specify the mechanical design of the controller (e.g. type of housing, clearances, position of the components)
  Specifying the mechanical design (Page 65)

3.2 Product overview

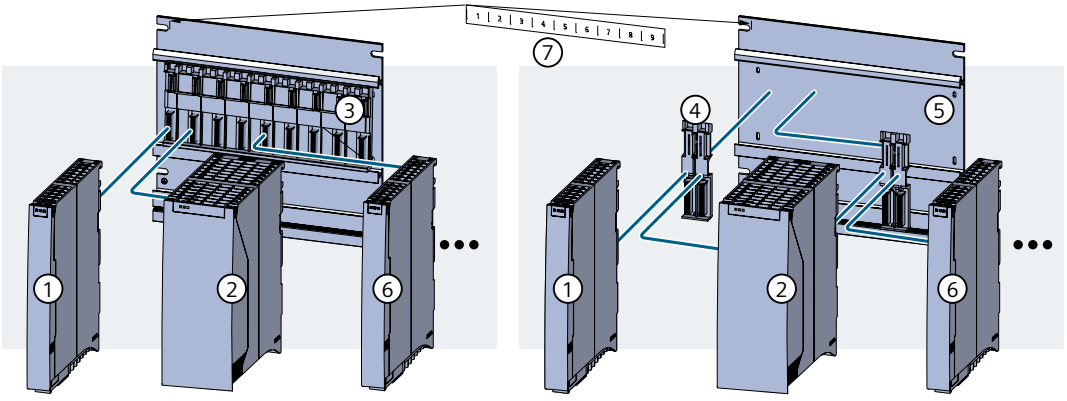
Definition

The SIMATIC S7-4100 controller has a modular design.

Description

The following figure shows the design of the controller. The table below offers an overview of the components of the controller in its design versions:

- Left rack design with bus module ③
- Right rack design with U-connector ④



No.	Component	Function
Components of the controller		
①	Power supply module (Page 23)	Module of the controller: Used to implement the supply voltage to the internal system voltage. It provides the required power to supply all components of the controller.
②	CPU (Page 25)	Central unit of the controller: Used to execute the user program. Has integrated interfaces for PROFINET IO/Industrial Ethernet and PROFIBUS DP.
③	Rack design with bus module	Design version 1 (figure on the left) The rack design (mounting rail with bus module) is the typical design version of the controller. Nine slots are available per bus module.
	• Mounting rail (Page 21)	Used as a mounting platform for the controller.
	• Bus module (Page 21)	Used for electrical and mechanical connection of all modules of a controller.
	• Terminal for bus module (Page 22)	For the rack design with bus module, used to fasten and secure the bus modules to the mounting rail.
④	U-connector (Page 23)	Design version 2 (figure on the right) Used for the electrical and mechanical connection between two modules.
⑤	Mounting rail (Page 21)	Used as a mounting platform for the controller.
⑥	CP (Page 26)	Module of the controller: As a communications processor, used to connect the controller to a communication network (e.g. LAN) and the distributed I/O.
	Slot cover (Page 27)	Used for protecting unused slots in the rack design with bus module.
⑦	Labeling strips	Labeling strips for slots (Components for the rack configuration (Page 168))

Information on types and article numbers: Accessories and spare parts (Page 167)

3.3 Notes on hardware planning

Introduction

Ensure that the requirements regarding setup, installation and service can be observed:
Safety instructions (Page 13)

Components of the controller

Product overview (Page 37)

Article numbers (in this documentation)

Accessories and spare parts (Page 167)

Technical specifications

Note

You can find the currently valid approvals on the nameplate of the respective product.

Standards and approvals (Page 159)

Modules

Power supply (in this documentation)

- Power supply module PS 4160-SA (Page 153)
- Power supply module PS 4160-SD (Page 156)

CPU
You can find the technical specifications in the following documentation:

- SIMATIC S7-4100, CPU 4168-H (Page 201)

CPs
You can find the technical specifications in the following documentation:

- SIMATIC S7-4100, PROFINET CP 4163-1 (Page 202)
- SIMATIC S7-4100, PROFIBUS CP 4163-5 (Page 202)

Rack configuration

- Table 7-7 Components for the rack configuration (Page 149)

Ambient conditions

- Transport and storage conditions (Page 144)
- Mechanical and climatic ambient conditions for operation (Page 145)
- Derating depending on the height above mean sea level (Page 147)
- Electromagnetic compatibility (Page 141)
- Information on insulation tests, protection class and degree of protection (Page 148)

Additional information

Product information

- Additional support (Page 31)
- Digital nameplate (QR code on the front) (Page 12)

Observe the following:

- When configuring
  EN 60079-14 / IEC 60079-14
- When conducting functional checks
  EN 60079-17 / IEC 60079-17
- Local standards and directives

Directives of the PROFIBUS user organization

The PROFIBUS user organization (PNO) has provided documents and tools to support you:

PROFIBUS user organization (https://www.profibus.com/)

- Designing PROFINET IO/Industrial Ethernet
  - PROFINET_Planungsrichtlinie
  - PROFINET_Design_Guideline

  Designing PROFIBUS DP
  - PROFIBUS_Planungsrichtlinie
  - PROFIBUS_Design_Guideline
- Calculating network load for PROFINET IO/Industrial Ethernet
  - The compressed file for the network load calculation.

Note the PROFINET Security Guideline (Link to the PROFINET Security Guideline (https://www.profibus.com/download/profinet-security-guideline))

3.3.1 Scaling and licensing (scaling concept)

License management

Process objects (PO) are scalable license objects in SIMATIC PCS neo. During configuration, SIMATIC PCS neo determines the number of POs required for executing the user program on the CPU.

The CPU is scaled via the System Expansion Card, that is, the System Expansion Card (SEC) determines the maximum quantity of process objects.

PCS neo manages the used POs required by the user program. The number of POs that can be loaded to the CPU is limited by the quantity specified by the System Expansion Card.

System Expansion Cards (Page 167)

Slot for the System Expansion Card (SEC)

Note

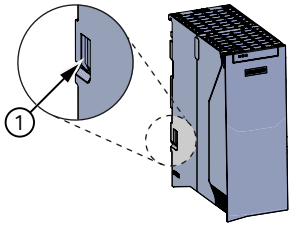
Operation of the CPU is only possible with SEC

The SEC is a part of the hardware of the CPU that is absolutely required for the operation of the CPU. The SEC must be plugged into the CPU before installation and commissioning.

The slot for the SEC is located on the left of the CPU.

If a CPU does not recognize a valid SEC during startup, the CPU does not start.

The figure shows the slot for the SEC on the CPU (on the left side ①):



Expansion of a PCS neo project

When you expand a PCS neo project and load it to the CPU, a check is conducted as to whether the project can run in the CPU with the current number of process objects. If the number is not sufficient, you can increase the number of process objects by replacing the System Expansion Card.

Increasing the number of process objects by replacing the SEC

To replace the SEC, you must switch off the power supply of the controller. The CPU must be briefly removed from the mechanical assembly.

Replacing the System Expansion Card (Page 137)

3.3.2 Supply voltage

3.3.2.1 Requirements on the supply voltage

Definition

The supply voltage required for the controller depends on the power supply module used in each case.

Modules permitted for power supply

Only use the associated power supply modules for the SIMATIC S7-4100 controller.

Use of power supply modules (Page 43)

- Note Derating depending on the height above mean sea level (Page 147)
- Note Notes on use in hazardous areas (Page 15)

24 V DC supply voltage

The PS 4160-SD power supply module is designed for connection to a safety extra low voltage.

Make sure that the supply voltages of the controller are generated safely separately:
U_{rated}= 24 V DC +-20% (⎓)

⚠ CAUTION

Supply voltage in the hazardous area - Zone 2

The supply voltage of the device must meet at least one of the following conditions:

- The supplied safety extra low voltage (SELV) with limited power (Limited Power Source, LPS) meets the following standards:
  - IEC 60950-1 / EN 60950-1 / VDE 0805-1

  or
  - IEC 62368-1 / EN 62368-1 / VDE 62368-1
- The power supply unit of the device complies with NEC Class 2 according to the National Electrical Code (r) (ANSI / NFPA 70).

When the device is connected to a redundant power supply (two separate power supply units), both units must meet these requirements.

Note

Equipment safety

Make sure that all necessary arrangements for the intended use of the equipment are made. Consult the equipment documentation for more information. If the equipment safety depends on SELV or PELV circuits, the equipment must be marked with an "X" as specified in EN / IEC 60079-0.

Supply voltage - Connection to a low voltage

The PS 4160-SA power supply module is designed for connection to a low voltage:

- Alternating voltage: 85 V to 264 V AC
- Direct voltage: 88 V to 300 V DC

Make sure that the following requirements relating to the controller supply voltage are observed:

- A disconnector (all-pole) must be provided in the building installation for fixed plants or systems without all-pole disconnectors.
- The fluctuation/deviation of the supply voltage from the rated value must be within the permissible tolerance for the power supply of the controller.

You can find more information in the section Power supply module (PS) (Page 151).

External fuses/switches

Install external fuses/switches close to the controller in front of the power supply modules.

Lightning strike voltages and overvoltages

Ensure adherence to the following requirements for the supply voltage:

- The controller assembly is protected against lightning strike and overvoltages by suitable measures (e.g. a surge arrester).
  You can find suitable components for flash voltage and overvoltage protection and more information in the Function Manual Designing interference-free controllers (http://support.automation.siemens.com/WW/view/en/59193566).
- Observe the mounting instructions in the respective documentation of the utilized component.

3.3.2.2 Use of power supply modules

Introduction

The power supply of a controller is only permitted by means of the approved power supply modules.

The power supplied by only one power supply module is sufficient for the maximum configuration of the controller.

Slots for power supply modules

The following slots can be used for power supply modules (to the left of the CPU):

- Slot 1
- Slot 2 (only for redundant power supply module)

Design version of the controller

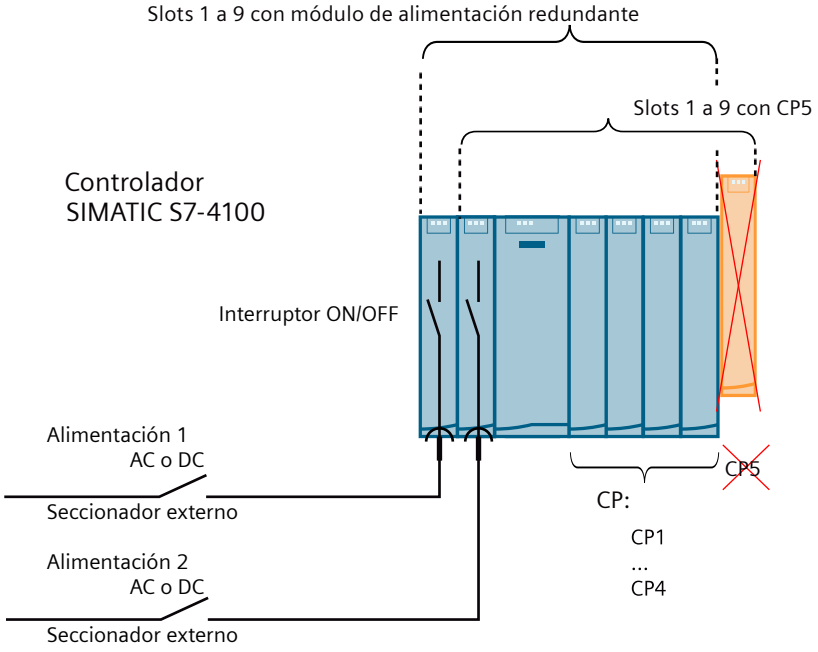


Figure 3-1 Design with one power supply module

Note

Redundant power supply modules

- The rack design with bus module is absolutely required.
- The rack design with U-connectors is not permitted.

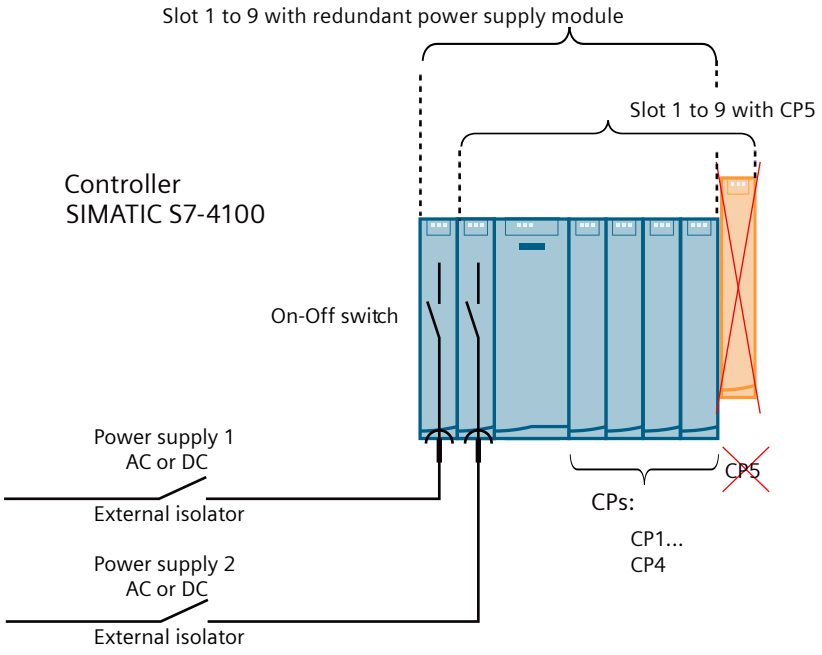


Figure 3-2 Design version with redundant power supply module

Reference

You can find more information on the power values (feed-in power, power consumption) in the technical specifications of the respective module:

- Power supply modules
- CPU
- CP

3.3.3 Potential relationships

Galvanic isolation

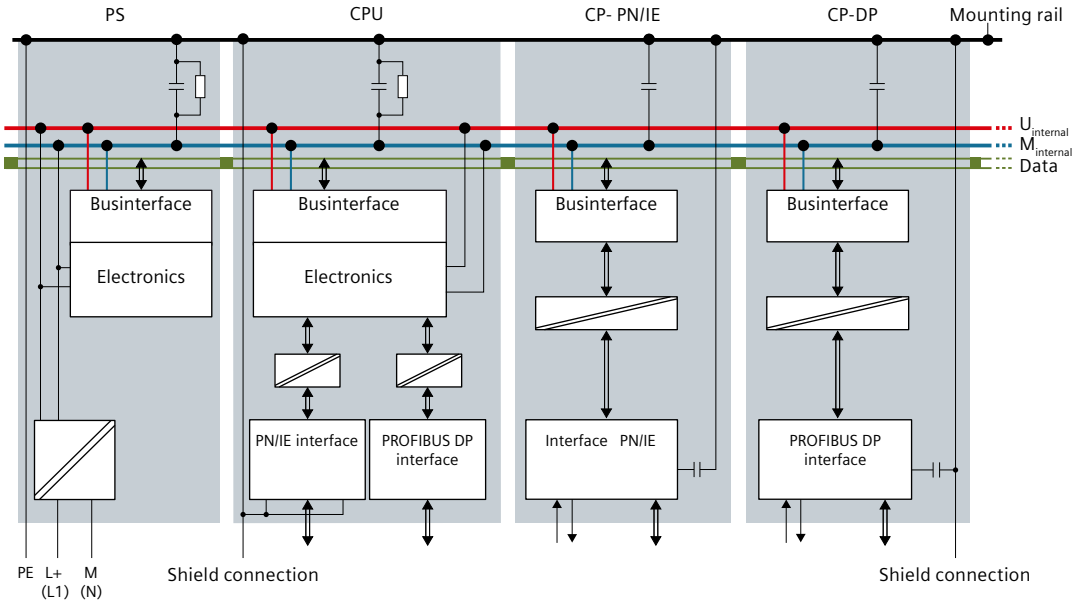
The SIMATIC S7-4100 controller has galvanic isolation between:

- The primary side of the power supply modules (PS) and all other circuit components.
- The communications interfaces (PROFINET IO/Industrial Ethernet and PROFIBUS DP) of the CPU or the CPs and all other circuit components
- The electronics of the individual modules and all other circuit components of the controller.

High-frequency interference currents are discharged, and electrostatic charges prevented by means of integrated RC combinations or integrated capacitors.

Potential relationships in the controller

The following figure shows a simplified representation of the potential relationships in the controller.



PS	• Power supply module (PS 4160 SD and/or PS 4160 SA)
CPU	• CPU
CP-PN/IE	• CP with PN/IE interface: CP 4163-1
CP-DP	• CP with PROFIBUS DP interface: CP 4163-5

3.3.4 Networks on the controller

3.3.4.1 Possible interfaces for network connection

Interfaces

The following connection paths are possible for the network connection of a SIMATIC S7-4100 controller:

- **Connection to Industrial Ethernet or PROFINET IO**
  - Network connection via the internal CPU PN/IE interface
    Typical for the connection of IO devices of the distributed I/O
  - Network connection via a communications processor (e.g. CP 4163-1)
    Typical for the connection of the controller to, for example, the Monitoring & Control station, engineering station, central plant clock and distributed I/O.
- **Connection to PROFIBUS DP**
  - Network connection via the integrated PROFIBUS DP interface of the CPU to a PROFIBUS DP subnet
    Typical for the connection of the distributed I/O
  - Network connection via a communications processor (e.g. CP 4163-5) to a PROFIBUS DP subnet
    Typical for the connection of the distributed I/O

Components and network participants

You have to make sure that all cables and components meet the requirements of PROFINET IO/ Industrial Ethernet or PROFIBUS DP.

You can find suitable cables in the documentation:

- SIMATIC NET, Industrial Ethernet / PROFINET, Passive network components (Page 202)
- SIMATIC NET, PROFIBUS network manual (Page 203)

Configuring the communication

The reference manual "CPU Data" contains all CPU-specific information you need for configuring the communication.

3.3.4.2 Connection to the plant network

Configuration example

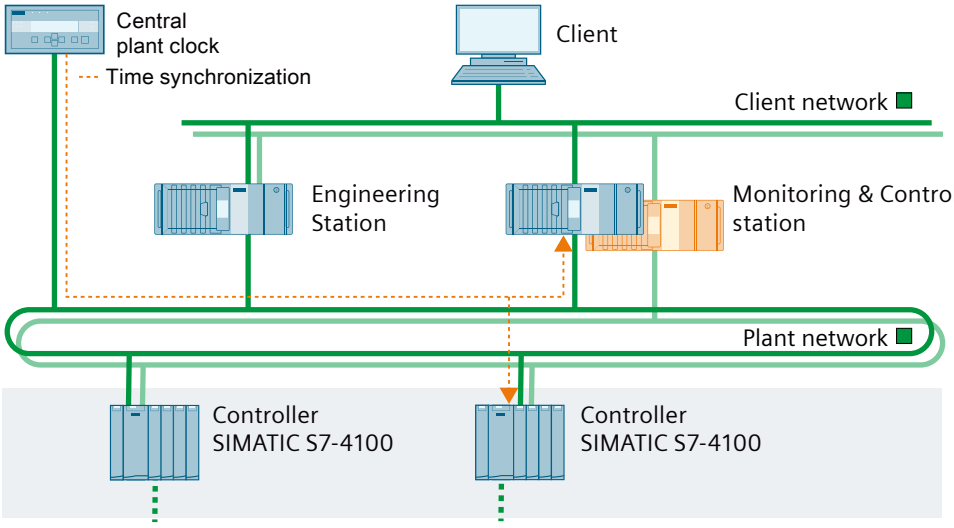


Figure 3-3 Options for connecting the controllers to the plant network with operator control and monitoring stations and time-of-day synchronization

Network connection of a SIMATIC S7-4100 controller

The following connection paths are possible for the network connection of a controller:

- **Connection to an Industrial Ethernet subnet**
  - Typical for the connection of the controller to, for example, the Monitoring & Control station, engineering station and central plant clock.
  - Typical connection to other controllers

  Typical connection paths
  - Network connection via a CP at the Industrial Ethernet
  - Network connection via the integrated PN/IO interface of the CPU

Configuration of the PN/IE interfaces

You can find information on configuring PN/IE interfaces in the following documentation:

- Online help for engineering: Configuring > Devices

You can find information on the parameters of the PN/IE interface in the following documentation:

- CPU:
  - SIMATIC S7-4100, CPU 4168-H (Page 201)
- CP:
  - SIMATIC S7-4100, PROFINET CP 4163-1 (Page 202)

3.3.4.3 Distributed I/O on the controller

I/O can be connected via PROFINET IO or PROFIBUS DP.

You can use distributed I/O from the catalog on the SIMATIC S7-4100 controller, such as:

- ET 200SP HA
- ET 200iSP
- ET 200SP
- ET 200M
- CFU
- Devices at PROFINET IO downstream networks
- Devices at PROFIBUS DP or downstream networks

3.3.4.4 Connection of the distributed I/O

Configuration example

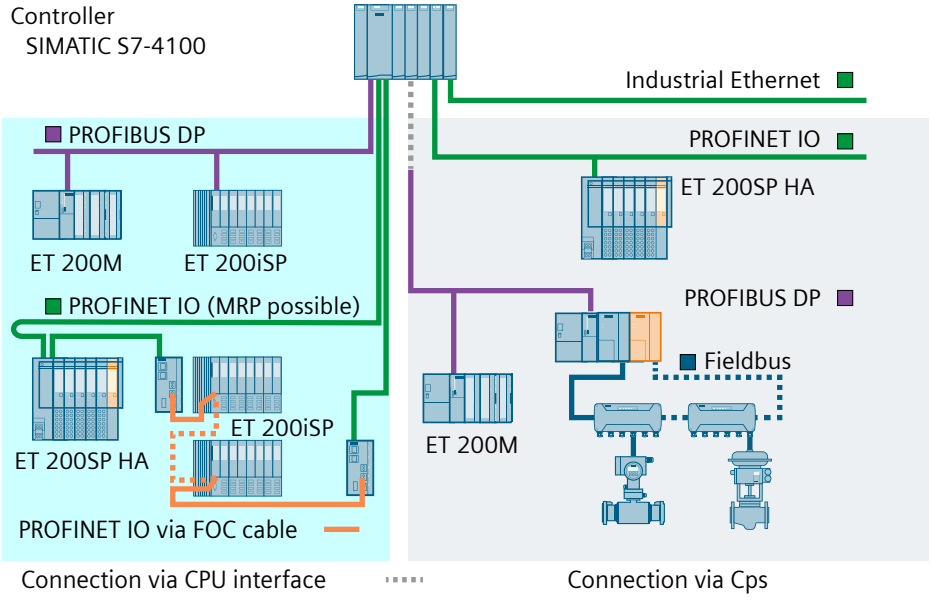


Figure 3-4 Options for the connection of the distributed I/O to the controller

I/O connection

The following connection paths are possible for the connection of the I/O to the SIMATIC S7-4100 controller:

- **Connection of PROFINET IO**
  Typical connection of IO devices of the distributed I/O
  Typical connection paths to the PROFINET IO
  - Connection via an integrated PN/IE interface of the CPU
  - Connection via a CP 4163-1
- **Connection of PROFIBUS DP**
  Typical connection of distributed I/O as DP device
  Typical connection paths to the PROFIBUS DP subnet
  - Connection via the integrated PROFIBUS DP interface of the CPU
  - Connection via a CP 4163-5

Note

Connecting link modules

Connection of the following modules to the SIMATIC S7-4100 controller is not supported:

- IE/PB link
- IE/PB link HA

Configuring the interfaces

You can find information on configuring the interfaces in the following documentation:

- Under engineering in the online help: Configuring > Devices

You can find information on the parameters of the interfaces in the following documentation:

- CPU:
  - SIMATIC S7-4100, CPU 4168-H (Page 201)
- CP:
  - SIMATIC S7-4100, PROFINET CP 4163-1 (Page 202)
  - SIMATIC S7-4100, PROFIBUS CP 4163-5 (Page 202)

3.3.4.5 I/O configuration variants

Design of the I/O devices

The following design version is available for the I/O modules:

- Distributed I/O without increased availability.
  In the single configuration, the distributed I/O is available once (single channel).
- Distributed I/O with redundant connection via PROFINET IO
  In the redundant connection, the distributed I/O is connected to the CPU via an MRP ring.
- Redundant distributed I/O connected
  Connection can be made via redundant interfaces (symmetrical networks or MRP ring) if the redundant stations of the distributed I/O have redundant interfaces

3.3.4.6 Basics of time synchronization

Definition of time synchronization

Time synchronization means that devices in a group (e.g. controllers of a plant) receive or retrieve their local time from a central time server (central time sender/time server). Time synchronization is based on the uniform Coordinated Universal Time (UTC).

Time synchronization is required to evaluate the chronological sequences of events (operations and different controllers).

Rules

For time synchronization of the controller and the distributed I/O, the CPU must be connected to an active time server.

The internal clock of the controller may only be synchronized via one access path at the same time, e.g. as an NTP client or time client (using the SIMATIC procedure).

Time synchronization (Page 70)

3.3.5 Mechanical design

3.3.5.1 Design versions of the controller

Observe the safety instructions:

Safety instructions (Page 13)

Mounting position

The SIMATIC S7-4100 controller can be used in the following mounting position:

- Horizontal (horizontal mounting of the mounting rail)

You can find more information in the section Mechanical and climatic ambient conditions for operation (Page 145).

Length of the mounting rail

The mounting rails are available in different lengths.

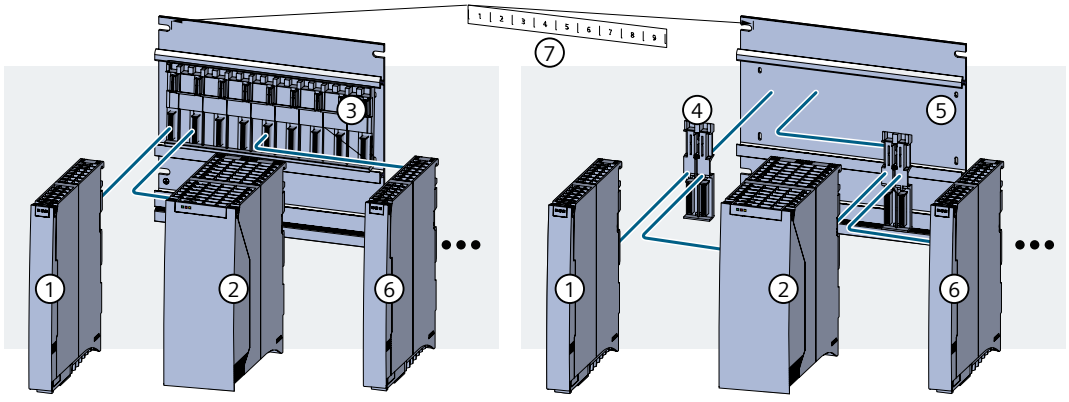
Available lengths of the mounting rails: Mounting rail dimensions (Page 171)

The article numbers can be found in the section Components for the rack configuration (Page 168).

Design versions for connecting the modules

You can select from the following design versions to make the module slots available:

- Rack design with bus module (Page 53) (figure on the left)
  or
- Rack design with U-connector (Page 55) (figure on the right)



① Power supply module
② CPU
③ Rack design with bus module
④ U-connector
⑤ Mounting rail
⑥ CP
⑦ Labeling strips for slots

See also

Minimum clearances (Page 57)

Maximum configuration (Page 55)

3.3.5.2 Rack design with bus module

Definition

In the controller design with a bus module, the bus module connects all modules belonging to the controller.

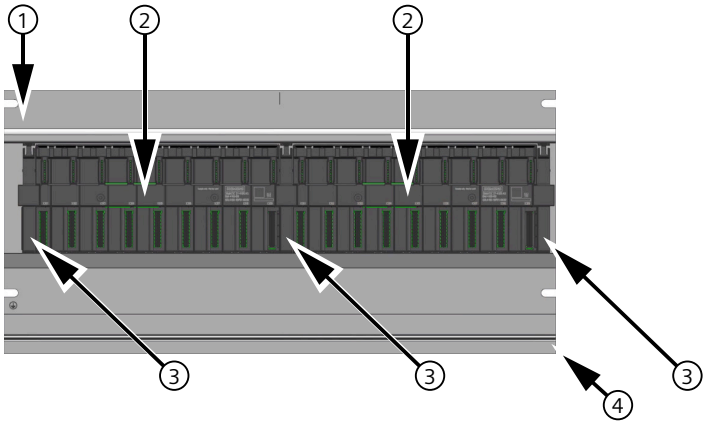
The rack design with bus module is the recommended design version because it lets you achieve the full system functionality of the controller.

Properties

The rack design with bus module is the typical design version for controller. Nine slots are available per bus module.

The bus module establishes the electrical connection between the modules. The cables for transfer of the system voltage and system-internal communication of the controller are integrated into the bus module.

The figure below shows an example of the rack design with two bus modules.



① Mounting rail
② Bus module
③ Terminal for bus module
④ Connection for grounding (see Installing the mounting rail (Page 76))

Advantages compared to the configuration with U-connector

- The configuration with redundant power supply module is possible. This configuration allows for the replacement of a power supply module during operation.
- The CPs can be changed in number and replaced during operation. No additional modules need to be removed.
- Gaps are permitted in the configuration of the CPs. The position of the slots is marked on the bus module.

Installing a rack

If a bus module is to be installed on a mounting rail:
Installing bus modules (Page 77)

More information

- Maximum configuration (Page 55)
- Article numbers: Components for the rack configuration (Page 168)

3.3.5.3 Rack design with U-connector

Properties

The controller can be configured with U-connectors for the module connection.
The complete system functionality of the controller can only be achieved when using a bus module.

The following applies when compared to the configuration with bus module:

- Advantage:
  Compact design - Only width of the required modules is needed
- Disadvantages are:
  - The power supply with two power supply modules is not permitted
  - Pulling/plugging of modules during operation is not permitted.
  - Changing the controller configuration:
    The U-connector must be inserted on the left module prior to installation.

Note

Expanding the controller by up to 5 CPs

You need a U-connector for each permitted expansion of the controller by one CP.

More information

- Maximum configuration (Page 55)
- Article numbers: Components for the rack configuration (Page 168)

3.3.5.4 Maximum configuration

The SIMATIC S7-4100 controller consists of a single-tier configuration in which all modules are mounted in a rack. The modules are connected electrically and mechanically to each other in the controller.

Maximum configuration

Maximum 7 modules =

1 CPU (requires 3 slots)

+

6 modules (power supply + communications processors)

Note

Position of the slots

- In a rack design with a bus module, the position of the slots ① to ⑨ is marked on the bus module.
- For designs with U-connectors, you can apply a labeling strip for the slots ① to ⑨ on the mounting rail.

Table 3-1 Assignment of the slot numbers

Module type	**Permitted slots ① to ⑨**	**Maximum number of modules**
Power supply module (PS)	① (and ② redundant PS)	2
CPU (requires 3 slots)	② (or ③ for redundant PS)	1
CP (communications processor)		
• CP with PN/IE interface	⑤ (⑥ with redundant PS) to ⑨	5 (4 for redundant PS)
• CP with PROFIBUS DP interface	⑤ (⑥ with redundant PS) to ⑨	5 (4 for redundant PS)
Maximum number of modules:		7

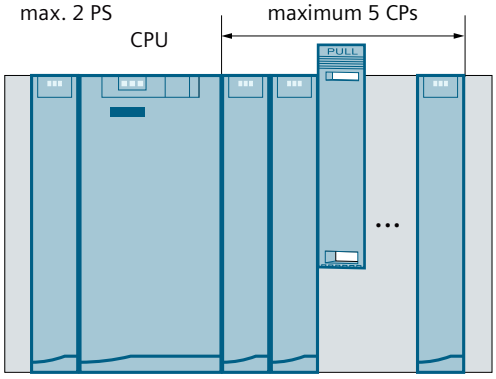


Figure 3-5 Maximum configuration of SIMATIC S7-4100 controller

Note

Number of CPs depending on the number of power supply modules (PS)

- Note the following for the configuration with U-connector
  - Only one PS is permitted for the design with U-connector.
  - No protruding U-connectors are permitted in the assembly.
    (To the left of the first left module or to the right of the last right module.)
- Maximum of two power supply modules
  - The configuration with two PS (redundant PS) is only permitted on a bus module.
  - The configuration with two PS allows for a maximum of four CPs (as of slot ⑥) in the assembly.
- Maximum of five CPs
  - The configuration with one PS allows for the installation of up to five CPs (as of slot ⑤).
  - With assembly on a bus module, gaps are permitted in the assembly to the right of the CPU.

3.3.5.5 Minimum clearances

The controller design with U-connectors lets you install modules up to the outer edge of the mounting rail.

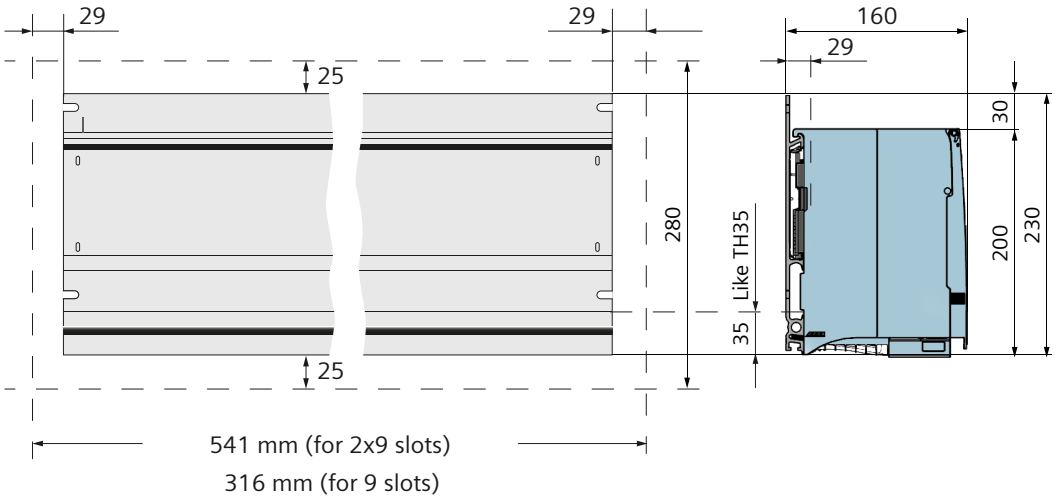
Clearances

Take into account specific minimum clearances between a rack and the adjacent devices.

You need these minimum clearances during installation and operation:

- to install and remove modules,
- to ensure the air flow required during operation for heat dissipation of the modules.
- The rack design has a depth of 28 mm without modules and 160 mm with modules.

The following figure shows the minimum space you must reserve for the rack design.



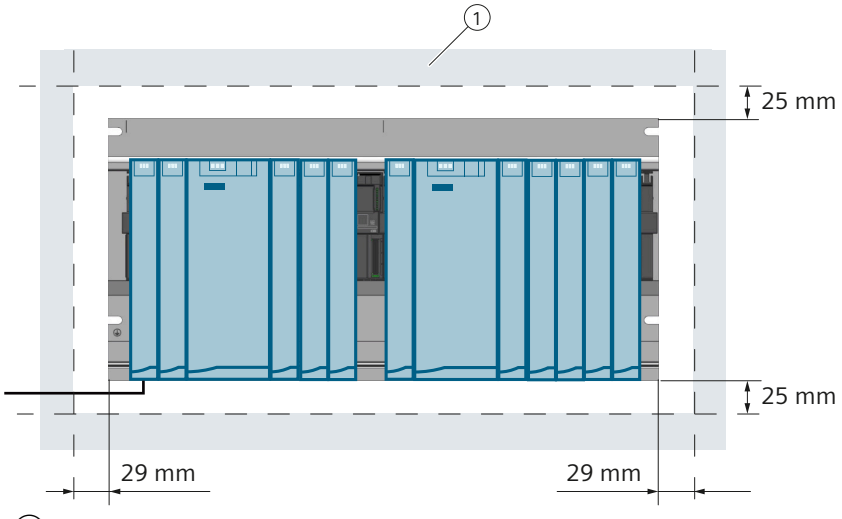
Note

TH35 profile

The lower area of the mounting rail is designed like a TH35 mounting rail.

Minimum clearances

Observe the following minimum clearances for installation or removal of the controller:



① Enclosure

Figure 3-6 Minimum clearances in the control cabinet

Clearances to other racks

When you configure a plant with multiple racks, you must observe clearances between the individual racks.

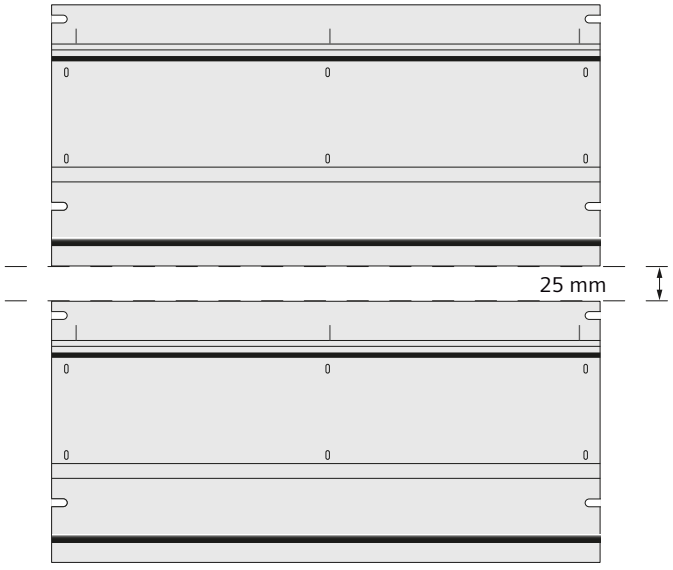


Figure 3-7 Minimum clearance between two racks

3.3.5.6 Selection of cabinets

A 19" rack is the typical mounting frame for the controller. The rack must be installed in a suitable environment:
Cabinets with 19" frames (according to IEC 60297) are recommended.

Necessity for installation

The installation of the controller is necessary:
Important notes on using the device (Page 13)

Take into account the requirements for use in hazardous Zone 2:
Important notes on using the device (Page 13)

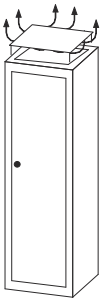
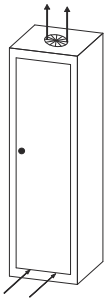
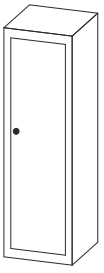
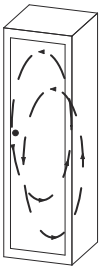
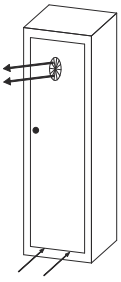
The ambient conditions (e.g. temperature, humidity, risk of explosion) at the place of installation of the cabinet determine the required degree of protection of the cabinet. More information on degrees of protection is available in IEC 529 and DIN 40050.

Selection and sizing of cabinets

Consider the following criteria when selecting and sizing cabinets:

- Ambient conditions at the place of installation of the cabinet
- Required design clearances for the racks
- Total power loss of the components installed in the cabinet

The following table gives you an overview of the most common types of cabinets. The table also includes the applied principle of heat dissipation as well as an estimate of the maximum power loss that can be reached and the degree of protection.

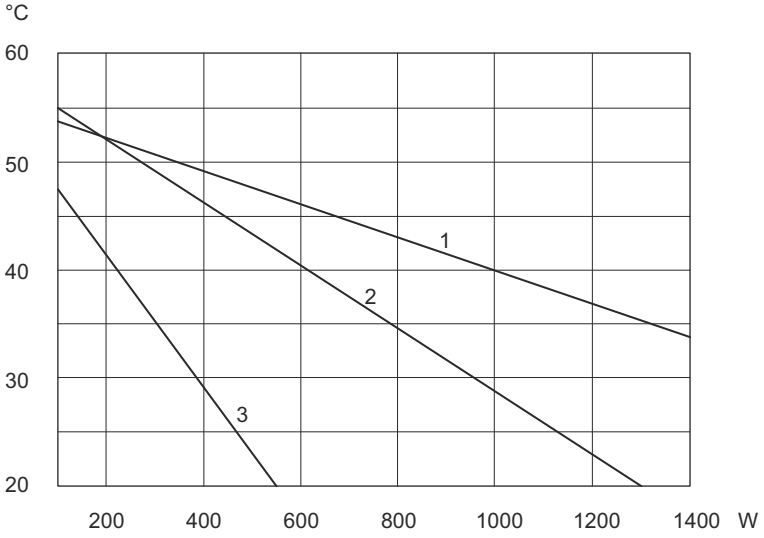
Open cabinet		**Closed cabinet**		
Draft ventilation through self-convection	Enhanced draft ventilation	Self-convection	Forced circulation through floor fans, improved self-convection	Forced circulation through heat exchangers, forced ventilation inside and outside
				
Heat dissipation primarily through own heat management, small percentage through cabinet wall.	Increased heat dissipation through increased air movement.	Heat dissipation only via cabinet wall; only minor power loss permitted. Heat usually builds up at the top in the cabinet.	Heat dissipation only via cabinet wall. Improved heat dissipation through forced circulation of inside air and prevention of heat build-up.	Heat dissipation through heat exchange of heated inside air and cool outside air. The increased surface of the heat exchanger's laminar surface profile wall and the forced circulation of the inside and outside air result in good heat dissipation.
IP 20 degree of protection	IP 20 degree of protection	IP 54 degree of protection	IP 54 degree of protection	IP 54 degree of protection
Power loss that can typically be dissipated under the following constraints: • Cabinet size 2200 x 600 x 600 mm • Difference between outside and inside temperature of the cabinet 20 °C (for other temperature differences, you must consult the temperature characteristic curves of the cabinet manufacturer)				
Up to 700 W	Up to 2700 W (up to 1400 W with ultra-fine filters)	Up to 260 W	Up to 360 W	Up to 1700 W

Example: Dissipate power loss from the cabinet

The power loss that can be dissipated from a cabinet depends on the construction of the cabinet, its ambient temperature and the requirements of the devices in the cabinet.

NOTICE
Modules can be damaged. When modules are exposed to an impermissible ambient temperature, they can be damaged. Make sure that the ambient temperature is within the permitted value range.

The following figure shows a diagram with reference values for the permissible ambient temperature of a cabinet with the dimensions 600 x 600 x 2000 mm depending on the power loss. These values only apply when you observe the specified installation and clearance dimensions for racks. More detailed information is available in the Siemens catalogs NV21 and ET1.



① Closed cabinet with heat exchanger; heat exchanger size 11/6 (920 x 460 x 111 mm)
② Cabinet with draft ventilation through self-convection
③ Closed cabinet with self-convection and forced ventilation through device fans

Figure 3-8 Maximum cabinet ambient temperature (°C) depending on the power loss (W) of the devices in the cabinet

Example: Determining the cabinet type

The following example shows the maximum ambient temperature permitted for a specific power loss with different construction types of the cabinet.

The following device configuration is to be installed in a cabinet:

Component	Power loss
Controller	10 W
Total power loss	350 W

Based on the diagram above, the resulting ambient temperatures at a total power loss of 350 W are shown below:

Construction type of the cabinet	Maximum permissible ambient temperature
Closed, with self-convection and forced ventilation (curve 3)	approximately 30 °C
Open with draft ventilation (curve 2)	approximately 47 °C
Closed, with heat exchanger (curve 1)	approximately 50 °C

Cabinet dimensions

To determine the dimensions of a cabinet that is suitable for the configuration, you must take into account the following specifications:

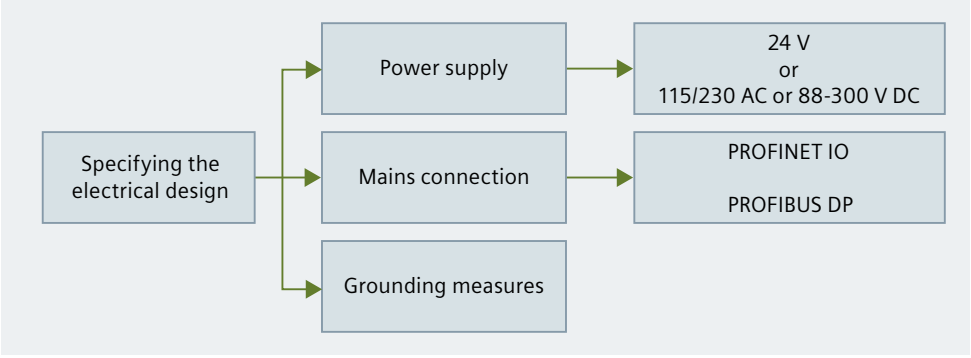
- Space requirement of the controller (rack design with bus module / rack design with U-connector)
  Components for the rack configuration (Page 168)
- Minimum clearances of the configuration to the cabinet walls
- Minimum clearances to other components or additional controllers (e.g. 19" mounting rail with only one bus module)
- Position of the tiebars

See also

Mounting rail dimensions (Page 171)

3.4 Electrical design

3.4.1 Specifying the electrical design



1. Determine the supply voltages available to you. Specify the modules for the power supply.
   Specifying the power supply (Page 63)
2. Determine the required network connections. Specify the interfaces for the communication connections and the paths for time synchronization.
   Specifying the network connection (Page 63)
3. Determine the plant-specific requirements for grounding the controller.
   Grounding (Page 64)

3.4.2 Specifying the power supply

Requirement

- The available supply voltages are known.
  The following supply voltages are permissible:
  - 24 V DC
  - 120/230 V AC or 88-300 V DC.
- Requirements on availability are known (redundancy yes/no).

Procedure

1. Select the number of power supply modules.
   Use of power supply modules (Page 43)

   Note

   Redundant power supply modules
   - The rack design with bus module is absolutely required.
   - The rack design with U-connectors is not permitted.

2. Select the power supply modules depending on the available supply voltage.
   Requirements on the supply voltage (Page 42)

Result

The power supply modules are specified.

3.4.3 Specifying the network connection

Requirement

- Required interfaces are known.
- Number of networks are known.
- Requirements on availability are known (redundancy yes/no).

Procedure

1. Select the required network types.
   Possible interfaces for network connection (Page 46)

   Note

   Design guidelines

   Observe the design guidelines.

2. Select the interface to the plant network.
   Connection to the plant network (Page 48)
3. Select the interface to the distributed I/O.
   Connection of the distributed I/O (Page 50)

Result

The networks and their connections are specified.

3.4.4 Grounding

Introduction

Proper functioning of the controller depends on grounding measures that were carefully conducted as set forth in the regulations.

Ground connections

Low-resistance ground connections reduce the risk of electric shock in the event of a short-circuit or defect in the system. Moreover, proper grounding (low-resistance connections: large surface area, large contact area) in combination with an effective shielding of the cables and devices reduces the effect of interference on the system or the radiation of interference signals.

Note

Always make sure that the operating currents do not flow via ground.

Protective earth

All devices with protection class I and all larger metallic parts must be connected to protective earth. This is the only way to guarantee that the plant user is reliably protected from electric shocks.

It also diverts interference that is transmitted through external cables (e.g. signal cables or cables to I/O devices).

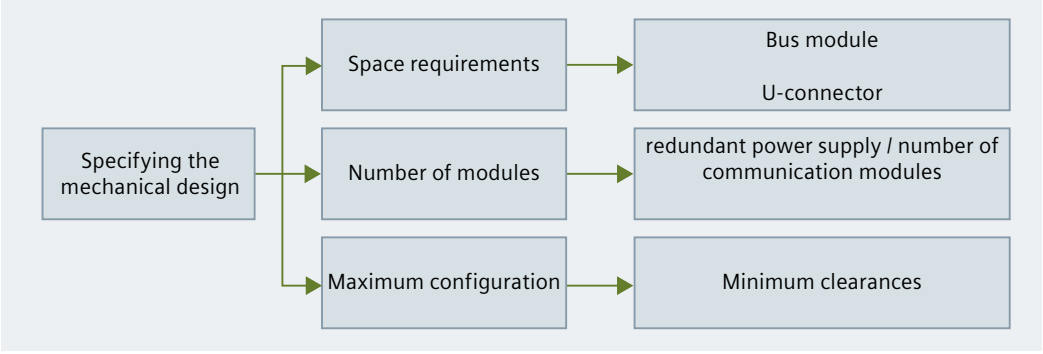
The following table lists the grounding measures required for the individual components.

Table 3-2 Measures for protective grounding

Device	Measure
Cabinet/mounting structure	Connection to central grounding point (e.g. main ground line) via cables with protective conductor quality
Mounting rail	Connection to central grounding point via cable with 10 mm^2 minimum conductor cross-section if mounting rails are not installed in the cabinet and are not connected to each other using large metallic parts
Modules (power supply module, CPU, CP)	None; connection to grounding depending on grounding of the mounting rail
Power supply module (PS) AC 120/230 V	Grounding via device plug
Shield of bus cable (communication cable for Industrial Ethernet / PROFINET/ PROFIBUS)	Connection to the mounting rail or central grounding point (avoid ground loops)

3.5 Mechanical design

3.5.1 Specifying the mechanical design



Requirements

- The modules required for the power supply and connection of the networks are known.
- The available space and the ambient conditions are known.
- Maximum configuration is being observed.
  Maximum configuration (Page 55)

Design version

Design versions of the controller (Page 52)

- Rack design with bus module (Page 53)
- Rack design with U-connector (Page 55)

Specifying the mechanical design

1. Select the enclosure for the controller (reason: Open type equipment).
   Selection of cabinets (Page 59)
2. Select the version for setting up the slots.

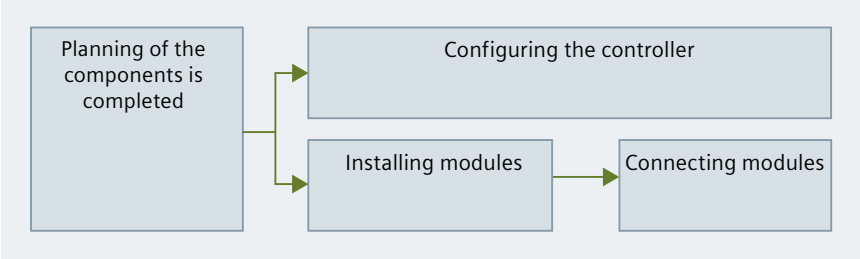
1. Determine the position of the rack or modules (rack design with U-connectors).
   Minimum clearances (Page 57)
2. Specify the slots of the controller modules.
   Notes on installation (Page 74)

Configuring and assembling

4

4.1 Configuring and assembling a controller

You can configure and assemble the controller simultaneously or in any order.



Requirement: Planning of the components is completed

- The required configuration is known.
- The minimum clearances are being observed.

Configuring and assembling a controller

- Configuring the controller
  - The information needed for the configuration is available in the engineering online help: Configuring > Devices > Controller
  - Observe the security recommendations
    Security recommendations (Page 67)
- Assembling the controller
  The controller assembly is divided up into the following steps:
  - Installing the controller (performing mechanical work)
    Installing a controller (Page 75)
  - Connecting the controller (make electrical connections)
    Connecting the controller (Page 87)

4.2 Notes on configuring and assembly

4.2.1 Security recommendations

Observe the following security recommendations to prevent unauthorized access to the system.

General

- Check regularly to ensure that the device meets these recommendations as well as any other company security guidelines.
- Evaluate your plant holistically regarding security. Use a cell protection concept with the corresponding products.
- Do not connect the device directly to the Internet. Operate the device within a protected network area.
- Check the Siemens website regularly for the latest information.
  - Here you will find information on Industrial Security:
    Link: (http://www.siemens.com/industrialsecurity)
  - Here you will find information on security in industrial communication:
    Link: (https://support.industry.siemens.com/cs/ww/en/view/92651441)
- Keep the firmware current. Check regularly for security updates of the firmware and apply them.
  Notes about product news and new firmware versions are available at the following address:
  Link: (https://support.industry.siemens.com/cs/ww/en/ps/15334/dl)
  Recommendation: Limit your search to "4100" or the product name.
- Note the security concept of the process control system, see:
  Link: (https://support.industry.siemens.com/cs/ww/en/view/109772128/en)

Physical access

Limit physical access to the device to qualified personnel.

Network connection

Do not connect the controller interfaces (PN/IE interfaces or PROFIBUS DP interfaces) directly to the Internet. If an Internet connection is desired, operate protective devices in front of the interface, for example, SCALANCE SC with firewall.

Protocols

The following table gives you an overview of the open ports in this device.

Note on the table columns

- **Protocol / Function:** Protocols supported by the device.
- **Port number (protocol):** Port number that is assigned to the protocol.
- **Default setting of the port**
  - Open: The port is open when you start configuring.
  - Closed: The port is closed when you start configuring.

- **Port state**
  - Open: The port is always open and cannot be closed.
  - Open after configuration: The port is open after it has been configured.
  - Open (login, when configured): The port is open by default. After configuration of the port, the communication partner must log in.
  - Open in case of block call: The port is only opened when a corresponding program block is called.
- **Authentication for PROFINET IO/Industrial Ethernet**
  Specifies whether the protocol authenticates the communication partner during access.

Protocol / Function	Port number (protocol)	Default setting of the port	Port state	Authentication
DCP	93 (UDP)	Open	Open	No
S7 communication	102 (TCP)	Open	Open	No
SNMP				
PROFINET	34964 (UDP)	Open	Open	No
PROFINET-RPC 2x **PROFINET-PN-EPM**	UDP/552xx	Open	Open	No

Ports of communication partners and routers

Make sure to enable the required client ports in the corresponding firewall in the communication partners and intermediate routers.

These can be:

- DHCP / 67, 68 (UDP)
- DNS / 53 (UDP)
- NTP / 123 (UDP)

4.2.2 Address imprint: MAC address

Definition

A MAC address is used for the unique identification of a station in an Ethernet-based network.

MAC addresses of the interface

Each PN/IE interface of the module is assigned a block with 3 consecutive MAC addresses.

The first address of each block is lasered to the left of the RJ45 socket and on the enclosure side of the module.

- PN/IE interface
  (visible in the engineering at "Accessible devices in the subnet")
- With the PN/IE interfaces, each of the ports has its own MAC address. The MAC addresses of the ports are used in PROFINET IO operation for detecting and evaluating neighbor and topology relationships (LLDP).

4.2.3 Time synchronization

Time synchronization enables the synchronization of the internal time with a time server or the compensation of time differences.

The time frames are transmitted using standardized protocols. The total configuration of the plant determines which components are being used and how the time is being synchronized.

Requirement

- Planning of the plant requirements is complete.
- The components of the plant are known.

Setting the interfaces for time synchronization

1. The time synchronization of a controller is only permitted simultaneously via exactly one PROFINET interface.
   This interface can be a PN/IE interface of the CPU or of a CP.
   Setting the interface as an NTP client / time client in the controller (Page 71)
   It is not permitted to perform time synchronization for a controller via a PROFIBUS interface of the CPU or of a CP (PROFIBUS device).
2. All interfaces of the controller must be configured separately regarding time synchronization.
   Setting the interface as time server in the controller (Page 72)

The information needed for the configuration is available in the process control system documentation.

Example

- CPU:
  - The plant network is connected to the PN/IE interface [X1].
    The interface is configured as an NTP client.
  - A downstream network is connected as a PROFINET IO network to the PN/IE interface [X2].
    The IO controller is configured as (time of day) master for devices on the PROFINET IO network.
  - A downstream PROFIBUS DP master system is connected to the PROFIBUS DP interface [X5].
    The interface is configured as (time of day) master for devices on the PROFIBUS DP master system.
- CP with PN/IE interface:
  - You can configure **one** CP as an NTP client
    - This CP must be the only access path for the time synchronization of the controller.
    - CPU Xn must be configured as an NTP client.
  - A downstream network is connected to the PN/IE interface [X1]
    The interface can be configured as a SIMATIC master for devices in the network.
    The CP is not able to provide the time for a PROFINET IO network.
- CP with PROFIBUS DP interface:
  - A downstream PROFIBUS DP master system is connected to the PROFIBUS DP interface [X1].
    The interface is configured as (time of day) master for devices on the PROFIBUS DP master system.

4.2.4 Setting the interface as an NTP client / time client in the controller

Make sure that only one access path to a time server (e.g. NTP server) is configured in the controller at the same time (e.g. exactly one interface to the plant bus). Select from one of the following settings for time synchronization.

NTP method

Possible NTP servers:

- With the NTP method, the controller requests the time from an NTP server.
- A controller can be assigned as an NTP client to up to 4 NTP servers.
- The NTP client determines the NTP server from which the time is taken by comparing the time quality.

Synchronize controller via PN/IE interface of the CPU

- NTP method
  - Option: Enable time synchronization via NTP server
  - NTP server: Set up to four NTP servers
  - Update interval: 10 s
- SIMATIC mode
  - Type of synchronization: "As client"
  - Time interval: "-"

Synchronize controller via CP with PN/IE interface

- NTP method
  - Synchronization method: NTP
  - Direction "As client"
  - Synchronization cycle: 10 s
  - NTP server: Set up to four NTP servers
- SIMATIC mode
  - Synchronization method: SIMATIC
  - Direction: "As client"

4.2.5 Setting the interface as time server in the controller

When you configure controller interfaces as time servers for downstream components, you must specify a synchronization interval.

Note

Time telegram

The CPU sends the time after the first successful higher-level synchronization or when it is set by the engineering station.

Note

UTC as time standard

UTC has to be selected as time standard for the time synchronization.

CPU (PN/IE interface):

- SIMATIC mode
  - Type of synchronization: "As server"
  - Time interval "10 seconds"
- Time synchronization via pTCP

  Note

  Synchronization procedure for time stamping input signals of the distributed I/O at the PROFINET IO

  Take into consideration the specific requirements of the plant design (e.g. application of the ET 200SP HA).

  - Time sync domain: Domain name
  - Synchronization source: Sync server

CPU (PROFIBUS DP interface)

- SIMATIC mode
- Type of synchronization: "As master"
- Time interval "10 seconds"

CP with PN/IE interface

It is not possible to provide the time for lower-level fieldbus systems with the CP.

The CP allows the time to be forwarded to devices that are located in a downstream Ethernet-based network and use the SIMATIC procedure:

- SIMATIC mode
- Type of synchronization: "As server"
- Time interval "1 second"

CP with PROFIBUS DP interface

- Synchronization method: SIMATIC
- Type of synchronization: "As master"
- Time interval "1 second"

4.3 Installation

4.3.1 Notes on installation

⚠ WARNING
Explosion hazard
Observe the safety instructions:
Safety instructions (Page 13) especially: Installing and connecting (Page 19)

You always start assembling the controller from the left.

Installation of the mounting rail

The mounting rails are designed for wall mounting, mounting on tiebars and for installation in frames and cabinets. Their mounting dimensions are according to DIN 41 494.

In areas that are subject to UL/CSA and the Low Voltage Directive 73/23/EEC, installation in a cabinet, an enclosure or in an enclosed operating room is required to meet the guidelines for electrical safety.

Modules that can be used

Note the information on the maximum configuration and the minimum distances:

Maximum configuration (Page 55)

Minimum clearances (Page 57)

Assembly rules

- Power supply
  Start by installing the power supply modules (PS) (left in the controller configuration):
  - First power supply module: Slot ①
  - If required - redundant power supply module: Slot ②
- CPU
  Always install the CPU to the right of the power supply.
- CPs
  When CPs are required:
  Install CPs only to the right of the CPU.

Note

Pulling and plugging modules

Make sure that the following modules are only pulled/plugged when the controller is de-energized:

- Modules that are connected via U-connectors.
- CPU
- Power supply module
  Exception for redundant power supply under the following requirements:
  - The power supply modules are installed on a bus module.
  - The remaining power supply module supplies the controller.
  - Only one power supply module is removed.

Connections on the slot and the module (Page 176)

See also

Rack design with bus module (Page 53)

Rack design with U-connector (Page 55)

4.3.2 Installing a controller

You need the following information for installing the controller.

Requirements

- The required configuration is known.
- The minimum clearances are being observed.

Preparation for module connection via bus module with mounting on empty mounting rail

Install the bus module.

Installing bus modules (Page 77)

Procedure

1. Install the mounting rail.
   Installing the mounting rail (Page 76)
2. Fasten the grounding cable to the mounting rail.
   Installing the grounding (Page 101)
3. Install the modules.

Module connection via bus module	Module connection via U-connector
• Installing modules on a bus module (Page 80)	• All modules: Plug the U-connector onto the module. Exception: Last module of a controller (right module in the assembly) – Installing U-connectors (Page 82) • Install the module. – Installing the power supply module (Page 82) – Installing the CPU (Page 84) – Installing a CP (Page 86)

4.3.3 Installing the mounting rail

Required tools

- Screwdriver
- Screwdriver or socket wrench size 10 mm for ground wire connection
- Spanner matching the selected fastening screws
- Stripping tool and crimping pliers for the grounding cable

Required accessories

Use the following types of screws for fixing the mounting rails (or racks):

Table 4-1 Fastening screws

Screw type	Explanation
Cylinder head screw M6 according to ISO 1207/ISO 1580 (DIN 84/DIN 85)	You must select the screw length that matches your configuration. You also need 6.4 washers according to ISO 7092 (DIN 433).
Hexagon socket-head screw M6 according to ISO 4017 (DIN 4017)	You also need washers for cylinder head screws with an inner diameter of 6.4 mm and an outer diameter of 11 mm.

Installing a mounting rail (or rack)

1. Place the mounting rail (or rack) in such a way that there is sufficient space for installation and heat dissipation of the modules.
   Note:
   - Mounting rail dimensions (Page 171)
   - Minimum clearances (Page 57)
2. Screw the mounting rail (or rack) to the base.
   - When the base is grounded and conductive (e.g. a grounded device support plate): Make sure that there is a low-resistance connection between the mounting rail (or rack) and the base. For painted or anodized metals, for example, use suitable contacting agents or special contact discs.
   - No special measures are required for all other bases.

Note

You can find more information on the exact dimensions of the mounting rail (or rack) in the Appendix Components for the rack configuration (Page 148).

See also

Components for the rack configuration (Page 168)

4.3.4 Configuration with bus module

4.3.4.1 Installing bus modules

Introduction

Rack designs with bus module are units in which at least one bus module is installed on a mounting rail.

The procedure must be applied in the following cases:

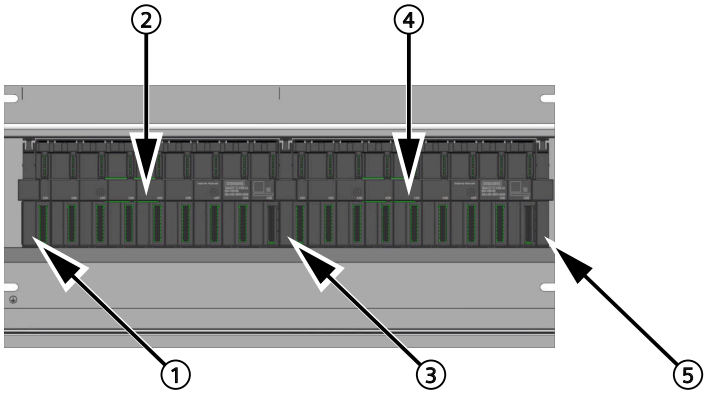
- When you are installing at least one bus module on a mounting rail.
- When you are replacing a bus module.

Requirements

- Mounting rail
- Required bus modules
- Terminals for bus modules (number of required terminals = number of bus modules +1)

Information on the article numbers: Accessories and spare parts (Page 167)

Installation sequence



① First terminal
② First bus module
③ Second terminal
④ Possible for RACK 4160-P18: Second bus module
⑤ With RACK 4160-P18 for a second bus module: Third terminal

Installation of a bus module on the mounting rail

Note

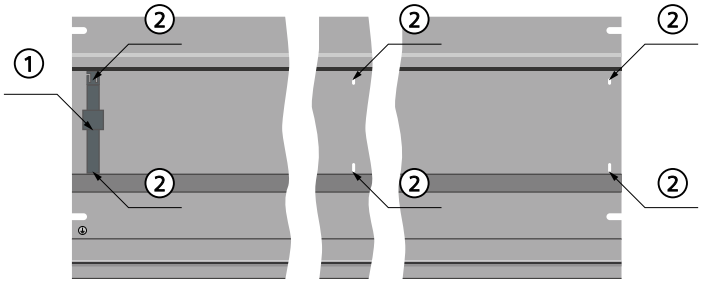
Installing a bus module

Make sure that each bus module is secured at both ends with a terminal for bus modules.

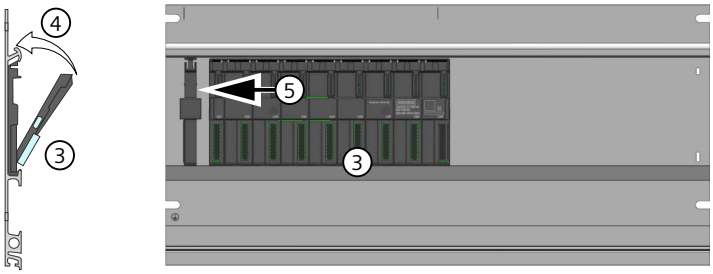
Only one terminal is needed between two bus modules that is used by both modules.

To install a bus module on the mounting rail, follow these steps:

1. Place the left terminal ① on the middle profile of the mounting rail and press the terminal into the mounting rail.
   Make sure that the terminal snaps into the slots (mounting position ②; in the figure, only the left position is installed).



2. Place the bus module into the middle rail of the mounting rail ③ and push the top edge of the bus module toward the back ④.



3. Slide the bus module onto the terminal ⑤.
4. Place a terminal to the right of the bus module on the mounting rail and press the terminal into the mounting rail.
   Make sure that the terminal snaps into the slots (mounting position ② see figure for step 1).
5. If you want to install a second bus module, repeat steps 2 to 4.

See also

Rack design with bus module (Page 53)

4.3.4.2 Installing modules on a bus module

Introduction

Modules are installed on a bus module using the same procedure for all modules.

NOTICE
Modules and bus modules can be damaged. If you use force when installing modules in the bus module, you can damage these components. Carefully execute the steps described below for the sequence of the installation.

Tool

Cylindrical screwdriver with a blade width of 4 mm

Requirement

Note
Installing the CPU

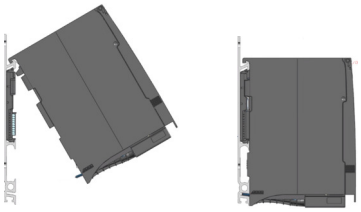
The SEC must be inserted before you install the CPU. The slot for the SEC is located on the left of the CPU.

If no valid SEC is detected, the CPU will not start.

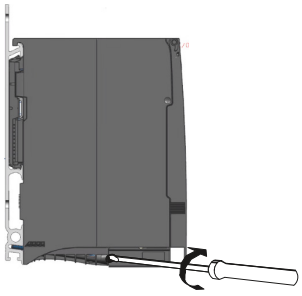
Installing modules

To install modules into a bus module, follow these steps:

1. Place the first module into the rack (1) and carefully push it down (2).
   If you notice resistance when pushing the module into place, lift the module up slightly and check the mounting position.
   Continue with the installation.



2. Fasten the module securely (tightening torque 1.5 Nm). There are two screws for the CPU.



3. Install the other modules accordingly.
4. Protect slots that are not in use with a slot cover.
   Slot cover (Page 27)

Information on removing modules is available at:
Removing modules (uninstalling) (Page 131)

See also

Replacing a power supply module (Page 133)

Replacing the CPU (Page 134)

Replacing a CP (Page 138)

Diagnostic options and service support (Page 111)

4.3.5 Configuration with U-connector

4.3.5.1 Installing U-connectors

Introduction

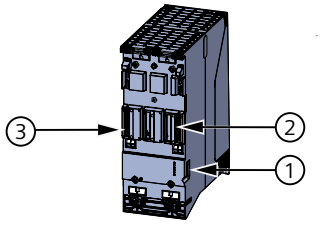
With the controller design without a bus module, the U-connectors establish the electrical connections between two controller modules.

Installing U-connectors

To install the modules, follow these steps:

To install a module with U-connectors, a U-connector must be installed at the left module before another module is installed.

1. Before you install the module, plug the U-connector onto the back of the module.
   Examples:
   - To install the CPU, the U-connector must be installed on the power supply module.
   - The figure below shows the back of a CPU.
     For installing one of the following CPs, the U-connector must be installed on the CPU.
     Note:
     If the module is the last (right) module of the controller, no U-connector must be installed on this module.



① Slot for the SEC
② Socket for U-connector to the power supply module
③ Socket for U-connector to the CP

2. Install the module.

See also

Rack design with U-connector (Page 55)

4.3.5.2 Installing the power supply module

Introduction

The power supply module has contacts on the rear panel that supply the internal system voltage for the controller modules.

For configurations with U-connectors, the U-connector forwards the internal system voltage to the modules on the right.

Tool

Cylindrical screwdriver with a blade width of 4 mm

Requirements

- The mounting rail is installed without bus module.
- U-connectors are available.

Installing the power supply module

To install the power supply module, follow these steps:

1. Open the front flap.
2. Pull the device plug from the power supply module.
3. Close the front flap.
4. Plug the U-connector into the rear into the power supply module.
5. Place the power supply module into the mounting rail.
6. Push the power supply module toward the back.

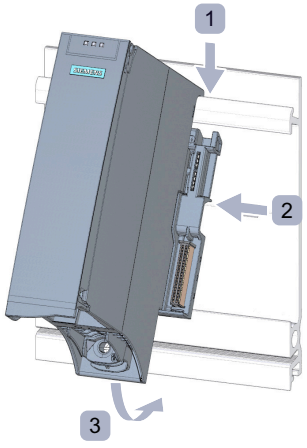


Figure 4-1 Installing the power supply module

7. Fasten the power supply module (tightening torque 1.5 Nm).
8. Plug the completely wired device plug into the power supply module.

You can find information on wiring the device plug in the section Connecting the supply voltage (Page 95).

Removing the power supply module

The power supply module is wired.

To remove the power supply module, follow these steps:

1. Open the front flap.
2. Switch off the power supply module.

3. Switch off the supply voltage.
4. Disconnect the device plug and pull the device plug from the power supply module.
5. Loosen the fixing screw.
6. Move the power supply module out of the mounting rail.
   Recommendation for tight spaces:
   - Move the module out toward the bottom.
   - Hold the module on both sides.
   - Remove the module toward the top.

Reference

More information is available in the device documentation of the power supply module in use.

See also

Replacing a power supply module (Page 133)

4.3.5.3 Installing the CPU

Introduction

For configurations with U-connectors, the U-connector forwards the internal system voltage to the modules on the right.

Requirements

- The mounting rail is installed.
- A U-connector is installed on the power supply module that is pre-installed in the assembly on the left.

Note

Installing the CPU

The SEC must be inserted before you install the CPU. The slot for the SEC is located on the left of the CPU.

If no valid SEC is detected, the CPU will not start.

Required tools

Cylindrical screwdriver with a blade width of 4 mm

Installing the CPU

To install a CPU, follow these steps:

1. If CPs are to be integrated into the controller:
   Install a U-connector on the back right of the CPU.
2. Place the CPU into the mounting rail. Slide the CPU toward the power supply module.
   Make sure that the U-connector is installed on the power supply module.
3. Push the CPU toward the back.
4. Fasten the CPU (tightening torque 1.5 Nm).

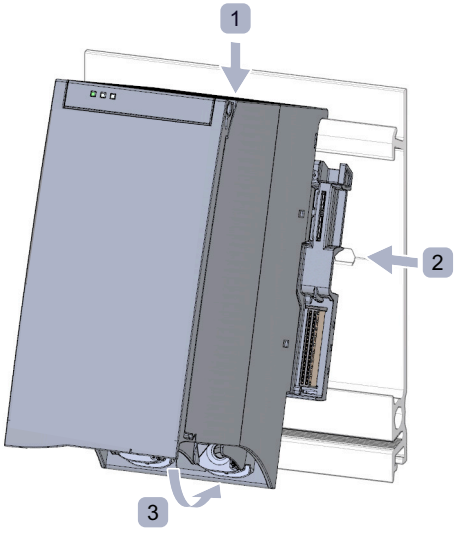


Figure 4-2 Installing the CPU

Removing the CPU

The CPU is wired, and more modules are installed behind it.

To remove a CPU, follow these steps:

1. Set the CPU to STOP mode via the engineering station.
2. Open the front flap.
3. Switch off the power supply module.
4. Disconnect the bus connector with the screw driver.
5. Remove the bus connector from the CPU.
6. Loosen the fixing screws of the CPU.
7. Move the CPU out of the mounting rail from below.
   Recommendation for tight spaces:
   - Move the module out toward the bottom.
   - Hold the module on both sides.
   - Remove the module toward the top.

See also

Replacing the CPU (Page 134)

4.3.5.4 Installing a CP

Introduction

A CP connects the CPU to an additional network (PROFINET IO/Industrial Ethernet or PROFIBUS DP).

For configurations with U-connectors, the U-connector forwards the internal system voltage to the modules on the right.

The CP exchanges data between the CPU and an external system.

Requirements

- The CPU is installed (or CPs are already installed).
- A U-connector is installed on the pre-installed module on the left in the design.

Required tools

Cylindrical screwdriver with a blade width of 4 mm

Installing a CP

To install a CP, follow these steps:

1. If you want to install more CPs in the assembly:
   Install the U-connector on the back right of the CP.
2. Place the CP into the mounting rail.
3. Push the CP toward the back.
4. Fasten the CP (tightening torque 1.5 Nm).

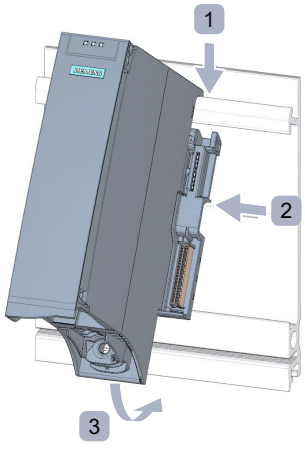


Figure 4-3 Installing a CP

Removing the CP

The CP is wired, and more modules are installed behind it.

To remove the CP, follow these steps:

1. Switch off the supply voltage.
2. Open the front flap.
3. Disconnect the bus connector.
4. Remove the bus connector from the CP.
5. Loosen the fixing screw of the CP.
6. Move the CP out of the mounting rail from below.
   Recommendation for tight spaces:
   - Move the module out toward the bottom.
   - Hold the module on both sides.
   - Remove the module toward the top.
7. Disconnect the U-connector.

4.4 Connecting

4.4.1 Connecting the controller

Procedure

1. Connect the grounding cable to the mounting rail.
   Installing the grounding (Page 101)
2. Connect the supply voltage.
   Connecting the supply voltage (Page 95)
3. Connect the network cables.
   Connecting interfaces for communication (Page 100)
   - Connect the RJ45 plugs.
     Information on cables, wiring and connection is available in the following documentation:
     System Manual SIMATIC; PROFINET; System description (https://support.industry.siemens.com/cs/ww/en/view/19292127/40650672139)
   - Connect the PROFIBUS plug.
     Information on cables, wiring and connection is available in the following documentation:
     System Manual SIMATIC NET; PROFIBUS Network manual (https://support.industry.siemens.com/cs/ww/en/view/35222591)

4.4.2 Notes on connecting

4.4.2.1 Introduction

The SIMATIC S7-4100 controller is one possible component of plants or systems.
Observe the installation and setup instructions specified in EN IEC 60079-14 as well as country-specific regulations.

4.4.2.2 Avoiding dangerous system conditions

Specific application

Observe the safety and accident prevention regulations that apply to specific applications, for example, the machinery directives.

Avoiding dangerous system conditions

Dangerous operating statuses must not occur:

- When the plant restarts after a voltage dip or power failure.
- When the bus communication is resumed after a fault.

When a dangerous operating state occurs, force an EMERGENCY STOP.

After the EMERGENCY-STOP apparatus is released, the SIMATIC S7-4100 controller must not start up in an uncontrolled or undefined manner.

EMERGENCY STOP devices

EMERGENCY STOP devices according to IEC 60204 (corresponds to DIN VDE 0113) must remain in effect in all operating modes of the plant or system.

Protection from electric shock

For protection from electric shock, you must connect the racks and any other existing protective conductor connection points of the controller to the protective conductor.

Ensure that the protective conductors are labeled so that they meet the standard.

Protection against external electrical influences

Be sure to adhere to the following rules for protection against electrical influences or faults:

- In all plants with a SIMATIC S7-4100 controller, the plant must be connected to a protective conductor with sufficient cross-section for discharging electromagnetic interference.
- Make sure that all supply cables, signal cables and bus cables are routed and installed correctly.
- For signal and bus cables, a line break, wire break or crossover must not result in undefined states of the plant or system.

Decommissioning

Decommission the device according to the applicable guidelines to prevent access by unauthorized persons to confidential data in the device memory.

- If possible, restore the factory settings on the module before you remove it.
- Remove the System Expansion Card (SEC), if inserted in the module.

Using a CPU already installed

A CPU stores a loaded user program until it is deleted.

Note: Effects of off/on, memory reset, reset (Page 124)

If you are reusing a CPU that has been used before, note the following:

- Make sure that the loaded configuration cannot cause any dangerous plant states at the location of use.
- If you are not aware of possible effects of its previous use, restore the factory settings on the CPU.

4.4.2.3 Configuration of a controller with non-grounded reference potential (ungrounded configuration)

Application

In extensive plants, there may be a requirement to mount the SIMATIC S7-4100 controller with non-grounded reference potential (e.g. due to ground-fault monitoring). This is the case, for example, in the chemical industry or in power plants.

Discharge of fault currents

In non-grounded controller assemblies, any fault currents that may occur are diverted to the mounting rail.

Connection diagram

The following figure shows a controller configuration with non-grounded reference potential. By default, the reference potential M of the controller is connected to the mounting rail via an RC network. When you connect the mounting rail to the functional grounding, you divert high-frequency fault currents and prevent static charges.

① Connection to the functional grounding

Figure 4-4 Configuration with non-grounded reference potential

AC power supply module

In a non-grounded assembly of the controller with the AC power supply module, you must ensure that the protective conductor is connected at the device plug.

Filtering 24 V DC mains voltage

In a non-grounded assembly of the controller with power supply from a battery, you must ensure that the 24 V DC supply voltage is interference-suppressed.
To this end, use a Siemens power line filter, such as a B84102-K40.

Insulation monitoring

When dangerous plant states occur due to double faults, you must ensure that insulation monitoring is available.

4.4.2.4 Wiring rules

Introduction

Use suitable cables when connecting the power supply modules. Also select the cable insulation that matches the supply voltage.
The following table shows which wiring rules are in effect for specific wires and cables.

Power supply

Table 4-2 Wiring rules for power supply modules

Wiring rules for ...		Power supply module
Cable cross-sections that can be connected for solid cables (Cu)		1.5 mm²
		AWG*: 16
Cable cross-sections that can be connected for flexible cables (Cu)	Without ferrule	1.5 mm²
		AWG*: 16
	With ferrule	1.5 mm²
		AWG*: 16
Number of cables per connection		1
Stripped length of the cables		7 mm
Ferrules according to DIN 46228	Without plastic sleeve	Form A, 7 mm long
	With plastic sleeve 0.25 to 1.5 mm²	Form A, 7 mm long
Sheath diameter		8.5 mm
Tool		Screwdriver, conical type, 4 mm
Connection method		Screw terminal
Tightening torque		From 0.5 Nm to 0.6 Nm

* American Wire Gauge

Permitted cable temperature

Note

Permitted cable temperatures

Select core cross-sections that are large enough so that the permitted cable temperatures are not exceeded.

A connection cable must be rated for a temperature range of min. 70 °C (see also Mechanical and climatic ambient conditions for operation (Page 145)).

Example of power supply module:
A core cross-section of the connection cables that is too low can result in excessive temperature rise of the cables, even if the ambient temperature is only 40 °C.

4.4.2.5 Operation on grounded infeed

Introduction

In the following, you can find information on the overall configuration of a SIMATIC S7-4100 controller connected to a grounded supply (TN-S system). The following topics are covered:

EMERGENCY STOP devices, short-circuit and overload protection according to

- IEC 60364, corresponds to DIN VDE 0100
- IEC 60204, corresponds to DIN VDE 0113

Grounded infeed

In grounded infeeds (TN-S network), the neutral conductor (N) and the protective conductor (PE) are grounded. Both conductors form part of an overvoltage concept. When a plant is out of operation, the current flows via the neutral conductor. When a fault occurs, the current flows via the protective conductor, for example, a single ground fault between a live conductor and ground.

Safety Extra-Low Voltage (SELV according to IEC 61131-2 or IEC 61010-2-201)

- The 24 V DC power supply modules require a safety extra low voltage and a voltage limit (extra low voltage).
- The 24 V DC power supply modules are not connected to the protective conductor. According to IEC 61131-2 or IEC 61010-2-201, this protection is called SELV (Safety Extra Low Voltage).

The wiring of SELV circuits must be safely separated from the wiring of other circuits that are not SELV or the insulation of all conductors must be rated for the higher voltage.

Grounded extra low voltage (PELV according to IEC 61131-2 or IEC 61010-2-201)

The PS 4160-SD power supply module requires a safe connection to the protective conductor and a voltage limit (extra low voltage).

According to IEC 61131-2 or IEC 61010-2-201, this protection is called PELV (Protective Extra Low Voltage).

The wiring of PELV circuits must be safely separated from the wiring of other circuits that are not PELV or the insulation of all conductors must be rated for the higher voltage.

Reference potential of the controller

The reference potential of the controller is connected to the mounting rail via a high-resistance RC combination in the CPU or the CP. This type of connection discharges high-frequency interference currents and prevents electrostatic charges. Due to the high-resistance connection, the reference potential of the controller is considered as ungrounded despite the grounded mounting rail.

You can find a simplified representation of the potential relationships in the section Potential relationships (Page 45).

Short-circuit and overload protection

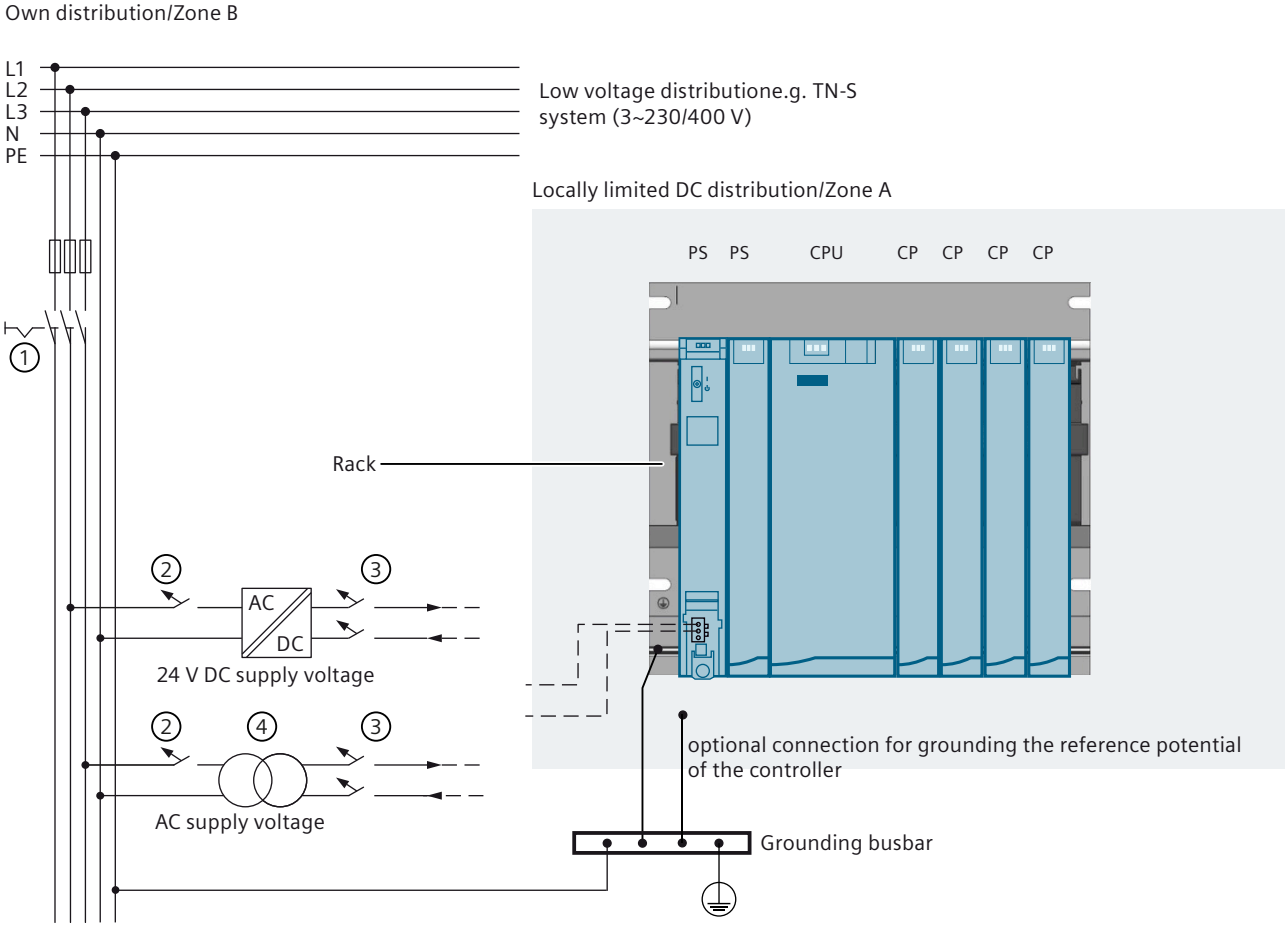
Setup of a complete plant requires various measures for short-circuit and overload protection. The type of components and the degree to which the required measures are binding depend on the regulations that are in effect for your plant configuration.
The table refers to the following figure and compares the IEC (DIN VDE) regulations.

Table 4-3 Components and required measures

	Reference to the following figure	**IEC 60364 (DIN VDE 0100)**	**IEC 60204 (DIN VDE 0113)**
EMERGENCY STOP for the controller	①	Main switch	Disconnector
Short-circuit and overload protection	② ③	Secure single pole of circuits	• With grounded secondary circuit: Secure **single pole** • Otherwise: Secure **all poles**
Power supply for AC circuits with more than 5 electromagnetic pieces of equipment	④	Galvanic isolation through transformer **recommended**	Galvanic isolation through transformer **recommended**

Controller in the overall configuration

The figure shows an example of the controller in the total configuration (power supply and grounding concept) for infeed from a TN-S network.



① Main switch
② Short-circuit and overload protection on the primary side
③ Short-circuit and overload protection on the secondary side
④ Optional for galvanic isolation
PS Power supply module
CPU CPU
CP CP

Figure 4-5 Operating a controller with grounded reference potential

4.4.3 Connecting the supply voltage

Device plug

Use the device plug to connect a power supply module to the supply voltage. Upon delivery, the device plug is plugged into the power supply module. There are two versions (AC and DC) of device plugs. The two versions are coded, which means:

- An AC device plug can only be plugged into an AC power supply module.
- A DC device plug can only be plugged into a DC power supply module.

Required tools

- Cylindrical screwdriver with a blade width of 4 mm
- Suitable tool for stripping the cables
- For multi-wire cables: Ferrules and crimping tool

Preparation

⚠ WARNING

Injuries may occur.

When you wire the device plug while it is supplied with power, you can suffer physical harm due to an electric shock.

Only wire a device plug with the power switched off.

Make sure that no voltage is present at the cables.

- Prepare the cables.
  Preparing cables (Page 97)
- Unplug the device plug.
  Loosening the device plug (Page 96)

Procedure

⚠ CAUTION

Power supply module or device plug can be damaged.

If you plug in or unplug the device plug while it is supplied with power, the power supply module or the device plug may be damaged.

Plug or unplug the device plug only in its de-energized state.

Note

The on/off switch of the power supply module does not disconnect the supply voltage from the mains!

1. Wire the device plug.
   Wiring the device plug (Page 98)
2. Plug the device plug into the power supply module.
   Plugging in the device plug (Page 100)

Result

The cables for power supply of the controller are connected to the controller.

4.4.4 Loosening the device plug

Requirement

⚠ WARNING

Injuries may occur.

When you wire the device plug while it is supplied with power, you can suffer physical harm due to an electric shock.

Only wire a device plug with the power switched off!

⚠ CAUTION

Power supply module or device plug can be damaged.

If you plug in or unplug the device plug while it is supplied with power, the power supply module or the device plug may be damaged.

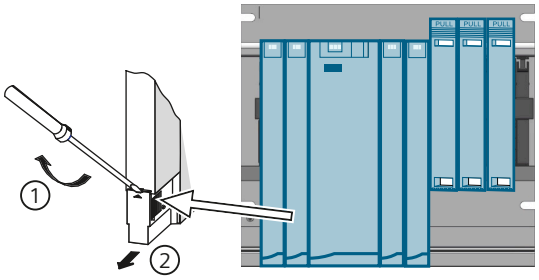
Plug or unplug the device plug only in its de-energized state.

Note

The on/off switch of the power supply module does not disconnect the supply voltage from the mains!

Procedure

1. Open the front flap of the power supply module.
2. Disconnect the device plug by prying it out with a suitable tool (e.g. screwdriver) at the cutout provided for it (1).
3. Unplug the device plug from the power supply module (2) toward the front.



4.4.5 Preparing cables

Required tools

- Suitable tool for stripping the cables
- For multi-wire cables: Ferrules and crimping tool

Preparing cables

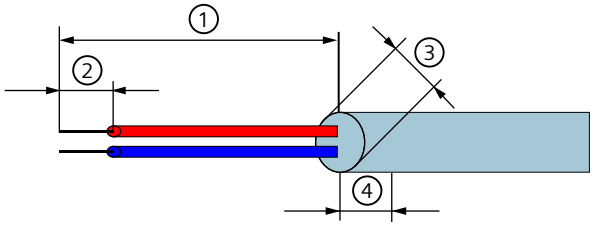


Figure 4-6 Preparing cables

Step no.:	Step	Conductor	
		Multi-wire (stranded), without ferrule, unprocessed	**solid without ferrule, stranded (stranded wire) with ferrule and ultrasonically sealed**
①	Remove cable jacket and shielding	When using a sheathed cable (as required for 230 V AC!), you remove the sheath to a length of 70 mm ①. Note: Note that strain relief is required for cables. Required total diameter of the cable ③: Between 3 mm and 9 mm. If required, strip the cables so that the overall diameter of the cables is between 3 mm and 9 mm after a length of 70 mm ④.	
②	Shorten cable	Shorten the two wires that are not required for connection to the PE by 10 mm.	
③	Strip cables	Strip cable for plug with screw-type terminal ②: 7 mm	
④	More preparation	Compress the wires or use ferrules. See the table Wiring rules (Page 90)	None

4.4.6 Wiring the device plug

Required tools

- Screwdriver 3 to 3.5 mm

Requirement

- The device plug is not plugged into the power supply module.
- The cables are prepared.

Wiring the device plug

⚠ WARNING

Injuries may occur.

When you wire the device plug while it is supplied with power, you can suffer physical harm due to an electric shock.

Only wire a device plug with the power switched off!

To wire the device plug, follow these steps:

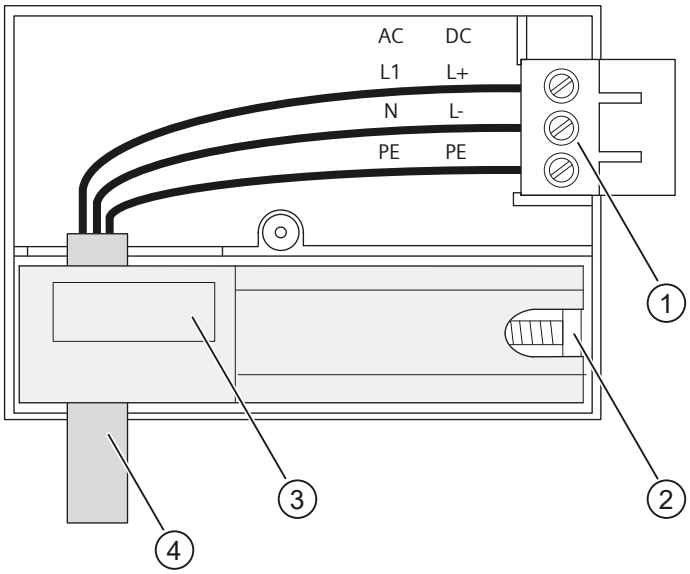
1. Disconnect the supply voltage at your disconnector unit.

   Note

   The on/off switch of the power supply module does not disconnect the operating voltage from the mains!

2. Loosen the screw in the device plug cover and open the device plug.
3. Loosen the screw of the strain relief and insert the cable.

4. Connect the wires to the terminals according to the diagram on the device plug cover.
   – Connect the longer wire to the PE.
   – Tighten the wires with a torque of 0.5 to 0.6 Nm.



① Terminals
② Strain relief screw
③ Strain relief
④ Cables

Figure 4-7 Wiring the device plug

5. Tighten the screw of the strain relief so that the cable is securely held in place.
6. Connect the device plug and screw on the cover.

⚠ CAUTION

Power supply module or device plug can be damaged.

If you plug in or unplug the device plug while it is supplied with power, the power supply module or the device plug may be damaged.

Plug or unplug the device plug only in its de-energized state.

4.4.7 Plugging in the device plug

Requirement

- When the power supply module is installed in the mounting rail:
  You can only plug in the device plug when the fastening screw is tightened.
- When the power supply module is not installed in the controller:
  You can only plug in the device plug when the fastening screw does not block the path of the plug.

Procedure

To plug in the wired device plug into the power supply module, follow these steps:

1. Open the front flap of the power supply module.
2. Slide the device plug into the guide slot at the module housing.
3. Slide the device plug into the power supply module as far as it will go.
4. Close the front flap of the power supply module.

4.4.8 Connecting interfaces for communication

Connecting the communication interfaces

You connect the communication interfaces of the CPU or CP using standardized connectors.

Make sure that you use cables and connectors that meet the requirements of the respective network.

You can find information on this and on pre-assembled cables in the following documentation:

- SIMATIC NET, Industrial Ethernet/PROFINET Industrial Ethernet (Page 202)
- SIMATIC NET, Industrial Ethernet / PROFINET, Passive network components (Page 202)
- SIMATIC NET, PROFIBUS network manual (Page 203)

Special feature: Unlock RJ45 FastConnect plug and remove it from the interface

The following information is only relevant when using a FastConnect RJ45 plug:

- Connector Industrial Ethernet FastConnect RJ45 plug 180 2x 2
- Connector Industrial Ethernet FastConnect RJ45 plug 180 4x 2

Required tools

- Industrial Ethernet FastConnect RJ45 plug 180 2x 2 (6K1901-1BB10-2Ax0): **Screwdriver 2.5 mm**
- Industrial Ethernet FastConnect RJ45 plug 180 4x 2 (6GK1901-1BB12-2Ax0): **Screwdriver 3.0 mm**

Procedure

1. Open the front flap of the module.
2. Press the screwdriver parallel to the connector to unlock it.
3. Remove the connector from the PN/IE interface.

Note

Do not pull on the connector when unlocking it!

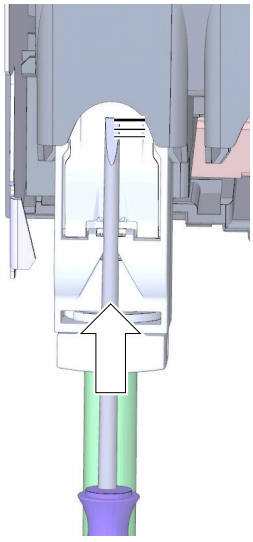


Figure 4-8 Unlocking the FastConnect connector

4.4.9 Installing the grounding

Required tools

- Spanner or socket wrench size 10 for grounding cable connection
- Stripping tool and crimping pliers for the grounding cable

Fastening the protective conductor

For electrical safety reasons, the components of the SIMATIC S7-4100 controller must be connected to the protective bonding circuit of the electrical installation.

To connect the protective conductor, follow these steps:

1. Strip the grounding conductor with a minimum conductor cross-section of 10 mm^2. Use crimping pliers to attach a ring cable lug for screws of size M6.
2. Slide the enclosed bolt into the T profile slot.
3. Slide the spacer washer, ring cable lug with the grounding conductor, washer and spring lock washer onto the bolt. Screw on the hexagon nut. Use the nut to tighten the components (tightening torque 4 Nm).
4. Connect the other end of the grounding conductor to the central grounding point/protective conductor busbar (PE).

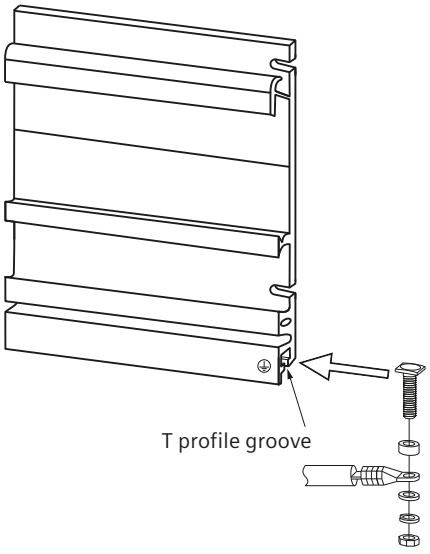


Figure 4-9 Installing the protective conductor (protective earth)

Note

Alternative grounding of the rack

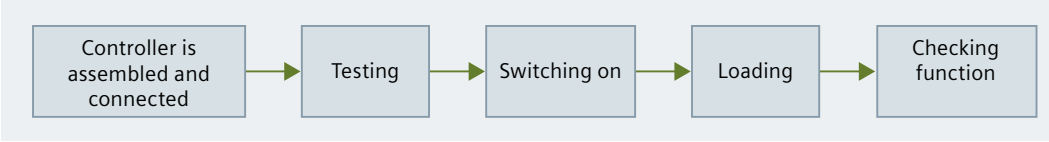
The grounding via grounding screw can be omitted under the following condition:

The rack must be permanently connected to the protective bonding circuit by means of an equivalent installation that meets the standard. This can be, for example, a permanent connection to a grounded control cabinet wall.

Commissioning

5

5.1 Commissioning the controller



Testing

Before you switch on the controller, you must ensure that all operating requirements are met:

Checklist before first switch on (Page 104)

Requirement

1. For the controller to be loaded, at least the configuration must have been performed on the engineering station and the consistency of the configuration must have been checked. Information on this topic is available in the engineering online help.
2. Due to its modular design, a SIMATIC S7-4100 controller can be quite extensive and complex.
   - Recommended procedure for initial commissioning (Page 105)
   - Switch on the controller.
     Switching on the controller (Page 107)

Loading

1. Load the controller:
   The information needed for loading is available in the engineering online help:
   Loading devices > Working with loading of devices

Checking function

1. Run diagnostics and remedy any faults that may exist.
   Running diagnostics and maintenance (Page 111)

5.2 Notes on commissioning

5.2.1 Regulations and directives

- You must observe the regulations in your country during commissioning.
- For functional checks, you must observe the guidelines specified in DIN EN IEC 60079-17.

5.2.2 Using a used CPU

Retentive load memory

CAUTION

Caution when reusing a CPU

When you reuse a CPU, you must ensure the following:
The contents saved in the load memory cannot cause any dangerous system states at the location of use.

If you do not know how the CPU was used before, reset the CPU to the delivery state.

5.2.3 Preparation for commissioning

Using the power supply modules PS AC

Note

Working under voltage

When using the PS AC power supply modules, the supply voltage is higher than 48 V.

Any work on the power supply must be conducted with the supply voltage being switched off.

If possible, only perform any mechanical work on the controller with the supply voltage switched off.

5.2.4 Checklist before first switch on

After installing and wiring the controller, we recommend that you check the steps you have executed so far before you switch on the controller for the first time.

The following table is a checklist with instructions that you can use to check the controller.

Object	Test	Check
Mounting rail	Is the mounting rail installed properly to the wall, in the rack or in the cabinet?	
	Are the necessary clearances observed?	
	Is sufficient air flowing to the controller?	
Grounding concept	Does a low-resistance connection (large surface area, large contact area) to the grounding exist?	
Module installation and wiring	Are all modules properly installed and fastened?	
Power supply	Is the device plug properly wired?	
	Are all power supply modules switched off? - Set the on/off switch to position ⏻ (output voltages 0 V).	
Supply voltage	Is the existing supply voltage correct?	
	Has the connection to the supply voltage been made?	

5.3 Recommended procedure for initial commissioning

Note

You must also observe the regulations in your country during commissioning.

For functional checks, you must also observe the guidelines specified in DIN EN IEC 60079-17.

Requirements

- The configuration has been configured and the consistency of the configuration has been checked on the engineering station.
- The PG/PC interface has been set for the engineering station.
  More information is available under Engineering in the online help.
- The controller is assembled and connected.
  Checklist before first switch on (Page 104)

Preparation

Preparation is only necessary in the following cases:
If you cannot ensure that the CPU was loaded with the correct user program or has been reset to factory settings.

Procedure:

1. Remove the network connections from the CPU and the CPs.
2. Switch on the power supply.
3. Reset the CPU to factory settings.
   Reset to factory settings (Page 129)

4. Switch off the power supply.
5. Restore the required network connections to the CPU and the CPs.

Procedure

We recommend the following procedure for the first commissioning:

1. Commission the controller with the following modules:
   - Power supply module
   - CPU
2. First, switch on the supply voltage using the disconnector unit.
3. Then set the on/off switch of the power supply module to position I (output voltage to nominal value).
4. Check the LEDs of the modules.
   Switching on the controller (Page 107)
5. Install all other components and put them into operation one after the other.

Procedure in case of a fault

In case of a fault, you can proceed as follows:

- Check the LEDs of the modules.
- If necessary, remove individual modules (CPs or redundant power supply module) again to determine any faults that may have occurred.

Assigning the real CPU to the controller

Assigning the real CPU to the controller in the engineering:

1. Select the CPU configured in the controller in the project.
2. Select "Assign device".
3. For the device filter, enable "Show devices of the same type".
4. In "Accessible devices in the subnet", select the MAC address of the real CPU.

Result:
You can load the controller.

Loading the configuration data

Loading the configuration data to the CPU is possible via any PN/IO interface of the controller.

The configuration data of the CP is transferred when the station is loaded. When the CPU starts up, the CP is supplied with the relevant data.

More details on loading are available under engineering in the online help:

- "Loading devices"
- "Service support and diagnostics"

5.4 Applications

5.4.1 Switching on the controller

Note

First switch on

A first switch on of a controller with all I/O modules installed in the distributed I/O is usually not very efficient. Instead, we recommend a gradual commissioning. Note:
Recommended procedure for initial commissioning (Page 105)

Requirement

- A configuration was created in the engineering.
- The controller is assembled (installation, connection).

Procedure

1. First, switch on the supply voltage using the disconnector unit.
2. Set the on/off switch of the power supply module to position I (output voltage to nominal value).

Result

If the operating requirements are met, the controller switches to "RUN" mode.

Information on the LEDs of the modules:

- Status displays on the power supply module (Page 115)
- Status and error displays on the CPU (Page 116)
- Status and error displays on the CPs (Page 120)

5.4.2 Commissioning the PN/IE interface of the CPU

Introduction

Below you will find a description for commissioning a PN/IE interface of the CPU with a station in one of the following networks:

- PROFINET IO network
- Industrial Ethernet network

Requirements

Before you can commission the network, the following requirements must be met:

- The CPU is accessible via an interface for engineering.
- You have configured the network in engineering and assigned an IP address to the PN/IE interface (X1 or X2) of the CPU.

Procedure during commissioning

1. Download the configuration of the network (preset configuration) that you created in engineering to the CPU.
2. Switch the CPU from STOP to RUN.
3. Switch on the other network participants (for PROFINET IO, the IO devices: also possible one after the other).

Behavior of the CPU when starting up

When starting up, the CPU compares the preset configuration to the actual configuration. The test time is automatically set by engineering.

After starting up, the CPU switches to RUN.

Meaning of the LEDs of the PN/IE ports

The meaning of the color combinations of the PN/IE interface LEDs Xn P1 and Xn P2 is explained in:

Status and error displays at the PN/IE interface (Page 121)

5.4.3 Commissioning the PROFIBUS DP interface of the CPU

Introduction

Below you will find a description of commissioning a PROFIBUS DP network in which the CPU provides the DP master.

Requirements

Before you can commission the PROFIBUS DP network, the following requirements must be met:

- The PROFIBUS DP network is set up.
- You have configured the PROFIBUS DP network in engineering and assigned all participants a PROFIBUS DP address and an address space. Note that, for some DP devices, you must also set address switches (see description of the respective DP device).

Procedure during commissioning

1. Download the configuration of the PROFIBUS DP network (preset configuration) that you created in engineering to the CPU.
2. Switch on all DP devices.
3. Switch the CPU from STOP to RUN.

Behavior of the CPU when starting up

When starting up, the CPU compares the preset configuration to the actual configuration. The test time is automatically set by engineering.

After starting up, the CPU switches to RUN.

See also

Assignment of the connection plug for PROFIBUS DP (D-sub DE-9) (Page 176)

5.5 Commissioning

Requirement for commissioning: Configuration

The configuration has been configured and the consistency of the configuration has been checked on the engineering station.

Pulling/plugging a module during operation

⚠ WARNING
No pulling or plugging in hazardous zone 2
Pulling or plugging of modules is generally prohibited in hazardous zone 2.

Outside of hazardous zones, the following applies depending on the installation:

- Installation in the bus module
  The following modules may be removed or installed when the power supply is switched on:
  - CPs
  - With redundant power supply - one of the power supply modules
- Installation with U-connector
  The modules may only be removed or installed when the power supply is switched off.

Retentive load memory

CAUTION

Caution when reusing a CPU

When you reuse a CPU, you must ensure the following:
The contents saved in the load memory cannot cause any dangerous system states at the location of use.

If you do not know how the CPU was used before, reset the CPU to the delivery state.

Loading the configuration data

The configuration data can be loaded to the CPU via any PN/IE interface of the controller.

The configuration data of the CP is transferred when the station is loaded. When the CPU starts up, the CP is supplied with the relevant data.

More details on loading are available under engineering in the online help:

- "Loading devices"
- "Service support and diagnostics"

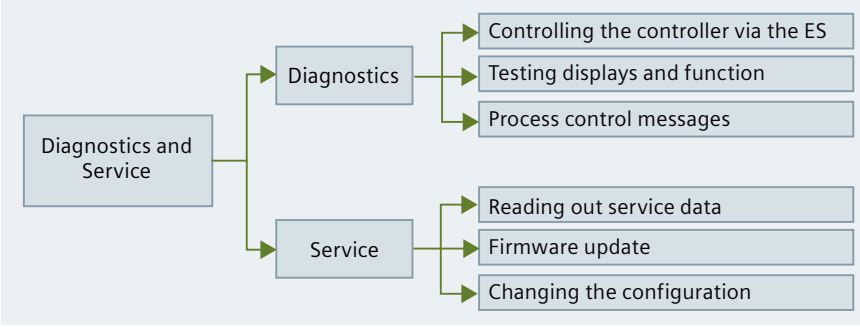
Diagnostic options and service support

6

6.1 Running diagnostics and maintenance

The following refers to the procedure for using an SIMATIC S7-4100 controller.

Procedure



Diagnostics

To determine the status of the controller, you can evaluate the status information.

Testing displays and function

- Power supply module
  On/off switch of the power supply module
  Operator controls and indicators (Page 112)
- LED displays
  - LED on the power supply module
    Status displays on the power supply module (Page 115)
  - LED on the CPU
    Status and error displays on the CPU (Page 116)
  - LED on the CP
    Status and error displays on the CPs (Page 120)
- Diagnostics buffer
  Display diagnostics buffer of the controllers
  You can find information about this in the online help for engineering.
- Measuring specific values, e.g. supply voltage

Controlling the controller with the engineering station

- Find device (let diagnostics LED flash)
- Device cockpit (CPU)
  - Switching the operating mode (RUN/STOP)
  - Determine cycle time and memory utilization of the controller

Display process control messages on the M&C station

You can find information about this on the M&C station in the online help.

Service

Servicing on the controller includes the following:

Note

Note the specific configuration and the sequence of the required work.

- Maintenance work:
  e.g. cleaning
- Specific changes of the system state, for example:
  - Firmware update
    You can find information about this under engineering in the online help.
  - Replacing components
  - Changing the configuration of the controller
- Saving service data (for evaluation by system experts)
  Saving service data is one of the diagnostic functions.
  You can find the relevant information under engineering in the online help.

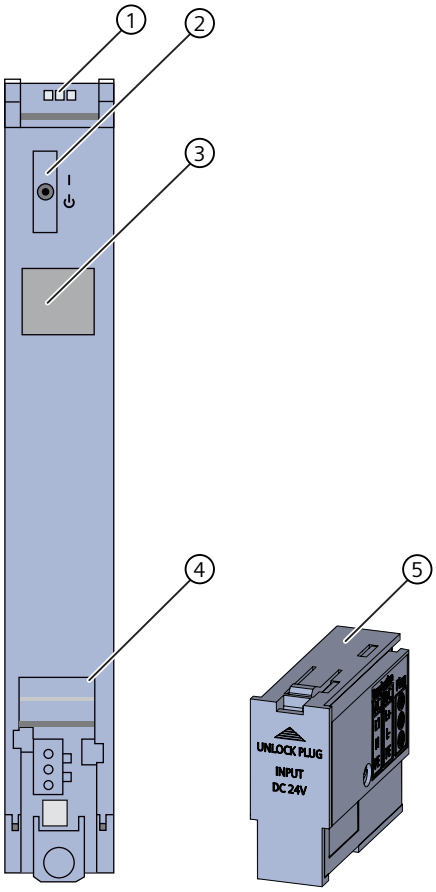
6.2 Power supply modules

6.2.1 Operator controls and indicators

Operator control and display elements

The power supply modules have the same operator control and display elements.

- The LED displays are installed on the front of the module above the front flap.
- The operator controls and connectors are installed below the front flap.



① Status displays of the module
- LEDs for displaying the module status (Page 114)
- Status displays on the power supply module (Page 115)

② On/off switch

③ Digital nameplate (QR code on the front) (Page 12)

④ Connection for power supply via the device plug

⑤ Device plug (unplugged - plugged in when delivered)

Figure 6-1 Operator control and display elements of the power supply modules PS 4160

Function of the operator controls of the power supply modules

Element	Function	
On/off switch	No disconnection from the supply voltage.	
	|	System voltage to rated value
	⏻	Power supply module "OFF"
Device plug	3-pin plug for connecting the supply voltage (do not remove or install under voltage) • Wiring the device plug (Page 98) • Plugging in the device plug (Page 100)	

Diagnostic messages

On the power supply module, you can recognize a pending diagnostic message by one of the following "LED patterns":

- The red ER LED flashes.
  An external or internal error has occurred.
- The yellow MT LED lights up.
  Maintenance, maintenance is demanded.

Detailed information on the status displays:

Status displays on the power supply module (Page 115)

External errors, internal errors and defects

If possible, a defect also always triggers a diagnostic message.

If the power supply module still shows the "Defective" state after an "Off/On", it must be sent in for repair.
Information on sending in for repair or spare parts is available on the Internet:
Service & Support (https://support.industry.siemens.com/cs)

6.3 Status and error displays

6.3.1 LEDs for displaying the module status

Definition

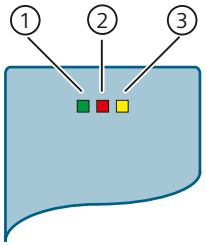
The status displays are group displays.

Status displays of the module

These LEDs are visible on all controller modules above the front flap.
The status displays are only labeled on the CPU.

The front flap may hide additional module-specific LED displays.

The LED displays are arranged in the same order for all controller modules:
Order from left to right:



	Display (LED)	Color (when active)	Meaning
①	RUN/STOP LEDs	RUN green / STOP yellow	The RUN/STOP LEDs provide information on the operating state of the module.
②	ER (ERROR) LED	Red	The ER LED lights up in case of an error.
③	MT (Maintenance) LED	Yellow	The MT LED lights up in case of maintenance required.

Reference

Information on the specific meaning of the status displays and on the hidden LEDs:

- Power supply module
  Status displays on the power supply module (Page 115)
- CPU 4168-H
  Status and error displays on the CPU (Page 116)
- CP 4163-1/CP 3163-5
  Status and error displays on the CPs (Page 120)
- PN/IE interface
  Status and error displays at the PN/IE interface (Page 121)

6.3.2 Status displays on the power supply module

Introduction

The diagnostics offered by the LEDs are a first aid in detecting errors.
You can also evaluate the status of a module in the process control system. There you will find plain text information on the error that occurred.

Meaning of the LED displays

The following table explains the meaning of the status displays of the power supply module.

LED (green)	LED (red)	LED (yellow)	Meaning
RUN	ERROR	MAINTENANCE	
□ LED off	□ LED off	□ LED off	No supply voltage or supply voltage too low at the power supply module. Supply voltage incorrectly connected
■ **LED lights up green**	☼ **LED flashes red**	Not relevant	Diagnostic event present. Check the details via the online diagnostics in the diagnostic buffer. **Notice! With redundant power supply module** Make sure that both modules are supplied and switched on. The LEDs indicate the functionality of the electronics even when a module is switched off.
■ **LED lights up green**	■ **LED lights up red**	■ **LED lights up yellow**	LED test when starting: All LEDs briefly light up after a system startup or module startup after a firmware update.
☼ **LED flashes green**	Not relevant	Not relevant	Only valid during startup: Power supply module supplies the system voltage, power supply module waiting for parameter assignment.
☼ **LED flashes green**	☼ **LED flashes red**	□ LED off	• No configuration available • Firmware is being loaded
☼ **LED flashes green**	☼ **LED flashes red**	☼ **LED flashes yellow**	Module fault (LEDs flash synchronously) The power supply module is in the "Defective" status. Repairs (Page 30)
■ **LED lights up green**	□ LED off	□ LED off	Power supply module in RUN operating state No fault
■ **LED lights up green**	□ LED off	☼ **LED flashes yellow**	Maintenance required

6.3.3 Status and error displays on the CPU

The following tables show the following for the CPU:

- LED display during operation
- LED display after switching on (booted)
- LED display of errors during startup of the CPU

Table 6-1 LED display during operation

LED displays			Meaning
RUN (green) /STOP (yellow) - Operating mode	**ER (red) - ERROR**	**MT (yellow) - Maintenance**	
■ **LED lights up green**	□ LED off	□ LED off	CPU in RUN mode No fault
■ **LED lights up green**	Independent of the display	■ **LED lights up yellow**	Maintenance requirement In addition, open the front flap. Check if more information is displayed: Examples: • **CTRL ER/MT yellow:** e.g. CPU firmware loaded but not activated • **X<n> ER/MT yellow**: e.g. there is a maintenance requirement on the part of the decentralized I/O
■ **LED lights up green**	☼ **LED flashes red** at 2 Hz	Independent of the display	Error In addition, open the front flap. Check if more information is displayed: Examples: • **CTRL ER/MT flashes red:** e.g. CPU has refused to load the configuration • **X<n> ER/MT flashes red**: e.g. there is an error on the part of the decentralized I/O
□ LED off	□ LED off	□ LED off	No supply voltage or supply voltage too low at the CPU
☼ **(STOP) LED flashes yellow** at 2 Hz	☼ **LED flashes red** at 2 Hz	☼ **LED flashes yellow** at 2 Hz	Remaining LEDs off - Error detected: Avoid switching off the CPU! Also open the front flap. **Wait a few minutes and check whether the display changes** (usually up to 2 minutes display no. 4 - 7)**.**
■ **(STOP) LED lights up yellow**	☼ **LED flashes red** at 2 Hz	☼ **LED flashes yellow** at 2 Hz	Service data is being generated - Avoid switching off the CPU! **Wait a few minutes and check whether the display changes** (usually up to 10 minutes display no. 5 - 7)**.**
☼ **(STOP) LED flashes yellow** at 2 Hz	☼ **LED flashes red** at 2 Hz	☼ **LED flashes yellow** at 2 Hz	☼ **CTRL ER flashes red** at 2 Hz • The service data is available retentively. • A restart follows.

LED displays			Meaning
RUN (green) /STOP (yellow) - Operating mode	**ER (red) - ERROR**	**MT (yellow) - Maintenance**	
(STOP) LED flashes yellow at 2 Hz	**LED flashes red** at 2 Hz	**LED flashes yellow** at 2 Hz	□ CTRL ID A LED off **CTRL ER, X1 ER, X2 ER, X3 ER, X4 ER, and X5 ER are flashing red** at 2 Hz • The service data is available retentively. • Try to restart the power supply module (turn it off and then on again).
(STOP) LED flashes yellow at 2 Hz	**LED flashes red** at 2 Hz	**LED flashes yellow** at 2 Hz	**CTRL ID A flashes yellow** with 2 Hz **CTRL ER, X1 ER, X2 ER, X3 ER, X4 ER, and X5 ER are flashing red** at 2 Hz The CPU is defective.
(STOP) LED flashes yellow at 0.5 Hz	□ LED off	□ LED off	Request memory reset
Displays the status	**LED flashes red** at 2 Hz	**LED flashes yellow** at 2 Hz	Display during "Find device" action (flash test) All LEDs of the CPU except RUN/STOP flash for 3 seconds.

Table 6-2 LED display after switching on (booted)

LED displays			Meaning
RUN (green) /STOP (yellow) - Operating mode	**ER (red) - ERROR**	**MT (yellow) - Maintenance**	
□ LED off	□ LED off	□ LED off	Only short display after switching on the supply voltage or rebooting
■ **(STOP) LED lights up yellow**	**LED flashes red** at 0.5 Hz	□ LED off	Boot process - Stage 1
■ **(STOP) LED lights up yellow**	**LED flashes red** at 2 Hz	□ LED off	Boot process - Stage 2
■ **(STOP) LED lights up yellow**	■ **LED lights up red**	□ LED off	Boot process - Stage 3

LED displays			Meaning
RUN (green) /STOP (yellow) - Operating mode	**ER (red) - ERROR**	**MT (yellow) - Maintenance**	
(STOP) LED flashes yellow at 2 Hz	**LED lights up red**	**LED flashes yellow** at 2 Hz	Self test is starting
(STOP) LED lights up yellow	**LED lights up red**	**LED flashes yellow** at 2 Hz	Self test completed
(STOP) LED lights up yellow	**LED lights up red**	**LED lights up yellow**	Boot process completed
LED off	LED off	LED off	Start of the operating system
(STOP) LED flashes yellow at 2 Hz	LED off	LED off	Operating system starts up
(STOP) LED flashes yellow at 2 Hz	Depending on state	Depending on state	Operating system starts up. Additional LEDs are controlled depending on the state.
(STOP) LED lights up yellow	Depending on state	Depending on state	STOP state reached. STARTUP completed Additional LEDs are controlled depending on the state.

Table 6-3 LED display of errors during startup of the CPU

LED displays			Meaning
RUN (green) /STOP (yellow) - Operating mode	**ER (red) - ERROR**	**MT (yellow) - Maintenance**	
(STOP) LED flashes yellow at 2 Hz	**LED flashes red** at 2 Hz	**LED flashes yellow** at 2 Hz	**CTRL ER and X(n) ER are flashing red** at 2 Hz (n = 1 to 4) Error (s) while booting

Restart not possible. Try the following to exit this state:
Voltage off > on.

6.3.4 Status and error displays on the CPs

LED (green)	LED (red)	LED (yellow)	Meaning for	
RUN	**ERROR**	**MAINTENANCE**	**CP 4163-1**	**CP 4163-5**
LED lights up green	LED flashes red	-	• Diagnostic event present. • CP has started with retentive configuration and waits for connection to the CPU	Diagnostic event present.
LED off	LED off	LED off	• No supply voltage or supply voltage too low at the CP • No CPU or defective CPU -> CP has no power	
LED lights up green	**LED lights up red**	**LED lights up yellow**	LED test during starting	
LED lights up green	**LED lights up red**	LED off	Starting of the CP	
LED flashes green	**LED flashes red**	LED off	CP waiting for connection to CPU	
LED lights up green	LED off	LED off	• CP in RUN mode • No fault	
LED lights up green	**LED flashes red**	LED off	• Diagnostic event present. • CP has started with retentive configuration and waits for connection to the CPU	
LED lights up green	LED off	**LED lights up yellow**	Maintenance is demanded	
LED lights up green	**LED flashes red**	**LED lights up yellow**	Maintenance demanded and a diagnostic event present	
LED flashes green	**LED flashes red**	**LED flashes yellow**	• Module fault (LEDs flash synchronously) • Display during "Find device" action (flash test): All LEDs of the CP **flash for 3 seconds**.	

6.3.5 Status and error displays at the PN/IE interface

CPU: LED displays of the PN/IE interfaces (ports)

The LEDs on the module front in the "PN (LAN)" area show the current status of the interfaces for the configuration on PROFINET IO (or Industrial Ethernet).
Interface controller = PROFINET IO controller or Industrial Ethernet controller

LED display	Meaning
X1 ER/MT [1]	Interface controller at the interface X1 signals an error or maintenance required. [1]
■ **LED lights up yellow**	• One or more communication partners (e.g. IO devices) at this interface are signaling maintenance required.
☼ **LED flashes red** at 2 Hz	• One or more errors present for one or more communication partners (e.g. IO devices) at the interface.
X1 P1 R LINK/ACT [2]	Connection at the interface is active.
■ **LED lights up green**	• Connection exists between port of the PN/IE interface and a communication partner.
■ **LED lights up yellow** or ☼ LED flickers yellow	• Data is being sent or received via the port.
□ LED off	• No connection to the network • No connection between the port of the PN/IE interface and the communication partner. No data is currently being received/sent via the port.
☼ **LED flashes green** at 2 Hz for 3 seconds	The following LEDs also flash at 2 Hz for 3 seconds: **RUN/STOP; ER; MT** Display during flash test "Find device (let LEDs flash)" The flashing LED X_n P_n R LINK indicates the connection path to the Engineering Station.

[1] Also applies to interface X2: for "X2 ER/MT"

[2] Also applies to interface X1: for "X1 P2 R LINK/ACT", "X2 P1 R LINK/ACT", "X2 P2 R LINK/ACT"

CP: LED displays of the PN/IE interfaces (ports)

Each port has a two-color LED (green/yellow) to signal whether a connection exists, and data transmission is in progress:

- X1 P1 R LINK/ACT
- X1 P2 R LINK/ACT

The following table shows the meaning of the different color combinations of the LEDs Xn P1 and Xn P2.

LED (green)	LED (yellow)	Meaning for
□ LED off	□ LED off	• No connection to the network • No connection between port of the CP and the communication partner. No data is currently being received/sent via the port.
■ **LED lights up green**	□ LED off	The "participant flash test" is in progress.
■ **LED lights up green**	□ LED off	• Connection to the network available • Connection between port of the CP and there is a communication partner.
■ **LED lights up green**	☼ LED flickers yellow	Data is being sent or received via the port.

6.4 Service support

6.4.1 Maintenance

A regular maintenance of the modules is not necessary.

WARNING

Hazardous area - Zone 2

Before starting work, make sure that there is no explosive atmosphere and that the power supply is switched off.
It is not permitted to pull or plug modules or cables under voltage.

WARNING

Cleaning the enclosure

You may only clean the outer enclosure parts.

- **In the hazardous area - Zone 2**
  If you need to clean the product, use a dry ESD cleaning cloth (while adhering to ESD protection measures).
- **In the safe area (non-hazardous area)**
  If you need to clean the product, use a dry or damp cloth but not a wet cloth.
  Do not use any solvents.

6.4.2 Replacing IO device with configured port interconnections

IO devices can be easily replaced.

Requirements

- In engineering, the ports are interconnected at the PROFINET IO system.
  This configuration is loaded to the CPU.
- You are only replacing one device at a time. The neighboring devices are available.
- The configured preset networking is the same as the actual networking.
- The replacement device has been reset to factory settings before the swap.
  The device name does not need to be assigned (not before replacement, for example, via a PC station).

Procedure

- Replace a device.
  By using the neighborhood relationships, the IO controller determines the unnamed device (IO device) and transmits the name and the configuration to the device.

Result

The device can participate in the process.

More information

More information is available in the PCS neo online help and in the documentation SIMATIC; PROFINET System description (Page 203).

6.4.3 Effects of off/on, memory reset, reset

Effects on the CPU

You have the following options to switch the CPU operating mode:

- Switch the operating voltage off/on
- In engineering, control in the device cockpit using the online functions.
- Via the Reset button

Note

Reset button

The Reset button has the following functions:

- Force a restart of the CPU:
  Reset in runtime (write service data and forced RESTART) (Page 125)
- Resetting the station to factory settings
  Reset to factory settings (Page 129)

Below you will find a table with the differences depending on the executed actions:

The functions will STOP the user program.

Property	**RESTART (voltage off/on)**	**Forced RESTART (via the reset button)**	**Memory reset (via the reset button or online diagnostics)**	**Reset to factory settings (via the reset button)**
User program	Stops, is retained	Stops, is retained	Deleted	Deleted
Diagnostic buffer data	Retained	Retained	Retained	Deleted
Service data	Retained	Are currently being collected	Retained	Retained
Parameters of the PROFIBUS interface	Retained	Retained	Deleted	Deleted
Parameters of the PN/IE interfaces • Name (device name) • IP address • Subnet mask • Static SNMP parameters • Time • MRP parameter assignment	Retained	Retained	Retained	Deleted
MAC addresses	Retained	Retained	Retained	Retained
Effect on CPs	The configuration is transferred again when starting the CPU.		The configuration is deleted in the CPU. The parameters of the PN/IE interface are retained in CP 4163-1.	

Effects on the CP

Property	RESTART (voltage off/on)	Reset to factory settings (Via the reset button of the CPU - affects the entire station)
MAC addresses (CP 4163-1 only)	Retained	Retained
Parameters of the PN/IE interface (CP 4163-1 only) • Name (device name) • IP address • Subnet mask • Static SNMP parameters • MRP parameter assignment	Retained	Deleted
Parameters of the PROFIBUS (CP 4163-5 only)	Retained	Deleted
Service data	Retained	Deleted

6.4.4 Reset in runtime (write service data and forced RESTART)

If you need the service data (=> memory dump) from the current state of the CPU, you may actively write it into the memory of the CPU.

Procedure

Note

Force RESTART

Writing the service data and the RESTART cannot be forced in all states (e.g. not in startup, defect).

1. Open the front flap of the CPU.
2. Press the Reset button on the CPU with the thin, blunt object and keep it pressed for 5 seconds.
   - If the CPU detects the pressed reset button, it indicates this via the LEDs.
   - During the 5 seconds, the operating mode of the CPU remains unchanged.
   - If the button is released before 5 seconds elapse, then:
     The CPU indicates the current status via the LED displays.
     No service data is written and RESTART is not performed.
   - If the button remains pressed for at least 5 seconds, the LED displays on the CPU switch to the display for defective state (regular defect with RESTART).
     The CPU writes the current service data to the memory and writes the event W#16#4308 ("Memory reset started by switch setting") to the diagnostic buffer.
     After writing the service data, the CPU goes to STOP and the RESTART is performed automatically.

Table 6-4 LED sequence at forced RESTART of the CPU

LED displays				Meaning
No.	**RUN (green) /STOP (yellow) - Operating mode**	**ER (red) - ERROR**	**MT (yellow) - Maintenance**	
1	□ LED off	□ LED off	**LED flashes yellow** at 2 Hz	The operation of the reset key has been detected. (All other LEDs are off.) Press the reset button for 5 seconds.
2	■ **(STOP) LED lights up yellow**	**LED flashes red** at 2 Hz	**LED flashes yellow** at 2 Hz	Service data is being generated - Avoid switching off the CPU! **Wait a few minutes and check whether the display changes** (usually up to 10 minutes display no. 4)**.**
3	**(STOP) LED flashes yellow** at 2 Hz	**LED flashes red** at 2 Hz	**LED flashes yellow** at 2 Hz	**CTRL ER flashes red** at 2 Hz • The service data is available retentively. • A restart follows.
4	See "Table 6-2 LED display after switching on (booted) (Page 118)"			

See also

Status and error displays on the CPU (Page 116)

6.4.5 CPU memory reset

A memory reset of the CPU is only possible via the engineering.

Requirement

- The CPU is in STOP operating state.
- The CPU can be reached online via the engineering.
- The CPU is opened in the device cockpit.
  You can find information about this under engineering in the online help.

Procedure

Select "Memory reset".
You can find the relevant information under engineering in the online help.

Sequence in the CPU during memory reset

The following process takes place in the CPU:

- The CPU deletes the entire user program in the work memory.
- The CPU deletes the user program in the load memory.
- The parameters in the CPU are largely retained.
  Effects of off/on, memory reset, reset (Page 124)

Behavior of the LEDs

The LEDs behave as follows during the memory reset:

Table 6-5 LED sequence after power-on of the CPU (booting)

LED displays				**Meaning**
No.	**RUN (green) /STOP (yellow) - Operating mode**	**ER (red) - ERROR**	**MT (yellow) - Maintenance**	
1	□ LED off	□ LED off	□ LED off	Supply voltage switched on
2	■ **(STOP) LED lights up yellow**	☼ **LED flashes red** at 0.5 Hz	□ LED off	Starting
3	■ **(STOP) LED lights up yellow**	☼ **LED flashes red** at 2 Hz	□ LED off	Startup tests are being performed
4	■ **(STOP) LED lights up yellow**	■ **LED lights up red**	□ LED off	Startup tests are completed

LED displays				Meaning
No.	**RUN (green) /STOP (yellow) - Operating mode**	**ER (red) - ERROR**	**MT (yellow) - Maintenance**	
5	**(STOP) LED flashes yellow** at 2 Hz	**LED lights up red**	**LED flashes yellow** at 2 Hz	Firmware is being loaded
6	**(STOP) LED lights up yellow**	**LED lights up red**	**LED flashes yellow** at 2 Hz	Firmware is loaded
7	**(STOP) LED lights up yellow**	**LED lights up red**	**LED lights up yellow**	Boot process completed
8	LED off	LED off	LED off	System is starting
9	**(STOP) LED flashes yellow** at 0.5 Hz	LED off	LED off	Operating system is starting
10	**(STOP) LED lights up yellow**	LED off	LED off	Operating system running. The CPU is in STOP operating state.

6.4.6 CPU memory reset in case of defect

If a CPU indicates a defect and no online access is possible, you may try to fix the defect with a memory reset.
Perform the following on the CPU.

Procedure

1. Open the front flap of the CPU.
2. Press the Reset button on the CPU with the thin, blunt object and keep it pressed for 5 seconds.
   - If the CPU detects the pressed reset button, it indicates this via the LEDs.
   - During the 5 seconds, the operating mode of the CPU remains unchanged.
   - If the button is released before 5 seconds have elapsed, the following happens:
     The CPU displays the current status via the LED displays.
     The memory reset is not executed.
   - If the button is pressed for at least 5 seconds, the LED displays on the CPU change to the display for the memory reset operation.
     See Memory reset.

Table 6-6 LED sequence at forced RESTART of the CPU

LED displays				Meaning
No.	**RUN (green) /STOP (yellow) - Operating mode**	**ER (red) - ERROR**	**MT (yellow) - Maintenance**	
1	□ LED off	□ LED off	☼ **LED flashes yellow** at 2 Hz	The operation of the reset key has been detected. (All other LEDs are off.) Press the reset button for 5 seconds.
2	A memory reset of the CPU with restart is performed. The LED sequence corresponds to the LED sequence after switching on the CPU "CPU memory reset (Page 127)".			

See also

Status and error displays on the CPU (Page 116)

6.4.7 Reset to factory settings

Recommendation:

- Perform the reset of the CPU and the CPs to factory settings in a separate system or without process connections.
  It is not necessary to reset power supply modules (PS) and bus modules (BM).
- When you remove the CPU from the system and want to store it for future use:
  Perform the reset to factory settings before removing the CPU from the system.

Requirement

- The CPU can be accessed directly.
- The supply voltage at the power supply module is switched on.
- Tool:
  A thin, blunt object (diameter approx. 2.5 mm) to press the reset button.

Procedure

To reset a CPU to factory settings, follow these steps:

1. Open the front flap of the CPU and of the power supply module (with redundant power supply - both front flaps).
2. Switch off the power supply.
3. Press the Reset button on the CPU with the thin, blunt object and keep it pressed.
   Switch on the power supply and wait until you see the following LED pattern:

Table 6-7 LED sequence during the action "Reset to factory settings" of the CPU

LED displays				Meaning
No.	**RUN (green) /STOP (yellow) - Operating mode**	**ER (red) - ERROR**	**MT (yellow) - Maintenance**	
1	□ LED off	Does not matter	☼ **LED flashes yellow** at 0.5 Hz	Reset to factory settings was detected.
2	Does not matter	Does not matter	Does not matter	Release the Reset button. Service data is partially retained Avoid switching off the CPU! **Wait a few minutes and check whether the display changes** (usually up to 10 minutes)
3	Does not matter	Does not matter	Does not matter	The CPU reboots.
4	See "Table 6-2 LED display after switching on (booted) (Page 118)"			

Result

The CPU has been reset to factory settings and is in the STOP operating state.
The event "Reset to factory settings" is entered in the diagnostic buffer.

See also

Status and error displays on the CPU (Page 116)

6.4.8 Replacing components

Definition

Some modules can be pulled or plugged in "RUN" mode of the CPU.

Requirement

- Assembly with bus module
  Note: Not permitted in RUN when configured with U-connector.
- Compliance with specific conditions for the respective modules

Pulling or plugging

The conditions for removing or installing modules with the CPU in "RUN" mode are shown in the following table:

Module	Pulling and plugging	Conditions
Power supply	Yes	Only permitted with redundant power supply. Replace only one module (replace defective module) or plug in second module
CPU	No	-
System Expansion Card	No	-
CP	Yes	The respective network connection fails. This is especially important when the CP is the connection of the controller to the plant network.

6.4.9 Removing modules (uninstalling)

Introduction

Modules are removed using the same procedure for all modules.

NOTICE
Modules, bus modules or U-connectors can be damaged.
If you use force when removing modules, components can be damaged.
Removal takes place in the order of the steps listed below.

Note

Decommissioning

Decommission the device according to the applicable guidelines to prevent access by unauthorized persons to confidential data in the device memory.

- If possible, restore the factory settings on the module before you remove it.
- Remove or delete the System Expansion Card (SEC), if installed in the module.
- Remove or delete the SIMATIC Memory Card (SMC), if installed in the module.

Tool

To remove the modules, you need a screwdriver with a blade width of 4 mm.

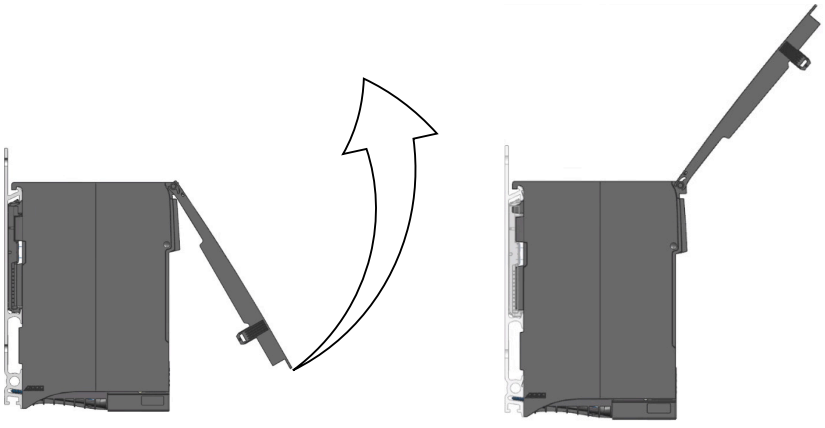
Requirement

The controller is de-energized.

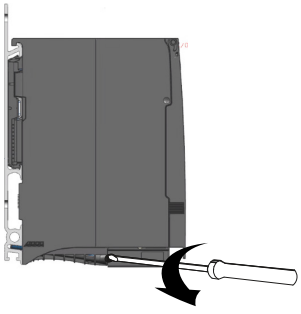
Removing modules

To remove modules, follow these steps:

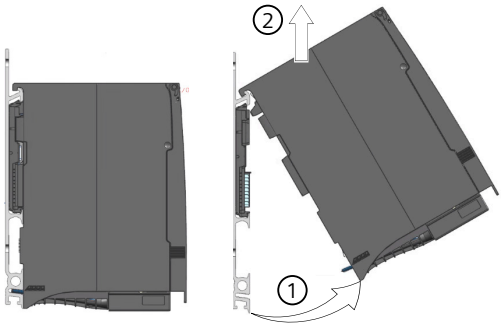
1. If cables are installed at the module, open the front flap and remove the cables.
   Open the front flap:
   - Power supply module:
     Disconnect the device plug.
   - CPU:
     Disconnect the existing network cables.
   - CP for PROFINET with PN/IE interface:
     Disconnect the RJ45 plug.
   - CP with PROFIBUS DP interface:
     Remove the D-sub 9-pin plug.



2. Disconnect the screwed joint of the module. Triple-width modules are fastened at the bottom with two screws.



3. Carefully move the module up ① and lift the module out of the mounting rail ②.



4. When mounting on a bus module:
   If a CP has been removed, the unused slot can be protected with a "Slot cover for S7-4100".
   Components for the rack configuration (Page 168)

6.4.10 Replacing a power supply module

Replacing a module

1. Open the front flap of the power supply module.
2. Set the on/off switch of the power supply module to position ⏻ (output voltage 0 V).
3. Switch the disconnector to "Off".
4. Unplug the device plug from the power supply module.
5. Loosen the fixing screws of the module.
6. Move the module from the bus module toward the bottom.
   Recommendation for tight spaces:
   - Move the module out toward the bottom.
   - Hold the module on both sides.
   - Remove the module toward the top.

Installing a new module

1. Place the new module (of the same type) on the rail and press it down into place.
2. Fasten the module with screws.
3. Open the front flap of the power supply module.
4. Check if the disconnector switch is in position "Off" and the on/off switch of the power supply module is in position ⏻.
5. Unplug the device plug that is not wired from the power supply module.
6. Plug the wired device plug of the plant into the power supply module.
   For information, see: Connecting the supply voltage (Page 95)

7. Switch the disconnector to "On".
8. Set the on/off switch of the power supply module to position I (output voltage to nominal value).
9. Close the front flaps of the modules.

Behavior after module replacement

When an error is present after the module replacement, the online diagnostics supports you in:

- Reading out the cause of the error from the diagnostics buffer
- Saving the service data.
  If an evaluation is required, contact an expert (Page 31) to assist you.

6.4.11 Reacting to overload at the power supply module

If an overload occurs, the red LED ER on the power supply module flashes.

Behavior

The power supply module tries to start up. If there is no short-circuit, the power supply module will first supply the CPU (in rack design with bus module - the bus module as well).

- Once the CPU has started up, it activates the CPs.
- If the maximum load is exceeded by switching on the CPs, the power supply switches off all modules. The power supply module continues to try to start up.
- If the load is too high, the power supply switches off.

Remedy

1. Switch off the controller.
2. Change the configuration.
   (For example, remove CPs one after the other; replace the CPU)
3. Switch on the controller.
4. Check the CPU status.

6.4.12 Replacing the CPU

Back up and restore project

After you have made all changes, you should create project versions and back up the project.

- Version a project
- Back up and restore project

You can find information about this under engineering in the online help.

Online diagnostics

The online diagnostics dialogs will show the current status or provide the service data saved in the CPU:

- Displaying the operating state
- Reading out the cause of the error from the diagnostic buffer
- The diagnostic functions allow you to save the service data. You can forward this data to experts for evaluation.

You can find information about this under engineering in the online help.

Delete data

Recommendation for decommissioning/storage/repair:

You should reset the CPU to factory settings in the following cases:

- When you want to store the module (e.g. as spare part)
- If an analysis of the data is not required, also before you repair the module (e.g. defective interface)

Note

Decommissioning

Prevent unauthorized access to data that is saved in the module.
Procedure:

- To this end, reset the device to its factory settings.
- Remove the System Expansion Card (SEC).
- If installed, remove or delete the SIMATIC Memory Card (SMC).

Note

Reset CPU to factory settings

The Reset button allows you to restore the factory settings.
Reset to factory settings (Page 129)

Requirement

CAUTION

Caution when replacing a CPU

If you are reusing a CPU that has been used before, note the following:

- Make sure that the loaded configuration cannot cause any dangerous plant states at the location of use.
- If you are not aware of possible effects of its previous use, restore the factory settings on the CPU.

Removing the CPU

1. Place the CPU into the STOP operating state.
2. Open the front flap of the CPU and the power supply module.
3. Set the on/off switch of the power supply module to position ⏻ (output voltage 0 V).
4. Remove existing bus cables (PROFINET IO/Industrial Ethernet and PROFIBUS DP).
5. Loosen the fastening screws of the CPU.
6. Move the CPU out of the assembly from below.
   Recommendation for tight spaces:
   - Move the module out toward the bottom.
   - Hold the module on both sides.
   - Remove the module toward the top.

Installing a new CPU

1. Place the new CPU of the same type on the rail and press it down into place.
2. Fasten the CPU with screws.
3. Open the front flap of the CPU and the power supply module.
4. Plug in the bus cables (PROFINET IO/Industrial Ethernet and PROFIBUS DP).
5. Set the on/off switch of the power supply module to position I (output voltage to nominal value).
6. Assigning the CPU to the controller in engineering.
   (Select the controller for the online actions in engineering.)
7. Download the configuration to the controller.
8. Check the CPU status.
9. Close the front flaps of the modules.

Behavior after module replacement

When an error is present after the module replacement, the online diagnostics supports you in:

- Checking the firmware
- Reading out the cause of the error from the diagnostic buffer
- Saving the service data. You can forward this data to experts for evaluation.
  Additional support (Page 31)

6.4.13 Replacing the System Expansion Card

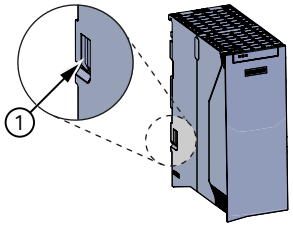
Note

Operation of the CPU is not possible without the SEC.

The SEC must be installed before you install the CPU. The slot for the SEC is located on the left of the CPU.

If no valid SEC is detected, the CPU will not start.

The figure shows the slot ① for the SEC is located on the left side of the CPU:



Requirements

- The CPU is de-energized.
- The CPU has been uninstalled.

Tool

Screwdriver 3-4 mm

Replacing the System Expansion Card

1. Place the screwdriver at the top end of the SEC slot and use the screwdriver to pry out the SEC.
2. Insert the new SEC.

6.4.14 Replacing a CP

Note
Only for configuration with U-connector
Controller must be set to STOP.

Removing the CP

1. Only when configured with U-connector:
   - Open the front flap of the power supply module.
   - Set the on/off switch of the power supply module to position ⏻ (output voltage 0 V).
2. Open the front flap of the CP.
3. Remove existing bus cables (PROFINET IO/Industrial Ethernet or PROFIBUS DP).
4. Loosen the fastening screw of the CP.
5. Move the CP out of the assembly from below.
   Recommendation for tight spaces:
   - Move the module out toward the bottom.
   - Hold the module on both sides.
   - Remove the module toward the top.

Installing a new CP

1. Place the new CP of the same type on the rail and press it down into place.
2. Fasten the CP with screws.
3. Open the front flap of the CP.
4. Plug in the bus cables (PROFINET IO/Industrial Ethernet or PROFIBUS DP).
5. Only when configured with U-connector:
   Set the on/off switch of the power supply module to position I (output voltage to nominal value).
6. Close the front flaps of the modules.

Behavior after module replacement

When an error is present after the module replacement, the online diagnostics supports you in:

- Reading out the cause of the error from the diagnostic buffer
- Saving the service data. You can forward this data to experts for evaluation.
  Additional support (Page 31)

Technical specifications

7

7.1 General technical specifications

7.1.1 Electromagnetic compatibility

Introduction

In this section, you can find information on the interference immunity of the modules of the SIMATIC S7-4100 controller and on RFI suppression.

The controller meets the requirements of the applicable European standards with all components, provided they are mounted in compliance with all relevant regulations.

Definition "EMC"

Electromagnetic Compatibility (EMC) is the ability of an electronic device to exist in an electromagnetic environment without causing interference to or being interfered with by other electronic devices within that environment.

⚠ WARNING
Injuries and damage to property may occur
The installation of add-ons that are not approved for the controller may violate the requirements and regulations for safety and electromagnetic compatibility.
Only use add-ons that are approved for the system.

Pulse disturbance variables

The following table shows the electromagnetic compatibility of the modules regarding pulse disturbance variables. The prerequisite is that the actual controller assembly meets the guidelines and directives for the electrical configuration.

Table 7-1 Pulse disturbance variables

Pulse disturbance variable	Test voltage		Corresponds to severity level
Electrostatic discharge according to IEC 61000-4-2	Air discharge: Contact discharge:	±8 kV ±6 kV	3
Burst pulses (fast transient disturbance variables) according to IEC 61000-4-4	2 kV (power supply cable) 2 kV (signal cable > 30 m) 1 kV (signal cable < 30 m)		3

Pulse disturbance variable	Test voltage	Corresponds to severity level
High-energy single pulse (surge) according to IEC 61000-4-5		3
• Asymmetric coupling	2 kV (supply cable) direct voltage with protective elements 2 kV (signal cable/data cable only > 30 m) with protective elements, if necessary	
• Symmetric coupling	1 kV (supply cable) direct voltage with protective elements 1 kV (signal cable only > 30 m) with protective elements, if necessary	

Sinusoidal disturbance variables

The following table shows the EMC behavior of the controller modules regarding sinusoidal disturbance variables.

Table 7-2 Sinusoidal disturbance variables

Sinusoidal disturbance variable	Test values	Corresponds to severity level
RF radiation (electromagnetic fields) according to IEC 61000-4-3 (Test disturbance variable according to NE 21:2017)	80 MHz up to 2.7 GHz 10 V/m with 80% amplitude modulation at 1 kHz 2.7 GHz up to 6 GHz 3 V/m with 80% amplitude modulation at 1 kHz	3
RF current feed on cables and cable shields according to IEC 61000-4-6	Test voltage 10 V with 80% amplitude modulation of 1 kHz in the range from 10 kHz to 80 MHz	3

Emission of radio frequency interference

Interference emission of electromagnetic fields according to EN 61000-6-4.

Interference emission via AC line voltage supply according to EN 61000-6-4.

Line harmonic distortions

The AC power supply modules of the controller meet the requirements of the following standards with regard to line harmonic distortions:

Harmonic currents: EN 61000-3-2

Voltage supply deviations and flickers: EN 61000-3-3

Additional measures

When you connect the controller to the public low-voltage network, you must ensure **Class B limits according to EN 55032.**

Take any additional measures if you need to increase the interference immunity of the system due to high external interference levels.

7.1.2 Transport and storage conditions

Transport and storage of modules

The modules of the SIMATIC S7-4100 controller surpass the requirements of IEC 61131-2 with regard to transport and storage conditions. The following information applies to modules that are transported or stored in their original packaging.

The climatic conditions meet the requirements of IEC 60721-3-3, class 3K7 for storage and IEC 60721-3-2, class 2K4 for transport.

The mechanical conditions meet the requirements of IEC 60721-3-2, class 2M2.

Table 7-3 Transport and storage conditions for modules

	Permitted range
Free-fall	≤ 1 m (up to 10 kg)
Temperature	-25 °C to +70 °C
Air pressure	1080 to 533 hPa (corresponds to an elevation of -1000 to 5000 m)
Relative humidity (at +25 °C)	5 to 95%, without condensation
Sinusoidal oscillations according to IEC 60068-2-6	5 - 9 Hz: 3.5 mm 9 - 500 Hz: 9.8 m/s^2
Shock according to IEC 60068-2-29	250 m/s^2, 6 ms, 1000 shocks

7.1.3 Mechanical and climatic ambient conditions for operation

Rated conditions

The SIMATIC S7-4100 controller is intended for stationary use in weather-protected locations. The controller meets the rated conditions according to the following standard:
DIN IEC 60721-3-3

- Class 3M3 (mechanical requirements)
- Class 3K3 (climatic ambient conditions)

Use with additional measures

It is not permitted to use the controller without additional measures, for example:

- At locations with a high degree of ionizing radiation
- At locations with difficult operating conditions, for example, caused by:
  - Dust formation
  - Corrosive vapors or gases
  - Strong electric or magnetic fields
- In installations requiring special monitoring, for example:
  - Elevators
  - Electrical plants in potentially hazardous areas

An additional measure can be, for example, the installation of the controller in a cabinet or an enclosure.

Mechanical ambient conditions

The mechanical ambient conditions for controller modules are specified in the following table in the form of sinusoidal vibrations.

Table 7-4 Mechanical ambient conditions

Frequency range in Hz	Test values
10 ≤ f < 58	0.075 mm amplitude
58 ≤ f < 500	1 g constant acceleration

Reduction of vibrations

When the controller is exposed to stronger shocks or vibrations, you must reduce the acceleration or the amplitude by using suitable measures.

We recommend installing the controller on damping materials (e.g. on rubber-bonded metals).

Tests for mechanical ambient conditions

The following table provides information about the type and scope of tests for mechanical ambient conditions.

Table 7-5 Test for mechanical ambient conditions

Testing for ...	Test standard	Comments
Vibrations	Vibration (sine) tested according to: IEC 60068-2-6	Type of vibration: Frequency sweeps with a slew rate of 1 octave/minute. 10 Hz ≤ f < 58 Hz, constant amplitude 0.075 mm 58 Hz ≤ f < 500 Hz, constant acceleration 1 g Vibration period: 10 frequency sweeps per axis in each of the three axes perpendicular to each other.
Shock	Shock test according to: IEC 60068-2-29	Type of shock: Half-sine Severity of shock: 10 g peak value, 6 ms duration Shock direction: 100 shocks in each of the three axes perpendicular to each other.

Climatic ambient conditions

The controller may be used under the following climatic ambient conditions:

Table 7-6 Climatic ambient conditions

Ambient conditions	Permitted range	Comment
Temperature	from -25 °C to 70 °C Note: No freezing	Note any load-dependent limitations. Relevant information is available in the documentation of the component in use. Dry heat tested according to: DIN EN / IEC 60068-2-2
Temperature change	Max. 10 °C/h	
Relative humidity	From 10 to 95% Max. 95% at +25 °C	Without condensation, corresponds to a relative humidity (RH) stress level 2 according to: EN / IEC 61131-2 Damp heat tested according to: EN / IEC 60068-2-78
Air pressure	Air pressure • from 1080 hPa (corresponds to an elevation of ca. -1000 m) • with PS 4160-SA: Up to 784 hPa (corresponds to an elevation of ca. 2000 m) • with PS 4160-SD: Up to 533 hPa (corresponds to an elevation of ca. 5000 m)	The density of air decreases with height. The potential cooling effect of air according to the height is shown in the Derating section: Derating depending on the height above mean sea level (Page 147)

Ambient conditions	Permitted range	Comment
Pollutant concentration	SO_2: < 0.5 ppm; RH < 60%, no condensation H_2S: < 0.1 ppm; RH < 60%, no condensation	Test: 10 ppm; 10 days Test: 1 ppm; 10 days
	ISA-S71.04 severity level G1; G2; G3	-

7.1.4 Derating depending on the height above mean sea level

The cooling effect of air decreases at greater heights due to the lower density.

The table shows the derating factor for the maximum permissible ambient temperature depending on the use of the devices at the height above mean sea level (German NHN).

Height above mean sea level [1]	Derating factor for ambient temperature [2]	Permitted
(-1000 m) to 2000 m	1.0	70 °C
3000 m	0.9	63 °C
4000 m	0.8	56 °C
5000 m	0.7	49 °C

1) When using the power supply module PS 4160-SA, the controller is only approved for an altitude of up to 2000 m. Starting from an altitude of 2000 m, only the power supply module PS 4160-SD is permitted.

2) Referring to the maximum permissible ambient temperature in °C for 2000 m.

7.1.5 Information on insulation tests, protection class and degree of protection

Test voltages

The insulation strength is, where required, verified during the routine test with test voltages according to IEC 61131-2.

Protection class

The device PS 4160-SD 6DL4160-2SD01-0XX0 (DC) has protection class III according to IEC 61140, which means a protective conductor connection is required at the power supply module.

The device PS 4160-SA 6DL4160-2SA01-0XX0 (AC & DC) has protection class I according to IEC 61140, which means a protective conductor connection is required at the power supply module.

Foreign matter and water protection

IP20 degree of protection according to IEC 60529, i.e. protection from contact with standard test fingers.

There is no protection that prevents water from entering.

7.2 Technical specifications of subcomponents of the controller

7.2.1 Rack design

7.2.1.1 Components for the rack configuration

Introduction

The following components have the following tasks:

- Mechanical housing of the components
- The electrical connection is made via the bus module or U-connector.

Design

Table 7-7 Components for the rack configuration

Type	Article number	Description
DIN Rail 4160-P18	**6DL4160-1PP00-0XX0**	19" mounting rail for S7-4100 Suitable for mounting a rack with 2 bus modules (2x9 slots)
DIN Rail 4160-P9	**6DL4160-1PF00-0XX0**	9.5" mounting rail for S7-4100 Suitable for mounting a rack with 1 bus module (1x9 slots)
Bus module	**6DL4160-1BF01-0XX0**	Bus module for quick mounting of the S7-4100 and redundant power supply
U-connector	**6ES7590-0AA00-0AA0**	S7-1500 U-connector

Dimensions

Information on the dimensions:

Mounting rail dimensions (Page 171)

- DIN Rail 4160-P18
  This 19" mounting rail for S7-4100 is made of aluminum and includes no other components.
- DIN Rail 4160-P9
  This 9.5" mounting rail for S7-4100 is made of aluminum and includes no other components.

Example for the design with bus module

See "Dimension drawings - Rack design with bus module (Page 172)"

Technical specifications

Bus module

Article number	6DL4160-1BF01-0XX0
General information	
Firmware version	V1.0.0
Hardware configuration	
Slots	
• Grid size	25 mm
• Number of slots	9
– of which for CPU, max.	1
– of which for PS, max.	2
– of which for IO/CM/CP/TM, max.	5
Test commissioning functions	
Service data	
• can be read out	Yes
Degree and class of protection	
IP degree of protection	IP20
Standards, approvals, certificates	
CE mark	Yes
UKCA mark	Yes
CSA approval	Yes
UL approval	Yes
RCM (formerly C-TICK)	Yes
EAC (formerly Gost-R)	No
Use in hazardous areas	
• ATEX	ATEX II 3G Ex ec IIC T4 Gc
• IECEx	Yes
Ambient conditions	
Ambient temperature during operation	
• min.	-25 °C; No condensation
• max.	70 °C
Ambient temperature during storage/transportation	
• min.	-40 °C; No condensation
• max.	70 °C
Altitude during operation relating to sea level	
• Installation altitude above sea level, max.	5 000 m; Restrictions for installation altitudes > 2 000 m, see manual
Resistance	
Usage in industrial process technology	
– Environmental conditions for process, measuring and control systems acc. to ANSI/ISA-71.04	Yes

Article number	6DL4160-1BF01-0XX0
Dimensions	
Width	213 mm
Height	100 mm
Depth	13 mm
Weights	
Weight, approx.	200 g

U-connector

UL/CSA note

Special requirements are in place for areas requiring UL/CSA approval; these may be met, for example, by installation in a cabinet.

7.2.2 Power supply module (PS)

7.2.2.1 Shared properties of the power supply modules

Tasks of the power supply modules

The power supply modules provide the other modules with system voltage. Depending on the configuration, the system voltage is transferred via the bus module or the U-connectors.

Shared properties of all power supply modules

In addition to their particular technical specifications, the power supply modules share the following properties:

- Assembly in encapsulated design for use in the controller
- Heat dissipation through self-convection
- Device plug for connecting the supply voltage with voltage-dependent coding
- Limitation of the inrush current according to NAMUR recommendation NE 21
- Short-circuit proof output
- The power supply modules can bridge a supply voltage failure for a duration of up to 20 ms
- Primary-clocked power supply

- Status displays (LEDs via the front flap)

  Note

  For installation of AC power supply modules, a disconnector must be installed upstream.

- The power supply modules support the following functions
  - Firmware update
  - Identification data: I&M0
  - Diagnostics

7.2.2.2 Power supply module PS 4160-SA

Article number

6DL4160-2SA01-0XX0

Function

The power supply module PS 4160-SA converts the supply voltage into the secondary-side, internal system voltage (15 V DC).

Supply voltage

The PS 4160-SA power supply module is designed for connection to a low voltage:

- Nominal value of the supply voltage: 120 V/230 V
- Tolerance range of the supply voltage:
  - AC voltage: 85 V to 264 V
  - DC voltage: 88 V to 300 V

The device plug is coded as an AC device plug.

Polarity reversal of L+ and L-

Polarity reversal of L+ and L- is permitted for the DC power supply.

Degree of pollution

The power supply is approved up to pollution degree 2.

Technical specifications of the PS 4160-SA

Article number	6DL4160-2SA01-0XX0
General information	
Firmware version	V1.0.0
Product function	
• SysLog	Yes
Supply voltage	
Rated value (DC)	120 V / 230 V
Rated value (AC)	120/230 V, 50/60 Hz
Short-circuit protection	Yes
Line frequency	
• permissible range, lower limit	47 Hz
• permissible range, upper limit	63 Hz
Mains buffering	
• Mains/voltage failure stored energy time	20 ms
• Repeat rate, min.	1/s
• Mains buffering according to NAMUR recommendation	Yes
Input current	
Rated value at 120 V DC	360 mA; Maximum
Rated value at 230 V DC	210 mA; Maximum
Rated value at 120 V AC	670 mA; Maximum
Rated value at 230 V AC	430 mA; Maximum
Output current	
Short-circuit protection	Yes
Power	
Infeed power to the backplane bus	30 W
Power loss	
Power loss, typ.	7 W; Maximum value
Interrupts/diagnostics/status information	
Diagnostics indication LED	
• RUN/STOP LED	Yes
• ERROR LED	Yes
• MAINT LED	Yes
Potential separation	
primary/secondary	Yes
Isolation	
Isolation tested with	2 000 V DC (routine test)
Overvoltage category	2
EMC	
Interference immunity against voltage surge	
• Interference immunity on supply lines acc. to IEC 61000-4-5	Yes; ±1 kV (acc. to IEC 61000-4-5; 1995; surge symm.), ±2 kV (acc. to IEC 61000-4-5; 1995; surge asymm.), no external protective circuit required

Article number	6DL4160-2SA01-0XX0
Compliance with line harmonic distortion limits	
• Compliance with line harmonic distortion acc. to IEC 61000-3-2, IEC 61000-3-3	Yes
Degree and class of protection	
IP degree of protection	IP20
Equipment protection class	I, with protective conductor
Standards, approvals, certificates	
CE mark	Yes
UKCA mark	Yes
CSA approval	Yes
UL approval	Yes
FM approval	Yes
RCM (formerly C-TICK)	Yes
KC approval	Yes
EAC (formerly Gost-R)	No
CCC	Yes
Use in hazardous areas	
• ATEX	ATEX II 3G Ex ec IIC T4 Gc
• IECEx	No
Ambient conditions	
Ambient temperature during operation	
• min.	-25 °C; No condensation
• max.	70 °C
Ambient temperature during storage/transportation	
• min.	-40 °C; No condensation
• max.	70 °C
Altitude during operation relating to sea level	
• Installation altitude above sea level, max.	2 000 m
Resistance	
Usage in industrial process technology	
– Environmental conditions for process, measuring and control systems acc. to ANSI/ISA-71.04	Yes
connection method / header	
Design of electrical connection	3x 1.5 mm², solid or stranded wire with end sleeve, external diameter 3 mm to 9 mm
Dimensions	
Width	25 mm
Height	203 mm
Depth	150 mm
Weights	
Weight, approx.	390 g

7.2.2.3 Power supply module PS 4160-SD

Article number

6DL4160-2SD01-0XX0

Function

The power supply module PS 4160-SD converts the supply voltage into the secondary-side, internal system voltage (15 V DC).

Supply voltage

The PS 4160-SD power supply module is designed for connection to a functional extra low voltage.

Direct voltage: U_{rated}= 24 VDC +-20% (⎓)

The device plug is coded as a DC connector.

Polarity reversal of L+ and L-

The PS 4160-SD power supply module is protected against reverse polarity of the supply voltage.

Degree of pollution

The module is approved up to pollution degree 2.

Technical specifications of the PS 4160-SD

Article number	6DL4160-2SD01-0XX0
General information	
Firmware version	V1.0.0
Product function	
• SysLog	Yes
Supply voltage	
Rated value (DC)	24 V
Reverse polarity protection	Yes
Short-circuit protection	Yes
Mains buffering	
• Mains/voltage failure stored energy time	20 ms
• Repeat rate, min.	1/s
• Mains buffering according to NAMUR recommendation	Yes
Input current	
Rated value at 24 V DC	1.7 A; Maximum
Output current	
Short-circuit protection	Yes
Power	
Infeed power to the backplane bus	30 W
Power loss	
Power loss, typ.	7 W; Maximum value
Interrupts/diagnostics/status information	
Diagnostics indication LED	
• RUN/STOP LED	Yes
• ERROR LED	Yes
• MAINT LED	Yes
Potential separation	
primary/secondary	Yes
Isolation	
Isolation tested with	700 V DC (routine test)
Overvoltage category	1
EMC	
Interference immunity against voltage surge	
• Interference immunity on supply lines acc. to IEC 61000-4-5	Yes; ±1 kV (acc. to IEC 61000-4-5; 1995; surge symm.), ±2 kV (acc. to IEC 61000-4-5; 1995; surge asymm.), no external protective circuit required
Compliance with line harmonic distortion limits	
• Compliance with line harmonic distortion acc. to IEC 61000-3-2, IEC 61000-3-3	Yes
Degree and class of protection	
IP degree of protection	IP20
Equipment protection class	PELV

Article number	**6DL4160-2SD01-0XX0**
Standards, approvals, certificates	
CE mark	Yes
UKCA mark	Yes
CSA approval	Yes
UL approval	Yes
RCM (formerly C-TICK)	Yes
EAC (formerly Gost-R)	No
Use in hazardous areas	
• ATEX	ATEX II 3G Ex ec IIC T4 Gc
• IECEx	Yes
Ambient conditions	
Ambient temperature during operation	
• min.	-25 °C; No condensation
• max.	70 °C
Ambient temperature during storage/transportation	
• min.	-40 °C; No condensation
• max.	70 °C
Altitude during operation relating to sea level	
• Installation altitude above sea level, max.	5 000 m; Restrictions for installation altitudes > 2 000 m, see manual
Resistance	
Usage in industrial process technology	
– Environmental conditions for process, measuring and control systems acc. to ANSI/ISA-71.04	Yes
connection method / header	
Design of electrical connection	2x 1.5 mm^2, solid or stranded with wire end sleeve, outer diameter 3 mm to 9 mm
Dimensions	
Width	25 mm
Height	203 mm
Depth	150 mm
Weights	
Weight, approx.	390 g

Standards and approvals

8

8.1 Overview

Introduction

In this section, you can find the technical specifications of the SIMATIC S7-4100 controller:

- The standards and test values that the controller complies with and meets.
- The test criteria by which the controller has been tested.

Technical specifications of the components

The technical specifications of the individual components are provided in the documentation for the relevant components. If the information in this document differs from that in the component-specific documentation, the information in the component-specific documentation has precedence.

Information on the nameplate

NOTICE
Markings and approvals In the documentation, you can find the markings and approvals which are generally possible or planned in the system. However, it is always and exclusively the marking and approval on the nameplate of the respective product that is valid.

⚠ WARNING

Open type equipment

Death, serious injuries or considerable damage to property can occur.

The device components are open type equipment, which means the following must be ensured:

- This device must only be operated installed in enclosures, cabinets or electrical operation rooms inside a building.
- The enclosures, cabinets or electrical operation rooms ensure protection from electric shock and prevent the spread of fire. The requirements for mechanical strength have been observed.
- The enclosure, cabinet or electrical operating rooms can only be accessed with a key or tool.
- The personnel have been trained accordingly or granted access permission.

For use in hazardous areas of Zone 2 (FM conditions / Hazardous Location Class I, Division 2, Groups A, B, C or D; Class I, Zone 2, Group IIC), the SIMATIC S7-4100 controller must be installed in an enclosure.

- Requirements on the enclosure:
  at least IP54 according to EN 60529

⚠ WARNING

Personal injury and damage to property can occur

Note the following information for use in hazardous areas:

- Personal injury and damage to property may occur if you disconnect the power supply during operation. Always ensure that the SIMATIC S7-4100 controller has been de-energized before disconnecting the supply voltage.

Hazardous area zone 2

Applicable markings and approvals are currently based on an altitude of up to 2000 m.

Standards and approvals for communications processors of the SIMATIC S7-4100 controller

The relevant information is available in the following documentation:

- SIMATIC S7-4100, PROFINET CP 4163-1 (Page 202)
- SIMATIC S7-4100, PROFIBUS CP 4163-5 (Page 202)

Declarations of Conformity and certificates on the internet

You can find the Declarations of Conformity and product certificates listed below on the internet at the following address:

Certificates (https://support.industry.siemens.com/cs/ww/en/ps/cert)

You can find the declarations of conformity for download on the Customer Support website under the keyword "Declaration of Conformity".

Information on the standards taken into account can be found in the respective certificate or Declaration of Conformity.

8.2 CE marking

SIMATIC S7 4100 meets the general and safety-related requirements of the following EU directives and conforms to the harmonized European standards (EN) for programmable logic controllers published in the official gazettes of the European Union (EU):

- 2014/35/EU (Low-Voltage Directive)
- 2014/30/EU (EMC)
- 2014/34/EU (ATEX explosion protection directive)
- 2011/65/EU (RoHS)

You can find the EU Declarations of Conformity for download on the internet (keyword "Declaration of Conformity").

See also

Certificates (https://support.industry.siemens.com/cs/ww/en/ps/15334/cert)

8.3 Low-Voltage Directive

2014/35/EU "Electrical equipment designed for use within certain voltage limits" (Low-Voltage Directive)
The components of the SIMATIC S7-4100 controller that fall under the Low-Voltage Directive have been tested according to the requirements of EN 61010-2-201.

8.4 EMC Directive

2014/30/EU "Electromagnetic Compatibility" (EMC Directive)

SIMATIC products are designed for operation in industrial areas.

Table 8-1 Use in industrial areas

Area of application	Requirement on interference emission	Requirement on immunity
Industry	DIN EN IEC 61000-6-4: 2020	DIN EN IEC 61000-6-2: 2019

Use in residential areas

Note

The SIMATIC S7-4100 controller is intended for use in industrial areas. When used in residential areas, it can affect radio/television reception.

If you use the SIMATIC S7-4100 controller in residential areas, you must ensure compliance with the radio frequency interference emission limits according to EN IEC 61000-6-3.

Suitable measures for achieving RF interference level Class B include, for example:

- Installation of the controller in grounded cabinets/switch boxes
- Use of filters in supply lines

Use in power plants

The controller meets the EMC requirements according to EN IEC 61000-6-5.

8.5 ATEX Directive

According to EN IEC 60079-7

Hazardous areas - Part 7: Equipment protection by increased safety "e" (IEC 60079-7:2015/A1:2017)

and

Hazardous areas - Part 0: Equipment - General requirements (IEC 60079-0:2017/COR1:2020)

(Electrical apparatus for potentially explosive atmospheres; Type of protection "n") and EN IEC 60079-0 (Electrical apparatus for explosive gas atmospheres - Part 0: General requirements)

II 3 G Ex ec IIC T4 Gc

8.6 RoHs directive

2011/65/EU "Directive 2011/65/EU of the European Parliament and of the Council of June 8, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment" (RoHS)
The components of the SIMATIC S7-4100 controller have been developed and produced in accordance with the requirements of **2011/65/EU**.

8.7 UKCA marking for the United Kingdom

The modules conform to the equipment and protective systems intended for use in hazardous areas in accordance with the following regulation:
UKSI 2016 No. 1107

UKCA

Importer UK:

Siemens plc

Manchester M20 2UR

8.8 Marking for Australia and New Zealand

The S7-4100 controller meets the requirements of the standard EN IEC 61000-6-4.

8.9 Explosion protection

ATEX - approval

Type Examination Certificate Number	**DEKRA 22ATEX0043X** **DEKRA 18ATEX0027X**	
Standards	EN IEC 60079-0	
	EN IEC 60079-7 + A1	
Marking		II 3 G Ex ec IIC T4 Gc
The certificate is valid for the "Certificates (https://support.industry.siemens.com/cs/ww/en/ps/cert)" products listed in the certificate.		

Special conditions

- The device may only be used in areas with a pollution degree of no more than 2 according to EN 60664-1.
- The modules must be set up in a suitable enclosure that guarantees at least IP54 degree of protection according to EN IEC 60079-7 taking into account the ambient conditions during use.
- Measures must be taken to prevent exceeding the rated voltage by more than 119 V of transient disturbance voltages.

IECEx - approval

Certificate number	**IECEx DEK 22.0026X** **IECEx DEK 18.0019X**
Standards	IEC 60079-0
	IEC 60079-7
Marking	Ex ec IIC T4 Gc
The certificate is valid for the "Certificates (https://support.industry.siemens.com/cs/ww/en/ps/cert)" products listed in the certificate.	

Special conditions

- The device may only be used in areas with a pollution degree of no more than 2 according to IEC 60664-1.
- The modules must be installed in a suitable enclosure which provides at least IP54 degree of protection in accordance with IEC 60079-7 and taking into account the ambient conditions of use.
- Measures must be taken to prevent exceeding the rated voltage by more than 119 V of transient disturbance voltages.

UKEx - approval

Certificate number	**DEKRA 22UKEX6004X** **DEKRA 21UKEX0003X**	
Standards	EN IEC 60079-0	
	EN IEC 60079-7 + A1	
Marking	Ex	II 3 G Ex ec IIC T4 Gc
The certificate is valid for the "Certificates (https://support.industry.siemens.com/cs/ww/en/ps/cert)" products listed in the certificate.		

Special conditions

- The device may only be used in areas with a pollution degree of no more than 2 according to EN 60664-1.
- The modules must be set up in a suitable enclosure that guarantees at least IP54 degree of protection according to EN IEC 60079-7 taking into account the ambient conditions during use.
- Measures must be taken to prevent exceeding the rated voltage by more than 119 V of transient disturbance voltages.

8.10 CCC approval

Table 8-2 China Compulsory Certification (CCC) approval

CCC approval	**2022323100485**5 **2022xxxxxxxxxxxxxx** **2022xxxxxxxxxxxxxx**
Classification	Ex ec IIC T4 Gc
Standards	GB 3836.1-2021 (Explosive atmospheres - Part 1: Equipment - General requirements)
	GB 3836.3-2021 (Explosive atmospheres - Part 3: Equipment protection by increased safety "e")

8.11 UL approval

cULus approval

Note

You can identify the cULus approvals that have been granted for your product by the markings on the nameplate.

Table 8-3 Underwriters Laboratories Inc. (UL) approval

cULus approval	**E 248953** **E 85972 – D1064**
Standards	UL 61010 (Industrial Control Equipment)
	CSA C22.2 No. 142 (Process Control Equipment)

or cUL approval, Hazardous Location

cULus Listed E248953 INT. CONT. EQ. FOR HAZ. LOC.

HAZ. LOC.

Table 8-4 Underwriters Laboratories Inc. (UL) approval

cULus approval	**E 223122**
Classification	Cl. 1, Div. 2, GP. A, B, C, D T4
	Cl. 1, Zone 2, GP. IIC T4
Standards	UL 61010 (Industrial Control Equipment)
	CSA C22.2 No. 142 (Process Control Equipment)
	ISA 12.12.01 (Hazardous Location)
	CSA-213 (Hazardous Location)

Observe the following notes.

Note

The system must be assembled according to the specifications of the NEC (National Electric Code).

When used in environments corresponding to Class I, Division 2 (see above), the SIMATIC S7-4100 controller must be installed in an enclosure with at least an IP54 rating according to EN 60529.

⚠ WARNING

Installation Instructions according cULus

WARNING – Explosion Hazard - Do not disconnect while circuit is live unless area is known to be non-hazardous.

WARNING – Explosion Hazard - Substitution of components may impair suitability for Class I, Division 2 or Class I, Zone 2

This equipment is suitable for use in Class I, Division 2, Groups A, B, C or D; Class I, Zone 2, Group IIC, or non-hazardous locations only.

Accessories and spare parts

9

9.1 Central processing unit (CPU)

CPU	Name	Article number
CPU 4168-H for S7-4100	CPU 4168-H	6DL4168-4FH04-3XX0

9.2 System Expansion Cards

Definition

The System Expansion Cards can be used with the following systems:

CPU type	Process control system
CPU 410-5H	• SIMATIC PCS 7 • SIMATIC PCS neo
CPU 4168-H	• SIMATIC PCS neo

System Expansion Cards

System Expansion Cards	Designation	Article number
SIMATIC PCS 7 System Expansion Card up to 100 Process Objects for PCS 7 CPU410-H	SEC 100 PO	6ES7653-2C**A00**-0XB0
SIMATIC PCS 7 System Expansion Card up to 500 Process Objects for PCS 7 CPU410-H	SEC 500 PO	6ES7653-2C**C00**-0XB0
SIMATIC PCS 7 System Expansion Card up to 1000 Process Objects for PCS 7 CPU410-H	SEC 1000 PO	6ES7653-2C**E00**-0XB0
SIMATIC PCS 7 System Expansion Card up to 1600 Process Objects for PCS 7 CPU410-H	SEC 1600 PO	6ES7653-2C**F00**-0XB0
SIMATIC PCS 7 System Expansion Card more than 2000 Process Objects for PCS 7 CPU410-H	SEC PO 2k+	6ES7653-2C**G00**-0XB0
CPU410 System Expansion Card up to 100 Process Objects including V10 Expansion for CPU 410-5H	SEC PO 100 & V10	6ES7653-2C**A02**-0XB0
CPU410 System Expansion Card up to 500 Process Objects including V10 Expansion for CPU 410-5H	SEC PO 500 & V10	6ES7653-2C**C02**-0XB0
CPU410 System Expansion Card up to 500 Process Objects including V10 Expansion for CPU 410-5H	SEC PO 1000 & V10	6ES7653-2C**E02**-0XB0
CPU410 System Expansion Card up to 1600 Process Objects including V10 Expansion for CPU 410-5H	SEC PO 1600 & V10	6ES7653-2C**F02**-0XB0
CPU410 System Expansion Card more than 2000 Process Objects including V10 Expansion for CPU 410-5H	SEC PO 2k+ & V10	6ES7653-2C**G02**-0XB0

9.3 Components for the rack configuration

A 19" rack is the typical mounting frame for the controller. The rack must be installed in a suitable environment:
Selection of cabinets (Page 59)

The mounting rails are suitable for the installation in 19" or $9^1/_2$" standard racks.

Rack component	Name	Article number
Mounting rail 482 mm for S7-4100	DIN Rail 4160-P18	6DL4160-1PP00-0XX0
Mounting rail 257 mm for S7-4100	DIN Rail 4160-P9	6DL4160-1PF00-0XX0
Bus module (BM) 9 slots for S7-4100 (with terminals for bus module for S7-4100 (2x))	BM 4160-B9	6DL4160-1BF01-0XX0
Slot cover for S7-4100 (5x)	SUPP 4160-COV	6DL4160-1NG00-0XX0
U-connector - Package with 5 units	U-CONNECTOR	6ES7590-0AA00-0AA0
Labeling strips for slots (slots 1 to 9)	LABEL 4160-P9	6DL4160-1EF00-0XX0

9.4 Power supply

Component	Name	Article number
Power supply module PS AC	PS 4160-SA	6DL4160-2SA01-0XX0
Power supply module PS DC 24 V	PS 4160-SD	6DL4160-2SD01-0XX0

9.5 Communication (CPs)

Communications processors	Name	Article number
CP 4163-1; Communications processor CP 4163-1 for connection of S7-4100 to PROFINET IO or Industrial Ethernet	CP 4163-1 for S7-4100	6DL4163-1EX00-0XE0
CP 4163-5; Communications processor CP 4163-5 for connection of S7-4100 to PROFIBUS DP	CP 4163-5 for S7-4100	6DL4163-5DX00-0XE0

9.6 Network components

Components for PROFINET IO/Industrial Ethernet - Connecting

Component	Name	Article number
Industrial Ethernet FC TP Standard Cable, GP 2x2 (PROFINET Type A), TP installation cable for connection to IE FC RJ45 2x2, for universal use, 4-wire, shielded CAT 5E, sold by the meter, delivery unit max. 4000 m, minimum order quantity 20 m	Ethernet FC TP Standard Cable, GP	6XV1840-2AH10
FastConnect RJ45 plug	FastConnect RJ45 Plug	6GK1901-1BB10-2AA0

Components for PROFIBUS DP - Connecting

Component	Name	Article number
PROFIBUS FC Standard Cable GP, bus cable 2-wire, shielded, special design for quick assembly, delivery unit: Sold by the meter, max. 1 000 m, minimum order quantity 20 m	PROFIBUS FC Standard Cable GP	6XV1830-0EH10
Bus connector plug SIMATIC DP, connection plug		6ES7972-0BA12-0XA0
Bus connector plug SIMATIC DP, connection plug		6ES7972-0BA52-0XA0
Bus connector plug SIMATIC DP, connection plug with socket (D-Sub19 - RS232)		6ES7972-0BB12-0XA0
Bus connector plug SIMATIC DP, connection plug with socket (D-Sub19 - RS232)		6ES7972-0BB52-0XB0

9.7 Complete SIMATIC S7-4100 controller systems

Complete systems	Name	Article number
Single controller based on S7-4100 (individual parts - set or ordered components)		6DL4166-1...

Appendix

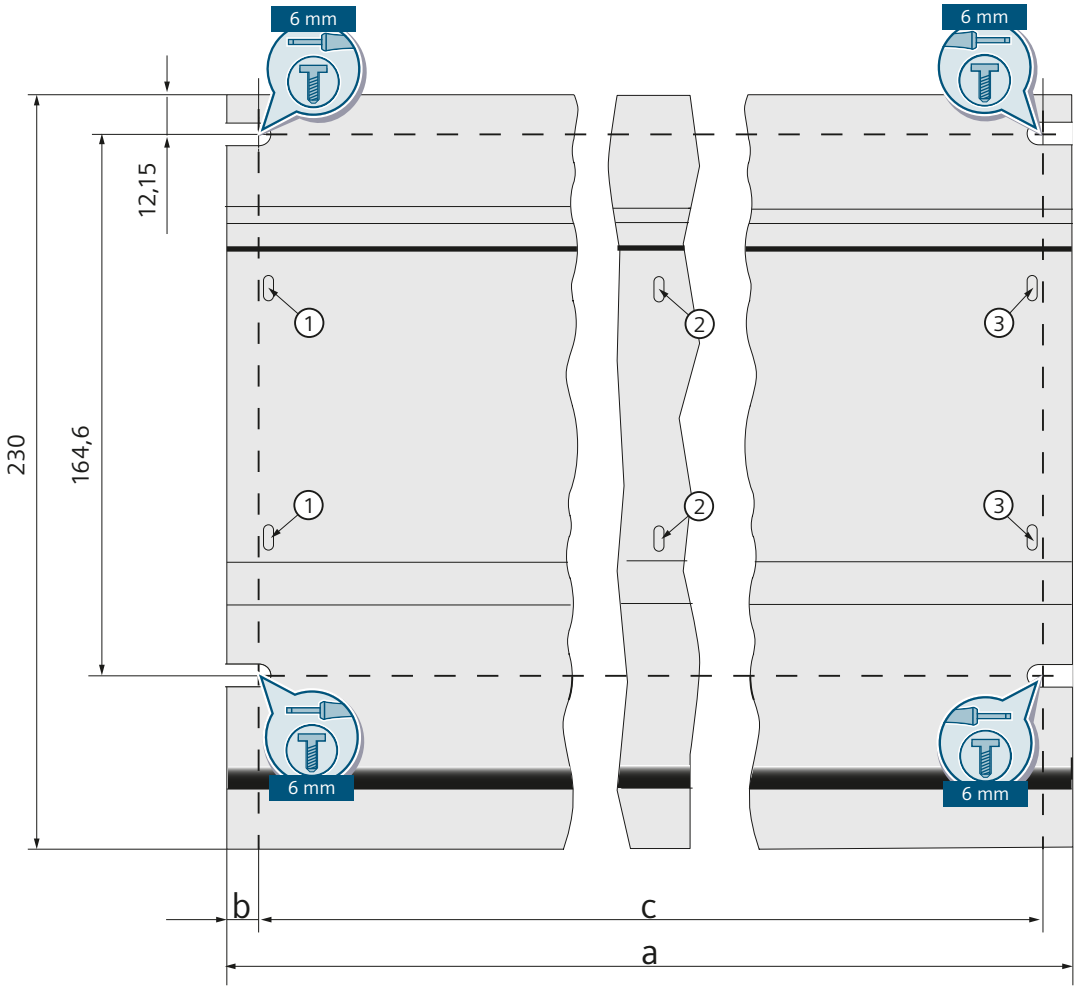
A

A.1 Dimension drawings

A.1.1 Mounting rail dimensions

The mounting rails are installed with screws in four locations (for dimensions, see figure below).

The cutouts are arranged so that they match the 19" standard.



Length of the mounting rail (a)	**Clearance (b)**	**Clearance (c)**	Positions of bus module terminals
258 mm	9.5 mm	239 mm	① left and ③ right
483 mm	9.5 mm	464 mm	① left, ② center and ③ right

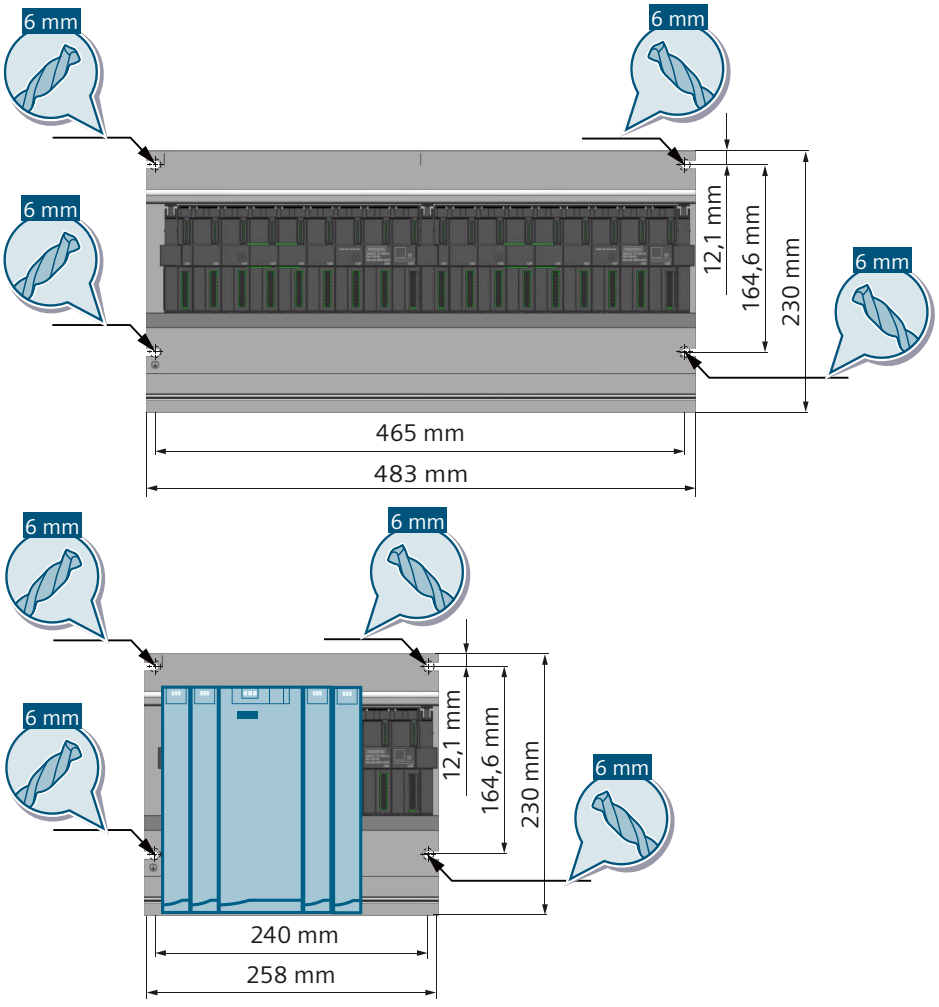
A.1.2 Dimension drawings - Rack design with bus module

The following figure provides an overview of the rack dimensions for 18 or 9 slots as well as the arrangement of cutouts for screw mounting.

The cutouts are arranged so that they match the 19" standard.

Mounting requires 4 screws each with a diameter of 6 mm.

Rack dimensions



A.1.3 Dimension drawing - Power supply module

Dimensions in dimension drawings given in millimeters.

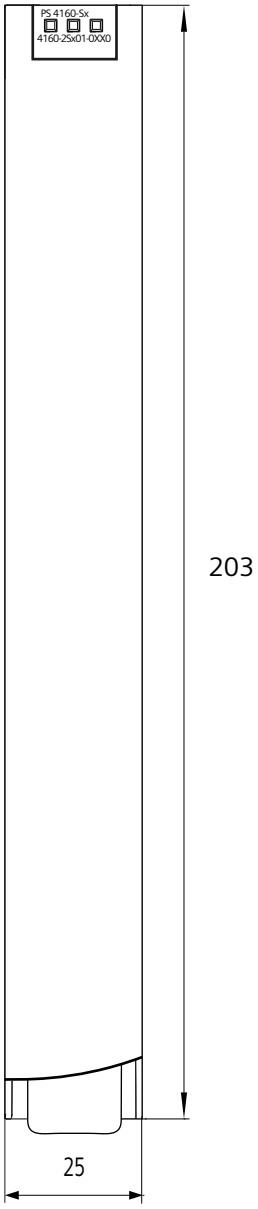


Figure A-1 Front view

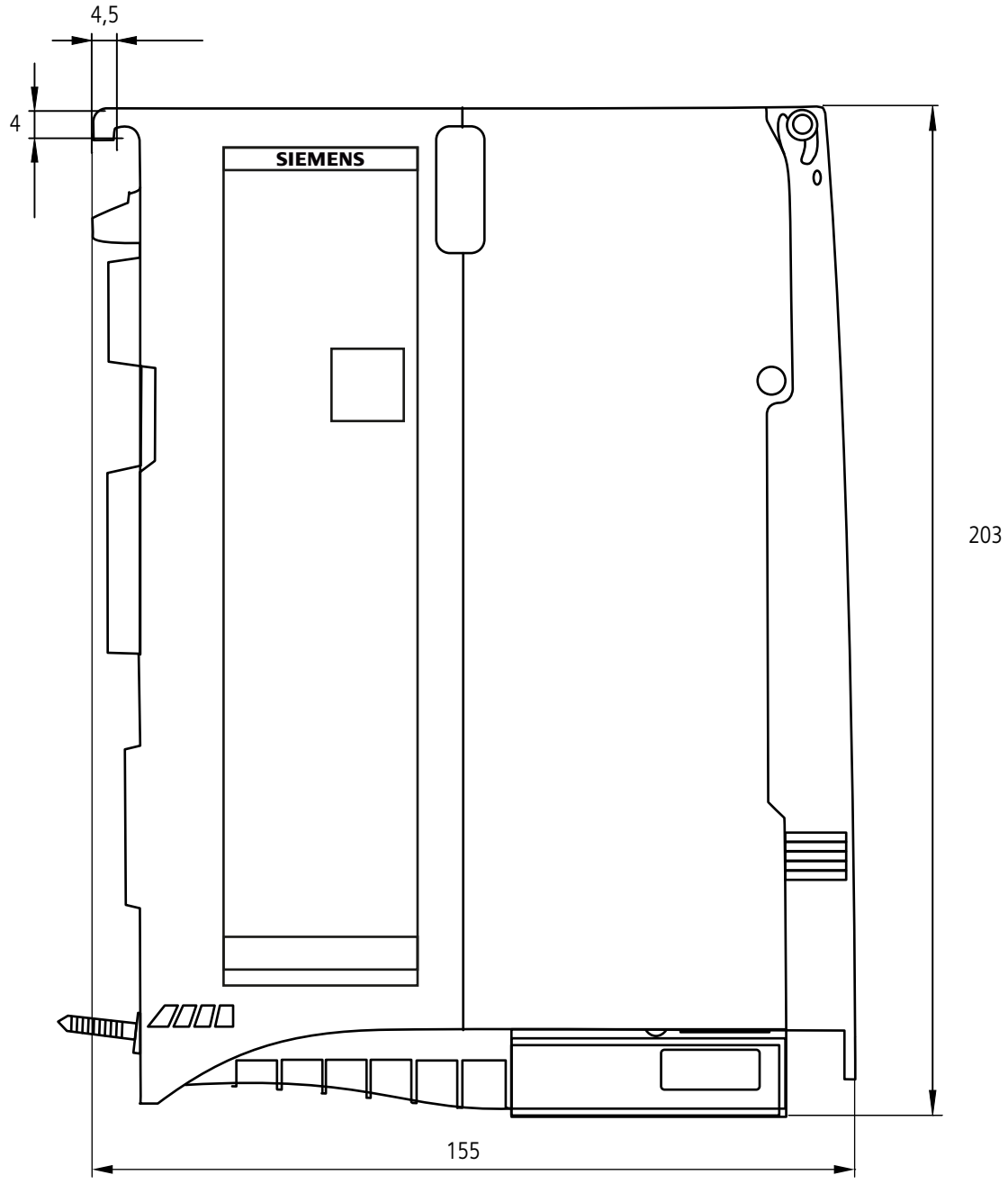
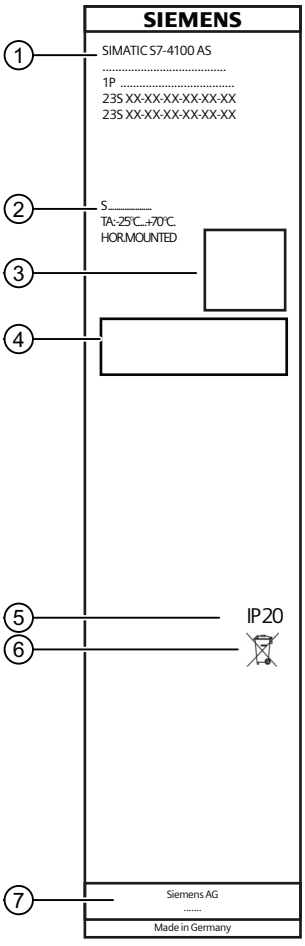


Figure A-2 Side view

A.1.4 Label

For the modules of the SIMATIC S7-4100 controller (PS, CPU, CP) you will find the label with the following information about the module:



①	• SIMATIC S7-4100	Product group
	• Product name	
	• 1P	Article number
	• 23S	MAC address of the 1st PN/IE interface (CPU and CP with PN/IE interface only)
	• 23S	MAC address of the 2nd PN/IE interface (CPU only)
②	• S	Information on the manufacturing time period
	• TA	Permissible ambient temperature Note the information in the system documentation: • Mechanical and climatic ambient conditions for operation • Derating
	• HOR.MOUNTED	Only horizontal installation permissible.
③	Digital nameplate (QR code on the front) (Page 12)	
④	International symbols for use and handling	
⑤	Degrees of protection from enclosure according to EN 60529 (VDE 0470): IP20	
⑥	Reference to suitability for recycling Repairs (Page 30)	
⑦	Manufacturer: Siemens AG and production site	

Note

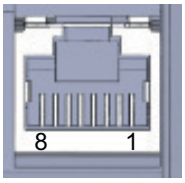
How to find the label

For all modules, the label is on the right side. In the installed state, the label is only visible on the module inserted furthest to the right.

A.2 Interface assignment

A.2.1 Assignment of the PN/IE interfaces (RJ45 socket)

The table shows the terminal assignment of the PN/IE interface. The pin assignment of the RJ45 sockets is designed according to IEEE 802.3.

View of an RJ45 socket	Pin	Signal name	Assignment
	1	Rx+	Receive Data +
	2	Rx-	Receive Data -
	3	Tx+	Transmit Data +
	4	-	-
	5	-	-
	6	Tx-	Transmit Data -
	7	-	-
	8	-	-

A.2.2 Assignment of the connection plug for PROFIBUS DP (D-sub DE-9)

9-pin D-sub female connector for PROFIBUS (used with IE/PB Link)

Pin no.	Signal name	PROFIBUS name	Used with RS-485
1	PI	Protective earth	yes
2	-	-	-
3	RxD/TxD-P	Data line B	yes
4	RTS (AG)	Control A	-
5	M5V2	Data reference potential	yes
6	P5V2	Supply plus	yes
7	BATT	-	-
8	RxD/TxD-N	Data line A	yes
9	-	-	-

A.2.3 Connections on the slot and the module

Definition

The connections on the slot and module of the SIMATIC S7-4100 controller connect the respective modules to one another.

The connections on the modules are the same.

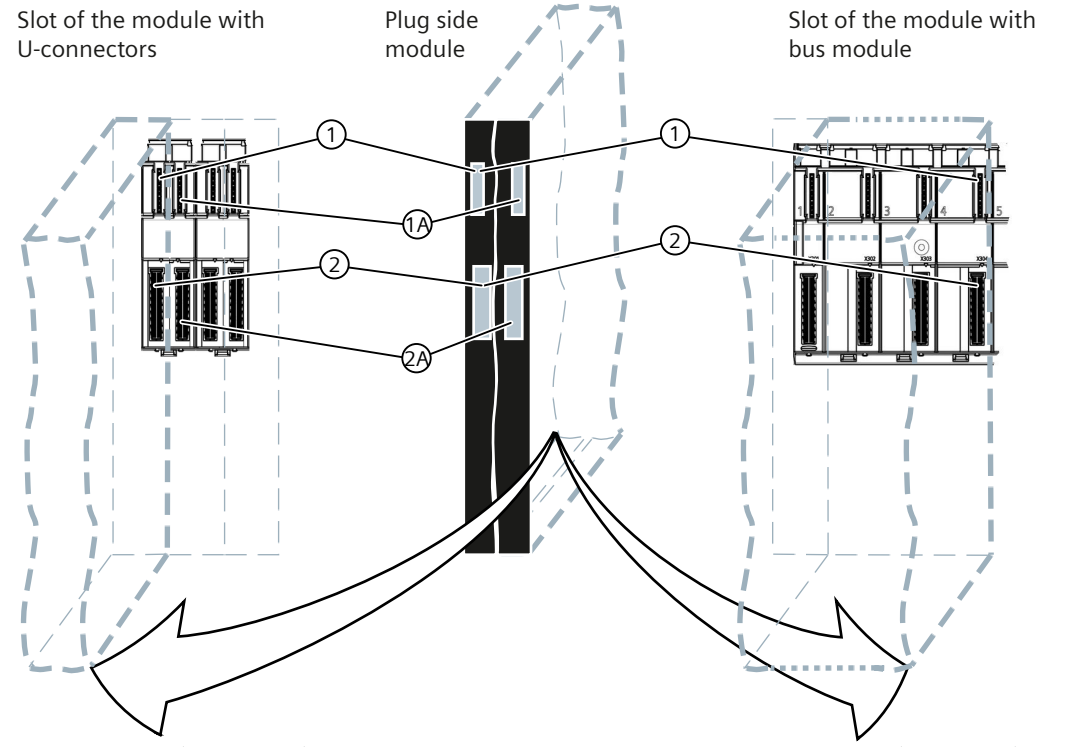
Description

WARNING

Dangerous system conditions

Access to the contacts of the bus module, a U-connector or a module is not permitted.
Ensure the following:
- When using a bus module, unused slots must be protected by slot covers.
- When using U-connectors, it is not permitted to plug an unused U-connector into the last module of the station.

The connections on the slot and the module are displayed as follows:



Example: Module (simple width)

Example: Module (3-fold width) CPU

1	Slot contacts of the bus module or contacts of 2 U-connectors. Maximum voltages and currents can be found in the technical data of the power supply module. Power supply module (PS) (Page 151)
2	Slot contacts of the bus module or contacts of 2 U-connectors. Slot contacts of the backplane bus (max. 3.0 A; 15 V DC ⎓)
1A / 2A	Slot contacts for forwarding via U-connector (see also 1 and 2)

A.3 Configuration of plants

A.3.1 General rules and regulations for operating an automation system

General rules

Due to the many ways in which you can use an automation system, we can only list some of the basic rules for the electrical configuration in this section. At a minimum, you must observe these basic rules to ensure the smooth operation of an automation system.

Specific application

Observe the safety and accident prevention regulations that apply to specific applications, for example, the machinery directives.

EMERGENCY STOP devices

EMERGENCY STOP devices according to IEC 60204-1 (equivalent to VDE 0113-1) must remain in effect in all operating modes of the plant or system.

Behavior of the plant after specific events

The following table shows what you must observe in the behavior of your plant in case of specific events.

Event	Demand
Failure of the operating or supply voltage	No dangerous operating states may occur.
Tripping of the "Emergency Stop" device	No dangerous operating states may occur.
Return of the operating or supply voltage	No dangerous operating states may occur. There must be no uncontrolled or undefined starting of the system.
Starting after unlocking of the "Emergency Stop" device	No dangerous operating states may occur. There must be no uncontrolled or undefined starting of the system.

120/230 V AC supply

The following table shows which items you must observe when connecting an automation system to a 120/230 V alternating voltage network.

For ...	... you must ensure ...
Buildings	that appropriate lightning protection measures are present on the outside.
Supply cables and signal cables	that appropriate lightning protection measures are present on the inside and outside.

For ...	... you must ensure ...
Stationary plants or systems without all-pole disconnectors	that a disconnector unit (switch) is present in the building installation.
Power supply modules	that the configured rated voltage range corresponds to the local supply voltage.
All electric circuits of the automation system	that fluctuations/deviations of the supply voltage from the rated value are within the permissible tolerance (see technical specifications of the modules).
Residual current devices (residual current operated circuit breaker)	that the residual current operated circuit breaker matches the total leakage currents of the power supply modules.

24 V DC supply

The following table shows which items you must observe when connecting an automation system to a 24 V DC supply.

For ...	... you must ensure ...
Buildings	that appropriate lightning protection measures are present on the outside.
24 V DC supply cables and signal cables	that appropriate lightning protection measures are present on the inside and outside.
24 V supply	that the supply voltage is generated as an electrically separated extra-low-voltage.

Protection against external electrical influences

The following table shows you what you must observe for protection against electrical influences or faults.

For ...	... you must ensure ...
All plants or systems in which an automation system is installed	that the plant and all system parts for the discharge of electromagnetic interferences are properly connected to the protective earth.
Connection cables and signal cables	that all cables are routed and connected correctly.
Signal cables	that the break of a signal cable does not put the plant into an undefined state.

Protection from other external influences

The following table shows the additional external influences from which you must protect an automation system.

Protection from ...	... by means of ...
Unauthorized operation of the operator controls	suitable arrangement or covering of keyboards and operator controls or recessed arrangement of the operator controls.
Spray and splash water	appropriate protection elements or installation in waterproof enclosures.

Protection from ...	... by means of ...
Direct sunlight	appropriate shading or installation at a site protected from direct sunlight exposure.
Mechanical damage	appropriate safeguards, protection elements or installation in mechanically stable enclosures.

A.3.2 Principles of system installation for EMC

Definition: EMC

EMC (electromagnetic compatibility) is the ability of electrical equipment and systems to function adequately in a specified electromagnetic environment without being impacted by or impacting on its surroundings in an impermissible way.

Introduction

Even though the automation system and its components were designed for use in an industrial environment and meet high EMC requirements, you should conduct EMC planning prior to installing your controller, detect any potential sources of interference and make them part of your planning.

Potential interferences

Electromagnetic interference can impact the automation system in different ways:

- Electromagnetic fields with a direct effect on the system
- Interference that is introduced via bus signals (PROFIBUS DP, etc.)
- Interference that has an effect on the process wiring
- Interference that enters the system via the power supply and/or protective earth

The following figure shows the different paths of electromagnetic interference.

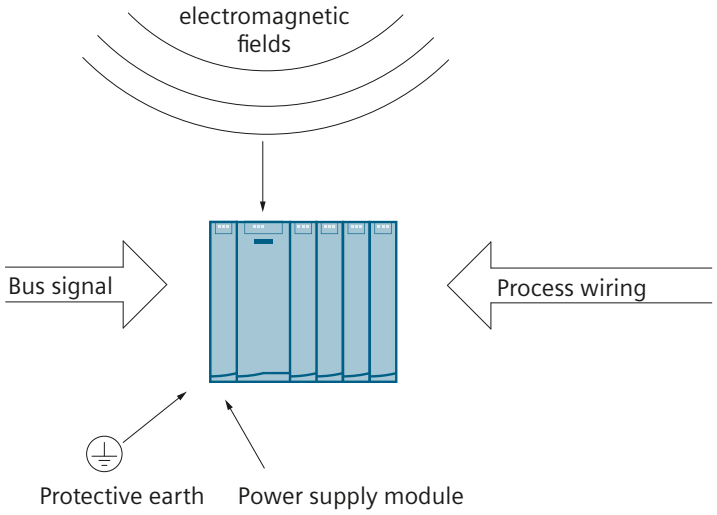


Figure A-3 The potential paths of electromagnetic interference

Coupling mechanisms

Depending on the propagation medium (conducted or without conductor) and the distance between source of interference and device, interference can enter the automation system by means of four different coupling mechanisms.

Coupling mechanism	Cause	Typical sources of interference
Galvanic coupling	Galvanic or metallic coupling occurs whenever two circuits share one cable.	• Clocked devices (network influenced through converter and third-party power supply units) • Starting motors • Different potential of component enclosures with shared power supply • Static discharge
Capacitive coupling	Capacitive or electrical coupling occurs between conductors that are on different potentials. The coupling is proportional to the change in voltage over time.	• Interference coupling through parallel signal cables • Static discharge of the operator • Contactors
Inductive coupling	Inductive or magnetic coupling occurs between two current-carrying conductor loops. The magnetic fields linked to the currents induce disturbance voltages. The coupling is proportional to the change in current over time.	• Transformers, motors, electric welders • Parallel network cables • Cables whose currents are switched • Signal cables with high frequency • Disconnected coils
Radiative coupling	Radiative coupling occurs when an electromagnetic wave encounters a set of conductors. The impact of the wave induces currents and voltages.	• Neighboring senders (e.g. walkie-talkies) • Spark gaps (spark plugs, electric motor collectors, welders)

Five basic rules to ensure EMC

In many cases, you can ensure EMC when you observe the following five basic rules.

Rule 1: Ground connection over a large area

When installing the programmable controllers, make sure that the inactive metal parts are connected to the ground over a large area.

- Connect all inactive metal parts over a large area and with low impedance to the ground.
- Use special contact washers for screwed connections on painted or anodized metal parts or remove the insulating protective layers at the contact points.
- If possible, do not use aluminum parts for ground connections. Aluminum is easily oxidized and therefore not very suitable for ground connections.
- Create a central connection between the ground and the ground electrode/protective bonding circuit.

Rule 2: Proper cable routing

Observe proper cable routing during wiring.

- Organize the cabling into conductor groups (high-voltage cables, power supply cables, signal cables, data cables).
- Always route high-voltage cables and signal or data cables in separate ducts or bundles.
- Install signal and data cables as close as possible to ground potential surfaces (e.g. support bars, metal rails, sheet metal).

Rule 3: Fastening of the cable shields

Ensure proper fastening of the cable shields.

- Only use shielded data cables. The shield must be connected to the ground at both ends over a large area.
- Analog cables must always be shielded. For signal transfer with low amplitudes, it may be beneficial when the shield is only connected to the ground on one side.
- Apply the cable shield directly after entering the cabinet or the enclosure over a large area on a shield/protective conductor rail or fasten it using a cable cleat. Continue routing the shield without interruption to the module but do not connect it to the ground again at the module.
- The connection between shield/protective conductor rail and cabinet/enclosure must be a low-impedance connection.
- Only use metallic or metalized connector enclosures for shielded data cables.

Rule 4: Special EMC measures

Use special EMC measures in special applications.

- Wire all inductances that are not controlled by modules of the automation system with suppressors.
- Use incandescent lamps or interference-suppressed fluorescent lamps for illumination purposes inside cabinets or enclosures close to your controller.

Rule 5: Uniform reference potential

Create a uniform reference potential and ground all electrical equipment, if possible.

- If potential differences exist or can be expected in your system between plant parts, you must install sufficiently large equipotential bonding conductors.
- Ensure the grounding measures are implemented effectively. The grounding of the controller is a protective and functional measure.
- Connect the plant units and the cabinets of the controller in star configuration with the grounding/protective conductor system. In this way, you prevent the formation of grounding loops.

A.3.3 Installation of automation systems avoiding EMC problems

Introduction

Measures for interference suppression are often not made until the controller is already in operation and it has been determined that the proper receipt of a useful signal is impaired.

These interferences are often caused by insufficient reference potentials that can be traced back to faults in the installation. This section provides you with information on how you can avoid such faults.

Inactive metal parts

Inactive parts are all electrically conductive parts that are electrically separated from active parts through basic insulation and can only receive an electric potential in case of a fault.

Installation and ground connection of inactive metal parts

When installing the automation system, connect all inactive metal parts over a large area to the ground. A properly conducted ground connection creates a uniform reference potential for the controller and reduces the effect of coupled interferences.

The ground connection establishes the electrically conducting connection of all inactive parts with each other. The totality of all inactive parts connected to one another is referred to as ground.

The ground must not have a dangerous touch potential even in case of a fault. The ground, therefore, must be connected to the protective conductor using adequate conductor cross-sections. To avoid ground loops, locally distanced ground constructions (cabinets, construction and machine parts) must always be connected to the protective bonding circuit in star topology.

Observe the following for the ground connection:

- Connect the inactive metal parts as carefully as the active metal parts.
- Make sure that the connections between metal parts have a low impedance (e.g. through contacting over a large area and with good conductivity).

- For painted or anodized metal parts, the insulating protection layer at the contact point must be pierced or removed. To do so, use special contact washers or completely scrape off the layer at the contact point.
- Protect the connection parts from corrosion (e.g. through appropriate grease)
- Connect moving grounding parts (e.g. cabinet doors) with flexible grounding braids. The grounding braids must be short and have a large surface (the surface is critical for discharge of high-frequency currents).

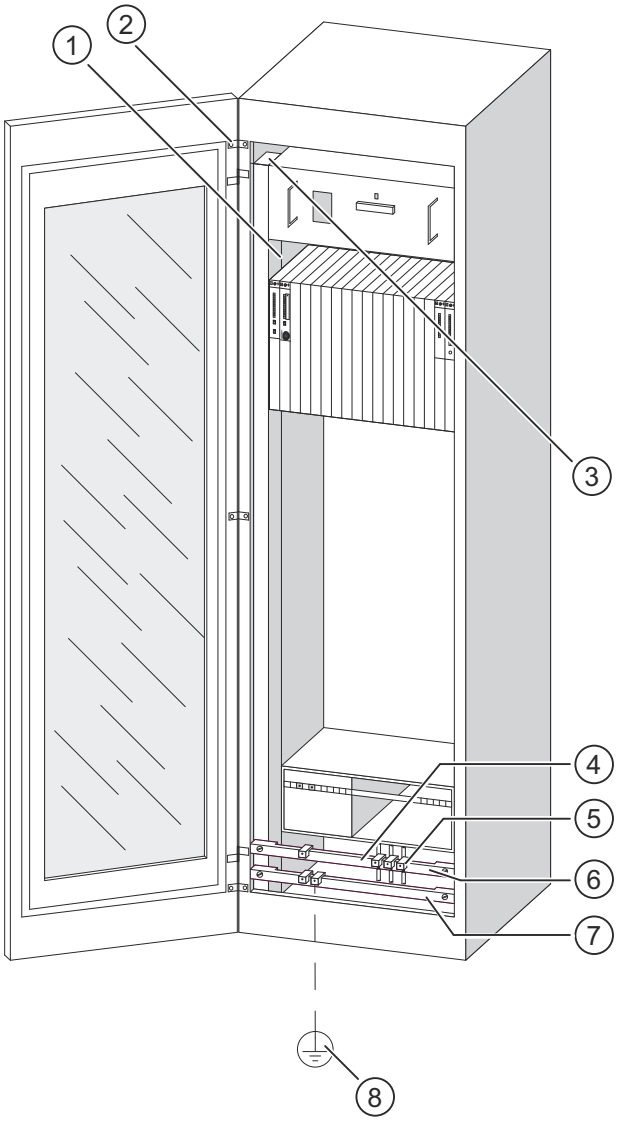
A.3.4 Examples of EMC-compatible assembly

Introduction

Below you will find two examples of EMC-compliant installation of automation systems.

Example 1: EMC-compliant cabinet design

The following figure shows a cabinet design in which the measures described above (ground connection of the inactive metal parts and connection of the cable shields) have been implemented. However, this example is only valid for grounded operation. Observe the points shown in the figure when assembling your system.



①	Grounding braids	If there are no metal-to-metal connections over large areas, you must connect inactive metal parts (e.g. cabinet doors or support plates) with each other using grounding braids or connect them to ground. Use short grounding braids with a large surface.
②	Support bars	Connect the support bars with the cabinet frame over a large area (metal-to-metal connection).
③	Fastening of the rack	A metal-to-metal connection over a large area must exist between support bar and rack.
④	Signal cables	Apply the shield of signal cables over a large area with cable cleats on the protective conductor rail or an additional shield rail.

⑤	Cable cleat	The cable cleat must cover a large area of the protective braided shield to ensure a good contact.
⑥	Shield rail	Connect the shield rail over a large area with the support bars (metal-to-metal connection). The cable shields are connected to the shield rail.
⑦	Protective conductor rail	Connect the protective conductor rail over a large area with the support bars (metal-to-metal connection). Connect the protective conductor rail with a separate cable (minimum conductor cross-section 10 mm^2) to the protective bonding circuit.
⑧	Cable to the protective bonding circuit (grounding point)	Connect the cable to the protective bonding circuit over a large area (grounding point).

Figure A-4 Example of an EMC-compliant cabinet design

Example 2: EMC-compliant wall mounting

When you operate the controller in a low-fault environment in which you adhere to the permitted ambient conditions, you can also mount the controller in frames or on the wall.

Coupled interferences must be discharged to large metal surfaces. Therefore, mount DIN rails, shield and protective conductor rails on metal construction parts. Assembly on reference potential areas made of sheet steel has proven particularly beneficial in wall mounting.

Install a shield rail for connection of the cable shields when you are laying shielded cables. The shield rail can also be used as a protective conductor rail.

Observe the following points for frame and wall mounting:

- Use special contact washers for painted and anodized metal parts or remove the insulating protection layers.
- When fastening the shield/protective conductor rail, create metal-to-metal connections over a large area with low impedance.
- Always cover mains wires so that they are protected from touch.

A.3.5 Shielding cables

Purpose of the shielding

A cable is shielded to reduce the effect of magnetic, electric and electromagnetic interference on this cable.

Operating principle

Fault currents on cable shields are discharged to ground via the conductive shield rail that is connected to the enclosure. To prevent these fault currents from turning into a source of interference themselves, a low-impedance connection to the protective conductor is especially important.

Suitable cables

If possible, use only cables with protective braided shield. The coverage of the shield should be at least 80%. Avoid cables with foil shield because the foil can be easily damaged by tensile and pressure loads, which would reduce the shielding effect.

Grounding of cable shields

NOTICE
Damage to property may occur. Cable shields are not suitable for equipotential bonding. Only use the equipotential bonding cables explicitly specified for this purpose. When setting up network connections, make sure that the equipotential bonding cables have an adequate cable cross-section; otherwise, the interface hardware can be damaged or even destroyed.

You should always connect the cable shields at both ends (that is, at the beginning and end of the cable) to ground. Only by connecting both ends of the shields will you achieve good noise suppression in the higher frequency range.

In exceptional cases, you can also connect the shield at only one end (that is, at the beginning or end of the cable) to ground. However, you will only be able to dampen the lower frequencies in this case. A one-sided shield connection can be advantageous when

- no equipotential bonding cable can be installed,
- analog signals (a few mA or µA) are being transferred,
- foil shields (static shields) are used.

Only use metallic or metalized connectors for data cables with serial coupling. Fasten the data cable shield on the connector enclosure. Do not connect the shield to pin 1 of the terminal strip.

For stationary operation, you should strip the insulation from the shielded cable and connect it to the shield/protective conductor rail.

Handling the shields

Observe the following items when handling the shield:

- Only use cable cleats made of metal to fasten the protective braided shields. The cleats must enclose the shield over a large area and ensure good contact.
- Apply the shield to a shield rail at the point where the cable enters the cabinet. Continue routing the shield to the module but do not connect it to the ground or the shield rail again at the module.
- For installation outside of cabinets (e.g. for wall mounting), you can also connect the cable shields to the cable duct.

The following figure shows a few options of how you can fasten shielded cables using cable cleats.

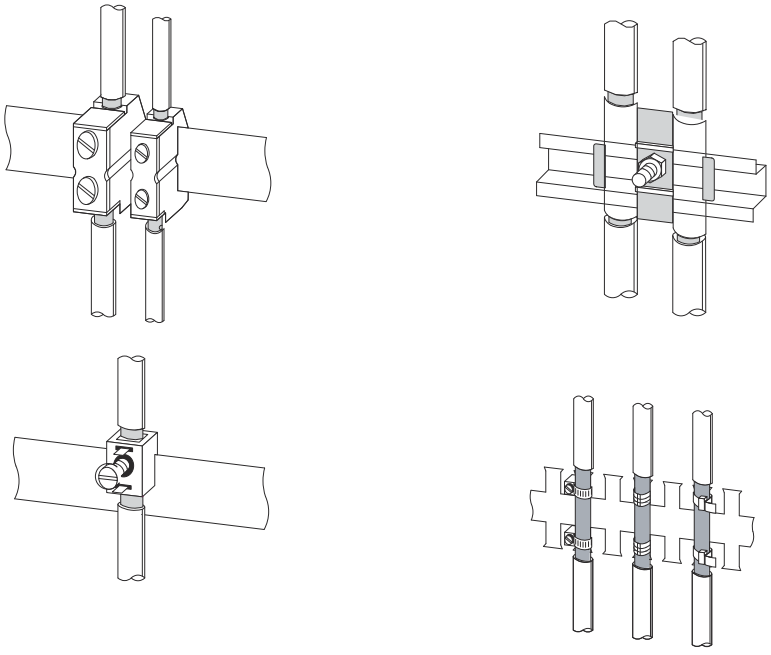


Figure A-5 Fastening of cable shields

A.3.6 Equipotential bonding

Potential differences

Potential differences may occur between separate parts of the plant that can result in high compensation currents, for example, when cable shields are connected at both ends and are grounded at different parts of the plant.

Potential differences can be caused by different grid infeeds.

NOTICE
Damage to property may occur. Cable shields are not suitable for equipotential bonding. Only use the equipotential bonding cables explicitly specified for this purpose (e.g. with a 16 mm² cross-section) When setting up network connections, make sure that the equipotential bonding cables have an adequate cable cross-section; otherwise, the interface hardware can be damaged or even destroyed.

Equipotential bonding cable

You must reduce the potential differences by installing equipotential bonding cables to ensure fault-free operation of the electronic components.

Note the following points when using an equipotential bonding cable:

- The lower the impedance of the equipotential bonding cable, the greater the effectiveness of the equipotential bonding.
- If two parts of a plant are connected by shielded signal cables whose shields are connected at both ends to the ground/protective conductor, the impedance of the equipotential bonding cable installed in addition must not exceed 10% of the shield impedance.
- The cross-section of an equipotential bonding cable must be dimensioned for the maximum equalizing current. In practice, equipotential bonding cables with a cross-section of 16 mm² seem to be best suited for the task.
- Use equipotential bonding cables made of copper or tin-plated steel. Connect the cables to the ground/protective conductor over a large area and protect the contacts from corrosion.
- Install the equipotential bonding cable so that the area between the equipotential bonding cable and signal cables is as small as possible (see figure).

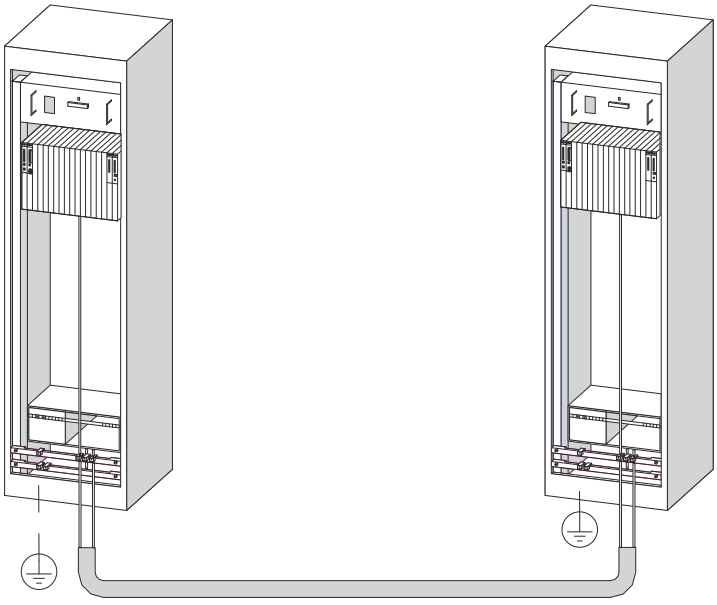


Figure A-6 Installation of equipotential bonding cable and signal cable

A.3.7 Cabling inside buildings

Introduction

For EMC-compliant routing of cables in buildings (inside and outside of cabinets), you must observe clearances between different groups of cables. The following table provides information on general clearances when selecting cables.

How to read the table

1. In column 1, look for the wire type of the first cable (cables for ...).
2. In the associated section of column 2, look for the wire type of the second cable (and cables for ...).
3. In column 3 (installing ...), read about the installation guidelines that must be observed.

Table A-1 Cable routing inside of buildings

Cables for ...	**and cables for ...**	**installing ...**
Bus signals, shielded (e.g. PROFIBUS) Data signals, shielded (PG, OP, printer, counting inputs, etc.) Analog signals, shielded Direct voltage (≤ 60 V), unshielded Process signals (≤ 25 V), shielded Alternating voltage (≤ 25 V), unshielded	Bus signals, shielded (e.g. PROFIBUS) Data signals, shielded (PG, OP, printer, counting inputs, etc.) Analog signals, shielded Direct voltage (≤ 60 V), unshielded Process signals (≤ 25 V), shielded Alternating voltage (≤ 25 V), unshielded	in shared bundles or cable ducts
	Direct voltage (> 60 V and ≤ 400 V), unshielded Alternating voltage (> 25 V and ≤ 400 V), unshielded	in separate bundles or cable ducts - Minimum clearance to fieldbus cables (e.g. PROFIBUS): 10 cm
Direct voltage (> 60 V and ≤ 400 V), unshielded Alternating voltage (> 25 V and ≤ 400 V), unshielded	Bus signals, shielded (e.g. PROFIBUS) Data signals, shielded (PG, OP, printer, count signals, etc.) Analog signals, shielded Direct voltage (≤ 60 V), unshielded Process signals (≤ 25 V), shielded Alternating voltage (≤ 25 V), unshielded	in separate bundles or cable ducts - Minimum clearance to fieldbus cables (e.g. PROFIBUS): 10 cm
	Direct voltage (> 60 V and ≤ 400 V), unshielded Alternating voltage (> 25 V and ≤ 400 V), unshielded	in shared bundles or cable ducts

Cables for ...	and cables for ...	installing ...
Direct and alternating voltage (> 400 V), unshielded	Bus signals, shielded (e.g. PROFIBUS) Data signals, shielded (PG, OP, printer, count signals, etc.) Analog signals, shielded Direct voltage (≤ 60 V), unshielded Process signals (≤ 25 V), shielded Alternating voltage (≤ 25 V), unshielded	**in cabinets:** in separate bundles or cable ducts - Minimum clearance to fieldbus cables (e.g. PROFIBUS): 20 cm **outside of cabinets:** on separate cable ducts with a minimum clearance of 20 cm
	Direct voltage (> 60 V and ≤ 400 V), unshielded Alternating voltage (> 25 V and ≤ 400 V), unshielded	
Industrial Ethernet, LAN (e.g. office network), PROFIBUS	Industrial Ethernet, LAN (e.g. office network), PROFIBUS	in shared bundles or cable ducts
	Other	in separate bundles or cable ducts with a minimum clearance of 50 cm

A.3.8 Cabling outside buildings

Rules for EMC-compliant cable routing

The same rules must be observed for EMC-compliant cable routing outside of buildings as for cable routing inside of buildings. Also in effect:

- Install cables on metallic cable holders
- Galvanically connect all cable holder joints
- Ground cable holders
- If necessary, provide sufficient equipotential bonding between the connected devices
- Implement lightning protection (internal and external lightning protection) and grounding measures if they apply to your application

Rules for lightning protection outside of buildings

Install your cables either

- in metal tubes grounded at both ends or
- in concrete cable ducts with reinforcement

Overvoltage protection devices

Lightning protection measures always require an individual consideration of the entire plant.

A.3.9 Lightning protection and overvoltage protection

A.3.9.1 Overview

Overvoltages

The most common causes of failure include overvoltages caused by:

- atmospheric discharges or
- electrostatic discharges.

Content

We will show you first what the theory of overvoltage protection is based on: the lightning protection zone concept.

You will then find rules for the transitions between the individual lightning protection zones.

Note

This section can only give you information on how to protect an **automation system** against overvoltages.

However, complete protection against overvoltages is only guaranteed if the entire surrounding building is designed to protect against overvoltages. This applies above all to structural measures on the building during construction planning.

We therefore recommend that if you want comprehensive information about protection against overvoltages, you contact your SIEMENS representative or a company that specializes in lightning protection.

A.3.9.2 Lightning protection zone concept

Principle of lightning protection zones concept according to IEC 61312-1/DIN VDE 0185 T103

The principle of the lightning protection zones concept states that the volume to be protected from overvoltages, for example, a manufacturing hall, is divided up into lightning protection zones according to EMC aspects (see following figure).

The individual lightning protection zones are formed by the following measures:

The external lightning protection of the building (field side)	Lightning protection zone 0
The protection of buildings	Lightning protection zone 1
The protection of rooms	Lightning protection zone 2
The protection of devices	Lightning protection zone 3

Effects of a lightning strike

Direct lightning strikes occur in lightning protection zone 0. The effects of the lightning strike are high-energy electromagnetic fields that must be reduced or dissipated from one lightning protection zone to the next through suitable lightning protection elements/measures.

Overvoltages

In the lightning protection zones 1 and higher, overvoltages can occur due to switching operations, injections, etc.

Diagram of the lightning protection zones

The following figure shows a diagram of the lightning protection zone concept for a free-standing building.

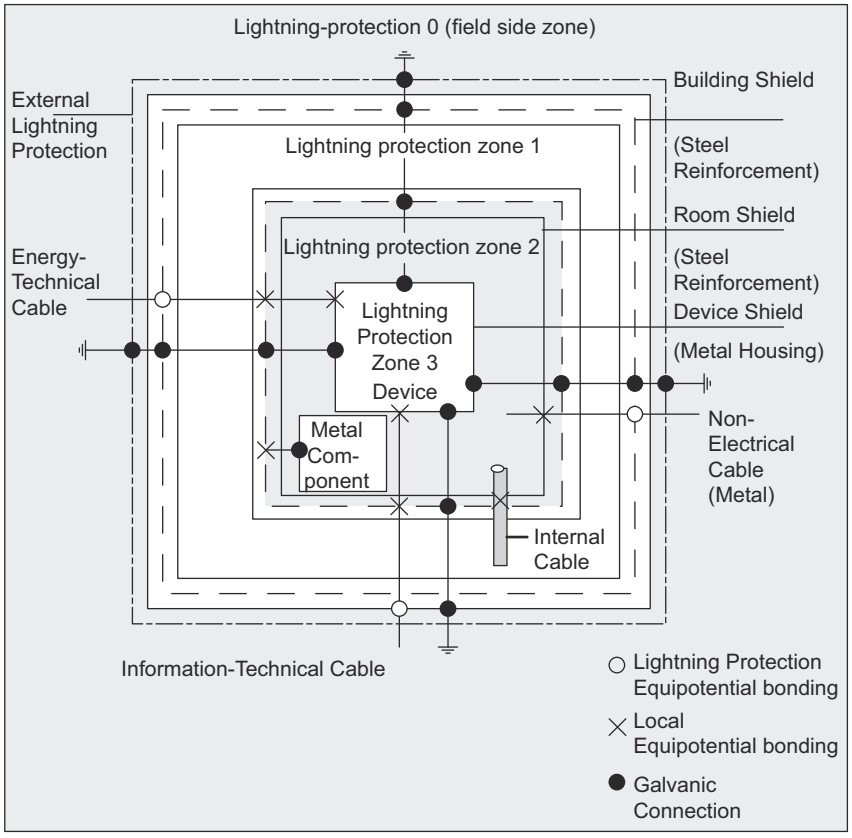


Figure A-7 Lightning protection zones of a building

Principle of the interfaces between lightning protection zones

You must implement measures at the interfaces between lightning protection zones that prevent the propagation of overvoltages.

The principle of the lightning protection zones concept also states that at the interfaces between the lightning protection zones, all cables that can carry lightning current (!) must be integrated into the equipotential bonding.

The following lines and cables can carry lightning current:

- Metal pipes (e.g. water, gas and heat)
- Power cables (e.g. line voltage, 24 V supply voltage)
- Data cables (e.g. bus cable).

A.3.9.3 Rules for the transition between lightning protection zones 0 and 1

Rules for the interface 0 <-> 1 (lightning protection equipotential bonding)

For the lightning protection equipotential bonding at the interface of lightning protection zone 0 <-> 1, the following measures can be used:

- Use metal strands or metal braids that are grounded at the beginning and end with spiral and current carrying capacity as cable shield, for example, NYCY or A2Y(K)Y.
- Install cables using one of these methods:
  - In metal pipes connected to each other and grounded at the beginning and end
  - In ducts made of reinforced concrete
  - In enclosed metal cable racks that are grounded at the beginning and end
- Use fiber-optic cables instead of metallic cables.

Additional measures

If you cannot implement the measures listed above, you must install primary protection at the interface 0 <-> 1 with a matching lightning arrester. The following table includes the components that you can use for primary protection of your system.

Table A-2 Primary protection of cables with overvoltage protection components

Seq. no.	Cables for ...	... connect at the interface 0 <-> 1 to:		Article number
1	Three-phase current TN-C system	1 unit	Lightning arrester DEHNbloc/3 Phase L1/L2/L3 to PEN	900 120*
	Three-phase current TN-S system	1 unit	Lightning arrester DEHNbloc/3 Phase L1/L2/L3 to PE	
		1 unit	Lightning arrester DEHNbloc/1 N to PE	900 222*
	Three-phase current TT system	1 unit	Lightning arrester DEHNbloc/3 Phase L1/L2/L3 to N	900 120*
		1 unit	N-PE lightning arrester DEHNgap B/n N to PE	961 102*
	Alternating current TN-S system	2 units	Lightning arrester DEHNbloc/1 Phase L1 + N to PE	900 222*
	Alternating current TN-C system	1 unit	Lightning arrester DEHNbloc/1 Phase L to PEN	
	Alternating current TT system	1 unit	Lightning arrester DEHNbloc/1 Phase to N	
		1 unit	N-PE lightning arrester DEHNgap B/n N to PE	961 102*
2	24 V DC power supply	1 unit	Blitzductor VT, Type A D 24 V -	918 422*
3	Bus cable, RS 232 (V.24)	1 unit	Lightning arrester Blitzductor CT Type B	919 506* and 919 510*
4	Power supply module 24 V DC	1 unit	Blitzductor VT, Type AD 24 V -	918 422* 900 222*
5	Power supply module 120/230 V AC	2 units	Lightning arrester DEHNbloc/1	900 222*

* You can order these parts directly from

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

A.3.9.4 Rules for the interfaces between lightning protection zones 1 <-> 2 and higher

Rules for the interfaces 1 <-> 2 and higher (local equipotential bonding)

For all lightning protection zone interfaces 1 <-> 2 and higher:

- Set up local equipotential bonding at each additional lightning protection zone interface.
- For all additional lightning protection zone interfaces, integrate all conductors (e.g. including metal pipes) into the local equipotential bonding.
- Integrate all metal installations within the lightning protection zone into the local equipotential bonding (e.g. metal part within lightning protection zone 2 to interface 1 <-> 2)

Additional measures

We recommend secondary protection for the following elements:

- All lightning protection zone interfaces 1 <-> 2 and higher
- All cables within a lightning protection zone that are longer than 100 m

Lightning protection element for the 24 V DC supply

You may only use the Blitzductor VT, Type AD 24 V SIMATIC for the 24 V DC power supply. All other overvoltage protection components do not meet the tolerance range of 20.4 V to 28.8 V of the power supply.

Secondary protection elements for 1 <-> 2

For the interfaces between the lightning protection zones 1 <-> 2 and higher, we recommend the overvoltage protection components listed in the table below.

Table A-3 Overvoltage protection components for lightning protection zones 1 <-> 2

Seq. no.	Cables for ...	... connect at the interface 1 <-> 2 to:		Article number
1	Three-phase current TN-C system	3 units	Surge arrester DEHNguard 275	952 070*
	Three-phase current TN-S system	4 units	Surge arrester DEHNguard 275	
	Three-phase current TT system	3 units	Surge arrester DEHNguard 275 Phase L1/L2/L3 to N	
		1 unit	N-PE surge arrester DEHNgap C N to PE	952 030*
	Alternating current TN-S system	2 units	Surge arrester DEHNguard 275	952 070*
	Alternating current TN-C system	1 unit	Surge arrester DEHNguard 275	
	Alternating current TT system	1 unit	Surge arrester DEHNguard 275 Phase L to N	
		1 unit	N-PE surge arrester DEHNgap C N to PE	952 030*
2	24 V DC supply	1 unit	Blitzductor VT Type AD 24 V	918 422*

Seq. no.	Cables for ...	... connect at the interface 1 <-> 2 to:		Article number
3	Bus cable			
* You can order these parts directly from DEHN + SÖHNE GmbH + Co. KG Elektrotechnische Fabrik Hans-Dehn-Str. 1 92318 Neumarkt, Germany				

A.3.9.5 Example protective circuit for a networked SIMATIC S7-4100 controller for protection from overvoltages

Example wiring

The following example shows you how to wire two automation systems connected to the grid to provide effective protection from overvoltages:

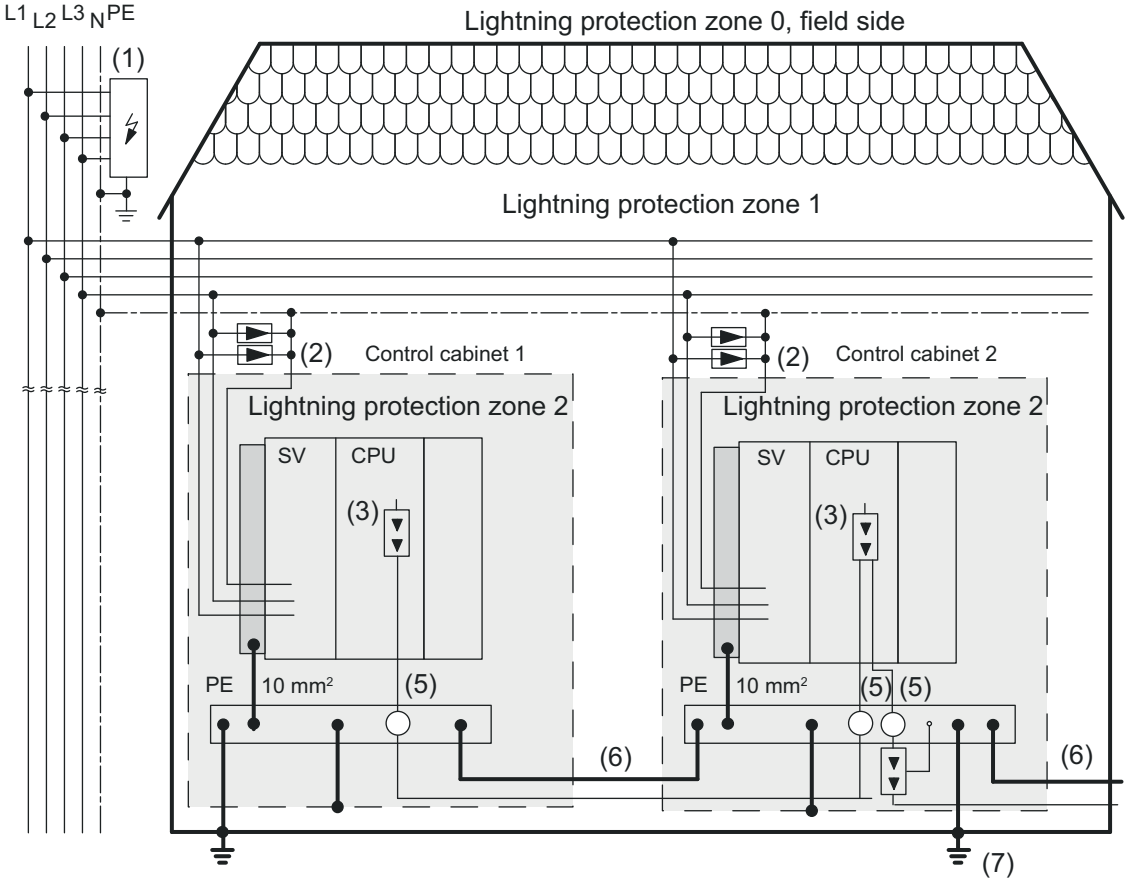


Figure A-8 Example for the wiring of automation systems connected to the grid

Table A-4 Legend for example wiring:

Seq. no. from figure	Component	Meaning
1	Lightning arrester, depending on grid systems, e.g. TN-S system: 1 unit DEHNbloc/3 article number: 900 120* and 1 unit DEHNbloc/1 article number: 900 222* Siemens: 5SD7414-1	Primary protection from direct lightning strikes and overvoltages starting at interface 0 <-> 1
2	Surge arrester, 2 units DEHNguard 275; article number: 952 070* Siemens: 5SD7463-0 or -1 (with fault indicator)	Primary protection from overvoltages at interface 1 <-> 2
3	Surge arrester, Blitzductor CT Type MD/HF article number: 920 300* and 920 370*	Secondary protection from overvoltage for RS 485 interface at interface 1 <> 2
5	Shield fastening for bus cable via EMC-spring-loaded terminal at the base part of the Blitzductor CT article number: 920 395*	Discharge of fault currents
6	Equipotential bonding cable 16 mm	Standardization of the reference potentials
7	Blitzductor CT, Type B for building transfer; article number: 920 300* and 920 370*	Primary protection from overvoltages for RS 485 interfaces at interface 0 <> 1
* You can order these parts directly from DEHN + SÖHNE GmbH + Co. KG Elektrotechnische Fabrik Hans-Dehn-Str. 1 92318 Neumarkt, Germany		

A.3.10 Safety of electronic control equipment

Introduction

The following figures apply independent of the type of electronic controller and its manufacturer.

Reliability

The reliability of the SIMATIC devices and components is at its highest level thanks to comprehensive and cost-effective measures in development and manufacturing.

This includes the following measures:

- Selection of high-quality components
- Worst-case sizing of all switching circuits
- Systematic and computer-controlled testing of all supplied components
- Burn-in of all large-scale integrated switching circuits (e.g. processors, memory, etc.)

- Measures to prevent static charges when handling MOS switching circuits
- Visual inspection during different stages of manufacturing
- Pre-aging at increased ambient temperature
- Thorough and computer-controlled final inspection
- Statistical evaluation of all returns for immediate introduction of corrective measures
- Monitoring of the most important controller parts through online tests (CPU watchdog, etc.)

These measures are referred to as basic measures in safety engineering. They prevent or control the majority of all potential errors.

The risk

Wherever errors can result in injuries or damages, special measures for plant safety and, thus, the situation at hand must be implemented. Special, plant-specific regulations exist for these applications; these must be taken into account when assembling the controller (e.g. VDE 0116 for combustion plants).

For electronic controllers that are responsible for safety, the measures that must be taken to prevent or master errors are based on the risk arising from the plant. The basic measures listed above are often no longer sufficient as of a specific risk potential. Additional measures must be implemented for the controller (e.g. two channels, tests, checksums, etc.) and certified (DIN VDE 0801).

A.4 ESD directives

A.4.1 Electrostatic discharge and components/modules (ESD)

Definition

All electronic modules are equipped with large-scale integrated blocks or components. Because of their technology, these electronic components are very sensitive to overvoltages and, thus, to discharges of static electricity.

The international designation for these components is **ESD**, which stands for **E**lectrostatic **S**ensitive **D**evice.

Electrostatic-sensitive devices are identified by the following symbol:

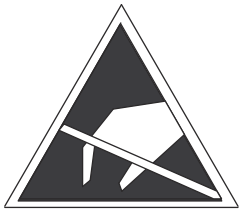


Figure A-9 ESD symbol

NOTICE
Electrostatic-sensitive devices Electrostatic-sensitive devices can be destroyed by voltages that are much below the perception threshold of human beings. These voltages can occur even when you only touch a component or electrical connections of a module without having discharged your electrostatic charge. The damage to the module due to an overvoltage is often not detected immediately, but will only become noticeable after the module has been operated for some time.

A.4.2 Basic protective measures against electrostatic discharge

Ensure good grounding

When dealing with electrostatic-sensitive devices, make sure that human beings, the workstation and packaging are properly grounded. In this way, you prevent static charging.

Avoid touching directly

NOTICE
Damage to components through discharge Only touch electrostatic sensitive devices when absolutely necessary (e.g. during maintenance work). Hold the modules in such a way that you do not touch block pins or conductor paths. This way, the discharged energy cannot reach and damage sensitive components.

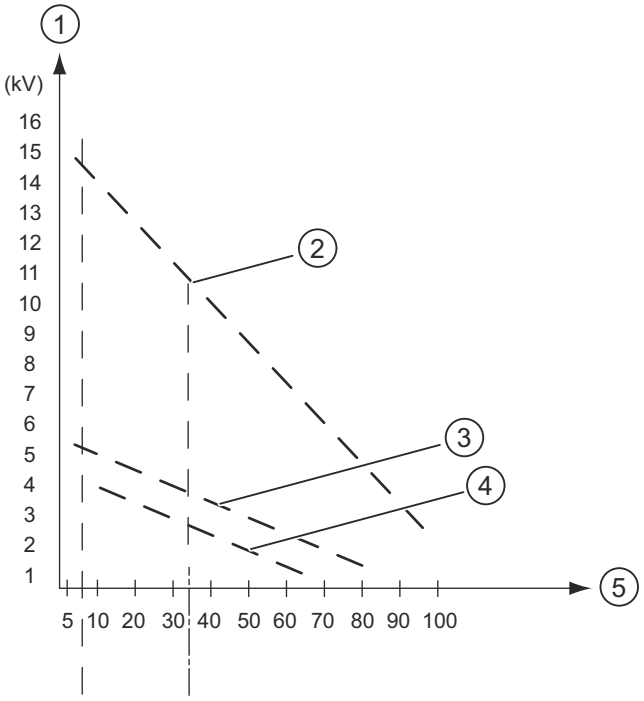
When you have to conduct measurements on a module, discharge your body before you start working on the module. To do so, touch grounded metallic objects. Only use grounded measuring instruments.

A.4.3 Electrostatic charging of the body

Charging

Any person that is connected to the electrical potential of his or her environment (non-conductive) may be electrostatically charged.

In the following figure, you can see the maximum values of electrostatic voltages to which a person can be charged when he/she comes in contact with the materials shown in the figure. These values correspond to the values in IEC 61000–4–2.



① Voltage in kV
② Synthetic material
③ Wool
④ Antistatic material, for example, wood or concrete
⑤ Relative humidity in %

Figure A-10 Electrostatic voltages to which a person can be charged

A.5 List of references

A.5.1 SIMATIC S7-4100, controller

SIMATIC S7-4100; SIMATIC S7-4100 controller

System documentation

Siemens AG

System Documentation SIMATIC S7-4100; Controller (https://support.industry.siemens.com/cs/ww/en/view/109805150)

A.5.2 SIMATIC S7-4100, CPU 4168-H

SIMATIC S7-4100, CPU 4168-H

Equipment Manual

Siemens AG

Documentation SIMATIC S7-4100, CPU 4168-H (https://support.industry.siemens.com/cs/ww/en/view/109805153)

A.5.3 SIMATIC S7-4100, PROFINET CP 4163-1

SIMATIC S7-4100, CP 4163-1

Operating instructions

Siemens AG

Documentation SIMATIC S7-4100, CP 4163-1 (https://support.industry.siemens.com/cs/ww/en/view/109805210)

A.5.4 SIMATIC S7-4100, PROFIBUS CP 4163-5

SIMATIC S7-4100, CP 4163-5

Operating instructions

Siemens AG

Documentation SIMATIC S7-4100, CP 4163-5 (https://support.industry.siemens.com/cs/ww/en/view/109805213)

A.5.5 SIMATIC NET, Industrial Ethernet/PROFINET Industrial Ethernet

SIMATIC NET

Industrial Ethernet

System Manual

Siemens AG

Documentation SIMATIC NET: Industrial Ethernet/PROFINET Industrial Ethernet (https://support.industry.siemens.com/cs/ww/de/view/27069465)

A.5.6 SIMATIC NET, Industrial Ethernet / PROFINET, Passive network components

SIMATIC NET, Industrial Ethernet / PROFINET

System documentation

Siemens AG

Documentation SIMATIC NET, Industrial Ethernet / PROFINET, Passive Network Components (https://support.industry.siemens.com/cs/ww/en/view/84922825)

A.5.7 SIMATIC, PROFINET system description

SIMATIC; PROFINET System description

System Manual

Siemens AG

https://support.industry.siemens.com/cs (https://support.industry.siemens.com/cs/ww/en/view/19292127)

A.5.8 SIMATIC NET, Network management Diagnostics and Configuration with SNMP

SIMATIC NET, Diagnostics and Configuration with SNMP

Diagnostics Manual

Siemens AG

Documentation Network Management Diagnostics and Configuration with SNMP (https://support.industry.siemens.com/cs/ww/en/view/103949062)

A.5.9 SIMATIC NET, PROFIBUS network manual

SIMATIC NET; PROFIBUS

System Manual

Siemens AG

System Manual SIMATIC NET - PROFIBUS Network manual (https://support.industry.siemens.com/cs/ww/en/view/35222591)

A.6 List of abbreviations

A.6.1 List of abbreviations

Abbreviations	Explanations
AC	Alternating current
ADC	Analog-to-digital converter
AI	Analog input
AO	Analog output
AS	Automation system
COMP	Compensation connector
CP	Communications processor
CPU	Central processing unit

Abbreviations	Explanations
CR	Rack (central rack)
DAC	Digital-to-analog converter
DB	Data block
DC	Direct current
ESD	Electrostatic-sensitive devices
EMC	Electromagnetic compatibility
EEPROM	electrically erasable programmable read-only memory
EPROM	erasable programmable read-only memory
ER	Error - LED for fault display
ID	Input delay
RVC	Replacement value connection
FB	Function block
FC	Function
Flash	Memory that does not require power to store data.
ES	Encoder supply
IC	Constant current cable
L+	Power supply connection 24 V DC
KLV	Keep last valid value
FOC	Fiber-optic cable
M	Ground
M+	Measurement cable positive
M-	Measurement cable negative
MT	Maintenance - LED to display service and maintenance states
M_{ANA}	Reference potential of the analog measuring circuit
M&C	Maintenance & Control HMI device (operator system)
OB	Organization block
PIQ	Process image output
PII	Process image input
PRIM	Primary CPU (in redundant controller: Master)
PS	Power supply
RAM	Random access memory
REDF	Redundancy loss/redundancy fault
RUN/STOP	LED to display the operating state
SCL	Structured control language similar to PASCAL
SEC	Memory card for licensing the number of process objects
SFB	System function block
SMC	Memory card for the CPU
PLC	Programmable logic controllers
SSL	System state list
TD	Text display
UC	Universal current
U_{CM}	Common mode voltage

Abbreviations	Explanations
U_H	Auxiliary voltage
U_{iso}	Insulation voltage - Potential difference between M_{ANA} and local ground
USR	User
VZ	Sign