SIEMENS

SIMATIC

S7-1500 / ET 200MP

Automation system

System manual

Edition 12/2014

Answers for industry.

SIEMENS

SIMATIC

S7-1500, ET 200MP Automation system

System Manual

12/2014

A5E03461182-AC

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.

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Preface

Purpose of the documentation

This documentation provides you with important information on how to configure, install, wire and commission the S7-1500 automation system/ET 200MP distributed I/O system.

Basic knowledge required

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

Scope of validity of the documentation

This documentation is valid for all products from the SIMATIC S7-1500 and SIMATIC ET 200MP product families.

Conventions

STEP 7: In this documentation, "STEP 7" is used as a synonym for all versions of the configuration and programming software "STEP 7 (TIA Portal)".

Please also observe notes marked as follows:

Note

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

Special information

Note

Important note for maintaining operational safety of your plant

Plants with safety-related features are subject to special operational safety requirements on the part of the operator. Even suppliers are required to observe special measures during product monitoring. This is why we inform you about product developments and features that are or may become important for the operation of plants with regard to safety in a special newsletter. You need to subscribe to the corresponding newsletter to ensure that you always remain up-to-date and are able to make any necessary changes to your plant regarding operational safety should the need arise. Please go online (https://www.automation.siemens.com/WW/newsletter/guiThemes2Select.aspx?HTTPS=REDIR&subjectID=2) and register for the following newsletters:

- SIMATIC S7-300/S7-300F
- SIMATIC S7-400/S7-400H/S7-400F/FH
- SIMATIC S7-1500/SIMATIC S7-1500F
- Distributed I/O
- SIMATIC Industrial Software

Select the "Current" check box for these newsletters.

Note

When F-CPUs are used in safety mode, note the description of the fail-safe system SIMATIC Safety Programming and Operating Manual SIMATIC Safety - Configuring and Programming (http://support.automation.siemens.com/WW/view/en/54110126).

Note

Product information

The product information on the S7-1500 automation system/ET 200MP distributed I/O system contains:

- Module overview of SIMATIC, S7-1500 and ET 200MP
- Additions to the documentation

The product information can be found on the Internet (http://support.automation.siemens.com/WW/view/en/68052815).

Recycling and disposal

The products are low in pollutants and can be recycled. For environmentally compliant recycling and disposal of your electronic waste, please contact a company certified for the disposal of electronic waste.

Additional support

- Information about technical support can be found in the appendix to this documentation.
- The range of technical documentation for the individual SIMATIC products and systems can be found on the Internet (http://www.siemens.com/simatic-tech-doku-portal).
- The online catalog and the ordering system are available on the Internet (https://mall.industry.siemens.com).

Security information

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

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

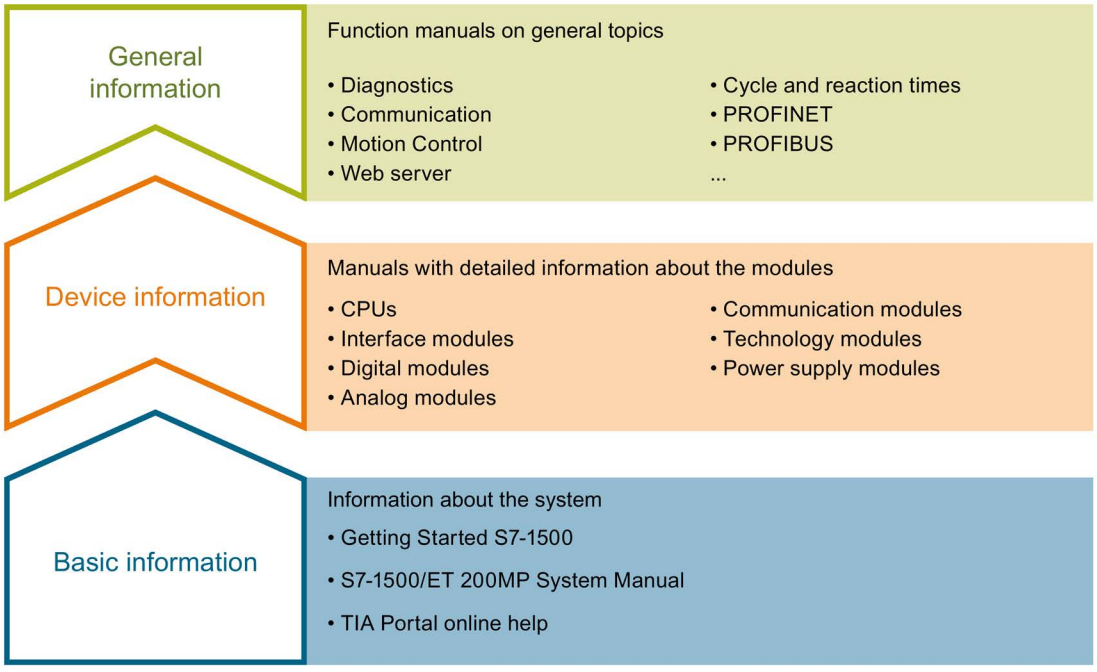
To stay informed about product updates as they occur, sign up for a product-specific newsletter. You can find more information on the Internet (http://support.automation.siemens.com).

Table of contents

Documentation guide

1

The documentation for the SIMATIC S7-1500 automation system and the SIMATIC ET 200MP distributed I/O system is arranged into three areas.
This arrangement enables you to access the specific content you require.



Basic information

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

Device information

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

General information

The function manuals contain detailed descriptions on general topics regarding the SIMATIC S7-1500 and ET 200MP systems, e.g. diagnostics, communication, Motion Control, Web server.

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

Changes and supplements to the manuals are documented in a Product Information.

Manual Collection S7-1500/ET 200MP

The Manual Collection contains the complete documentation on the SIMATIC S7-1500 automation system and the ET 200MP distributed I/O system gathered together in one file.

You can find the Manual Collection on the Internet (http://support.automation.siemens.com/WW/view/en/86140384).

My Documentation Manager

The My Documentation Manager is used to combine entire manuals or only parts of these to your own manual.
You can export the manual as PDF file or in a format that can be edited later.

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

Applications & Tools

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

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

CAx Download Manager

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

You configure your own download package with a few clicks.

In doing so you can select:

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

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

TIA Selection Tool

With the TIA Selection Tool, you can select, configure and order devices for Totally Integrated Automation (TIA).
This tool is the successor of the SIMATIC Selection Tool and combines the known configurators for automation technology into one tool.
With the TIA Selection Tool, you can generate a complete order list from your product selection or product configuration.

You can find the TIA Selection Tool on the Internet (http://w3.siemens.com/mcms/topics/en/simatic/tia-selection-tool).

System overview

2

2.1 What is the SIMATIC S7-1500 automation system?

SIMATIC S7-1500

The SIMATIC S7-1500 automation system is the further development of the SIMATIC S7-300 and S7-400 automation systems.

Through the integration of numerous new performance features, the S7-1500 automation system offers you excellent operability and the highest performance.

Customer benefits of the system

Simple to use

- Plug-in potential bridges make it simple and convenient to form potential groups
- Prewiring position allows simple wiring and reconnecting
- Integrated shielding for a high signal detection quality
- Integrated system diagnostics for uniform display concept without additional programming
- STEP 7 language innovations with retention of proven functions

Compact design

- Integrated display for machine-oriented commissioning and service purposes
- High variability through scalability of up to 30 I/O modules per rack
- Innovative labeling system provides maximum clearness in very confined spaces

Safety Integrated

- Simple integration of fail-safe CPUs (F-CPUs)

Security Integrated

- Know-how protection against unauthorized access and modifications.
- Copy protection on the SIMATIC memory card to prevent duplication of application programs

Integrated technology

- Motion Control functionality supports the connection of PROFIdrive capable drives
- Temperature controller
- PID control for continuous and discreet control processes with autotuning for simple commissioning and optimum control quality
- Seamless integration into TIA Portal for synchronous configuration and uniform operating concept
- TRACE support for effective commissioning, diagnostics and fast optimization of drives and controllers

High performance

- Fast signal processing for reduced reaction times and high productivity
- Fast backplane bus for high baud rate and efficient transmission protocol
- Easier location-independent information acquisition using integrated web server

Communication standards

- PROFINET IO
- PROFIBUS DP
- Point-to-point (RS232, RS485)

Figure 2-1 SIMATIC S7-1500 automation system - Customer benefits

Field of application

The S7-1500 automation system offers the required flexibility and performance for a high bandwidth of controller applications in machine and plant engineering. The scalable configuration makes it possible for you to adapt your PLC to the local conditions.

By using fail-safe S7-1500 CPUs, you can implement applications for safety engineering. Configuration and programming of your safety program takes place the same way as for standard CPUs - in the TIA Portal.

The S7-1500 automation system complies with IP20 degree of protection and is intended for installation in a control cabinet.

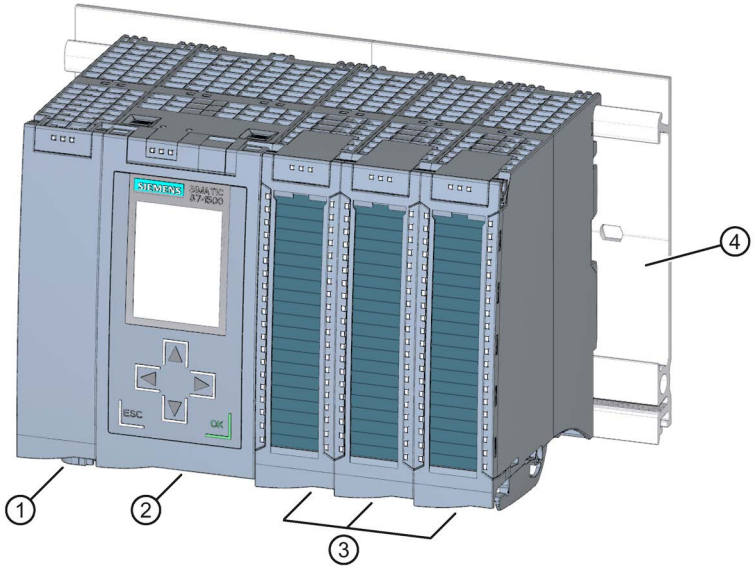
Configuration

The SIMATIC S7-1500 automation system is made up of the following components:

- CPU
- Digital and analog I/O modules
- Communications modules (PROFINET/Ethernet, PROFIBUS, point-to-point)
- Technology modules (counting, position detection)
- System power supply

You install the S7-1500 automation system on a mounting rail. It can consist of up to 32 modules. You connect the modules to each other with U connectors.

Configuration example



① System power supply
② CPU
③ I/O modules
④ Mounting rail with integrated DIN rail profile

Figure 2-2 Example configuration of an S7-1500 automation system

2.2 What is the SIMATIC ET 200MP distributed I/O system?

SIMATIC ET 200MP

The ET 200MP is a scalable and highly flexible distributed I/O system for connecting the process signals to a central controller via fieldbus.

Customer benefits of the system

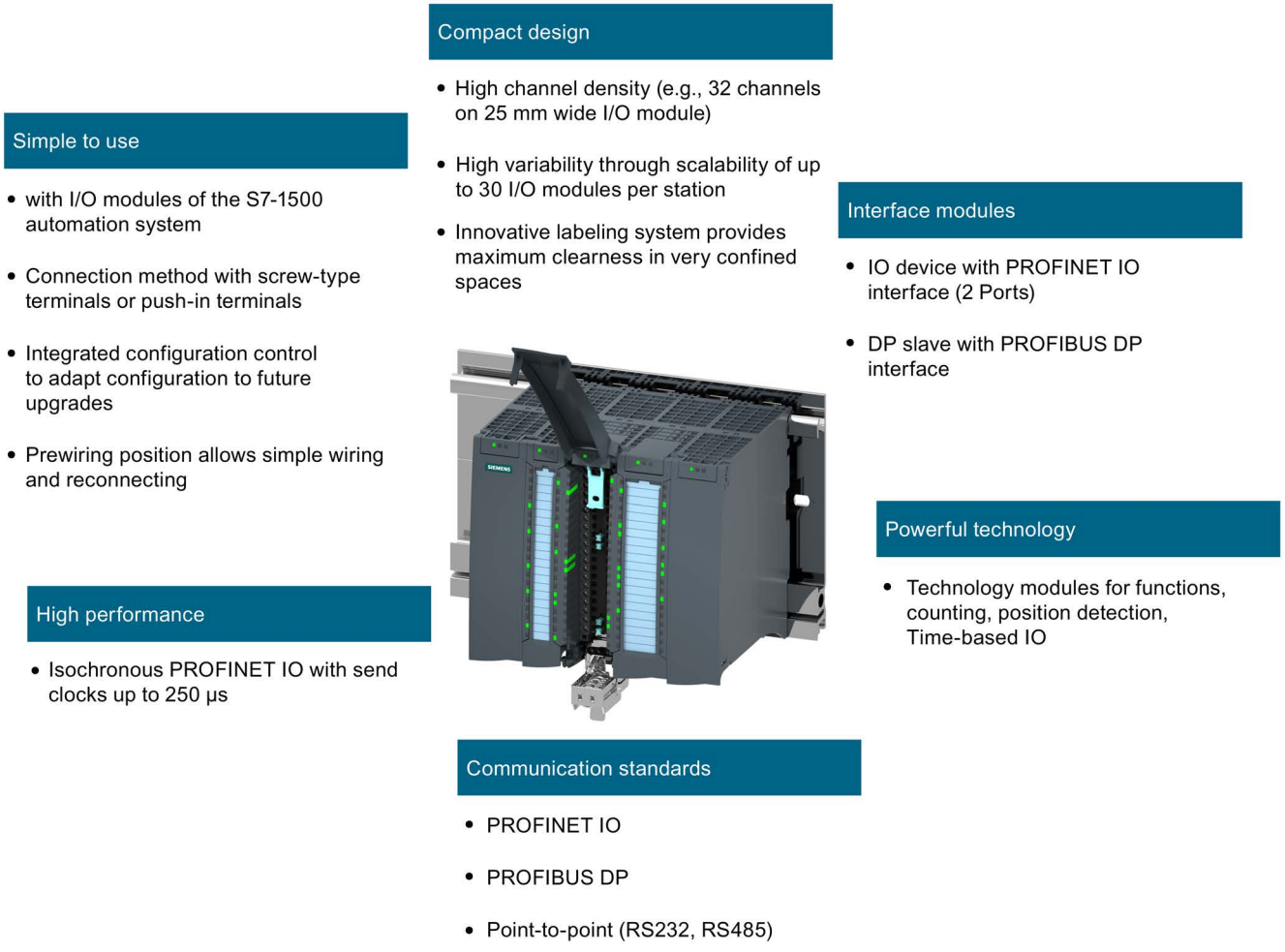


Figure 2-3 SIMATIC ET 200MP distributed I/O system - customer benefits

Field of application

Its scalable design gives you the option to tailor your configuration exactly to local requirements.

The ET 200MP distributed I/O system is approved for IP 20 degree of protection and suitable for installation in a cabinet.

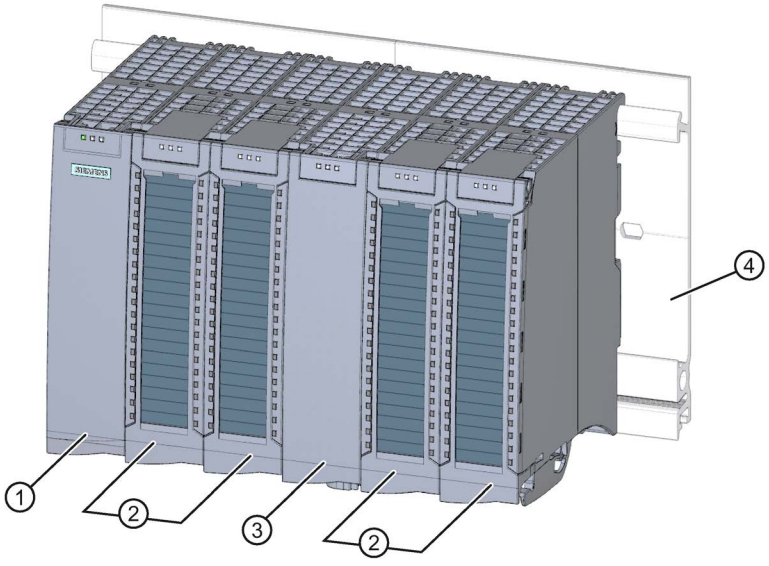
Configuration

The SIMATIC ET 200MP distributed I/O system is made up of the following components:

- Interface module (PROFINET or PROFIBUS)
- Digital and analog I/O modules
- Communications modules (point-to-point)
- Technology modules (counting, position detection)
- System power supply

The ET 200MP distributed I/O system is installed on a mounting rail like the S7-1500 automation system.

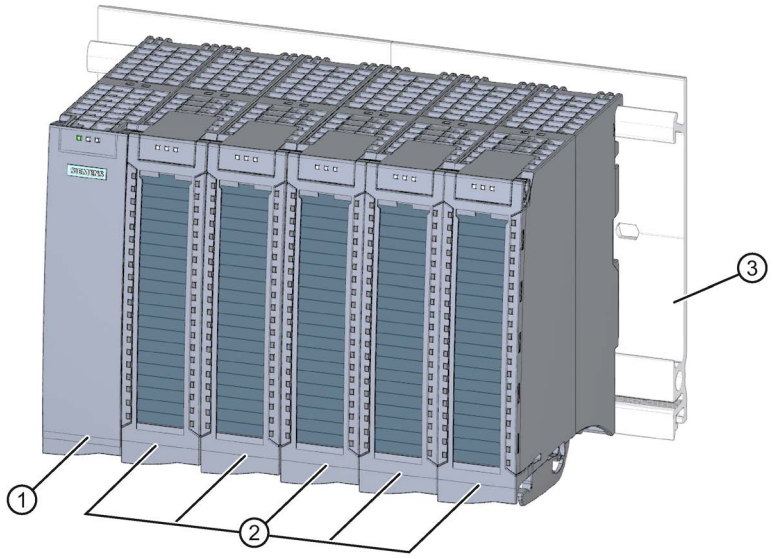
Example of a configuration with the IM 155-5 PN ST interface module



① Interface module
② I/O modules
③ System power supply
④ Mounting rail with integrated DIN rail profile

Figure 2-4 Example of a configuration of the ET 200MP with IM 155-5 PN ST

Example of a configuration with the IM 155-5 DP ST interface module



① Interface module
② I/O modules
③ Mounting rail with integrated DIN rail profile

Figure 2-5 Example of a configuration of the ET 200MP with IM 155-5 DP ST

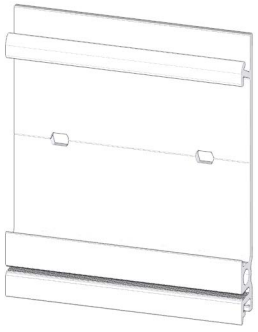
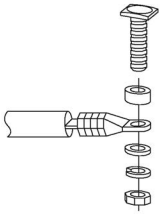
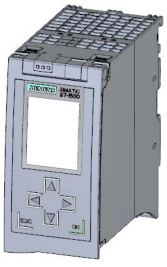
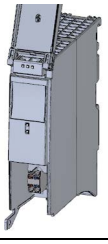
See also

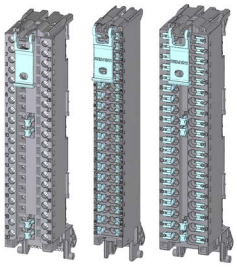
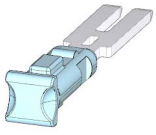
Accessories/spare parts (Page 224)

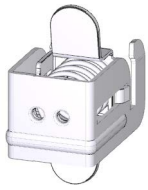
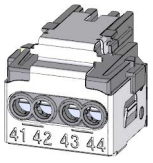
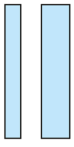
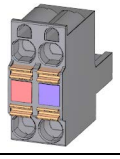
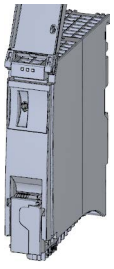
2.3 Components

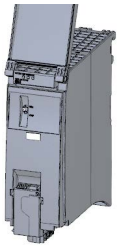
Components of the S7-1500 automation system/ET 200MP distributed I/O system

Table 2- 1 Components S7-1500/ET 200MP

Components	Function	Diagram
Mounting rail	The mounting rail is the rack of the S7-1500 automation system. You can use the entire length of the mounting rail (marginless assembly). The mounting rails may be ordered as accessories (Page 224).	
PE connection element for mounting rail	The set of screws is threaded into the mounting rail's T-profile groove, and is required for grounding the mounting rail. The set of screws is contained in the scope of delivery of the mounting rails in the standard lengths (160 to 830 mm), and may be ordered as an accessory (Page 224).	
CPU/Fail-safe CPU	The CPU executes the user program. The integrated system power supply of the CPU supplies the modules used via the backplane bus. Further features and functions of the CPU: • Communication via Ethernet • Communication via PROFIBUS / PROFINET • HMI communication • Integrated web server • Integrated technology • Integrated system diagnostics • Integrated protection functions (access, know-how and copy protection) • Safety mode (when using fail-safe CPUs)	
Interface module for PROFINET IO	The interface module: • Can be used as IO device on PROFINET IO • Links the ET 200MP distributed I/O system with the IO controller. • Exchanges data with the I/O modules via the backplane bus.	

Components	Function	Diagram
Interface module for PROFIBUS DP	The interface module: • Can be used as DP slave on PROFIBUS DP • Links the ET 200MP distributed I/O system with the DP master. • Exchanges data with the I/O modules via the backplane bus.	
I/O module	The I/O modules form the interface between the controller and the process. The controller detects the current process state via the connected sensors and actuators, and triggers the corresponding reactions. I/O modules are divided into the following module types: • Digital input (DI) • Digital output (DQ) • Digital input/Digital output (DIQ) • Analog input (AI) • Analog output (AQ) • Analog input/analog output (AIQ) • Technology module (TM) • Communication module (CM) • Communication processor (CP) A U connector is included in the scope of delivery for each I/O module.	
U connector	The modules of the S7-1500 automation system/ ET 200MP distributed I/O system are connected using the U connector. The U connector provides the mechanical and electrical connection between the modules. The U connector is included in the scope of delivery of all modules (exceptions: CPU, interface module) and can be ordered as a spare part (Page 224).	
Front connectors	The purpose of the front connectors is to wire the I/O modules. The front connectors for technology and analog modules must be supplemented with a shielding bracket, power supply element, and shielding clamp. These components are included in the scope of delivery of the technology and analog modules, and may be ordered as accessories (Page 224). The front connectors are available for 35 mm modules with screw terminals and push-in terminals and for 25 mm modules with push-in terminals. The front connectors for 25 mm modules are included in the scope of delivery of the I/O module. Four potential bridges and one cable tie are included in the scope of delivery of the front connectors for 35 mm modules. The front connectors for 25 mm modules have no potential bridges.	
Potential bridges for front connector	You jumper two terminals with potential bridges. The potential bridges are included in the scope of delivery of the front connector, and may be ordered as a spare part (Page 224). The front connectors for 25 mm modules have no potential bridges. Therefore, you should also observe the information in the product manual for the respective analog module.	

Components	Function	Diagram
Shielding bracket	The shielding bracket is an insertable bracket for modules with EMC-critical signals (e.g., analog modules, technology modules), and (together with the shielding clamp) permits the low impedance application of shielding with minimal installation times. The shielding bracket is included in the scope of delivery of the analog and technology modules, and may be ordered as an accessory (Page 224).	
Shield clamp	The shield clamps are used to attach cable shielding to the shielding bracket. The shield clamp is included in the scope of delivery of the analog and technology modules, and may be ordered as an accessory (Page 224).	
Power supply element	The power supply element is inserted in the front cable connector, and serves to supply power to modules with EMC-critical signals (analog modules, technology modules). The power supply element (connection technology: screw terminal) is included in the scope of delivery of the analog and technology modules, and may be ordered as an accessory (Page 224).	
Labeling strips for the exterior of the front cover of the I/O modules	The labeling strips are used to label the modules for specific plants. You can label the labeling strips using a machine. The labeling strips are available in various colors. The labeling strips are included in the scope of delivery of the I/O modules. Additional labeling strips may be ordered as Accessories (Page 224).	
4-pole connection plug for supply voltage of the CPU/interface module	The supply voltage is supplied by means of the 4-pole connection plug.	
System power supply (PS)	The system power supply is a diagnostics-capable power supply module, that can be connected with the backplane bus using a U connector. A system power supply is required, if the power fed from the CPU/interface module into the backplane bus is not sufficient to supply the connected modules with power. System power supplies are available in various models: • PS 25W 24V DC • PS 60W 24/48/60V DC • PS 60W 120/230V AC/DC A power cable connector with coding element and U connector is included in the scope of delivery of the system power supply and may be ordered as spare part.	

Components	Function	Diagram
Load current supply (PM)	The system power supply (PS), central modules (CPU), input and output circuits of the I/O modules are supplied with 24 V DC through the load current supply (PM). A load current supply does not occupy a slot in the configuration and is not included in the system diagnostics. If you are using load current supplies, we recommend the devices from our SIMATIC series. These devices can be mounted on the mounting rail. You can configure the load current supply using STEP 7. Load current supplies are available in various models: • PM 70W 120/230V AC • PM 190W 120/230V AC	

Application planning

3

3.1 Hardware configuration

Introduction

The S7-1500 automation system/ET 200MP distributed I/O system consists of a single-row configuration in which all modules are installed on one mounting rail. The modules are connected by means of U connectors, and thus form a self-assembling backplane bus.

3.1.1 Hardware configuration of the S7-1500 automation system

Maximum configuration

An S7-1500 automation system consists of a maximum of 32 modules, which occupy slots 0 to 31.

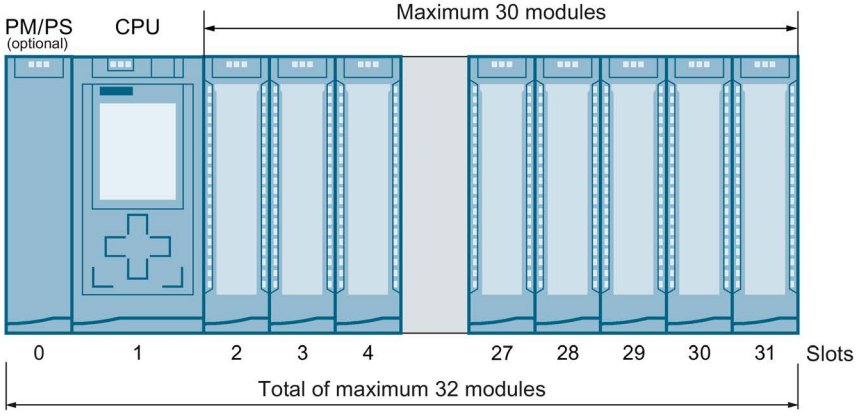


Figure 3-1 S7-1500 maximum configuration

Applicable modules

The following table shows which modules may be used in the various slots:

Table 3- 1 Assignment of slot numbers

Module type		Permissible slots	Maximum number of modules
Load current supply (PM)[1]		0	Unlimited / only 1 PM can be configured in STEP 7
System power supply (PS)		0; 2 - 31	3
CPU		1	1
Analog and digital I/O modules		2 - 31	30
Communications modules			
• Point-to-point		2 - 31	30
• PROFINET/Ethernet, PROFIBUS			
	When a CPU 1511-1 PN is used	2 - 31	4
	When a CPU 1513-1 PN is used	2 - 31	6
	When a CPU 1515-2 PN is used	2 - 31	6
	When a CPU 1516-3 PN is used	2 - 31	8
	When a CPU 1517-3 PN/DP is used	2 - 31	8
	When a CPU 1518-4 PN/DP is used	2 - 31	8
Technology modules		2 - 31	30

[1] No connection to the backplane bus

3.1.2 Hardware configuration of the ET 200MP distributed I/O system with PROFINET interface module

Maximum configuration

- The integrated system power supply of the interface module feeds 14 W into the backplane bus. The exact number of the I/O modules operated with the interface module depends on the power budget (see section Power balance calculation (Page 34)).
- A maximum of three system power supplies (PS) is possible: one before the interface module and two after the interface module.
- If you use a system power supply (PS) before the interface module, the maximum possible configuration is a total of 32 modules (up to 30 modules after the interface module).

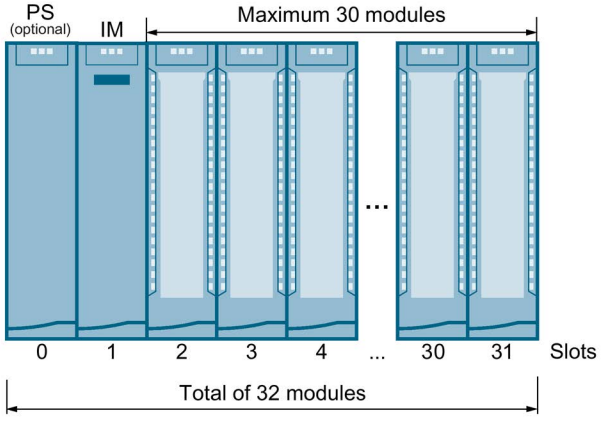


Figure 3-2 Maximum configuration ET 200MP with IM 155-5 PN

Applicable modules

The following table shows which modules may be used in the various slots:

Table 3- 2 Assignment of slot numbers

Module type	Permissible slots	Maximum number of modules
System power supply (PS)	0; 2 - 31	3
Interface module	1	1
Analog and digital I/O modules	2 - 31	30
Communications modules		
• Point-to-point	2 - 31	30
Technology modules	2 - 31	30

3.1.3 Hardware configuration of the ET 200MP distributed I/O system with PROFIBUS interface module

Maximum configuration

The integrated system power supply of the interface module feeds 14 W into the backplane bus. The exact number of the I/O modules operated with the interface module depends on the power budget (see section Power balance calculation (Page 34)).

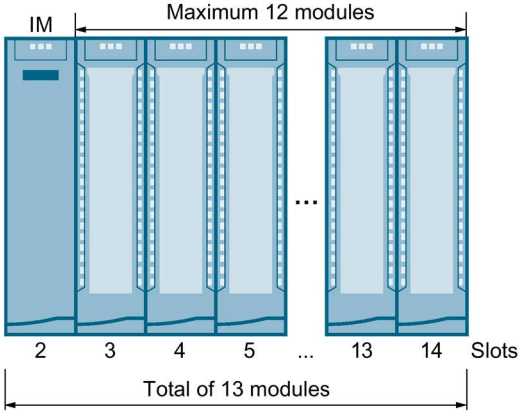


Figure 3-3 Maximum configuration ET 200MP with IM 155-5 DP

Applicable modules

The following table shows which modules may be used in the various slots:

Table 3- 3 Assignment of slot numbers

Module type	Permissible slots	Maximum number of modules
Interface module	2	1
Analog and digital I/O modules	3 - 14	12
Communications modules		
• Point-to-point	3 - 14	12
Technology modules	3 - 14	12

3.2 System and load power supply

Types of power supplies

The S7-1500 automation system/ET 200MP distributed I/O system distinguishes between two types of power supply:

- System power supply (PS)
- Load current supply (PM)

System power supply (PS)

The system power supply has a connection to the backplane bus (U connector) and supplies solely the internally required system voltage. This system voltage supplies parts of the module electronics and the LEDs. A system power supply can also supply CPUs or interface modules if these are not connected to a 24 VDC load current supply.

Load current supply (PM)

The load current supply feeds the input/output circuits of the modules, as well as the sensors and actuators of the plant, if installed. The supply of the CPU/interface module with 24 V DC is optional if you supply the voltage for the backplane bus via a system power supply.

Special characteristic of the load current supply

Load current supplies can be mounted on the "S7-1500 mounting rail" but do not have a connection to the backplane bus.

Total configuration with power supplies

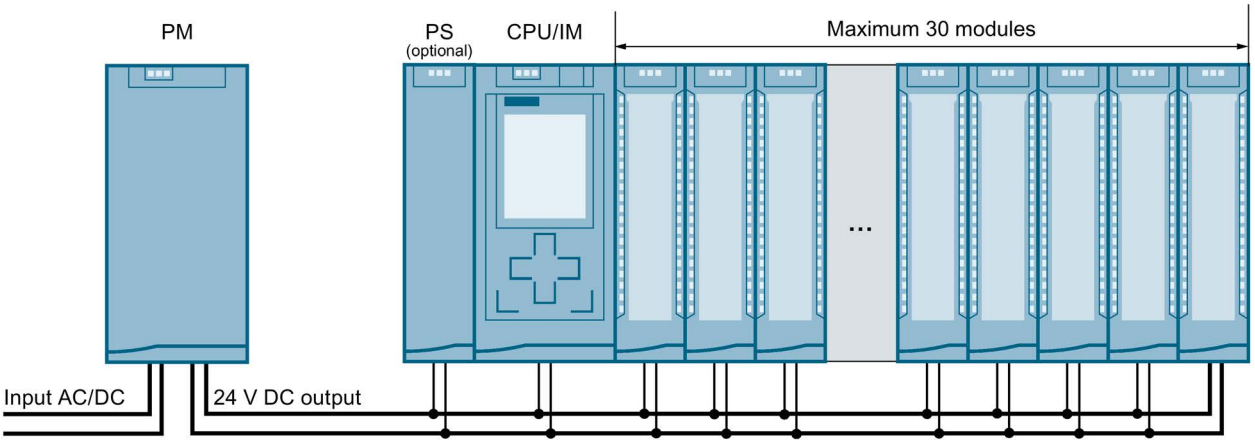


Figure 3-4 Total configuration with load current supply (PM) and system power supply (PS)

Optionally, you can insert up to two system power supplies (PS) in the slots to the right of the CPU/interface module (power segments).

The number of load current supplies is unlimited.

Observe the installation rules and specified installation distances in the manuals of the load current supplies.

System power supplies

- PS 25W 24V DC: Supply with 24 V DC and 25 W of power
- PS 60W 24/48/60V DC: Supply with 24/48/60 V DC and 60 W of power
- PS 60W 120/230V AC/DC: Supply with 120/230 V AC and 60 W of power

Load current supplies

The load current supplies listed below have been technically adapted especially to the S7-1500 automation system/ET 200MP distributed I/O system. Use of the listed load current supplies is not imperative because a SITOP module, for example, can be used an alternative.

- PM 70W 120/230 V AC: Supply with 120/230 V AC and 70 W of power
- PM 190W 120/230 V AC: Supply with 120/230 V AC and 190 W of power

3.2.1 Use of system power supplies

Introduction

If the power fed from the CPU/interface module into the backplane bus is not sufficient to supply all connected modules with power, system power supplies (PS) are required. You can also use system power supplies with 120/230 V AC and supply the CPU/interface module by means of the backplane bus. The CPU then does not have to be supplied with 24 V DC.

Whether or not you need an additional system power supply depends on the power consumption of the modules used. The power supplied by the CPU/interface module and the system power supplies must be greater than the power required by the I/O modules.

During configuration, STEP 7 compares the supplied power and the power required by the modules. If the required power is too high, you receive a corresponding message from STEP 7.

Slots for system power supplies

The following slots may be used for system power supplies:

- A system power supply in slot 0 to the left of the CPU/interface module
- Up to 2 system power supplies in the slots to the right of the CPU/interface module (power segments)

Power segment

If you are using additional system power supplies to the right of the CPU/interface module, divide the configuration into power segments.

Configuration variant with power segments

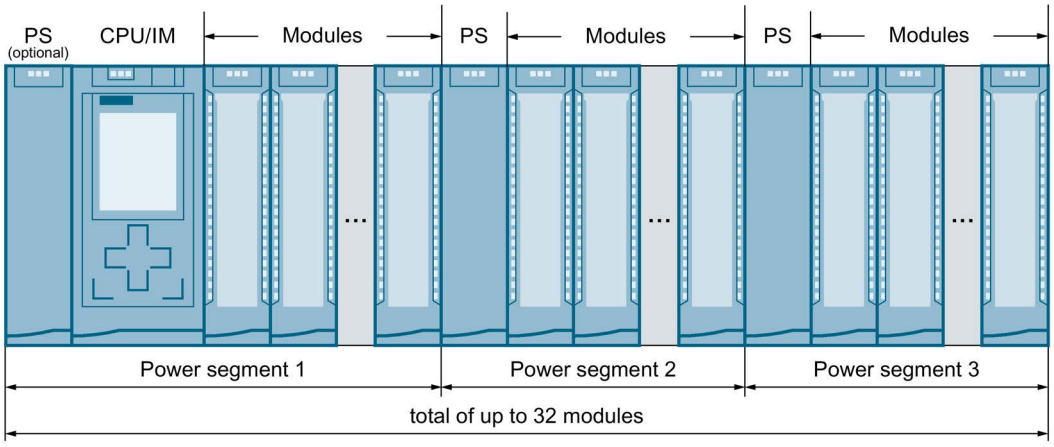


Figure 3-5 Configuration variants with 3 power segments

Note

If you make the configuration with TIA Portal, it automatically checks the configuration for consistency and informs you as of which module you must open up a new power segment.

Reference

Information about the required power is available in the section Power balance calculation (Page 34).

Additional information on the performance values (power feed, power consumption) of the CPU, interface module, system power supply, and I/O modules can be found in the manuals (http://support.automation.siemens.com/WW/view/en/57251228) of the respective modules.

3.2.2 Special considerations for the use of a system power supply in the first power segment

Infeed options

There are three options for the infeed of the required system voltage in the backplane bus:

- Infeed via CPU/interface module
- Infeed via CPU/interface module and system power supply
- Infeed via system power supply only

Infeed via CPU/interface module

Infeed via the CPU/interface module generally suffices for small and medium hardware configurations. The power consumption of the connected modules must not exceed the power supplied by the CPU/interface module.

In this configuration variant, supply the CPU/interface module with 24 V DC from a load current supply.

Procedure

To set up the supply by means of the CPU/interface module, follow these steps:

1. Open the "Properties" tab of the CPU/interface module in STEP 7 and select the "System power supply" in the navigation.
2. Select the option "Connection to supply voltage L+".

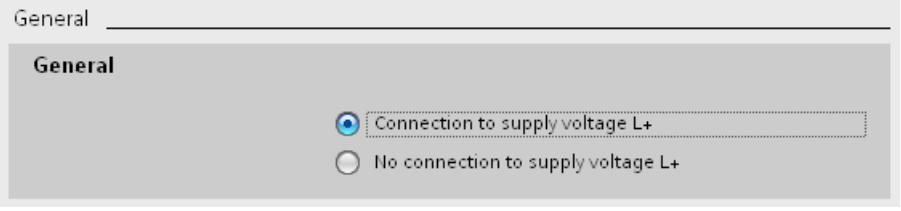


Figure 3-6 Supply voltage via CPU/interface module only

Infeed via CPU/interface module and system power supply

For larger hardware configurations, infeed into the backplane bus by the CPU/interface module alone no longer suffices. If the modules consume more power in total than the power supplied by the CPU/interface module, insert an additional system power supply.

Supply the system power supply with the permissible supply voltage and the CPU/interface module with 24 V DC from a load current supply.

Both the system power supply and the CPU/interface module feed current into the backplane bus. The supplied power is summed.

Power addition: "Infeed power of the system power supply" + "Infeed power of the CPU/ interface module"

Procedure

To set up the supply by means of the CPU/interface module and system power supply, follow these steps:

1. Open the "Properties" tab of the CPU/interface module in STEP 7 and select the "System power supply" in the navigation.
2. Select the option "Connection to supply voltage L+".

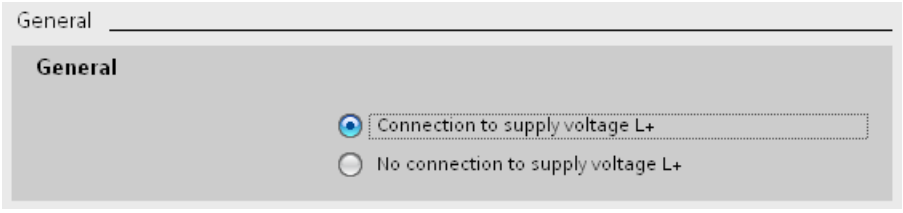


Figure 3-7 Supply voltage via the CPU/interface module and system power supply

Infeed via system power supply only

As a further possibility you can feed the required power into the backplane bus using only a system power supply. In this case, the CPU/interface module is not supplied with 24 V DC, and draws its supply from the backplane bus. Insert the system power supply to the left of the CPU/interface module.

In general you can use system power supplies with AC or DC infeed for the configuration. If you want to supply the first power segment directly with 230 V AC, an infeed via only one system power supply makes sense, for example, if no 24 V DC supply voltage is available.

Procedure

To set up the supply by means of the system power supply, follow these steps:

1. Open the "Properties" tab of the CPU/interface module in STEP 7 and select the "System power supply" in the navigation.
2. Select the option "No connection to supply voltage L+".

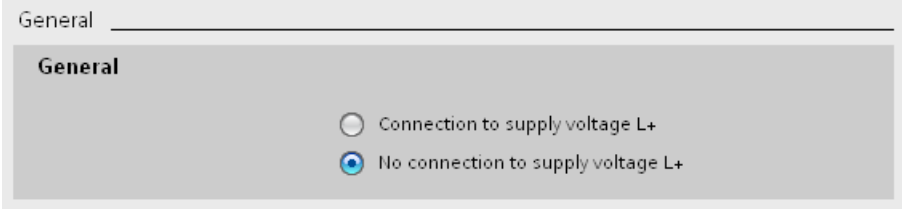


Figure 3-8 No infeed into the backplane bus by means of the CPU/interface module

3.3 Use of load power supplies

Introduction

The system power supply (PS), central modules (CPU), interface module and input and output circuits of the I/O modules are supplied with 24 V DC by the load current supply (PM).

Load current supplies can be mounted on the mounting rail but do not have a connection to the backplane bus.

Observe the installation rules and specified installation distances in the manuals of the load current supplies.

Use of multiple load current supplies

Several load current supplies (PM) can be used as follows for higher output currents:

- Parallel connection of two load current supplies
- Every load current supply feeds independent 24 V DC load lines.

Alternatively an external 24 V power supply from the SITOP spectrum can be used.

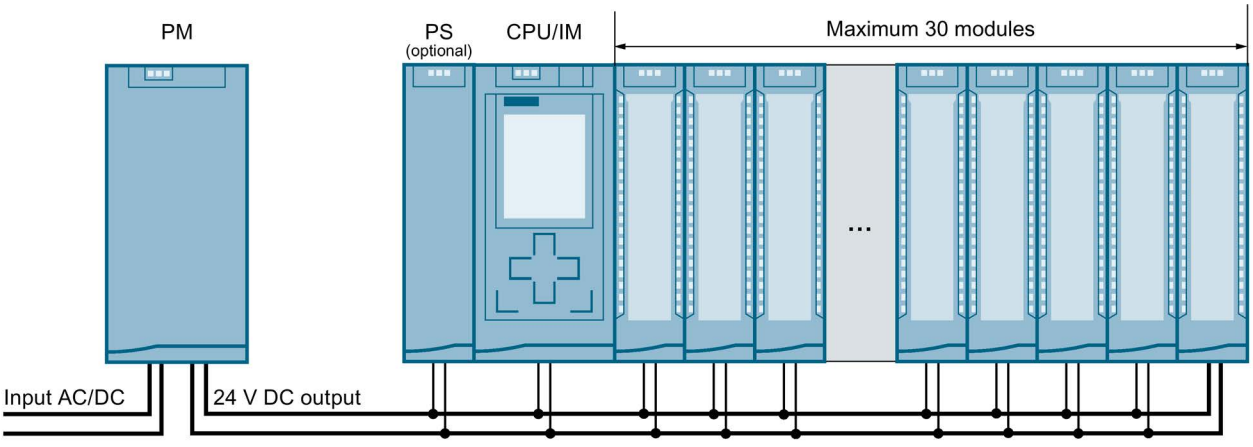


Figure 3-9 Supply of the modules from 24 V DC load current suppl

Note

Alternative 24 V supply of the modules from the control cabinet

If safe galvanic isolation (SELV/PELV to IEC 60364-4-41) is ensured, you can supply the modules alternatively with 24 V DC from the control cabinet.

Reference

More information on load current supplies can be found on the Internet (https://mall.industry.siemens.com) in the online catalog and in the online ordering system.

3.4 Power balance calculation

Principle of power balance calculation

In order to ensure the supply of the modules from the backplane bus, the infed power is compared with the required power. The power balance calculation checks whether the power provided by the system power supplies including CPU/interface module is greater than or equal to the power used by the consumers (modules).

In order to operate the configuration with its used modules, the power balance must be positive for each power segment in use.

This means that the power fed into the power segment is greater than the power consumed by the modules.

Take care even during planning, that the power fed into the backplane bus is always greater than or equivalent to the power drawn.

The power fed into the backplane bus by the CPU/interface module and system power supply is listed in the technical specifications of the CPU/interface module in the corresponding manuals.

The power consumed from the backplane bus by an I/O module or the CPU/interface module can be found in the technical specifications in the corresponding manuals.

The power balance calculation is performed:

- During planning with STEP 7
- During operation by the CPU

Power balance calculation during planning with STEP 7

STEP 7 checks compliance with the power balance during the configuration.

Proceed as follows to evaluate the power balance calculation:

1. Perform the configuration of the S7-1500/ET 200MP with all the required modules.
2. In the network view, select the CPU/interface module or the system power supply.
3. Open the "Properties" tab in the inspector window.
4. Select the "System power supply" entry in the area navigation.
5. Check the "Power segment overview" table, so see whether the power balance is positive. If the power balance is negative, the underpowered modules will be marked in red.

Module	Slot	Supply/consumption
PS 25W 24V DC_1	0	25.00W
PLC_1	1	-8.30W
DI 32x24VDC HF_1	2	-1.10W
DQ 8x230VAC/5A ST_1	3	-0.80W
AI 8xU/I/RTD/TC ST_1	4	-0.70W
AQ 4xU/I ST_1	5	-0.60W
	Summary	13.50W

Figure 3-10 Example of a power balance calculation with STEP 7

Power balance calculation check for overload by the CPU/interface module

Compliance with a positive power balance is monitored by the CPU/interface module:

- At every POWER ON
- At every change of the installed hardware

Causes for overload

An overload can still occur despite a positive power balance during planning. The cause for overload can be a hardware configuration that does not correspond to the configuration in STEP 7, for example:

- More I/O modules are inserted in the actual configuration than were planned
- A system power supply that is necessary for operation is not inserted
- A system power supply that is necessary for operation is not switched on (power cable connector and on/off switch)
- A system power supply that is necessary for operation has no U connector inserted

Response of the CPU to negative power balance or failure of system power supplies

As soon as a negative power balance/overload is detected by the CPU in a power segment, the following actions are executed:

- CPU stores the retentive data
- CPU enters the event in the diagnostics buffer
- CPU carries out a restart and repeats this until the cause of the negative power balance is resolved

Response of the interface module to negative power balance or failure of system power supplies

As a result of the overload, the interface module switches off all power segments. The I/O controller or DP master can no longer access the I/O modules. The interface module provides diagnostic information and periodically checks the connection to the backplane bus and re-establishes it.

Exception: In the case of a voltage drop or a hardware fault in power segment 2 or 3, the corresponding system power supply module switches off its power segment (and possibly the following segments), and generates a diagnostic alarm, if possible.

More information on the behavior of the system power supply (PS) in the event of a fault can be found in the manuals for the system power supplies.

Installation 4

4.1 Basics

Introduction

All modules of the S7-1500 automation system/ET 200MP distributed I/O system are open equipment. This means that you may only install this system in housings, cabinets or electrical operating rooms. These housings, cabinets or electrical operating rooms must only be accessible with a key or tool. Access may only be possible for instructed or authorized personnel.

Installation position

The S7-1500 automation system/ET 200MP distributed I/O system can be used in a horizontal installation for ambient temperatures up to 60 °C and in vertical installation for ambient temperatures up to 40 °C. Additional information can be found in the chapter Mechanical and climatic ambient conditions (Page 214).

Mounting rail

In addition to the S7-1500/ET 200MP modules, other components can be mounted on the mounting rail; for example, modules from the S7-1200 and ET 200SP portfolio, terminals, circuit breakers, small contactors or similar components.

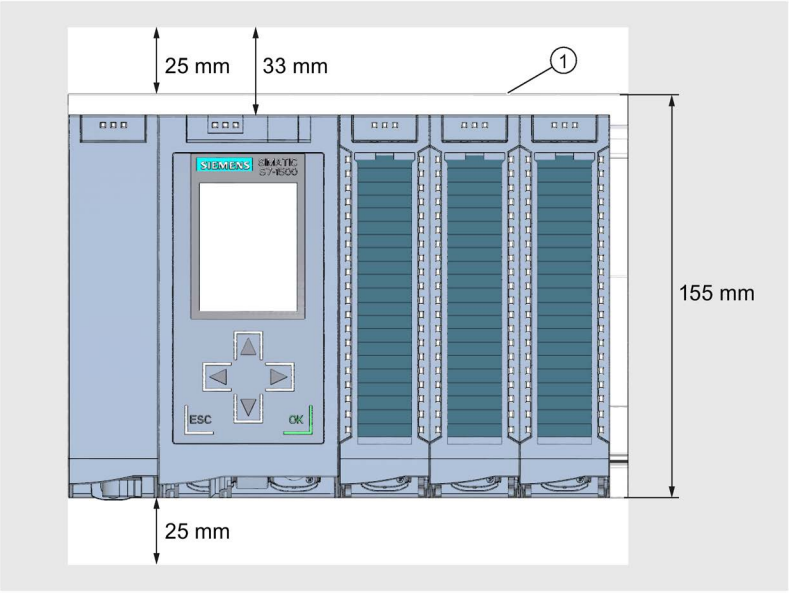
These components can influence the installation dimensions for the cable duct.

Modules can be mounted up to the outer edge of the mounting rail (marginless assembly).

The mounting rails are available in various lengths. You can order the mounting rails using the online catalog or the online ordering system. The available lengths and part numbers can be found in the Accessories/spare parts (Page 224) section.

Minimum clearances

Modules can be mounted up to the outer edge of the mounting rail. Maintain the following minimum clearances at the top and bottom when installing or removing the S7-1500 automation system/ET 200MP distributed I/O system.



① Upper edge of the mounting rail

Figure 4-1 Minimum clearances in the control cabinet

Installation rules

- The installation starts on the left with a CPU/interface module or a system power supply.
- The modules are connected to each other with U connectors.
- Note that no U connector protrudes from the first and last module.

Note

Only remove and insert modules when the power to the system is switched off.

4.2 Installing the mounting rail

Lengths and drill holes

The mounting rails are delivered in five lengths:

- 160 mm
- 245 mm
- 482.6 mm (19 inches)
- 530 mm
- 830 mm
- 2000 mm

The part numbers can be found in the Accessories/spare parts (Page 224) section.

The mounting rails (from 160 to 830 mm) come with two drill holes for fixing screws. A set of screws for grounding the mounting rail is provided.

The 2000 mm mounting rail is provided for assemblies with special lengths and does not have holes for fixing screws. No set of screws for grounding is enclosed with the mounting rail (can be ordered as an accessory (Page 224)).

The specifications of the maximum offsets between two drill holes can be found in the table, "Dimensions for the drill holes".

Tools required

- Commercially available hacksaw
- Drill ∅ 6.5 mm
- Screwdriver
- Size 10 adjustable screw-wrench or socket wrench for grounding cable connection
- Adjustable screw-wrench, matching the selected fixing screws
- Stripping tool and crimp tool for the grounding cable

Required accessories

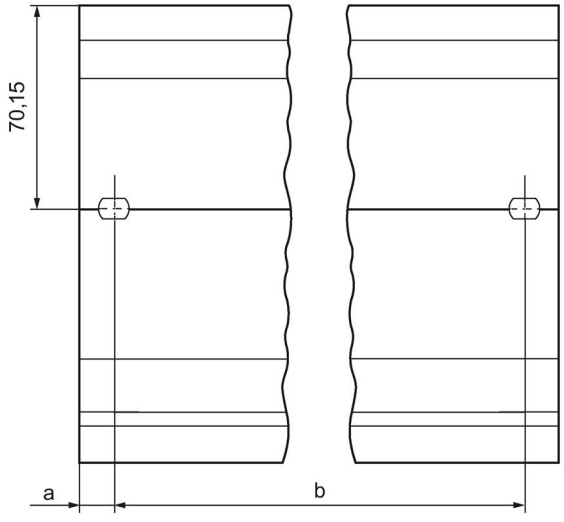
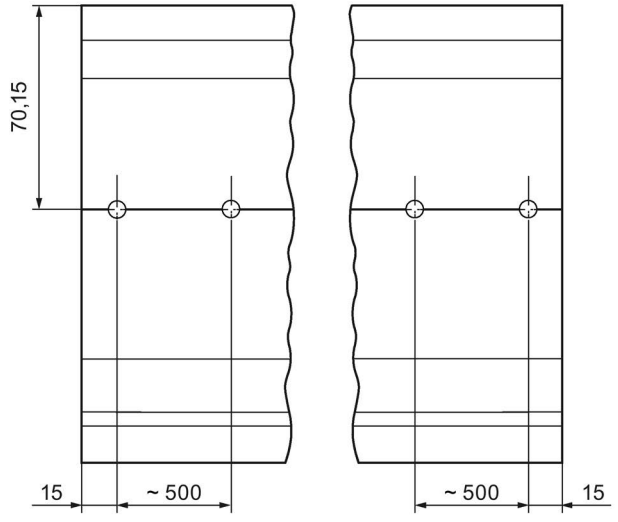
You can use the following screw types for fastening of the mounting rails:

Table 4- 1 Required accessories

For ...	you can use ...	Explanation
• outer fixing screws • additional fixing screws (for mounting rails > 482.6 mm)	M6 fillister head screws according to ISO 1207/ISO 1580 (DIN 84/DIN 85)	Choose a suitable screw length for your assembly.
	M6 hexagon head screws according to ISO 4017 (DIN 4017)	You also need washers for cylinder head screws with an internal diameter of 6.4 mm and an external diameter of 11 mm in accordance with ISO 7092 (DIN 433).

Dimensions for the drill holes

Table 4- 2 Dimensions for the drill holes

"Standard" mounting rails	"Longer" mounting rails
	

Length of the mounting rail	Distance a	Distance b
160 mm	10 mm	140 mm
245 mm	10 mm	225 mm
482.6 mm	8.3 mm	466 mm
530 mm	15 mm	500 mm
830 mm	15 mm	800 mm

Additional fixing screws (for mounting rails > 530 mm)

For mounting rails > 530 mm, we recommend using additional fixing screws at intervals of ≤ 500 mm on the identification groove.

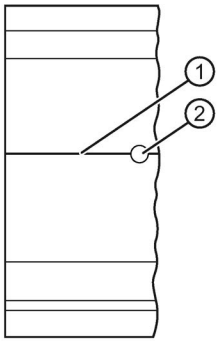
Preparing the 2000 mm mounting rail for installation

To prepare the 2000 mm mounting rail for installation, follow these steps:

1. Cut the 2000 mm mounting rail to the required length.
2. Mark the holes. The necessary dimensions can be found in the table "Dimensions for the drill holes":
   - Two drill holes at the beginning and end of the mounting rail
   - Additional drill holes at equal intervals of 500 mm maximum, along the identification groove
3. Drill the marked holes according to the selected type of fastening.
4. Ensure that there are no burrs or shavings on the mounting rail.

Note

To ensure secure installation of the modules, make sure you position the drill holes centered on the identification groove and only use screws of the maximum size.



① Identification groove for additional drill holes
② Additional drill hole

Figure 4-2 Preparing the 2000 mm mounting rail for installation

Installing the mounting rail

Place the mounting rail such that sufficient space remains for installation of and heat dissipation from the modules. Note the figure Minimum clearances in the control cabinet (Page 38).

Screw the rail onto the mounting surface.

Attaching the protective conductor

The S7-1500 automation system/ ET 200MP distributed I/O system has to be connected to the protective conductor system of the electrical system to ensure electrical safety.

To connect the protective conductor, follow these steps:

1. Strip the grounding conductor with a minimum diameter of 10 mm^2 and attach a ring terminal for size M6 bolts with the crimping pliers.
2. Slide the enclosed bolt into the T profile groove.
3. Insert the spacer, ring terminal with the grounding connector, flat washer, and lock washer onto the bolt (in that order). Thread the hexagon head nut, and fasten the components in place with the nut (torque 4 Nm).
4. Connect the opposite end of the grounding cable to the central grounding point/protective conductor busbar (PE).

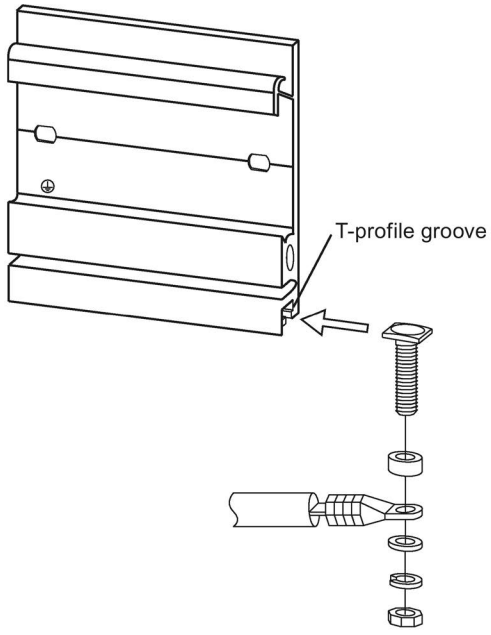


Figure 4-3 Attaching the protective conductor

Note

Alternative grounding of the mounting rail

If it is ensured that the mounting rail is permanently connected to the protective conductor system using an equivalent installation that complies with standards, for example, by permanent attachment to a grounded control cabinet wall, grounding via the grounding screw can be omitted.

Reference

Additional information on the precise dimensions of the mounting rails can be found in the Dimension drawings of the mounting rails (Page 217) section.

4.3 Installing a system power supply

Introduction

The system power supply has a connection to the backplane bus and supplies the configured modules with the internal supply voltage.

Requirements

The mounting rail is installed.

Tools required

Screwdriver with 4.5 mm blade

Installing a system power supply

To install the system power supply, follow these steps:

1. Insert the U-connector into the back of the system power supply.
2. Hang the system power supply on the mounting rail.
3. Swivel the system power supply to the rear.

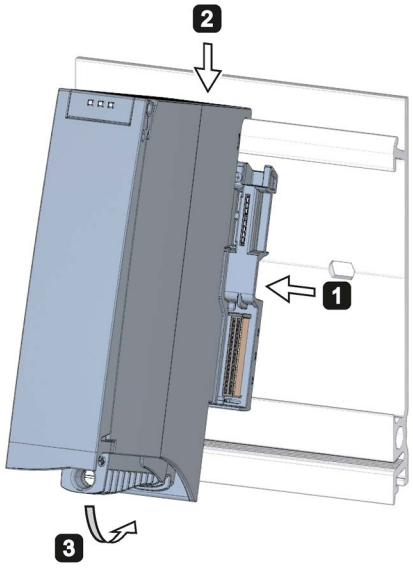


Figure 4-4 Installing a system power supply

4. Open the front cover.
5. Disconnect the power cable connector from the system power supply.
6. Screw the system power supply tight (torque 1.5 Nm).
7. Insert the already wired-up power cable connector into the system power supply.

Information about wiring of the power cable connector is available in the section Connecting system power supply and load current supply (Page 62).

Uninstalling a system power supply

The system power supply is wired up.

To uninstall the system power supply, follow these steps:

1. Turn off the feed supply voltage.
2. Open the front cover.
3. Shut down the system power supply.
4. Disconnect the power cable connector, and remove the connector from the system power supply.
5. Undo the power supply module's fixing screw(s).
6. Swivel the system power supply out of the mounting rail.

Reference

Further information can be found in the manuals for the system power supplies.

4.4 Installing a load current supply

Introduction

Load current supplies do not have a connection to the backplane bus of the S7-1500 automation systems/ET 200MP distributed I/O system and therefore do not occupy a configurable slot. The system power supply, CPU, interface module and input and output circuits of the I/O modules are supplied with 24 V DC by the load current supply.

Requirements

The mounting rail is installed.

Tools required

Screwdriver with 4.5 mm blade

Installing a load current supply

To install a load current supply, follow these steps:

1. Hook the load current supply on the mounting rail.
2. Swivel the load current supply to the rear.

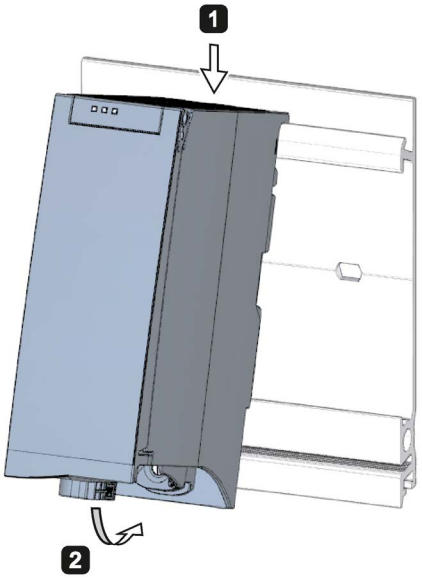


Figure 4-5 Installing a load current supply

3. Open the front cover.
4. Disconnect the power cable connector from the load current supply.
5. Tighten the screw for the load current supply (torque 1.5 Nm).
6. Insert the already wired-up power cable connector into the load current supply.

For a description on how to wire the power cable connector, refer to the section Connecting system power supply and load current supply (Page 62).

Note

Load current supplies can only be mounted on left or right side outside the S7-1500 automation system / ET 200MP distributed I/O system. If you mount a load current supply on the right of the configured setup, the heat development of the load current supply may make a gap to the configured setup necessary. For additional information, refer to the relevant manuals. The number of load current supplies that can be used is unlimited.

Uninstalling the load current supply

The load current supply is wired up.

To uninstall a load current supply, follow these steps:

1. Turn off the feed supply voltage.
2. Open the front cover.
3. Shut down the load current supply.
4. Disconnect the power cable connector, and remove the connector from the load current supply.
5. Undo the power supply module's fixing screw(s).
6. Swivel the load current supply out of the mounting rail.

Reference

Further information can be found in the manuals for the load current supplies.

4.5 Installing the CPU

Introduction

The CPU executes the user program and supplies the electronics of the modules with power via the backplane bus.

Requirements

The mounting rail is installed.

In a system power supply located on the left next to the CPU, a U connector is inserted on the back right.

Note

Protective film

Note that a protective film is applied to the display in the delivery state of the CPU. You can remove the protective film as required.

Tools required

Screwdriver with 4.5 mm blade

Installing the CPU

To install a CPU, follow these steps:

1. Insert a U-connector into the back right on the CPU.
2. Hook the CPU on the mounting rail and slide the CPU up to the left-hand system power supply.
3. Ensure that the U-connector is inserted at the system power supply. Swivel the CPU in to the rear.
4. Tighten the screw for the CPU (torque 1.5 Nm).

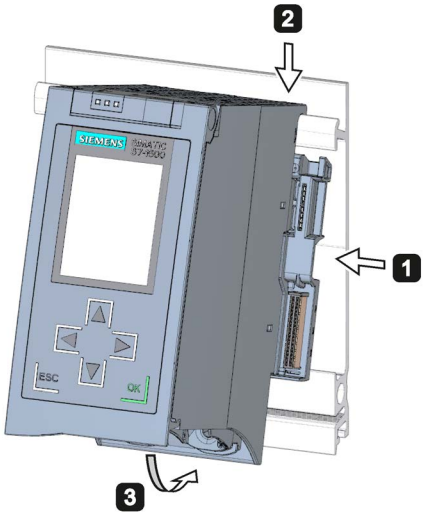


Figure 4-6 Installing the CPU

Uninstalling the CPU

The CPU is wired, and is followed by additional modules.

To uninstall a CPU, follow these steps:

1. Open the front cover.
2. Switch the CPU into STOP mode.
3. Turn off the feed supply voltage.
4. Pull off the connector for the supply voltage.
5. Loosen the bus connectors for PROFIBUS/PROFINET with the screwdriver, and remove them from the CPU.
6. Undo the CPU's fixing screw(s).
7. Pivot the CPU out of the mounting rail.

4.6 Installing the interface module

Introduction

The interface module connects the ET 200MP with the PROFINET IO/PROFIBUS DP and exchanges data between the higher-level controller and the I/O modules.

Requirements

The mounting rail is installed.

In a system power supply located before the interface module, a U connector is inserted on the back right.

Tools required

Screwdriver with 4.5 mm blade

Installing the interface module

Watch video sequence
(http://cache.automation.siemens.com/media/67462859_installing_web_en/start.htm)

To install an interface module, proceed as follows:

1. Mount the U-connector on the back right-hand side of the interface module.
2. Hook the interface module on the rail.
3. Pivot the interface module towards the back.
4. Tighten the screw for the interface module (torque 1.5 Nm).

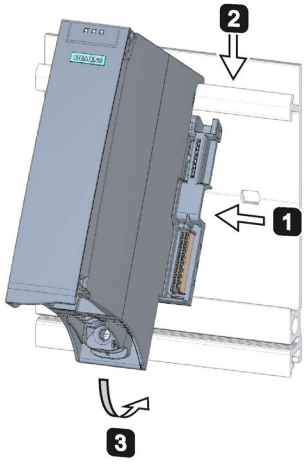


Figure 4-7 Installing the interface module

Uninstalling the interface module

The interface module is wired and is followed by additional modules.

To uninstall the interface module, follow these steps:

1. Switch off the supply voltage for the interface module.
2. Open the front cover.
3. Loosen the bus connector and the connector for the supply voltage with the screwdriver and remove the connectors from the interface module.
4. Loosen the fixing screw of the interface module.
5. Pivot the interface module out of the mounting rail.

4.7 Installing I/O modules

Introduction

The I/O modules are installed following the CPU/interface module. I/O modules form the interface between the controller and the process. The controller detects the current process state via the connected sensors and actuators, and triggers the corresponding reactions.

Requirements

The mounting rail is installed.

The CPU/interface module is installed.

In the module/CPU/interface module located to the left of the I/O module, a U-connector is inserted on the back right.

Tools required

Screwdriver with 4.5 mm blade

Installing I/O modules

Proceed as follows to install an I/O module:

1. Insert a U connector into the back right on the I/O module.
   Exception: the last I/O module in the assembly
2. Hook the I/O module on the mounting rail and slide the I/O module up to module on the left.
3. Pivot the I/O module towards the back.
4. Tighten the screw for the I/O module (torque 1.5 Nm).

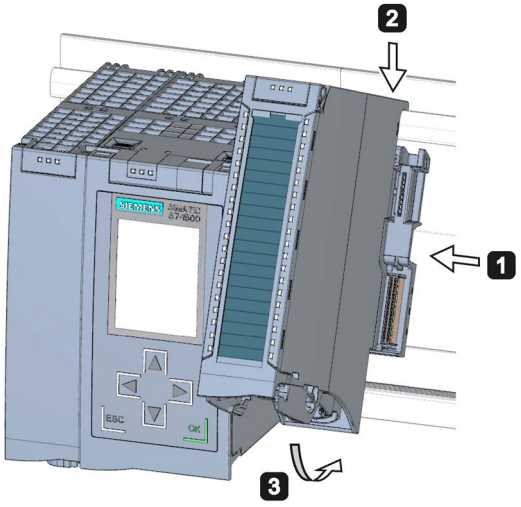


Figure 4-8 Installing I/O module

Uninstalling I/O modules

The I/O module is wired.

Proceed as follows to dismantle an I/O module:

1. Turn off all feed supply voltages.
2. Open the front cover.
3. For communications modules: Loosen and remove the connector from the module.

   At I/O modules: Pull the front connector out of the I/O module using the unlocking strap. Swivel the front connector downward and remove it from the groves.
4. Loosen the fixing screw of the I/O module.
5. Pivot the I/O module out of the mounting rail.

Wiring

5

5.1 Rules and regulations for operation

Introduction

When installing the S7-1500 automation system/ ET 200MP distributed I/O system as part of a plant or system, special rules and regulations need to be adhered to depending on the area of application.

This section provides an overview of the most important rules that must be observed for the integration of the S7-1500 automation system/ ET 200MP distributed I/O system in a plant or system.

Specific application

Please observe the safety and accident prevention regulations applying to specific applications (e.g., machine protection guidelines).

EMERGENCY-STOP devices

EMERGENCY OFF equipment to IEC 60204 (corresponds to DIN VDE 0113) must remain effective in all operating modes of the plant or system.

Excluding hazardous plant states

Hazardous operating states must not occur when:

- The plant starts up again after a voltage dip or voltage failure.
- The bus communication is resumed after a fault.

If necessary, EMERGENCY-STOP must be forced.

An uncontrolled or undefined startup is not permitted after the EMERGENCY STOP is unlocked.

Line voltage

Below is described, what you must pay attention to with respect to the supply voltage (see the section Statements on insulation tests, protection classes, degree of protection, and rated voltage (Page 215)):

- For fixed plants or systems without multipole circuit breaker, a mains disconnection device (multipole) must be available in the building installation.
- For load current supplies, the configured rated voltage range must correspond to the local line voltage.
- For all power circuits of the S7-1500 automation system/ET 200MP distributed I/O system, the fluctuation/deviation of the line voltage from the rated value must be within the permitted tolerance.

24 V DC supply

The following describes what you must pay attention to in terms of the 24 V DC supply:

- Power supply units for the 24 V DC supply must have a safe galvanic isolation in accordance with IEC 60364-4-41.
- To protect the S7-1500 automation system/ET 200MP distributed I/O system from lightning and overvoltages, use overvoltage arresters.

  Suitable components for the lightning and overvoltage protection are specified in the Defining interference-free controllers (http://support.automation.siemens.com/WW/view/en/59193566) function manual.

Protection against electrical shock

The mounting rail of the S7-1500 automation system/ET 200MP distributed I/O system has to be connected conductively with the protective conductor as protection against electrical shock.

Protection against external electrical influences

The following describes what you must pay attention to in terms of protection against electrical influences and/or faults:

- Make sure that the system for discharging electromagnetic interference is connected to a protective conductor with sufficient diameter for all plants with an S7-1500 automation system/ ET 200MP distributed I/O system.
- For supply, signal and bus lines, you must ensure that the laying of the lines and the installation is correct.
- For signal and bus lines, you must ensure that a wire/cable breakage or a cross-wire does not lead to undefined states of the plant or system.

Reference

Additional information can be found in the function manual, Designing interference-free controllers (http://support.automation.siemens.com/WW/view/en/59193566).

5.2 Operation on grounded infeed

Introduction

Information is provided below on the overall configuration of an S7-1500 automation system/ET 200MP distributed I/O system on a grounded infeed (TN-S system). The specific subjects discussed are:

- Disconnecting devices, short-circuit and overload protection to IEC 60364 (corresponding to DIN VDE 0100) and IEC 60204 (corresponding to DIN VDE 0113)
- Load power supplies and load circuits

Grounded infeed

In the case of grounding incoming supplies (TN-S system) the neutral conductor (N) and the protective conductor (PE) are each grounded. Both conductors form a part of the overvoltage concept. When a plant is in operation, the current flows across the neutral conductor. When a fault occurs, for example a single ground fault between a live conductor and ground, the current flows through the protective conductor.

Safe galvanic isolation (SELV/PELV in accordance with IEC 60364-4-41)

Load current supplies/system power supplies with safe galvanic isolation are required for the operation of the S7-1500 automation system/ET 200MP distributed I/O system. This protection is designated as SELV (Safety Extra Low Voltage)/PELV (Protective Extra Low Voltage) in accordance with IEC 60364-4-41.

Reference potential of the controller

The reference potential of the S7-1500 automation system/ ET 200MP distributed I/O system is connected with the mounting rail through a high-resistance RC combination in the CPU/interface module. In this way, high-frequency interference currents are conducted and electrostatic charges are avoided. Despite the grounded mounting rail, the reference potential of the S7-1500 automation system/ET 200MP distributed I/O system has to be considered as ungrounded due to the high-resistance connection.

If you want to configure the S7-1500 automation system/ET 200MP distributed I/O system with grounded reference potential, connect the M connection of the CPU/interface module galvanically with the protective conductor.

You can find a simplified representation of the potential relationships in section Electrical configuration (Page 56).

Short-circuit and overload protection

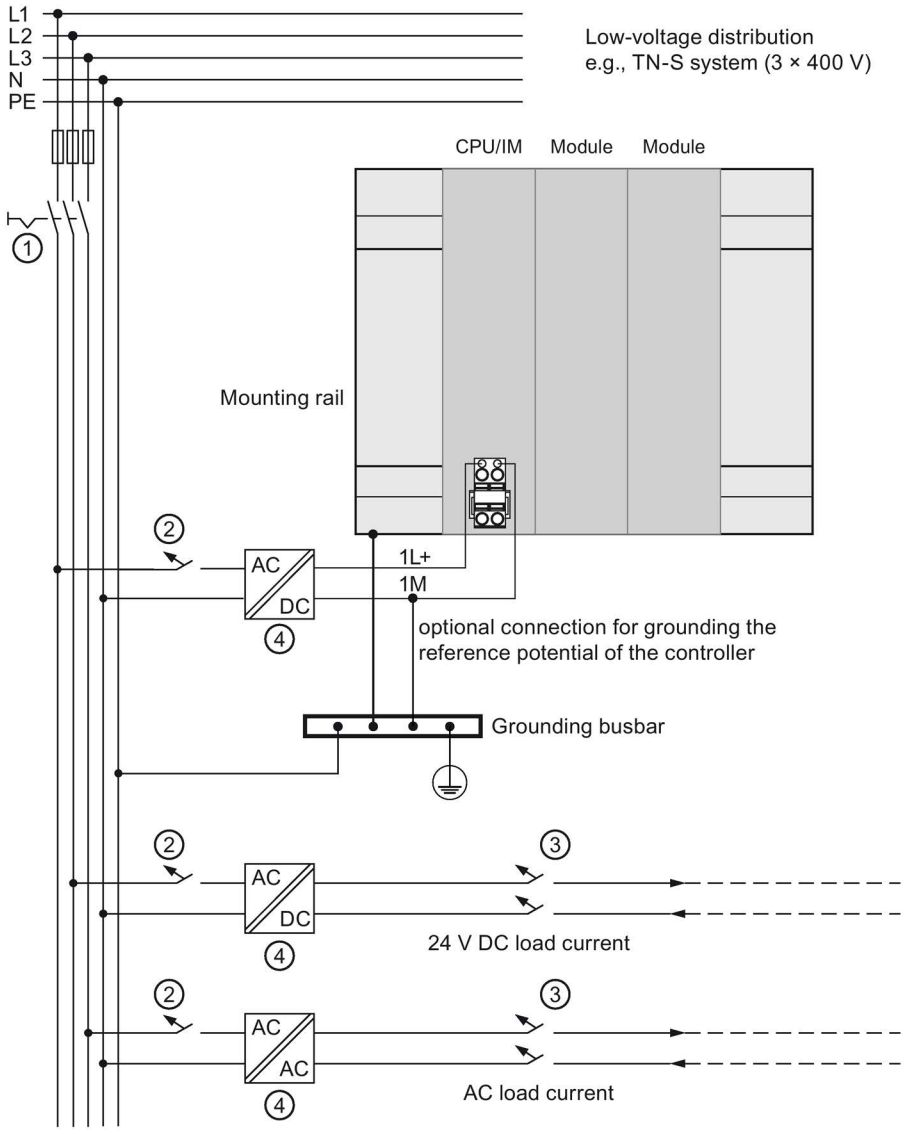
Various measures as protection against short-circuits and overloads are required for setting up a full installation. The nature of the components and the degree to which the required measures are binding depends on the IEC (DIN VDE) regulation applicable to your plant configuration. The table refers to the following figure and compares the IEC (DIN VDE) regulations.

Table 5- 1 Components and required measures

	Reference to following figure	IEC 60364 (DIN VDE 0100)	IEC 60204 (DIN VDE 0113)
Shut-off device for control system, sensors, and actuators	①	Main switch	Disconnector
Short-circuit and overload protection: In groups for sensors and actuators	② ③	Single-pole protection of circuits	• With grounded secondary circuit: fuse **unipolar** • Otherwise: fuse **all poles**
Load current supply for AC load circuits with more than five electromagnetic devices	④	Galvanic isolation by transformer **recommended**	Galvanic isolation by transformer **recommended**

S7-1500/ET 200MP in the overall configuration

The figure below shows the overall configuration of the S7-1500/ET 200MP (load current supply and grounding concept) with infeed from a TN-S system.



① Main switch
② Short-circuit and overload protection on the primary side
③ Short-circuit and overload protection on the secondary side
④ The load current supply (galvanic isolation)

Figure 5-1 Operating the S7-1500/ET 200MP with grounded reference potential

5.3 Electrical configuration

Galvanic isolation

With the S7-1500 automation system/ET 200MP distributed I/O system, there is galvanic isolation between:

- The primary side of the system power supply (PS) and all other circuit components
- The (PROFIBUS/PROFINET) communication interfaces of the CPU/interface module and all other circuit components
- The load circuits/process electronics and all other circuit parts of the S7-1500/ET 200MP components

High-frequency interference currents are conducted and electrostatic charges are avoided through integrated RC combinations or integrated capacitors.

S7-1500 potential relationships

The following figure shows a simplified representation of the potential relationships of the S7-1500 automation system.

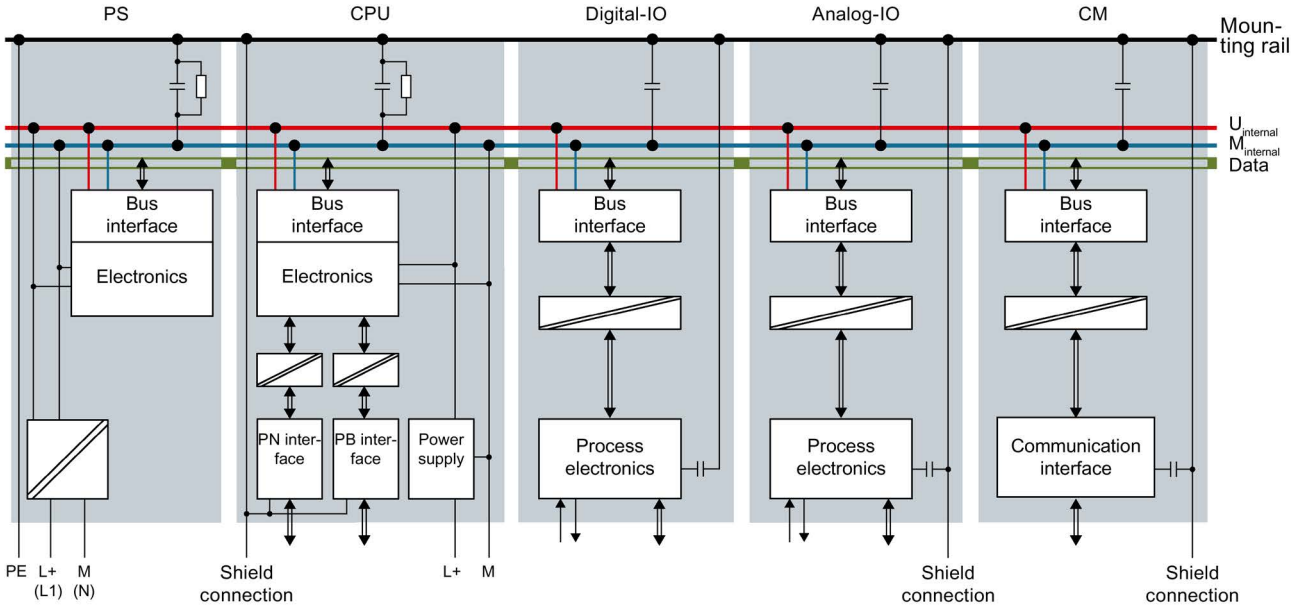


Figure 5-2 Potential relationships for S7-1500 using CPU 1516-3 PN/DP as an example

Potential relationships ET 200MP on PROFINET IO

The following figure shows a simplified representation of the potential relationships of the ET 200MP distributed I/O system on PROFINET IO.

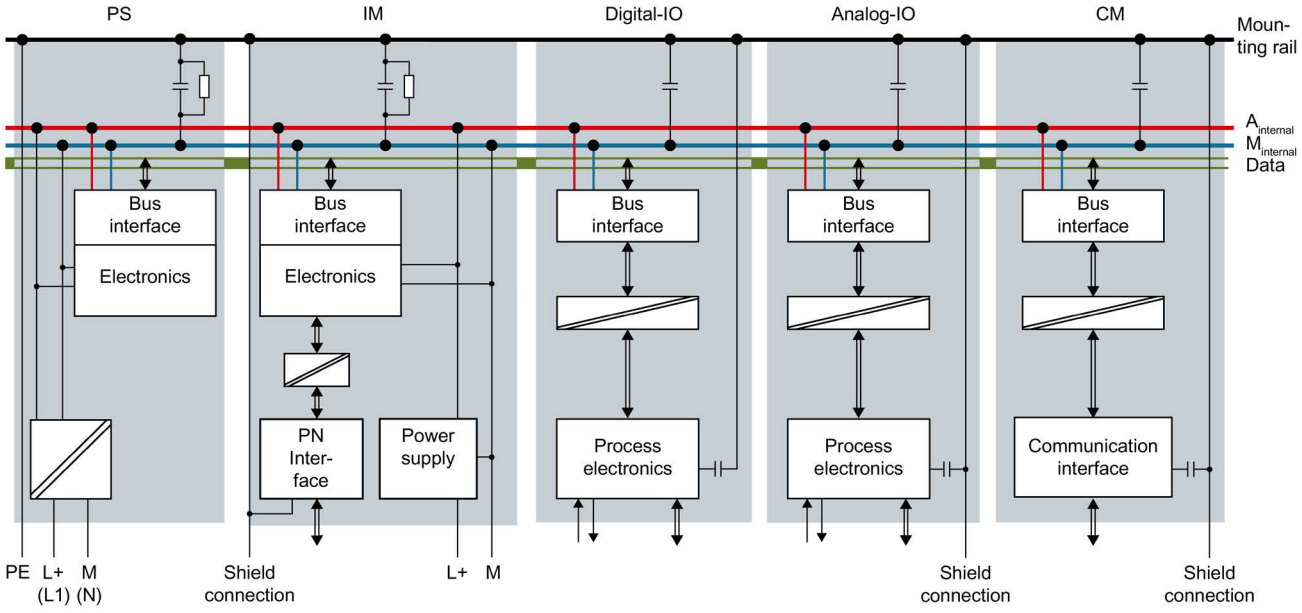


Figure 5-3 Potential relationships for ET 200MP using an IM 155-5 PN HF interface module as an example

Potential relationships ET 200MP on PROFIBUS DP

The following figure shows a simplified representation of the potential relationships of the ET 200MP distributed I/O system on PROFIBUS DP.

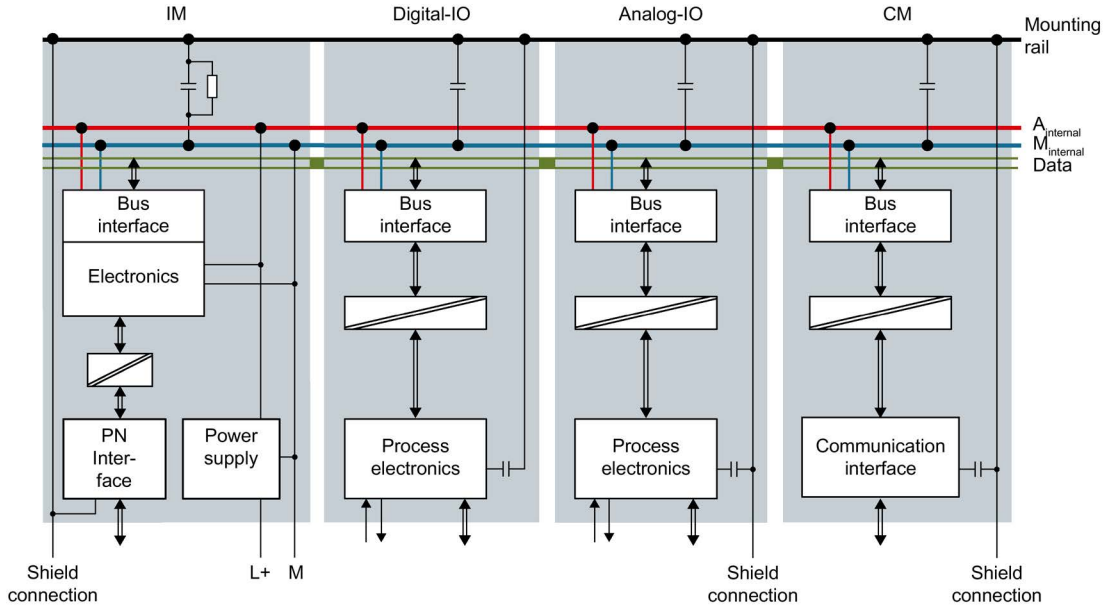


Figure 5-4 Potential relationships for ET 200MP using an IM 155-5 DP ST interface module as an example

5.4 Wiring rules

Table 5- 2 Wiring rules for CPU, interface module, system power supply and load current supply

Wiring rules for...		CPU/interface module	System power and load current supply
Connectible conductor cross-sections for solid wires		-	-
		-	-
Connectible conductor cross-sections for stranded wires	Without end sleeve	0.25 to 2.5 mm^2	1.5 mm^2
		AWG*: 24 to 16	AWG*: 16
	With end sleeve	0.25 to 1.5 mm^2	1.5 mm^2
		AWG*: 24 to 16	AWG*: 16
Number of wires per connection		1	1
Length of stripped wires		10 to 11 mm	7 to 8 mm
End sleeves according to DIN 46228	without plastic sleeve	Design A, 10 mm long	Design A, 7 mm long
	with plastic sleeve 0.25 to 1.5 mm^2	Design E, 10 mm long	Design A, 7 mm long
Sheath diameter		-	8.5 mm
Tool		3 to 3.5 mm screwdriver, conic design	3 to 3.5 mm screwdriver, conic design
Connection system		Push-in terminal	Screw terminal
Tightening torque		-	from 0.5 Nm to 0.6 Nm

* American Wire Gauge

Table 5- 3 Wiring rules for front connector

Wiring rules for...		40-pin front connector (screw terminal, for 35 mm module)	40-pin front connector (push-in terminal, for 35 mm module)	40-pin front connector (push-in terminal, for 25 mm module)
Connectible conductor cross-sections for solid wires		up to 0.25 mm²	up to 0.25 mm²	up to 0.25 mm²
		AWG*: up to 24	AWG*: up to 24	AWG*: up to 24
Connectible conductor cross-sections for stranded wires	Without end sleeve	0.25 to 1.5 mm²	0.25 to 1.5 mm²	0.25 to 1.5 mm² (max. 40 x 0.75 mm²)
		AWG*: 24 to 16	AWG*: 24 to 16	AWG*: 24 to 16 mm² (max. 40 x 0.75 mm²)
	With end sleeve	0.25 to 1.5 mm²	0.25 to 1.5 mm²	0.25 to 1.5 mm² (max. 32 x 0.75 mm²; 8 x 1.5 mm²)
		AWG*: 24 to 16	AWG*: 24 to 16	AWG*: 24 to 16 (max. 32 x AWG 19; 8 x AWG 16)
Number of wires per connection		1 or combination of 2 wires up to 1.5 mm² (total) in the same end sleeve	1 or combination of 2 wires up to 1.5 mm² (total) in the same end sleeve	1 or combination of 2 wires up to 1.5 mm² (total) in the same end sleeve
Length of stripped wires		10 to 11 mm	8 to 11 mm (corresponding to length of end sleeve**: 8 mm, 10 mm)	8 to 11 mm (corresponding to length of end sleeve**: 8 mm, 10 mm)
End sleeves according to DIN 46228	without plastic sleeve	Design A, 10 mm and 12 mm long	Design A, 10 mm long	Design A, 10 mm long
	with plastic sleeve 0.25 to 1.5 mm²	Design E, 10 mm and 12 mm long	Design E, 8 mm and 10 mm long	Design E, 8 mm and 10 mm long
Sheath diameter		-	-	-
Tool		3 to 3.5 mm screwdriver, conic design	3 to 3.5 mm screwdriver, conic design	3 to 3.5 mm screwdriver, conic design
Connection system		Screw terminal	Push-in terminal	Push-in terminal
Tightening torque (screw terminal)		from 0.4 Nm to 0.7 Nm	-	-
Max. actuation force for complete opening of the push-in terminal		-	40 N	40 N

* American Wire Gauge

** End sleeve

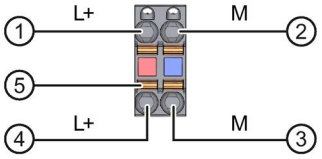
5.5 Connecting the supply voltage

Introduction

The supply voltage of the CPU/interface module is supplied by means of a 4-pole connection plug, which is located on the front of the CPU.

Connection for supply voltage (X80)

The connections of the 4-pole connector have the following meaning:



① + 24 V DC of the supply voltage
② Mass of the supply voltage
③ Mass of the supply voltage for looping (current limited to 10 A)
④ + 24 V DC of the supply voltage for looping (current limited to 10 A)
⑤ Spring opener (one spring opener per terminal)

Figure 5-5 Connection for supply voltage

The maximum connector cross-section is 1.5 mm^2. The cable connector offers you the option of looping the supply voltage uninterrupted, even when it is unplugged.

Requirements

- Only wire the cable connector when the supply voltage is turned off.
- Follow the wiring rules (Page 59).

Tools required

3 to 3.5 mm screwdriver

Tool-free connection of cables: multi-wire (stranded), with end sleeve or ultrasonic compressed

To connect a wire without tools, follow these steps:

1. Strip 8 to 11 mm of the wires.
2. Seal or crimp the wire with end sleeves.
3. Insert the wire into the push-in terminal as far as it will go.
4. Push the wired connector into the socket of the CPU/interface module.

Connection of wires: multi-wire (stranded), without end sleeve, unprocessed

To connect a wire without end sleeve, follow these steps:

1. Strip 8 to 11 mm of the wires.
2. Using a screwdriver, press the spring release and insert the wire into the push-in terminal as far as it will go.
3. Pull the screwdriver out of the spring release.
4. Push the wired connector into the socket of the CPU/interface module.

Loosening a wire

Push with the screwdriver as far as it will go into the spring release. Remove the wire.

Uninstalling the connection plug

To uninstall the connection plug, you need a screwdriver. With the screwdriver, pry the connection plug out of the CPU/interface module.

5.6 Connecting system power supply and load current supply

Introduction

In the delivery condition of the system power supplies/load current supplies, power connectors are inserted. The modules and the associated power connectors are coded. The coding is effected by means of two coding elements - one coding element is located in the module, and the other in the power connector. The system power supplies/load current supplies use identical power connectors for the voltage connection.

The coding element prevents the insertion of a power connector into a different type of system power supply/load current supply.

Tools required

3 to 3.5 mm screwdriver

Connecting the supply voltage to a system power supply/load current supply

Watch video sequence
(http://cache.automation.siemens.com/media/67462859_connecting_supply_web_en/start.htm)

To connect the supply voltage, follow these steps:

1. Swing the front cover of the module up until the front cover latches.
2. Press down the unlocking button of the power cable connector (Figure 1). Remove the power cable connector from the front of the module.
3. Loosen the screw on the front of the connector. This loosens the housing latch and the cable relief. With a tightened screw the connector's cover can't be removed (Figure 2).
4. Pry off the connector cover using a suitable tool (Figure 3).

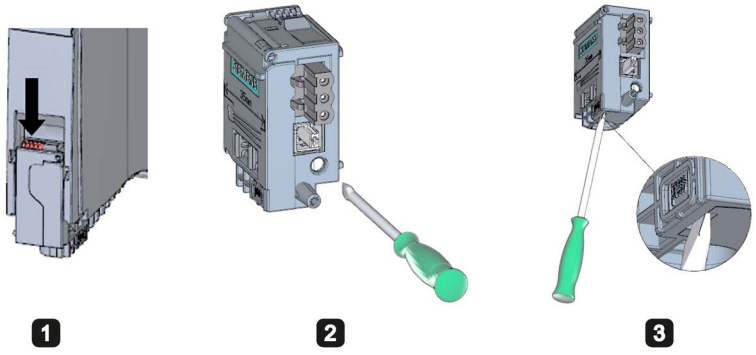


Figure 5-6 Connecting the supply voltage to a system power supply/load current supply (1)

5. Strip the cable sheathing to a length of 35 mm and the conductors to a length of 7 to 8 mm, and bring them up to the end sleeves.
6. Connect the wires in the connector according to the connection diagram (Figure 4).
7. Close the cover (Figure 5).
8. Retighten the screw (Figure 6). This effects a strain relief on the lines.

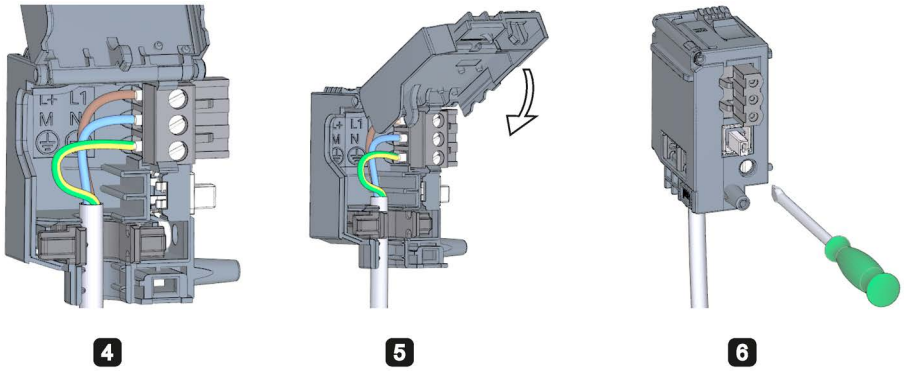


Figure 5-7 Connecting the supply voltage to a system power supply/load current supply (2)

9. Insert the power connector into the module, until the latch engages.

Reference

Further information about connecting the 24 V DC output voltage of the load voltage supply modules is available in the manuals of the corresponding modules.

5.7 Connecting interfaces for communication

Connecting interfaces for communication

The communication interfaces of the CPU/interface module are connected using standardized connectors.

Use prefabricated connecting cables for the connection. If you want to prepare communication cables yourself, the interface assignment is specified in the manuals of the corresponding modules. Observe the mounting instructions for the connectors.

5.8 Front connector for the I/O modules

Introduction

The sensors and actuators of your plant are connected to the automation system by means of front connectors. Wire the sensors and actuators to the front connector and then plug it into the I/O module. You can either wire the front connector in the "pre-wiring position" that makes convenient wiring possible, or completely, before you insert it into the I/O module.

You can remove the front connector easily from the I/O module with the wiring attached. This means it is not necessary to loosen the wiring when you replace the module.

Device versions of the front connector

① Front connector 35 mm with screw terminals
② Front connector 25 mm with push-in terminals
③ Front connector 35 mm with push-in terminals

Figure 5-8 Device versions of the front connector

Properties of the front connectors

The three different front connectors are characterized as follows:

- 40 clamping points each
- Connection technology: Screw terminal (for 35 mm modules only) or push-in terminal
- Module width: 35 mm or 25 mm
- If you want to supply load groups with the same potential (non-isolated), use the potential bridges supplied to the front connectors for the digital I/O modules. In four locations: 9 and 29, 10 and 30, 19 and 39, 20 and 40, the terminals can be bridged by means of potential bridges. Advantage: Reduction of the wiring effort.

  Note

  Use of potential bridges

  The use of potential bridges depends on the relevant module used.

  Potential bridges may not be used for 230 V modules. Use the potential bridges only with a maximum supply voltage of 24 V DC. The current capacity per potential bridge is 8 A maximum.

  Owing to the different assignment for analog I/O modules, potential bridges may not be used

  The front connectors for 25 mm modules have no potential bridges.

  Observe the instructions and wiring rules in the product manual of the respective I/O module when using potential bridges.

- In the delivery state a coding element is located in the module. When the front connector is first inserted into the I/O module, a part of the coding element clips onto the front connector. When the front connector is removed from the I/O module, one part of the coding element remains in the front connector, and the other part remains in the I/O module. The insertion of a front connector that is not suited to the module is thereby mechanically prevented. This ensures, for example, that the front connector with the coding element of a digital module cannot be inserted into an analog module.

Reference

Additional information about the coding element is available in the section Coding element at the I/O module and at the front connector (Page 184).

Further information on the use of the potential bridges can be found in the product manual for the respective I/O module.

5.8.1 Wiring front connectors for I/O modules without shield contact element

Requirements

- The I/O modules are installed on the mounting rail.
- The supply voltages are turned off.
- The wires are prepared according to the utilized clamping technology, take the wiring rules (Page 59) into account for this purpose.

Tools required

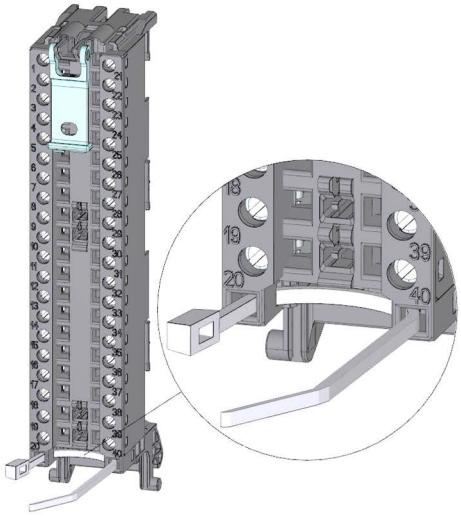
- Stripping tool
- 3 to 3.5 mm screwdriver

Preparing and wiring front connectors for I/O modules without shield contact element

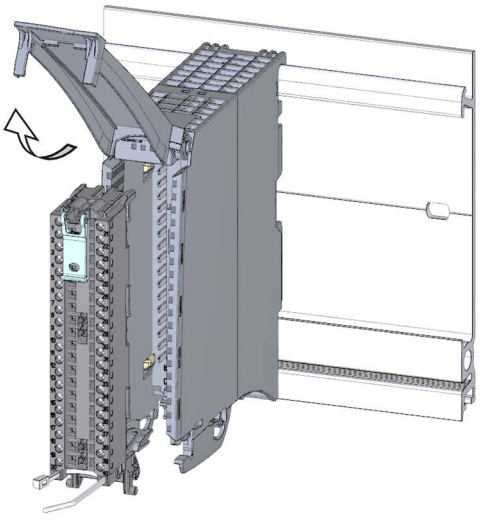
Proceed as follows to wire the front connector:

1. As needed, switch off the load current supply.
2. Place the included cable strain relief (cable tie) for the cable harness into the front connector (Figure 1).
3. Swing the front cover of the wired I/O module up until the front cover latches (Figure 2). Watch video sequence (http://cache.automation.siemens.com/media/67462859_wiring_front_web_en/start.htm)
4. Bring the front connector into the pre-wiring position. To do this, hook the front connector into the bottom of the I/O module and swivel the front connector upward until the front connector latches (Figure 3).

   Result: In this position, the front connector still protrudes from the I/O module (Figure 4). However, front connector and I/O module are not yet electrically connected. By means of the pre-wiring position, you can easily wire the front connector.



1



2

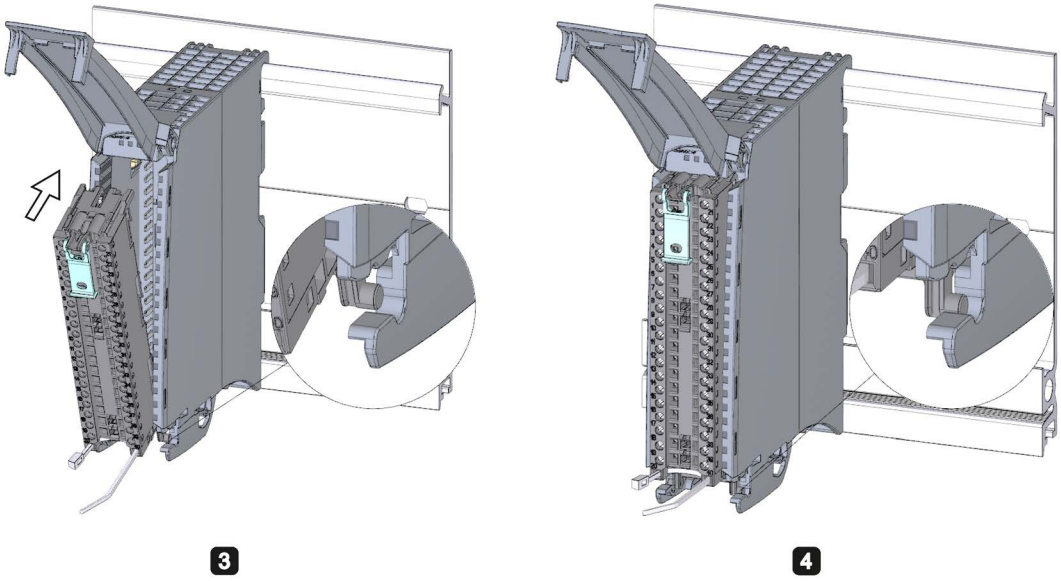


Figure 5-9 Wiring front connectors for I/O modules without shield contact element

5. Begin to completely wire the front connector.
6. Put the strain relief around the cable harness, and pull the strain relief for the cable harness tight.

Use of the potential bridges at digital modules

With the delivered potential bridges, for digital modules with a maximum rated voltage of 24 V DC, you can bridge the terminals for the voltage supply and thus reduce the wiring effort. The bridges are used to connect the terminals 9 and 29, 10 and 30, 19 and 39 as well as 20 and 40 facing each other.

Reference

Further information on wiring the inputs and outputs can be found in the manuals for the I/O modules.

5.8.2 Wiring front connectors for I/O modules with shield contact element

Requirements

- The I/O modules are installed on the mounting rail.
- The supply voltages are turned off.
- The wires are prepared according to the clamping technology used. To do this, follow the wiring rules (Page 59).

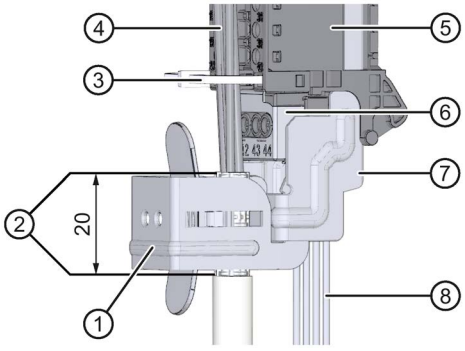
Tools required

- Stripping tool
- 3 to 3.5 mm screwdriver
- Flat pliers

Details view

The shielding bracket, the power supply element, and the shielding clamp are included in the scope of delivery for the analog and technology modules.

The following figure shows the details view of a front connector with shield connection element:



① Shield clamp
② Cable sheathing removed (approx. 20 mm)
③ Strain relief (cable tie)
④ Signal cables
⑤ Front connectors
⑥ Power supply element
⑦ Shielding bracket
⑧ Supply lines
①+⑦ Shield contact

Figure 5-10 Details view for front connectors with shield connection elements

Preparing front connectors for I/O modules with shield contact element

Watch video sequence
(http://cache.automation.siemens.com/media/67462859_wiring_shield_web_en/start.htm)

To prepare the front connector for wiring, follow these steps:

1. Remove the connection separator from the lower part of the connector (Figure 1).
2. Insert the power supply element (Figure 2).
3. Insert the shielding bracket from below into the guiding groove of the front connector until it latches into place (Figure 3).
4. Place the included cable strain relief (cable tie) for the cable harness into the front connector (Figure 4).

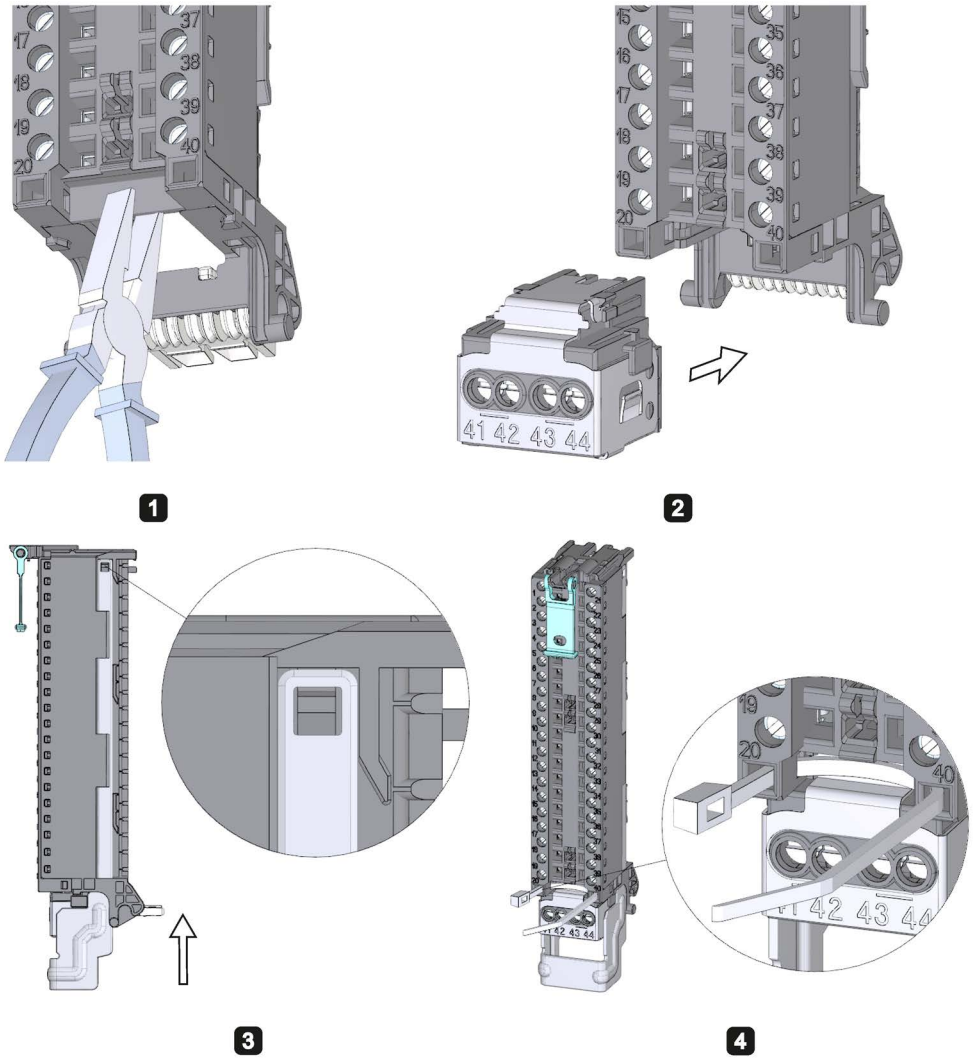


Figure 5-11 Preparing front connectors for I/O modules with shield contact element (1)

5. Swing the front cover up until the front cover latches (Figure 5).
6. Bring the front connector into the pre-wiring position. To do this, hook the front connector into the bottom of the I/O module and swivel it upwards until the front connector latches (Figure 6).

   Result: In this position, the front connector still protrudes from the I/O module (Figure 7). However, front connector and I/O module are not yet electrically connected.

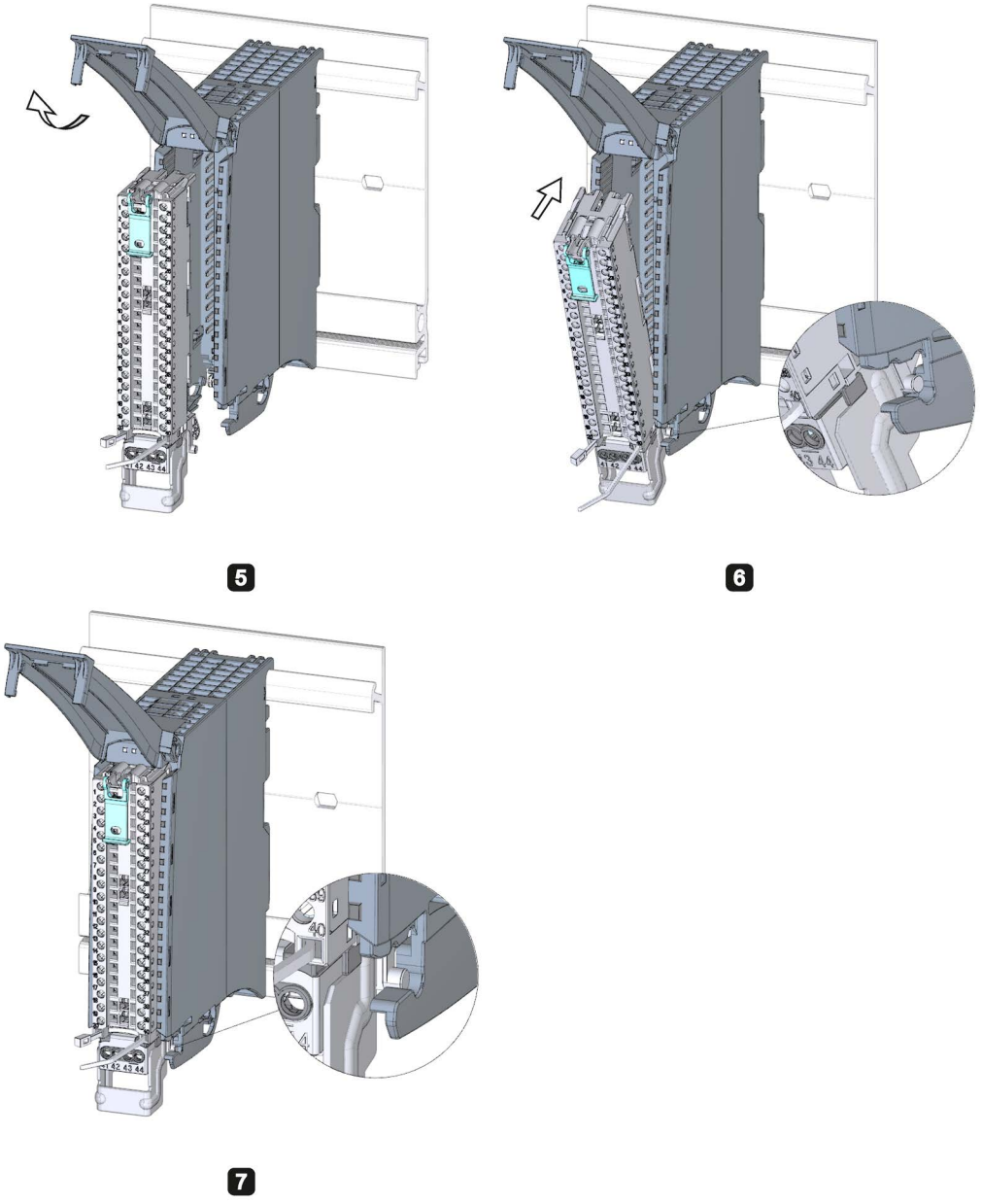


Figure 5-12 Preparing front connectors for I/O modules with shield contact element (2)

7. Wire the power supply element (Figure 8).
   Terminals 41/42 and 43/44 are galvanically connected to each other. If you connect the supply voltage to 41 (L+) and 44 (M), you can then loop-through the potential to the next module with terminals 42 (L+) and 43 (M).

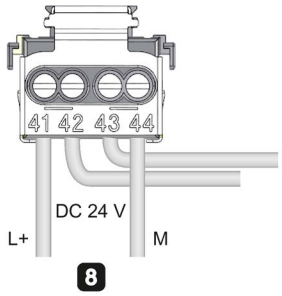


Figure 5-13 Preparing front connectors for I/O modules with shield contact element (3)

Wiring front connectors for I/O modules with shield contact element

To wire a front connector, follow these steps:

1. Strip the cable shielding.
2. Begin to completely wire the front connector (Figure 1).

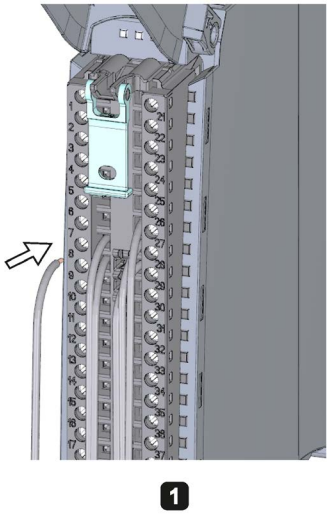
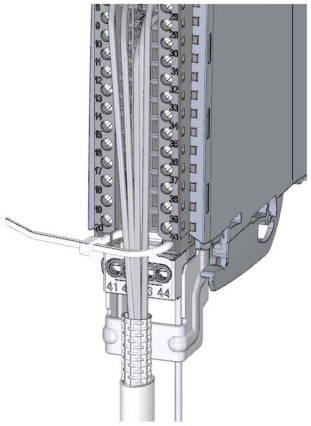


Figure 5-14 Wiring front connectors for I/O modules with shield contact element (1)

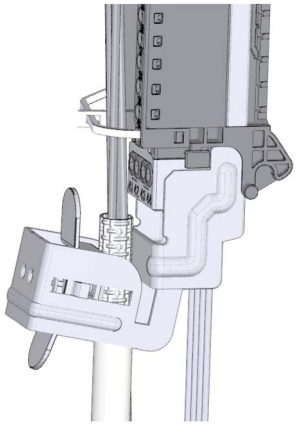
3. Put the strain relief (cable tie) around the cable harness, and pull the strain relief for the cable harness tight (Figure 2).



2

Figure 5-15 Wiring front connectors for I/O modules with shield contact element (2)

4. Insert the shield clamp from below into the shielding bracket in order to connect the cable shielding (Figure 3).



3

Figure 5-16 Wiring front connectors for I/O modules with shield contact element (3)

Functions of the shield contact

The shield contact:

- Is needed to apply cable shields (e.g., for analog modules)
- Interference currents on cable shields are diverted from the shield connection to ground via the mounting rail. The shielding connection is not required at cable entry into the switchboard.

Reference

Further information on wiring the inputs and outputs can be found in the manuals for the I/O modules.

5.8.3 Bringing the front connector into final position

Bring the front connector from the pre-wiring position into final position

Proceed as follows to bring the front connector from the pre-wiring position into final position:

1. Grip the front connector by the unlocking strap.
2. Pull on the strap until the front connector is released from its latched position.
3. Tilt the top section of the front connector and raise it slightly. The front connector slides over the guide channel into its final position.

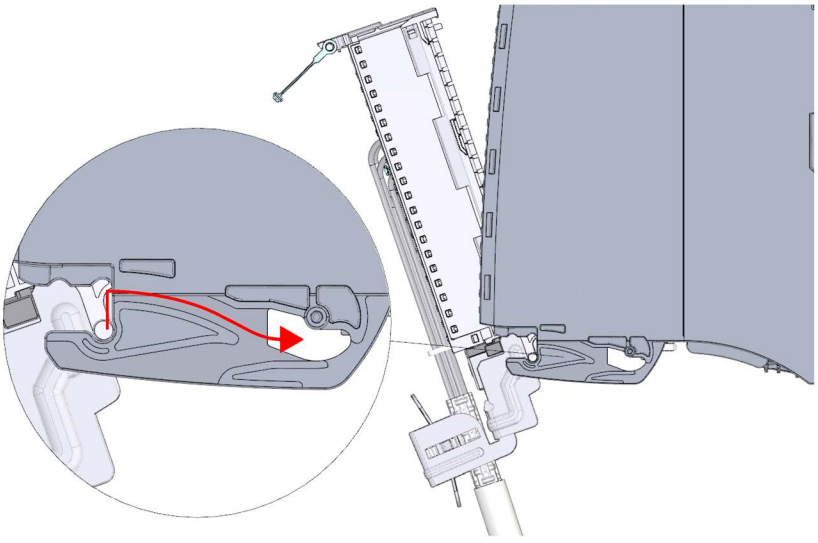


Figure 5-17 Bring the front connector from the pre-wiring position into final position

4. Push the front connector back into the I/O module until it latches. The front connector is now electrically connected with the I/O module.
5. Swivel the front cover down into place. Depending on the space requirement of the cable harness, various latch positions are possible so that the required cable storage space can grow as needed.

Bringing the front connector directly into final position

Proceed as follows to bring the front connector directly into final position:

1. Grip the front connector by the unlocking strap.
2. Push the guide pin of the front connector into the guide channel that has been displaced downwards. The front connector slides over the guide channel into its final position.

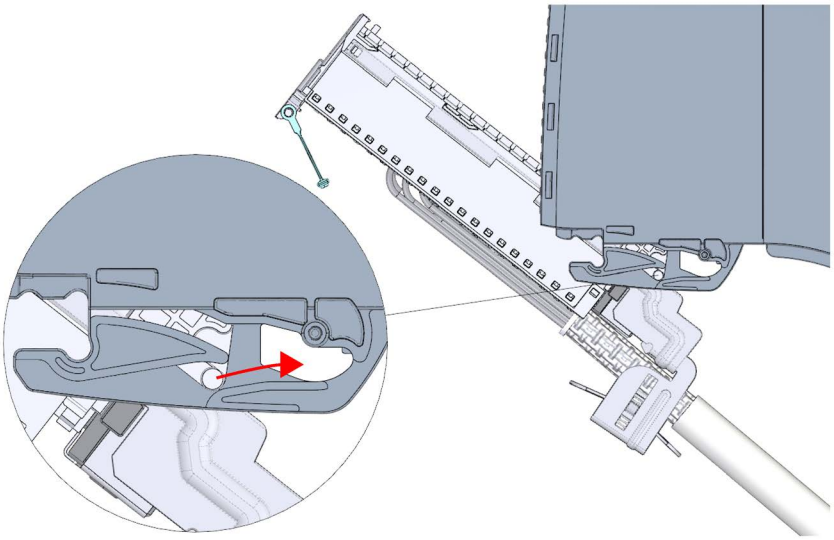


Figure 5-18 Bringing the front connector directly into final position

3. Tilt the front connector and press it into the I/O module until it latches. The front connector is now electrically connected with the I/O module.
4. Swivel the front cover down into place. Depending on the space requirement of the cable harness, various latch positions are possible so that the required cable storage space can grow as needed.

5.9 Marking the I/O modules

5.9.1 Labeling strips

Introduction

Mark the pin assignment of the I/O modules using labeling strips. You can label the labeling strips as desired and slide them into the outside of the front cover.

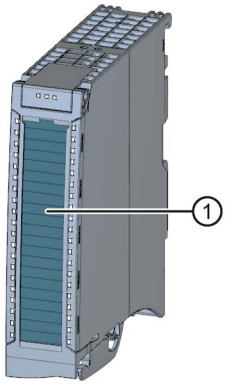
The labeling strips are available in the following models:

- Pre-prepared strips that are included with the I/O module as delivered.
- DIN A4 sheets, pre-perforated strips for machine printing, see chapter Accessories/Spare parts (Page 224)

Preparing and installing the labeling strip

Proceed as follows to prepare and install the labeling strips:

1. Label the labeling strip.
2. With a pre-perforated strip: Separate the labeling strip from the sheet.
3. Slide the labeling strip into the outside of the front cover.



① Labeling strips

Figure 5-19 Marking with labeling strips

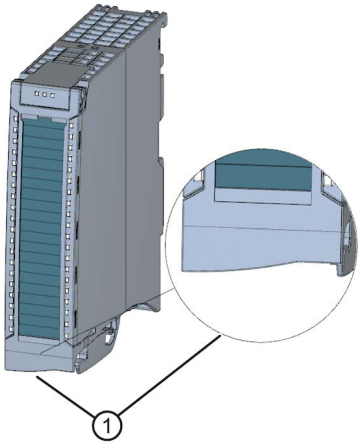
5.9.2 Optional marking

Introduction

On the I/O modules there is free space on the front cover, that permits an additional labeling or marking on the part of the customer.

Optional marking

The front cover provides about 30 mm x 10 mm of space in its lower part for an optional identifier label.



① Free space for example for equipment identifiers

Figure 5-20 Optional marking

Configuring

6

Introduction

You transfer the configuration (preset configuration) and mode of operation to the S7-1500 automation system/ET 200MP distributed I/O system by configuring, assigning parameters to and connecting the individual hardware components. The work needed for this is undertaken in the device and network view in STEP 7.

"**Configuring**" is understood to mean arranging, setting and networking devices and modules within the device or network view of STEP 7. STEP 7 graphically represents modules and racks. Just like "real" module carriers, the device view allows the insertion of a defined number of modules.

When the modules are plugged, STEP 7 automatically assigns the addresses and a unique hardware identifier (HW identifier). You can change the addresses later. The HW identifiers cannot be changed.

When the automation system is started, the CPU/interface module compares the configured preset configuration with the actual configuration of the system. You can assign parameters to control the response of the CPU/interface module to errors in the hardware configuration.

"**Parameter assignment**" is understood to mean setting the properties of the components used. The hardware parameters and the settings for data exchange are thereby assigned:

- Properties of the modules to which parameters can be assigned
- Settings for data exchange between components

The parameters are loaded into the CPU and transferred to the corresponding modules when starting up. Modules can be replaced with ease since the parameters set are automatically loaded into the new module during startup.

6.1 Configuring the CPU

Requirements for configuration of the CPU

Table 6- 1 Requirements for installation

Configuration software	Installation information
STEP 7(TIA Portal) as of V12.0 [1)]	STEP 7 online help

1) The following CPUs can configured as of V12: CPU 1511-1 PN, CPU 1513-1 PN, CPU 1516-3 PN/DP
Please note that all other CPUs can be configured only as of a later version (e.g., as of V12 SP1). Refer to the product manual for the CPU to find out whether the version of the CPU you are using is configurable in STEP 7.

6.1.1 Reading out the configuration

Introduction

When a connection exists to a physically present CPU, you can load the configuration of this CPU (including centrally present modules) from the device into your project using the "Hardware detection" function. You do not need to manually configure the CPU and the centrally present modules, as the physical configuration is read out automatically.

If a CPU and the centrally present modules have already been configured and you want to load the current configuration and parameters in a new project, it is advisable to use the "Upload device as new station" function. For more information about this function, refer to the chapter "Upload device as new station (Page 99)".

Procedure for reading out an existing configuration

1. Create a new project and configure an "Unspecified CPU 1500".

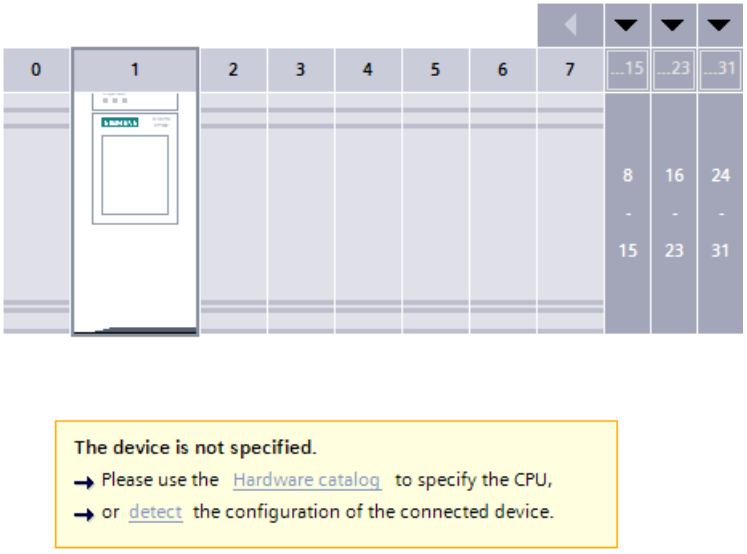


Figure 6-1 Unspecificd S7-1500 CPU in the device view

2. In the device view (or network view), select the "Hardware detection" command in the "Online" menu.

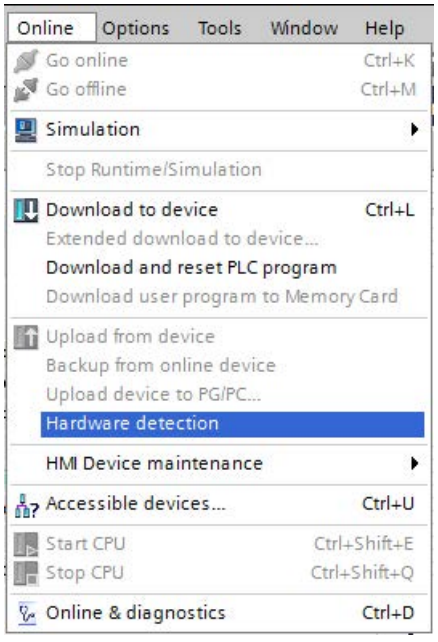


Figure 6-2 Hardware detection in the Online menu

STEP 7 opens the "Hardware detection for PLC_x" dialog box.

3. Select the CPU in the "Hardware detection for PLC_x" dialog box, and click "Detect".

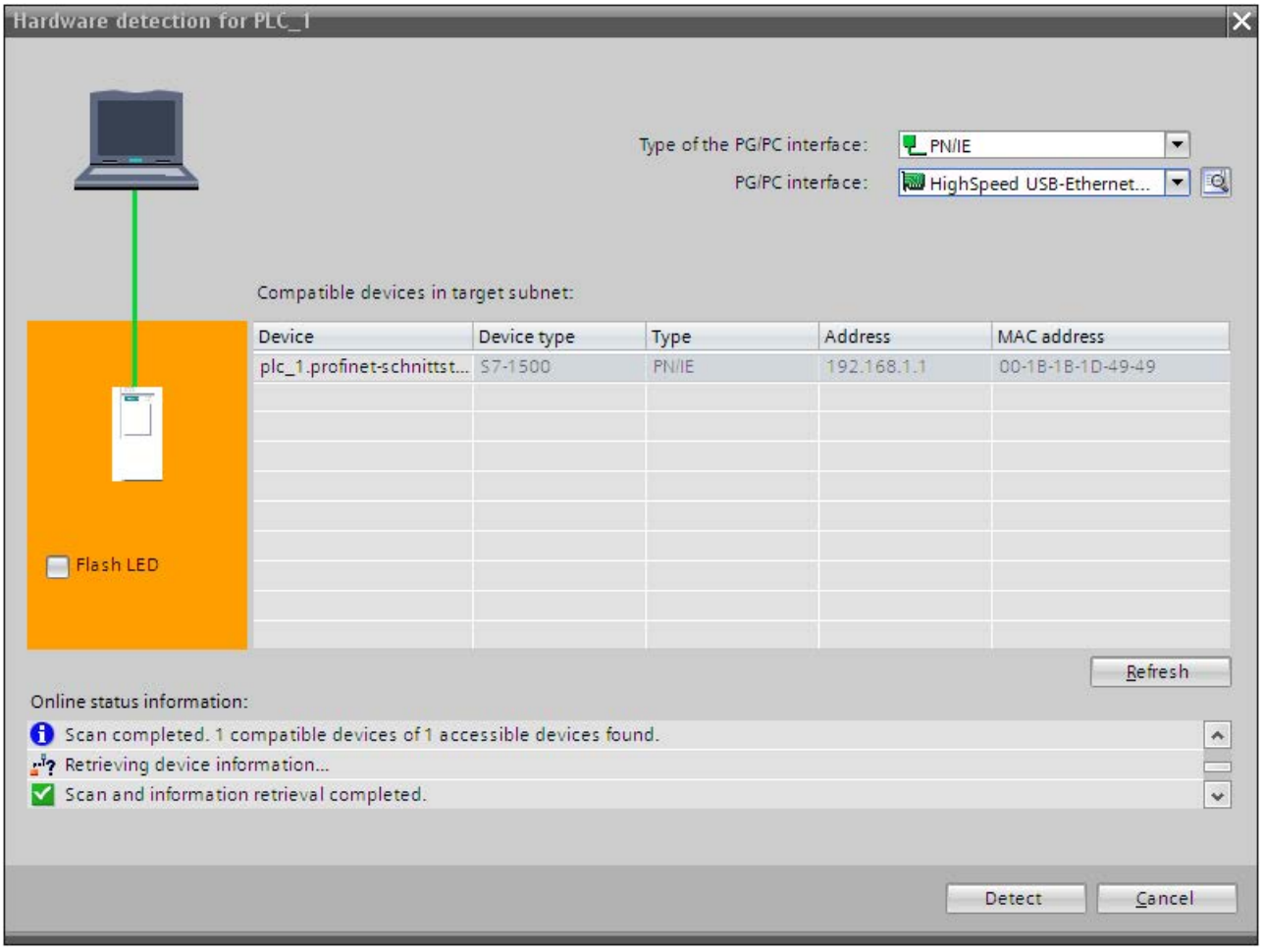


Figure 6-3 Hardware detection dialog box

Note

Alternative to step 2 and step 3, you can also click directly on the link "Detect" shown in step 1, to get to the "Hardware detection for PLC_x" dialog.

Result of the hardware detection

STEP 7 has read out the hardware configuration and the modules and transferred these to your project. STEP 7 assigns a valid default parameter assignments for all modules. You can change the parameter assignment subsequently.

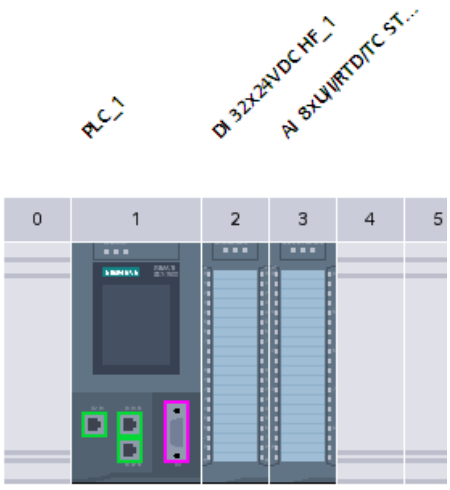


Figure 6-4 Result of the hardware detection in the device view

Note

If you want to go online after the hardware detection, you have to first download the detected configuration to the CPU; otherwise, an error may occur due to inconsistent configurations.

Properties of central modules

The properties of the CPUs have special significance for system behavior. For a CPU, you can, for example, make the following settings in STEP 7:

- Startup behavior
- Parameter assignment of the interface(s), for example IP address, subnet mask
- Web server, e.g., activation, user administration, and languages
- Cycle times, e.g., maximum cycle time
- Properties for the operation of the display
- System and clock memory
- Protection level for access protection with assigned password parameter
- Clock time settings (daylight saving time/standard time)

The properties that can be set and the corresponding value ranges are specified by STEP 7. Fields that cannot be edited are grayed out.

Reference

Information about the individual settings can be found in the online help and in the manual of the respective CPU.

6.1.2 Address assignment

6.1.2.1 Addressing - overview

Introduction

In order to address the automation components or I/O modules, unique addresses must be assigned to them. The various address areas are explained below.

I/O address

I/O addresses (input/output addresses) are required in the user program to read inputs and set outputs.

STEP 7 automatically assigns input and output addresses when you connect the modules. Each module uses a continuous area in the input and/or output addresses corresponding to its volume of input and output data.

Module	Rack	Slot	I address	Q address	Type	Order no.
	0	0				
▸ PLC_1	0	1			CPU 1516-3 PN/DP	6ES7 516-3AN00-0AB0
DI 16x24VDC HF_1	0	2	0...1		DI 16x24VDC HF	6ES7 521-1BH00-0AB0
DQ 32x24VDC/0.5A ST_1	0	3		0...3	DQ 32x24VDC/0.5A...	6ES7 522-1BL00-0AB0
AI 8xU/I HS_1	0	4	2...17		AI 8xU/I HS	6ES7 531-7NF10-0AB0
AQ 8xU/I HS_1	0	5		4...19	AQ 8xU/I HS	6ES7 532-5HF00-0AB0

Figure 6-5 Example with input / output addresses from STEP 7

The address areas of the modules are assigned by default to the process image partition 0 ("Automatic updating"). This process image partition is updated in the main cycle of the CPU.

Device address (e.g., Ethernet address)

Device addresses are addresses of modules with interfaces to a subnet (e.g., IP address or PROFIBUS address). They are required in order to address the various devices on a subnet, e.g., in order to download a user program.

Hardware identifier

STEP 7 automatically assigns a hardware identifier (HW identifier) to identify modules and submodules. The HW identifier is used, for example, for diagnostics alarms or for instructions, to identify the faulty module or the addressed module.

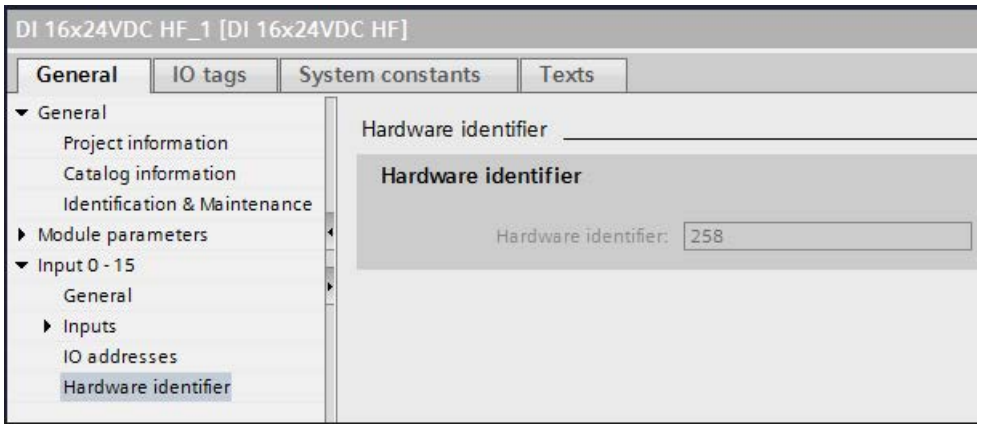


Figure 6-6 Example of a Hardware identifier from STEP 7

The "System constants" tab of a device includes all hardware identifiers and their names for the selected module.

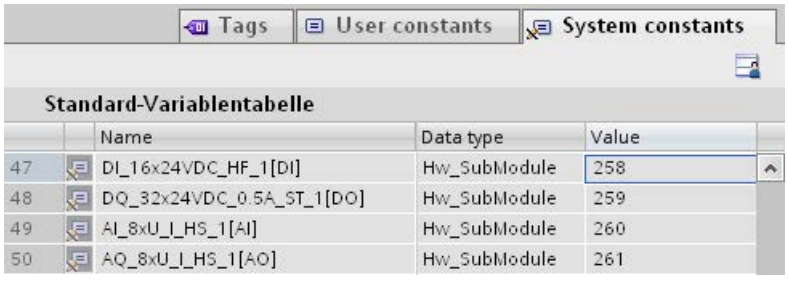


Figure 6-7 Example of a default tag table from STEP 7

The default tag table contains the HW identifiers and name for all modules.

You can change the name of a hardware identifier in the properties of a module in "General" You cannot change the value of a HW identifier.

6.1.2.2 Addressing digital modules

Introduction

The addressing of digital modules is described below. In your user program, you require the addresses of the channels of the digital module.

Digital module addresses

The address of a digital module's input or output is composed of the byte address and the bit address. The channels of the digital module are assigned bit addresses.

If you enable the value status for a digital module, then additional bytes are allocated in the input address area. Each bit is assigned to a channel and returns information about the validity of the digital value (0 = invalid value/1 = valid value).

The value status is a binary additional information of a digital input signal. The value status is entered simultaneously with the process signal in the process image input and provides information about the validity of the signal.

Example: **I 1.2**

The example consists of:

I	Input	-
1	Byte address	The byte address depends on the module start address
2	Bit address	You read the bit address from the module

When you insert a digital module into a free slot, STEP 7 assigns a default address. You can change the proposed default address in STEP 7.

Example for the assignment of channel addresses (digital module)

The following figure shows how the addresses of the individual channels of the digital input module (e.g., 6ES7521-1BL00-0AB0) are determined.

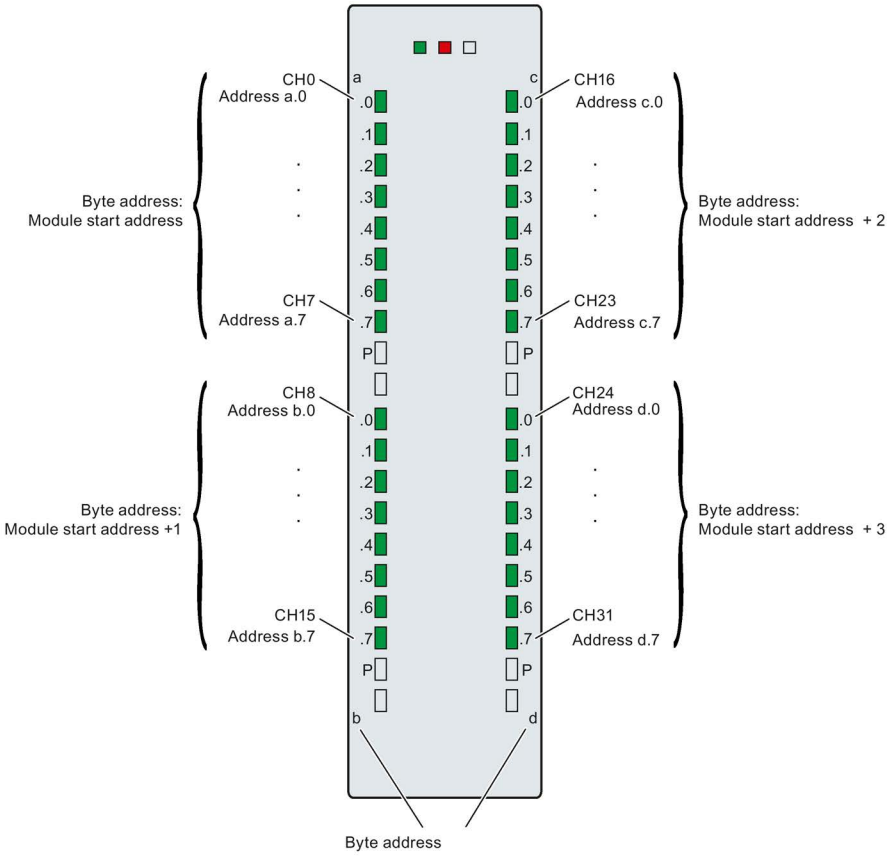


Figure 6-8 Example for the assignment of channel addresses (digital module)

Note

You can assign symbolic name to the addresses at the following locations in STEP 7:

- PLC tag table
- Properties of the module in the "IO Tags" tab.

Reference

Additional information on addressing and address allocation with value status can be found in the manuals of the digital modules, and in the online help for STEP 7. An example of the evaluation of the value status in the user program is available in the function manual Diagnostics (http://support.automation.siemens.com/WW/view/en/59192926).

6.1.2.3 Addressing analog modules

Introduction

The addressing of analog modules is described below. In your user program, you require the addresses of the channels of the analog module.

Analog module addresses

The address of an analog channel is always a word address. The channel address depends on the module start address. The channel addresses are automatically assigned during configuration in STEP 7. Based on the module start addresses, the assignment of the channel addresses occurs in increasing sequence (in the following figure, the module start address is 256).

When you insert an analog module into a free slot, STEP 7 assigns a default address. You can change the assigned default address in STEP 7.

If you enable the value status for an analog module, then additional bytes are allocated in the input address area. Each bit in this byte is assigned to a channel and returns information about the validity of the analog value (0 = invalid value/1 = valid value).

Example for the assignment of channel addresses (analog module)

The following figure shows how the addresses of the individual channels of the analog input module (e.g., 6ES7531-7NF10-0AB0) are determined, when the module has the start address 256.

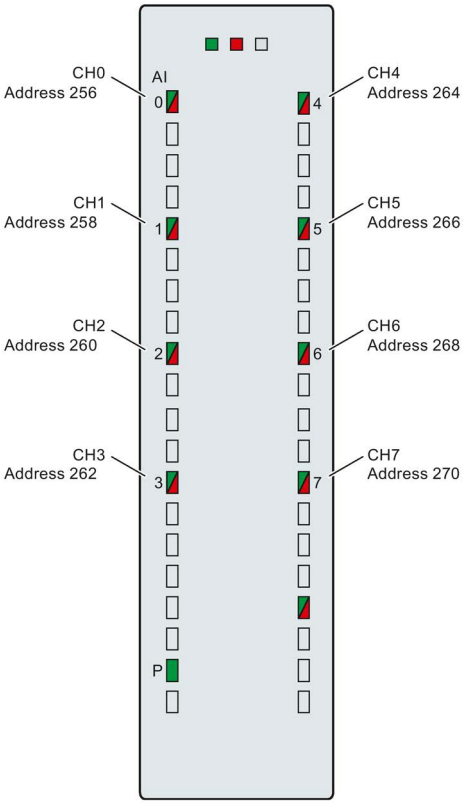


Figure 6-9 Example for the assignment of channel addresses (analog module)

Note

You can assign symbolic name to the addresses at the following locations in STEP 7:

- PLC tag table
- Properties of the module in the "IO Tags" tab.

Reference

Additional information on addressing and address allocation with value status can be found in the manuals of the analog modules, and in the online help for STEP 7. A detailed description of the value status for analog modules is available in the function manual Analog value processing (http://support.automation.siemens.com/WW/view/en/67989094). An example of the evaluation of the value status in the user program is available in the function manual Diagnostics (http://support.automation.siemens.com/WW/view/en/59192926).

6.1.3 Process images and process image partitions

6.1.3.1 Process image - overview

Process image of the inputs and outputs

When the user program addresses the input (I) and output (O) operand areas, it does not query the signal states directly from the I/O modules. Instead, it accesses a memory area of the CPU. This memory area contains an image of the signal states and is called the process image.

Advantages of the process image

A process image allows you to access a consistent image of process signals during cyclic program execution. If a signal state at an input module changes during program processing, the signal state is retained in the process image. The process image is not updated until the next cycle.

32 process image partitions

In the S7-1500 automation system, the overall process image is subdivided into up to 32 process image partitions (PIP).

PIP 0 (automatic update) is automatically updated in each program cycle and is assigned to OB 1.

Process image partitions PIP 1 through PIP 31 can be assigned to the other OBs. In STEP 7, this assignment occurs during configuration of the I/O modules.

After the OB has been started, the assigned process image partition of inputs is updated by the system and the process signals are read in. At the end of the OB the outputs of the assigned process image partition are written directly to the peripheral outputs by the system without having to wait for the termination of the cyclic program processing.

You can only assign the addresses of a module to a single process image partition.

6.1.3.2 Assign process image partitions to an OB

Update process image partition

You can assign a process image partition to an OB. In this case, the process image partition is automatically updated.

The process image partition of the inputs (PIPI) is always read in/updated before the processing of the associated OB. The process image partition of the outputs (PIPQ) is always output at the end of the OB.

The following figure illustrates the updating of the process image partitions.

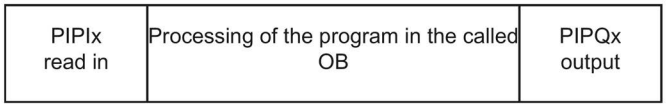


Figure 6-10 Update process image partitions

6.1.3.3 Update process image partitions in the user program

Requirements

As an alternative to the automatic updating and to updating by assignment to an OB, you can use the instruction "UPDAT_PI" or the instruction "UPDAT_PO" at the start or the at the end of the respectively assigned OB to update the process image. In STEP 7, these instructions are available on the "Instructions" Task Card under "Extended instructions" and may be called from any point in the program.

Requirements for updating process image partitions with the "UPDAT_PI" and "UPDAT_PO" instructions:

- The process image partitions may not be assigned to any OB, i.e. they may not be automatically updated.
- PIP 0 (automatic update) can likewise not be updated with the "UPDAT_PI" and "UPDAT_PO" instructions.

UPDAT_PI: Update the process image partition of the inputs

With this instruction you read the signal states from the input modules into the process image partition of the inputs (PIPI).

UPDAT_PO: Update the process image partition of the outputs

With this instruction you transmit the process image partition of the outputs to the output modules.

Isochronous mode interrupt OBs

In the isochronous mode interrupt OBs you use the instructions "SYNC_PI" and "SYNC_PO" to update the process image partitions. Additional information on isochronous mode interrupt OBs is available in the STEP 7 online help.

Direct I/O access to the inputs and outputs of the module

You also have direct read and write access to the I/O, as an alternative to access via the process image, should direct access be required for programming reasons.

Reference

Additional information on process image partitions is available found in the function manual, Cycle and response times (http://support.automation.siemens.com/WW/view/en/59193558).

6.1.4 Backing up and restoring the CPU configuration

6.1.4.1 Overview

Backup from online device

You will make a number of changes to your plant over time, for example, add new devices, replace existing devices or adapt the user program. If these changes result in undesirable behavior, you can restore the plant to an earlier state. Before you load a changed configuration to the CPU, first use the option "Backup from online device" to create a complete backup of the current device status.

Upload from device (software)

With the option "Upload from device (software)", you load the software project data from the CPU to an existing CPU in the project.

Upload device as new station

If you are operating a new programming device/PC in the plant, the STEP 7 project that was used to create the plant configuration might not be available. In this case you can use the option "Upload device as new station" to load the device's data into a project in your PG/PC.

Snapshot of the monitor values

You can use the option "Snapshot of the monitor values" to backup the current values of the data block, in order to be able to restore the current values if necessary at a later date.

Overview of backup types

The table below shows the backup of CPU data depending on the selected type of backup and its specific characteristics:

	Backup from online device	Upload from device (software)	Upload device as new station	Snapshot of the monitor values
Actual values of all DBs (global and instance data blocks)*	✓	✓	✓	✓
Blocks of the type OB, FC, FB and DB	✓	✓	✓	--
PLC tags (tag names and constant names)	✓	✓	✓	--
Technology objects	✓	✓	✓	--
Hardware configuration	✓	--	✓	--
Actual values (bit memories, timers, counters)*	✓	--	--	--
Contents of the SIMATIC memory card	✓	--	--	--
Archives, recipes	✓	--	--	--
Entries in the diagnostics buffer	--	--	--	--
Current time	--	--	--	--
Properties of the type of backup				
Backup possible for fail-safe CPUs	✓	--	--	✓
Backup can be edited	--	✓	✓	✓
Backup possible in operating mode	STOP	RUN, STOP	RUN, STOP	RUN, STOP

* Only the values of the tags that are set as retentive are backed up

6.1.4.2 Backup from online device

Full backup of the CPU

With the option "Backup from online device" you create a full backup of the CPU in an opened project with STEP 7. The following data are backed up:

- Actual values of all DBs
- Blocks of the type OB, FC, FB and DB
- PLC tags
- Technology objects
- Hardware configuration
- Actual values (bit memories, timers, counters)
- Contents of the SIMATIC memory card
- Archives, recipes

Note

Backup of current values

The "Backup from online device" type of backup backs up the current values of the tags that are set as retentive. To ensure consistency of the retentive data, all write access to retentive data must be disabled during the backup.

Actual values of the non-retentive data are reset to their start values during a transition for STOP to RUN mode. When the CPU is backed up only these start values of non-retentive data are then backed up.

Requirements

The following requirements must be met before you start the backup:

- The CPU has been set up in the project.
- The CPU is connected to the programming device/PC via the PROFINET interface. PROFIBUS interfaces of the CPU and interfaces of CMs/CPs are not supported.
- The CPU must be in STOP mode.
- The hardware configuration and software to be downloaded have to be compatible with STEP 7.
- You have the password for read access to the CPU or F-CPU, if an access level was configured for the CPU or F-CPU.

Procedure

To create a backup of the current configuration of a CPU, follow these steps:

1. Select the PLC station in the project tree.
2. Select the "Backup from online device" command in the "Online" menu.
   You may have to enter and confirm the password for read access and confirm that the CPU may be set to STOP mode.

Result

STEP 7 backs up the CPU saves the backup in the "Name of CPU > Online backups" folder in the project tree. The backup is assigned the name of the CPU with the time and date of the backup. You can rename the backup, but you cannot make any changes to the contents of the backup.

An entry is created for each backup operation in the diagnostics buffer of the CPU.

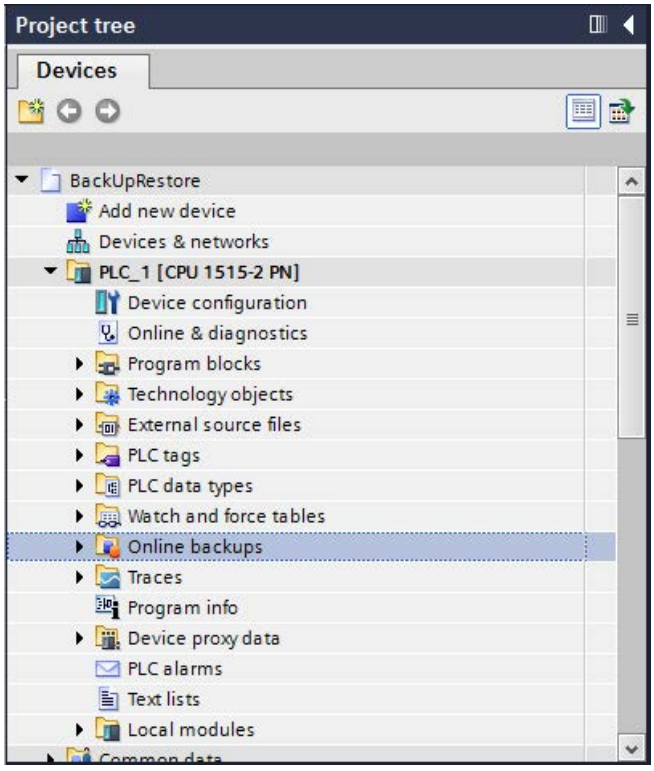


Figure 6-11 "Online backups" folder in the project tree of STEP 7

You can create as many backups as you want and store a variety of configurations for a CPU.

Restoring a full backup

You can transfer to the CPU a backup made at an earlier date The CPU restores the saved data.

Requirements

The following requirements must be met before you start the restore:

- You have previously configured the CPU and stored a backup of the device in the project.
- The CPU is connected to the programming device/PC via the PROFINET interface.
- The CPU must be in STOP mode.
- You have the password for read access to the CPU, if an access level was configured for the CPU.

Procedure

To restore the data on the CPU, follow these steps:

1. Open up the folder of the device in the project tree to display the lower-level objects.
2. Open the "Online backups" folder.
3. Select the backup you want to restore.
4. In the "Online" menu, select the "Download to device" command
   (you may need to enter the password for read access to the CPU)
   - If you had previously established an online connection, the "Load preview" dialog opens. The dialog includes alarms and suggests necessary actions for the download.
   - If you have not already established an online connection, the "Extended download to device" dialog opens automatically. In it, select the interfaces with which you want to establish the online connection to the device.
5. Check the alarms in the "Load preview" dialog, and select the actions in the "Action" column, if necessary.

   ⚠ WARNING

   Download of backups with unknown content

   If you activate the suggested actions during download and during plant operation, malfunctions or program errors can cause severe damage and serious injuries.

   Make sure that the backup contents do not include any configuration that would result in unpredictable behavior of the plant.

6. As soon as downloading becomes possible, the "Load" button is enabled.
7. Click "Load".
   The contents of the backup are transferred to the CPU and restored. The CPU is restarted.

   The "Load results" dialog opens. In this dialog, you can check whether or not the loading operation was successful and take any further action that may be necessary.
8. Click "Finish".

6.1.4.3 Upload from device (software)

Loading software project data from the CPU to a project

With the option "Upload from device (software)" you back up the software components from the CPU to a project. The option uploads the following data from the CPU to a project:

- Actual values of all DBs
- Blocks of the type OB, FC, FB and DB
- PLC tags
- Technology objects

Requirements

Before you start with the uploading of the data from the CPU to a project, the following requirements must be met:

- The CPU has been set up in the project.
- The CPU is connected to the programming device/PC via the PROFINET interface. PROFIBUS interfaces of the CPU and interfaces of CMs/CPs are also supported.
- The CPU is online.
- The software components that are to be loaded must be compatible with STEP 7.
- The CPU is in STOP or RUN mode.

Procedure

To upload the data to a project, follow these steps:

1. Select the required PLC station in the project tree.
2. In the "Online" menu, select the "Upload from device (software)" command.
3. In the "Upload preview" dialog window, select the check box "Continue".
4. Click the "Upload from device" button.

Upload blocks from the CPU to a project

You use this option to load blocks from the CPU back to the offline project.

The following requirements must be met before you start to backup the blocks:

- The project associated with the user program is open.
- The CPU has been set up in the project.
- The CPU is connected to the programming device/PC via the PROFINET interface. PROFIBUS interfaces of the CPU and interfaces of CMs/CPs are also supported.
- The CPU is online.
- The blocks that are to be loaded must be compatible with STEP 7.
- The CPU is in STOP or RUN mode.

To upload all blocks from the CPU to a project, select the "Program blocks" folder in the project tree. In the "Online" menu, select the "Upload from device (software)" command.

To upload an individual block, select the required block in the "Program blocks" folder. In the "Online" menu, select the "Upload from device (software)" command.

When a block is uploaded, the start values from the load memory of the CPU is transferred as start value in the offline version of the project.

A block is only uploaded from the CPU to a project if the online version of the block differs from the offline version of the block in the project.

After you have completed the backup of blocks from the CPU, you can perform the required changes offline and transfer the block to the CPU again. To do so, proceed as described in the following section.

Upload blocks from a project to the CPU

To upload one or multiple blocks to the CPU, select the "Program blocks" folder in the project tree. Select the "Download to device" > "Software (only changes)" command from the shortcut menu. Alternatively, select the "Download to device" command in the "Online" menu.

The block or blocks is/are compiled consistently. The download is terminated if an error occurs during compiling. You can only load blocks that are compiled without errors.

Note

Loading external objects

If you load blocks to the CPU which contain references to objects (other DBs, FCs, FBs, system constants, global tags) outside the project, these blocks cannot be compiled without errors.

⚠ WARNING

Reloading blocks while the plant is operating

Reloading blocks while the plant is operating can cause serious damage to property or injury to persons if there are functional disturbances or program errors. Make sure that no dangerous situations can arise before you start the actions.

6.1.4.4 Upload device as new station

Upload device as new station (hardware and software)

With this option you upload existing project data of a CPU to your project as a new station. The option can be used, for example, to save the project data of a new plant as a new project in your programming device/PC. "Upload device as new station (hardware and software)" loads the following data from the CPU to your project:

- Actual values of all DBs
- Blocks of the type OB, FC, FB and DB
- PLC tags
- Technology objects
- Hardware configuration

Requirements

The following requirements must be met before you can execute the option:

- The CPU is connected to the programming device/PC via the PROFINET interface. PROFIBUS interfaces of the CPU and interfaces of CMs/CPs are also supported.
- The hardware configuration and software to be uploaded to the device must be compatible with STEP 7.
- Modules present in the device from GSD (ML), HSPs, or service packs must be installed in STEP 7 on the programing device/PC.
- A project must be open. This project can be a new (empty) project or an existing project.

Note

Upload device as new station to an existing project

When you upload a device as new station to an existing project, make sure there are no conflicts between the names/IP addresses of the existing components and the components to be uploaded, for example, the name of the CPU is already used in the existing project.

If conflicts exist, follow these steps:

- Change the names/IP addresses used in the project.
- Compile the affected stations.
- Re-start the function "Upload device as new station (hardware and software)".

Procedure

To upload CPU to your project, follow these steps:

1. Select the project name in the project tree.
2. In the "Online" menu, select the "Upload the device as new station (hardware and software)".
   The "Upload device to PG/PC" dialog is opened.
3. Choose required interface type in the "Type of PG/PC interface" drop-down list.
4. Select the interface to be used from the "PG/PC interface" drop-down list.
5. Click the "Configure interface" button to the right of the "PG/PC interface" drop-down list to adapt the settings for the selected interface.
6. Display all compatible devices by selecting the relevant option and clicking the "Start search" command. In the accessible devices table, select the device from which you want to upload project data.
7. Click "Load".

6.1.4.5 Snapshot of the monitor values

Backing up actual values of all data blocks

With the option "Snapshot of the monitor values" you overwrite the start values of tags in the offline version of a data block with actual values from the CPU. In this way, you can restore the backed up status of the data blocks at a later date after changing the actual values.

To apply the actual values, you first generate a snapshot of tag values from the online program. You can then apply these as start values.

Note

Note that the values from the snapshot are always copied. STEP 7 does not hereby check whether all values originate from the same cycle.

The following options exist for the application of actual values from the snapshot as start values:

- Apply the values of an opened data block
  You can apply all values or only the values of the tags marked as a "Setpoint" as start values in an open data block.
- Apply the values of multiple data blocks in the project tree
  In the project tree, you can apply either all setpoints or all retentive values as start values.

The following requirements must be met in order to be able to back up the actual values of data blocks:

- The CPU is connected to the programming device/PC via the PROFINET interface. PROFIBUS interfaces of the CPU and interfaces of CMs/CPs are also supported.
- The CPU is online.
- As least one data block has been loaded to the CPU.
- The data blocks are not write-protected.

Applying monitored values

To apply all actual values or only the values of the tags marked as "Setpoint" in a data block, follow these steps:

1. Open the data block.
2. Start the monitoring by clicking the "Monitor all" button.
   The "Monitor value" column is shown in the table. This shows the actual data values.
3. On the toolbar, click "Snapshot of the monitor values".
   The actual monitor values are applied in the "Snapshot" column. Note here that the monitor values can originate from various program cycles.

The following options exist to apply the actual values from the snapshot as start value in the offline version of the data block.

- Apply individual start value
  To apply an individual value as start value, select the value in the "Snapshot" column. Use the "Copy" and "Paste" commands from the shortcut menu to copy the values and paste them in the "Start value" column.
- Apply all values
  To apply all values, click the "Copy all values from the "Snapshot" column to the "Start value" column" button in the toolbar.
- Apply setpoint values
  To apply setpoint values, click the "Copy all setpoints from the "Snapshot" column to the "Start value" column" button in the toolbar. The selected setpoint values from the column "Snapshot" are applied as start values.
- Apply the actual values of retentive data tags
  To apply only the actual values of retentive data tags as start values, select the data block in the project tree. In the shortcut menu, select the commands "Snapshot of monitor values" and "Apply monitor values as start values" > "Only retain values".
- Apply actual values of multiple data blocks as start values
  To apply the actual values of multiple data blocks as start values, select the data blocks in the project tree. Select the "Snapshot of monitor values" command in the shortcut menu. In the shortcut menu "Apply monitor values as start values" > "Only setpoints" or "Apply monitor values as start values" > "Only retain values".

6.1.4.6 Overwriting actual values of a data block with snapshot values

Overwrite actual values with a snapshot

With the option "Copy all values from the snapshot to the actual values of the CPU" you overwrite the actual values of a data block with momentary values. The values from the snapshot are then written to the CPU work memory. The CPU then uses these values as actual values in the online program.

WARNING

Changes to tag values

Changing the tag values while the plant is operating can cause serious damage to property or injury to persons if there are functional disturbances or program errors!

- Make sure that the plant is in a safe state before you overwrite the actual values.
- Make sure that the program does not read or write the affected data during transmission.
- You may want to use the "Modify tags" function in the watch table or in the DB editor as an alternative.

Requirement

The following requirements must be met before you can execute the option:

- The CPU is connected to the programming device/PC via the PROFINET interface. PROFIBUS interfaces of the CPU and interfaces of CMs/CPs are also supported.
- The CPU is online.
- As least one data block has been loaded to the CPU.

Procedure

To overwrite the actual values of a block with a snapshot, follow these steps:

1. Open the data block.
2. Start the monitoring by clicking the "Monitor all" button.
   The "Monitor value" column is shown in the table. This shows the actual data values.
3. On the toolbar, click "Snapshot of the monitor values".
   The actual monitor values are applied in the "Snapshot" column. Note here that the monitor values can originate from various program cycles.
4. To apply the values, click "Copy all values from the snapshot to the actual values of the CPU" on the toolbar.

Dependency on the CPU mode

You can execute this function in "RUN" mode as well as in "STOP" mode. The table below shows the reactions of the CPU in the different modes:

Table 6- 2 Reaction of the CPU depending on the mode

Action	System reaction	Consequences for the online program
Overwrite actual values in "RUN" mode	The values of all data block tags are overwritten during operation. No distinction is made between retentive and non-retentive values.	Changing actual values can lead to inconsistencies between the program and the actual process. If the volume of data to be transmitted is large, the values are possibly transmitted in several cycles. If the program accesses tags before all values are completely transmitted, there is a risk that inconsistent value combinations may be created and processed. The copying of the values of elementary data types can also possibly take place over several cycles. These values are potentially invalid until they have been completely transmitted. Dangerous states may occur if the program accesses these values before they have been completely transmitted.
Overwrite actual values in "STOP" mode	Only the actual values of the retentive tags are overwritten by the snapshot. Non-retentive tags are initialized with their start values during the transition from STOP to RUN. The values from the snapshot are not taken into consideration.	Because only the data from the snapshot are transmitted, there is a risk that inconsistent value combinations may be created and processed.

6.2 Configuring ET 200MP distributed I/O system

Introduction

You configure and assign parameters to the ET 200MP (interface module and I/O modules) with STEP 7 or in the configuration software of another manufacturer.

Requirements

Table 6- 3 Requirements for installation

Configuration software	Requirements	Installation information
STEP 7 (TIA Portal) as of V13 [1]	IM 155-5 PN ST and IM 155-5 DP ST: as of firmware version V2.0.0 IM 155-5 PN HF: as of firmware version V1.0.0	STEP 7 online help
STEP 7 V5.5 SP3 or higher	PROFINET IO GSD file: GSDML-Vx.y-siemens-et200mp-"Date in format yyyymmdd".xml (http://support.automation.siemens.com/WW/view/en/19698639/130000) PROFIBUS DP GSD file: SI0xxxxx.gsx (http://support.automation.siemens.com/WW/view/en/10805317/133300)	STEP 7 online help
Software of another manufacturer		Manufacturer documentation

[1] The TIA Portal supports GSDML specification V2.25. The ET 200MP is supplied with a GSD file based on specification V2.3. The GSD file can be installed and used in the TIA Portal.

Configuring operation on PROFIBUS DP using a GSD file

If you want to configure the operation on the PROFIBUS DP using GSD file, note the following additional requirements:

Table 6- 4 Requirements for PROFIBUS DP with GSD file

I/O modules	Required firmware version IM 155-5 DP ST as of ...	Required firmware version I/O modules as of ...
Input/output modules 35 mm	V1.0.0	V2.0
Input/output modules 25 mm	V2.0.0	V1.0
Technology modules (TM)	V2.0.0	V1.1
Communications module CM PtP	V1.0.0	V1.0.1

Configuration of the ET 200MP

Read the STEP 7 online help and/or the documentation of the configuration software manufacturer.

Basics of program processing 7

7.1 Events and OBs

Response to triggers

The occurrence of a trigger results in the following reaction:

- If the event comes from an event source to which you have assigned an OB, this event triggers the execution of the assigned OB. The event enters the queue according to its priority.
- If the event comes from an event source to which you have not assigned an OB, the default system reaction is executed.

Note

Some event sources, such as startup, pull/plug, exist even if you do not configure them.

Triggers

The table below provides an overview of the triggers, including the possible values for OB priority, possible OB numbers, default system reaction and number of OBs. The table is sorted in ascending order by OB numbers.

Table 7- 1 Triggers

Types of event sources	Possible priorities (default priority)	Possible OB numbers	Default system reaction*	Number of OBs
Startup**	1	100, ≥ 123	Ignore	0 to 100
Cyclic program**	1	1, ≥ 123	Ignore	0 to 100
Time-of-day interrupt**	2 to 24 (2)	10 to 17, ≥ 123	Not applicable	0 to 20
Time-delay interrupt**	2 to 24 (3)	20 to 23, ≥ 123	Not applicable	0 to 20
Cyclic interrupt**	2 to 24 (8 to 17, frequency dependent)	30 to 38, ≥ 123	Not applicable	0 to 20
Hardware interrupt**	2 to 26 (18)	40 to 47, ≥ 123	Ignore	0 to 50
Status interrupt	2 to 24 (4)	55	Ignore	0 or 1
Update interrupt	2 to 24 (4)	56	Ignore	0 or 1
Manufacturer-specific or profile-specific interrupt	2 to 24 (4)	57	Ignore	0 or 1
Isochronous mode interrupt	16 to 26 (21)	61 to 64, ≥ 123	Ignore	0 to 2
Time error***	22	80	Ignore	0 or 1
Maximum cycle time exceeded once			STOP	
Diagnostics interrupt	2 to 26 (5)	82	Ignore	0 or 1
Pull/plug interrupt for modules	2 to 26 (6)	83	Ignore	0 or 1
Rack error	2 to 26 (6)	86	Ignore	0 or 1
MC servo interrupt	17 to 26 (25)	91	Not applicable	0 or 1
MC interpolator interrupt	16 to 26 (24)	92	Not applicable	0 or 1
Programming error (only for global error handling)	2 to 26 (7)	121	STOP	0 or 1
I/O access error (only for global error handling)	2 to 26 (7)	122	Ignore	0 or 1

* If you have not configured the OB.

** For these event sources, besides the permanently assigned OB numbers (see column: possible OB numbers), you can also assign OB numbers from the range ≥ 123 in STEP 7.

*** If the cycle monitoring time is exceeded twice within a cycle, the CPU always switches to STOP regardless of whether you have configured OB80.

Assignment between event source and OBs

The type of OB determines where you make the assignment between OB and event source:

- With hardware interrupts and isochronous mode interrupts, the assignment is made during the configuration of the hardware or when the OB is created.
- STEP 7 automatically assigns OBs 91/92 to the MC-Servo interrupt and MC-Interpolator interrupt as soon as a technology object is added.
- For all other types of OB, the assignment is made when the OB is created, where applicable after you have configured the event source.

For hardware interrupts, you can change an assignment which has already been made during runtime with the instructions ATTACH and DETACH. In this case, only the actually effective assignment changes, and not the configured assignment. The configured assignment takes effect after loading, and upon each startup.

The CPU ignores hardware interrupts to which you did not assign an OB in your configuration or which occur after the DETACH instruction. The check as to whether an OB is assigned to an event does not take place when the associated event occurs, but only when the hardware interrupt actually has to be executed.

OB priority and runtime behavior

If you have assigned an OB to the event, the OB has the priority of the event. S7-1500 CPUs support the priority classes 1 (lowest) to 26 (highest). The following items are essential to the execution of an event:

- The call of the assigned OB
- The update of the process image partition of the assigned OB
- The execution of the assigned OB

The user program processes the OBs exclusively on a priority basis. This means the program processes the OB with the highest priority first when multiple OB requests occur at the same time. If an event occurs that has a higher priority than the currently active OB, this OB is interrupted. The user program processes events of the same priority in order of occurrence.

Note

Communication

Communication always has priority 15; always assign a priority >15 so that the OBs are not interrupted by the communication.

Reference

Further information on organization blocks is available in the STEP 7 online help.

7.2 CPU overload behavior

Requirements

For the event scenarios considered in the following section, it is assumed that you have assigned an OB to each event source and that these OBs have the same priority. The second condition, in particular, is only for the sake of a simplified representation.

Principle of CPU overload behavior

An occurring event triggers the execution of the associated OB. Depending on the OB priority and the current processor load, a time delay may occur before the OB is executed when there is an overload. The same event can therefore occur once or several times before the user program processes the OB belonging to the preceding event. The CPU treats such a situation as follows: In the order of their occurrence, the operating system positions the events into the queue associated with their priority.

To control temporary overload situations, you can limit the number of pending events that are linked from the same source. The next event is discarded as soon as the maximum number of pending triggers of a specific cyclic interrupt OB, for example, is reached.

An overload occurs when events which originate from the same source occur faster than they can be processed by the CPU.

More detailed information is provided in the following sections.

Discarding similar events or fetching them later

Below, the term "similar events" refers to events from a single source, such as triggers for a specific cyclic interrupt OB.

The OB parameter "Events to be queued" is used to specify how many similar events the operating system places in the associated queue and therefore post-processes. If this parameter has the value 1, for example, exactly one event is stored temporarily.

Note

Post-processing of cyclic events is often not desirable, as this can lead to an overload with OBs of the same or lower priority. Therefore, it is generally advantageous to discard similar events and to react to the overload situation during the next scheduled OB processing. If the value of the "Events to be queued" parameter is low, this ensures that an overload situation is mitigated rather than aggravated.

If the maximum number of triggers is reached in the queue for a cyclic interrupt OB (Cyclic interrupt), for example, each additional trigger is only counted and subsequently discarded. During the next scheduled execution of the OB, the CPU provides the number of discarded triggers in the "Event_Count" input parameter (in the start information). You can then react appropriately to the overload situation. The CPU then sets the counter for lost events to zero.

If the CPU, for example, first discards a trigger for a cyclic interrupt OB, its further behavior depends on the OB parameter "Report event overrun into diagnostics buffer": If the check box is selected, the CPU enters the event DW#16#0002:3507 once in the diagnostics buffer for the overload situation at this event source. The CPU suppresses additional diagnostics buffer entries of the event DW#16#0002:3507 until all events from this source have been post-processed.

Threshold mechanism for time error OB request

The cyclic interrupt OB parameter "Enable time error" is used to specify whether the time error interrupt should be called when a specific overload level is reached for similar events. You can find the OB parameter "Enable time error" in the properties of the OB in the "Attributes" category.

When you enable the time error OB (check box selected), use the OB parameter "Event threshold for time error" to specify the number of similar events in the queue as of which the time error OB is called. If this parameter has the value 1, for example, the CPU enters the event DW#16#0002:3502 once in the diagnostics buffer and requests the time error OB when the second event occurs. The CPU suppresses additional diagnostics buffer entries of the event DW#16#0002:3502 until all events from this source have been post-processed.

In the event of an overload, you therefore have the option of programming a reaction well before the limit is reached for similar events and thus before the events are discarded.

The following value range applies to the "Event threshold for time error" parameter:
1 ≤ "Event threshold for time error" ≤ "Events to be queued".

Protection

8

8.1 Overview of the protection functions

Introduction

This chapter describes the following functions for protecting the S7-1500 automation system/ET 200MP distributed I/O system against unauthorized access:

- Access protection
- Know-how protection
- Copy protection
- Protection by locking the CPU/interface module

Further measures for protecting the CPU

The following measures additionally increase the protection against unauthorized access to functions and data of the S7-1500 CPU from external sources and via the network:

- Deactivation of the Web server
- Deactivation of the time synchronization via an NTP Server
- Deactivation of the PUT/GET communication

When you use Web server, protect your S7-1500 automation system against unauthorized access:

- By setting password-protected access rights for specific users in the user administration.
- By using the pre-set option "Permit access only via HTTPS".
  The option allows access to the web server only with the secure hypertext transmission protocol HTTPS.

8.2 Configuring access protection for the CPU

Introduction

The CPU offers four access levels to limit access to specific functions.

By setting up the access levels and the passwords for a CPU, you limit the functions and memory areas that are accessible without entering a password. The individual access levels as well as their associated passwords are specified in the object properties of the CPU.

Access levels of the CPU

Table 8- 1 Access levels and access restrictions

Access levels	Access restrictions
Complete access (no protection)	The hardware configuration and the blocks can be read and changed by all users.
Read access	With this access level, read-only access to the hardware configuration and the blocks is possible without entering a password, which means you can download hardware configuration and blocks to the programming device. In addition, HMI access and access to diagnostics data is possible. Without entering the password, you cannot load any blocks or hardware configuration into the CPU. Additionally, the following are **not** possible without the password: Writing test functions and firmware update (online).
HMI access	With this access level only HMI access and access to diagnostics data is possible without entering the password. Without entering the password, you can neither load blocks and hardware configuration into the CPU, nor load blocks and hardware configuration from the CPU into the programming device. Additionally, the following are **not** possible without the password: Test functions which write, changing the operating mode (RUN/STOP), and firmware update (online).
No access (complete protection)	When the CPU is completely protected, no read or write access to the hardware configuration and the blocks is possible. HMI access is also not possible. The server function for PUT/GET communication is disabled in this access level (cannot be changed). Authentication with the password will again provide you full access to the CPU.

A list of which functions are available in the different access levels is available in the "Setting options for the protection" entry in the STEP 7 online help.

Properties of the access levels

Each access level allows unrestricted access to certain functions without entering a password, e.g. identification using the "Accessible devices" function.

The CPU's default setting is "No restriction" and "No password protection". In order to protect access to a CPU, you must edit the properties of the CPU and set up a password. In the default access level "Full access (no protection)" every user can read and change the hardware configuration and the blocks. A password is not set and is also not required for online access.

Communication between the CPUs (via the communication functions in the blocks) is not restricted by the protection level of the CPU, unless PUT/GET communication is deactivated.

Entry of the right password allows access to all the functions that are allowed in the corresponding level.

Note

Configuring an access level does not replace know-how protection

Configuring access levels offers a high degree of protection against unauthorized changes to the CPU by restricting the rights to download the hardware and software configuration to the CPU. However, blocks on the SIMATIC memory card are not write- or read-protected. Use know-how protection to protect the code of blocks on the SIMATIC memory card.

Behavior of functions with different access levels

The STEP 7 online help includes a table which lists the online functions that are available in the different access levels.

Parameterizing the procedure at access levels

To configure the access levels of an S7-1500 CPU, follow these steps:

1. Open the properties of the S7-1500 CPU in the Inspector window.
2. Open the "Protection" entry in the area navigation.

   A table with the possible access levels appears in the Inspector window.

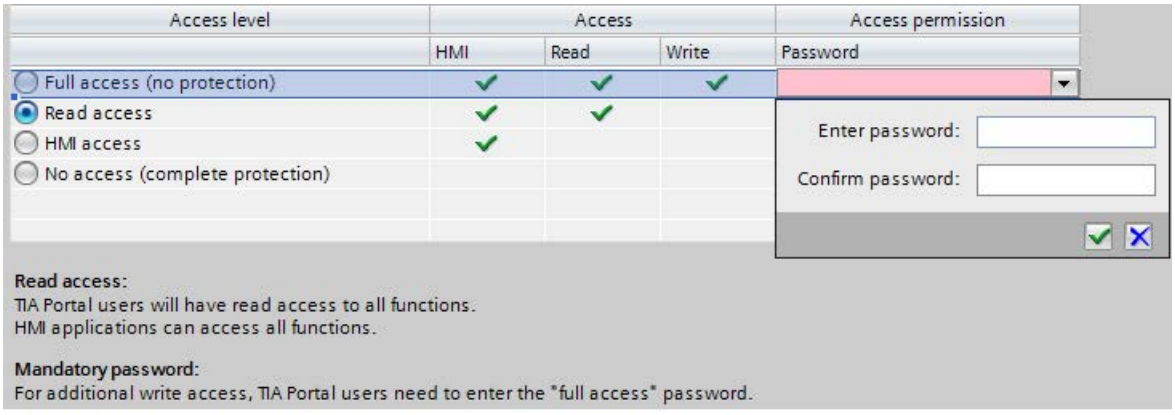


Figure 8-1 Possible access levels

3. Activate the desired protection level in the first column of the table. The green check marks in the columns to the right of the respective access level show you which operations are still available without entering the password.
4. In the "Enter password" column, specify a password for the access level "Full access" in the first row. In the "Confirm password" column, enter the selected password again to guard against incorrect entries.

   Ensure that the password is sufficiently secure, in other words, that is does not follow a pattern that can be recognized by a machine!
5. Assign additional passwords as needed to other access levels if the selected access level allows you to do so.
6. Download the hardware configuration for the access level to take effect.

The CPU logs the entry of the correct or incorrect password and any changes in the configuration of the access levels by a corresponding entry in the diagnostics buffer.

Behavior of a password-protected CPU during operation

The CPU protection takes effect after the settings are downloaded in the CPU.

Before an online function is executed, the necessary permission is checked and, if necessary, the user is prompted to enter a password. The functions protected by a password can only be executed by one programming device/PC at any one time. Another programming device/PC cannot log on.

Access authorization to the protected data is in effect for the duration of the online connection, or until the access authorization is manually rescinded with "Online > Delete access rights".

Access to a password-protected CPU in the RUN mode can be limited locally in the display so that access with a password is also not possible.

Access level for F-CPUs

For the fail-safe CPUs, there is an additional access level in addition to the four described access levels. For additional information on this access level, refer to the description of the fail-safe system SIMATIC Safety Programming and Operating Manual SIMATIC Safety - Configuring and Programming (http://support.automation.siemens.com/WW/view/en/54110126).

8.3 Using the display to set additional access protection

Blocking access to a password-protected CPU

On the display of an S7-1500, you can block access to a password-protected CPU (local lock). The access lock is only in effect, when the mode selector is in the RUN position.
The access block requires a configured protection level in STEP 7. The access block is effective regardless of the password protection. This means that even if someone accesses the CPU via a connected programming device and has entered the correct password, access to the CPU remains disabled.
The access block can be set separately for each access level on the display, so that, for example, read access is allowed locally, but write access is not allowed locally.

Procedure

If an access level with a password is configured in STEP 7, access can be blocked using the display.

Proceed as follows to set the local access protection for an S7-1500 CPU on the display:

1. On the display, select Settings > Protection menu.
2. Confirm the selection using "OK", and configure for each access level, whether access at the RUN mode selector is allowed or not:

   Allow: Access to the CPU is possible with the corresponding password in STEP 7.

   Disabled in RUN: When the mode selector is in the RUN position, no more users with privileges for this access level can log in to the CPU, even if they know the password. In STOP mode, access is possible with password entry.

Access protection for the display

A password can be configured for the display in STEP 7 in the properties of the CPU so that the local access protection is protected by a local password.

8.4 Using the user program to set additional access protection

Access protection by means of the user program

In addition to restricting access to the display you can also restrict access to a password-protected CPU in STEP 7 using the block SFC 110. You can find a description of this block in the online help under the keyword "ENDIS_PW: Limit and enable password legitimation".

8.5 Know-how protection

Application

You can use know-how protection to protect one or more blocks of the OB, FB, FC type and global data blocks in your program from unauthorized access. You can enter a password to restrict access to a block. The password offers high-level protection against unauthorized reading or manipulation of the block.

Readable data

If a block is know-how protected, only the following data is readable without the correct password:

- Block title, comments and block properties
- Block parameters (INPUT, OUTPUT, IN, OUT, RETURN)
- Call structure of the program
- Global tags without information on the point of use

Further actions

Further actions that can be carried out with a know-how protected block:

- Copying and deleting
- Calling within a program
- Online/offline comparison
- Load

Global data blocks and array data blocks

You cannot provide global data blocks (global DBs) with know-how protection. Users who do not possess the valid password can read the global data block but not change it.

You cannot provide array data blocks (array DBs) with know-how protection.

Setting up block know-how protection

To set up block know-how protection, follow these steps:

1. Open the properties of the respective block.
2. Select the "Protection" option under "General".

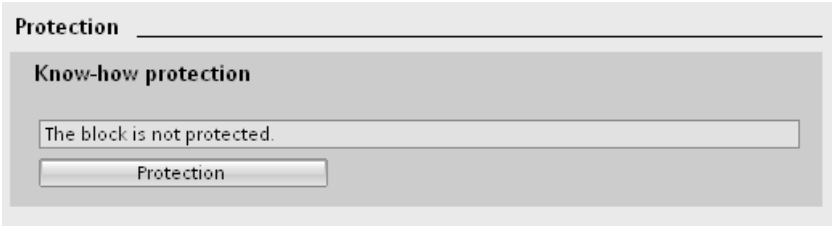


Figure 8-2 Setting up block know-how protection (1)

3. Click the "Protection" button to display the "Know-how protection" dialog.

Figure 8-3 Setting up block know-how protection (2)

4. Click the "Define" button to open the "Define password" dialog.

Figure 8-4 Setting up block know-how protection (3)

5. Enter the new password in the "New password" field. Enter the same password in the "Confirm password" field.
6. Click "OK" to confirm your entry.
7. Close the "Know-how protection" dialog by clicking "OK".

Result: The blocks selected will be know-how-protected. Know-how protected blocks are marked with a lock symbol in the project tree. The password entered applies to all blocks selected.

Opening know-how protected blocks

To open a know-how protected block, follow these steps:

1. Double-click the block to open the "Access protection" dialog.
2. Enter the password for the know-how protected block.
3. Click "OK" to confirm your entry.

Result: The know-how-protected blockopens.

Once you have opened the block, you can edit the program code and the block interface of the block for as long as the block or STEP 7 is open. The password must be entered again the next time the block is opened. If you close the "Access protection" dialog with "Cancel", the block will open but the block code will not be displayed and you will not be able to edit the block.

If you copy the block or add it to a library, for example, this does not cancel the know-how protection of the block. The copies will also be know-how-protected.

Removing block know-how protection

To remove block know-how protection, follow these steps:

1. Select the block from which you want to remove know-how protection. The protected block must not be open in the program editor.
2. In the "Edit" menu, select the "Know-how protection" command to open the "Know-how protection" dialog.
3. Clear the "Hide code (Know-how protection)" check box.

Figure 8-5 Removing block know-how protection (1)

4. Enter the password.

Figure 8-6 Removing block know-how protection (2)

5. Click "OK" to confirm your entry.

Result: Know-how protection will be removed from the block selected.

8.6 Copy protection

Application

The copy protection allows you to protect your program against unauthorized duplication. Copy protection allows you to link the program or the blocks to a specific SIMATIC memory card or CPU. Through the linking of the serial number of a SIMATIC memory card or of a CPU the use of this program or of this block is only possible in combination with a specific SIMATIC memory card or CPU.

Copy and know-how protection

Recommendation: To prevent an unauthorized reset of the copy protection, provide a copy-protected block with additional know-how protection. First set up the copy protection for the block and after this the know-how protection.

Setting up copy protection

To set up copy protection, follow these steps:

1. Open the properties of the respective block.
2. Select the "Protection" option under "General".

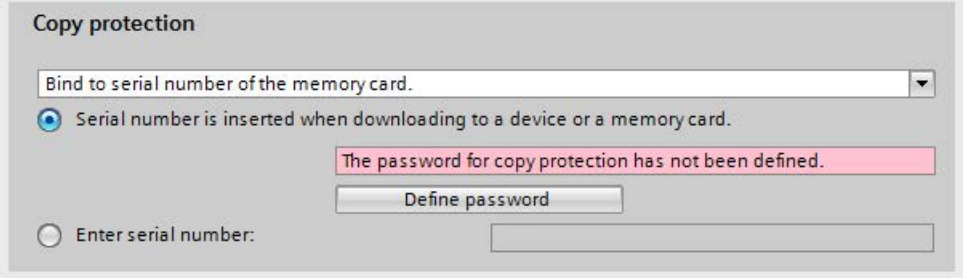


Figure 8-7 Setting up copy protection (1)

3. In the "Copy protection" area, select either the "Bind to serial number of the CPU" entry or the "Bind to serial number of the memory card" entry from the drop-down list.

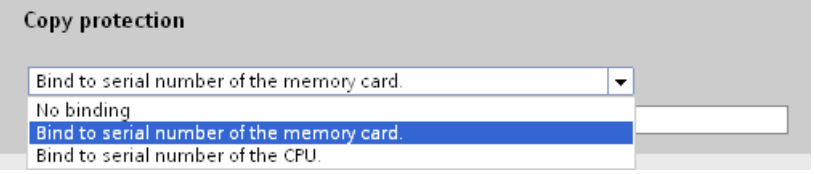


Figure 8-8 Setting up copy protection (2)

4. Activate the option "Serial number is inserted when downloading to a device or a memory card" if the serial number is to be inserted automatically during the uploading process (dynamic binding). Assign a password using the "Define password" to link the use of a block/program additionally to be input of a password.
   Activate the option "Enter serial number" if you want to manually bind the serial number of the CPU or the SIMATIC memory card to a block (static binding).
5. You can now set up the know-how protection for the block in the "Know-how protection" area.

Note

If you download a copy protected block to a device that does not match the specified serial number, the entire download operation will be rejected. This means that blocks without copy protection will also not be downloaded.

Removing copy protection

To remove copy protection, follow these steps:

1. Remove any existing know-how protection (Page 117).
2. Open the properties of the respective block.
3. Select the "Protection" option under "General".
4. In the "Copy protection" area, select the "No binding" entry from the drop-down list.

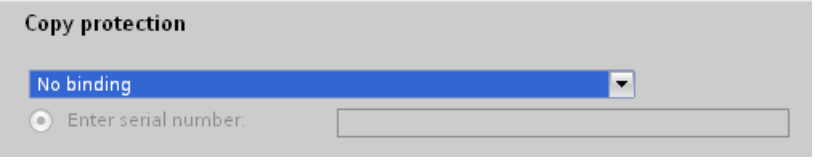


Figure 8-9 Removing copy protection

8.7 Protection by locking the CPU/interface module

Locking options

Protect your CPU/interface module from unauthorized access by additionally using a sufficiently secured front cover.

You have e.g. the following options:

- Affix a seal
- Secure the front cover with a lock (shackle diameter: 3 mm)

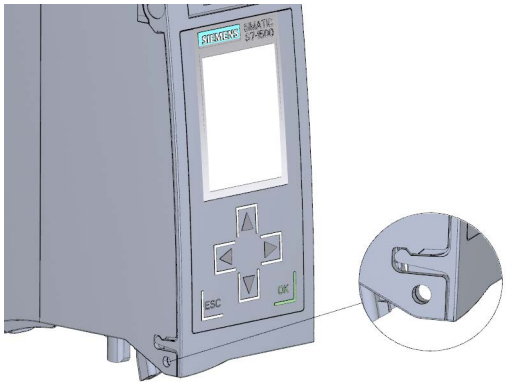


Figure 8-10 Locking latch using a CPU as an example

Flexible automation concepts

9

9.1 Standard machine projects

Introduction

Standard machine projects are STEP 7 projects that use a set of innovative functions allowing simple configuration and commissioning of flexible automation solutions for standard machines or for machines with a modular structure.

A hardware configuration consisting of an S7-1500 CPU as the IO controller and any connected IO devices represents a "PROFINET IO system master". This master is configured with a maximum configuration based on which various options can be derived for different standard machines, for example with different configuration variants of the IO system.

Greater flexibility at all levels

Standard machine projects have the following central characteristics:

- From one project (IO system master) with an engineered maximum configuration, different variants of a standard machine can be loaded (IO system options). The standard machine project covers all variants (options) of the IO system.
- An IO system option can be integrated in an existing network locally using simple tools.

Flexibility is provided in more ways than one:

- With suitable configuration, adaptation of the IP address parameters of the IO controller is possible locally using simple tools. This allows a standard machine to be integrated in different plants with little effort or to be included in a network several times.
  IO systems with this property are known as **multiple use IO systems**.
- With suitable configuration and programming, different setups of IO system options can be operated locally that differ in terms of the selection of IO devices used or in terms of the arrangement of the IO devices.
  Since the specific configuration of the IO system is controlled by the user program, this is known as **configuration control for IO systems**.
- Independently of the functions described above, with suitable configuration and programming, you can use different station options of central devices or distributed I/O devices in one project. The devices can be different in terms of the selection and arrangement of the modules.
  Since the concrete configuration of the station is controlled by the user program, this is also known as **configuration control**.

Additional information

You can find additional information on configuration control in the chapter Configuration control (Page 124).

You can find additional information on multiple use IO systems and on configuration control for IO systems in the function manual PROFINET with STEP 7 V13 (http://support.automation.siemens.com/WW/view/en/49948856).

9.2 Configuration control

Operating principle of configuration control

You can use configuration control to operate different real configurations (station options) with a single configuration of the S7-1500 automation system/ET 200MP distributed I/O system.

- A station master is configured in a project (maximum configuration). The station master comprises all modules that are required in a series of similar plant units or machines.
- The user program for the project provides for several station options for various plant units or machines as well as selection of a station option. A station option uses, for example, only some of the configured modules of the station master and these modules are inserted in the slots in a different order.
- An operator selects a station option for a specific plant on-site. To do this, the project need not be modified, which means that it is not necessary to load a modified configuration.

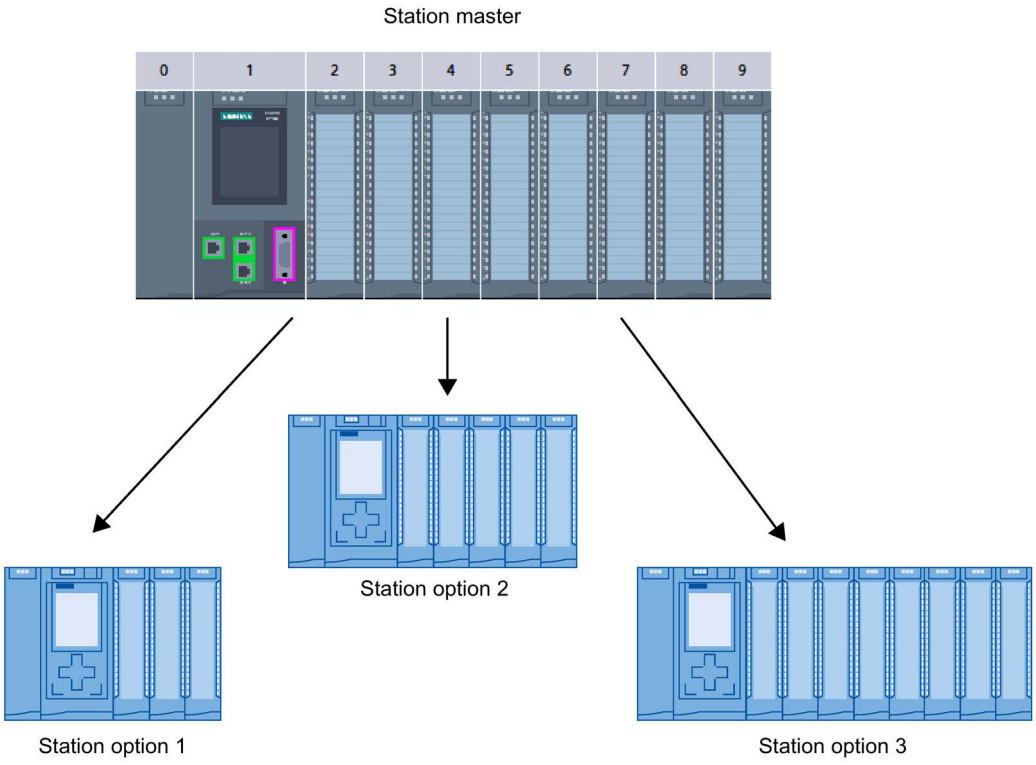


Figure 9-1 Operating principle of configuration control

You use a control data record you have programmed to notify the CPU/interface module as to which modules in a station option are missing or located on different slots in the real installation as compared to the station master. The configuration control does not have an impact on the parameter assignment of the modules.

The configuration control enables you to vary the central/distributed configuration flexibly. This is only possible if the station option can be derived from the station master.

Note

With the S7-1500, configuration control is possible both with central plugged modules and also with distributed I/O devices via PROFINET IO.

9.2.1 Rules

General rules

Observe the following rules:

- Slot entries in the control data record outside the station master are ignored by the CPU/interface module.
- The control data record must contain the entries up to the last slot of the station option.
- Each slot may only be present once in the control data record.
- Each slot may only be assigned to one slot in the station master.
- System power supplies (PS) can also be subject to configuration control.

Note

Configuration control for system power supplies

In the case of a configuration loaded using a data record, STEP 7 does not automatically check compliance with the power budget.

Make sure that the power fed into each power segment of the station option is greater than or equal to the power extracted.

You will find more information in the section Power balance calculation (Page 34).

Special features of the ET 200MP distributed I/O system

- If you have enabled configuration control, the ET 200MP station is not ready for operation without a control data record. As long as no valid control data record is transferred, the I/O modules are considered as failed by the CPU and exhibit substitute value behavior. The interface module continues to exchange data.
- You transfer the control data record with WRREC to the interface module (slot 1/ submodule 1). You address the interface module as follows:
  - With the diagnostics address in STEP 7 V5.5

    You can find the diagnostics address in the properties header of the interface module in the hardware configuration.
  - With the HW identifier in STEP 7 (TIA Portal)

    If you have selected the interface module in the network view or device view, the HW identifier is available in the System constants tab of the Inspector window. Use the value of the system constant '<Name_of_the_interface_module>~Head'.
- The control data record is retentively stored in the interface module. Note:
  - If there have been no changes to the configuration, you do not need to rewrite the control data record 196 during restart.
  - If you write a control data record with modified configuration, it will result in a station failure in the distributed I/O system. The retentively saved original data record 196 will be deleted and the new data record 196 will be saved retentively. The station will then restart with the modified configuration.

Special features of the S7-1500 automation system

- If you have enabled configuration control, the CPU is not ready for operation without a control data record. The CPU returns from startup to STOP if a valid control data record is not transferred to the startup OB. The central I/O is not initialized in this case. The cause for the STOP mode is entered in the diagnostics buffer.
- For addressing the WRREC instruction, use the HW identifier 33 (decimal, for the "ID" block parameter) to write the control data record.
- The control data record is stored retentively in the CPU. Note:
  - The retentivity of the control data record is independent of the retentivity settings in the STEP 7 memory area. (This means that the DB area or bit memory area in which the control data record is configured does not have to be configured as retentive for this purpose).
  - If there have been no changes to the configuration, you do not need to rewrite the control data record 196 during restart.
  - If you write a control data record with modified configuration, the CPU will automatically execute a memory reset. The retentively saved original data record 196 will be deleted and the new data record 196 will be saved retentively. The CPU will then restart with the modified configuration.
  - Recommendation: Before you download a new program with a modified control data record, perform a memory reset. This action will prevent inconsistent states as a result of any existing control data records.
- Using communications modules:
  - Point-to-point communications module:
    Point-to-point communications modules can be used with restrictions for the configuration control.
  - PROFINET/Ethernet and PROFIBUS communications modules:
    CPUs as of firmware version V1.7 support configuration control when PROFINET/Ethernet or PROFIBUS communications modules are used. If PROFINET/Ethernet or PROFIBUS communications modules are plugged in the central configuration, such as a CM 1542-5 (DP master or DP slave), these communications modules cannot be influenced by the configuration control. You must therefore leave these modules on the default slots in the station master and enter the slot numbers from the station master in the control data record ("Station option slot = Station master slot"). In a station option, all slots up to the slots furthest from the CPU communications module must be present in the control data record. Maximum flexibility is achieved by inserting the communications modules to the immediate right of the CPU.

9.2.2 Control data record for the S7-1500 Automation System

Slot assignment

The following table shows the slot assignment of the modules for the S7-1500 automation system:

Table 9- 1 Slot assignment

Slot	Modules	Comment
0	System power supply (optional)	Upstream of CPU
1	CPU	Slot 1 is always the CPU
2 - 31	I/O modules/system power supplies, depending on the station option	Downstream of CPU

Control data record

A control data record 196v4.0 containing a slot assignment is defined for the configuration control of the S7-1500 automation system. The table below shows the structure of a control data record with explanations of the individual elements.

Table 9- 2 Configuration control: Structure of control data record 196

Byte	Element	Code	Explanation
0	Block length	4 + number of slots	Header
1	Block ID	196	
2	Version	4	
3	Version	0	
4	Slot 0 of the station master	Slot assignment in the station option	**Control element** Describes in each element which slot of the station option is assigned to the slot in the station master. The structure of a control element is described in the following section.
5	Slot 1 of the station master	Slot assignment 1 in the station option (always 1, because the CPU is always in slot 1)	
6	Slot 2 of the station master	Slot assignment in the station option	
7	Slot 3 of the station master	Slot assignment in the station option	
:	:	:	
4 + (max. slot number)	Maximum slot of the station master	Slot assignment in the station option	

Structure of a control element

A control element contains the information on which module is inserted in which slot.

The byte numbers represent the station master slots in ascending order:

- Byte 4 stands for the slot 0 of the station master
- Byte 5 stands for the slot 1 of the station master
- Byte 6 stands for the slot 2 of the station master
- etc. ....

The value that you need to enter in the corresponding byte depends on the following rule:

- If the module exists in the station option, enter the slot number of the module.
- If the module does not exists in the station option, enter 16#FF (255).

Error messages

The following error messages are returned if an error occurs during writing of the control data record:

Table 9- 3 Error messages

Error code	Meaning
$80B1_H$	Invalid length; the length information in data record 196 is not correct.
$80B5_H$	Configuration control parameters not assigned.
$80E2_H$	Data record was transferred in the wrong OB context. The data record must be transferred in the startup program.
$80B8_H$	Parameter error A parameter error is caused by: • Incorrect block ID in the header (not equal to 196) • Invalid version identifier in the header • A reserved bit was set • A station master slot was assigned an invalid slot in the station option • Multiple slots in the station master are assigned to the same slot in the station option • For shared device on submodule level: Violation of defined restrictions

9.2.3 Control data record for the ET 200MP distributed I/O system

Slot assignment

The following table shows the slot assignment of the modules for the ET 200MP distribution I/O system:

Table 9- 4 Slot assignment

Slot	Modules	Comment
0	System power supply (optional)	Upstream from interface module
1	Interface module	Interface module (slot 1) is not an element of the configuration control, but instead controls this
2 - 31	I/O modules/system power supplies, depending on the station option	Downstream from the interface module

Control data record

A control data record 196v3.0 containing a slot assignment is defined for the configuration control of the ET 200MP distributed I/O system. The table below shows the structure of a control data record with explanations of the individual elements.

Table 9- 5 Configuration control: Structure of control data record 196

Byte	Element	Code	Explanation
0	Block length	4 + number of slots	Header
1	Block ID	196	
2	Version	3	
3	Version	0	
4	Slot 0 of the station master	Slot assignment in the station option	**Control element** Describes in each element which slot of the station option is assigned to the slot in the station master. The structure of a control element is described in the following section.
5	Slot 2 of the station master	Slot assignment in the station option	
6	Slot 3 of the station master	Slot assignment in the station option	
:	:	:	
4 + (max. slot no. - 1)	Maximum slot of the station master	Slot assignment in the station option	

Structure of a control element

A control element contains the information on which module is inserted in which slot.

The byte numbers represent the station master slots in ascending order:

- Byte 4 stands for the slot 0 of the station master
- Byte 5 stands for the slot 2 of the station master
- Byte 6 stands for the slot 3 of the station master
- etc. ....

The value that you need to enter in the corresponding byte depends on the following rule:

- If the module exists in the station option, enter the slot number of the module.
- If the module does not exists in the station option, enter 16#FF (255).

Error messages

The following error messages are returned if an error occurs during writing of the control data record:

Table 9- 6 Error messages

Error code	Meaning
$80B1_H$	Invalid length; the length information in data record 196 is not correct.
$80B5_H$	Configuration control parameters not assigned.
$80E2_H$	Data record was transferred in the wrong OB context. The data record must be transferred in the startup program.
$80B8_H$	Parameter error A parameter error is caused by: • Incorrect block ID in the header (not equal to 196) • Invalid version identifier in the header • A reserved bit was set • A station master slot was assigned an invalid slot in the station option • Multiple slots in the station master are assigned to the same slot in the station option • For shared device on submodule level: Violation of defined restrictions

9.2.4 Feedback data record of the ET 200MP distributed I/O system

Operating principle

The feedback data record informs you about the accuracy of the module assignment and gives you the option of detecting assignment errors in the control data record. The feedback data record is mapped by means of a separate data record 197.

Slot assignment

The feedback data record exists only when configuration control is configured and always refers to the maximum quantity framework **without interface module**, i.e., 31 slots.

The following table shows the slot assignment of the modules:

Table 9- 7 Slot assignment

Slot	Modules	Comment
0	System power supply (optional)	Upstream from interface module
2 - 31	I/O modules/system power supplies, depending on the station option	Downstream from the interface module

Partial reading of the feedback data record is possible.

Feedback data record

Table 9- 8 Feedback data record

Byte	Element	Code	Meaning
0	Block length	66	Header
1	Block ID	197	
2	Version	2	
3		0	
4	Status slot 0	0/1	Bit 0 = 1: • Module from station master is inserted in the station option • Slot is marked as not available in the control data record Bit 0 = 0: • Module pulled • Incorrect module inserted in the station option* Bit 1 to 15: Reserved
5	Reserved	0	
6	Status slot 2	0/1	
7	Reserved	0	
:	:	:	
64	Slot n status	Maximum slot	
65	Reserved	0	

* Not possible if the slot is marked as not available.

Note

The data in the feedback data record is always mapped for all modules. In a Shared Device configuration, it is therefore irrelevant which IO controller the respective modules are assigned to.

As long as no control data record was sent, a one-to-one module assignment is assumed for the compilation of data record 197 (station master → station option).

Error messages

The following error messages are returned if an error occurs during reading of the feedback data record:

Table 9- 9 Error messages

Error code	Meaning
$80B1_H$	Invalid length; the length information in data record 197 is not correct.
$80B5_H$	Configuration control not configured
$80B8_H$	Parameter error The following events cause a parameter error: • Incorrect block ID in the header (not equal to 197) • Invalid version identifier in the header • A reserved bit was set • Multiple slots in the station master are assigned to the same slot in the station option

9.2.5 Configuring and programming configuration control

Requirements

For S7-1500 automation system:

- STEP 7 Professional Version V13 or higher
- CPU S7-15XX as of firmware version V1.5
- The startup parameter "Compare preset to actual configuration" is set to "Startup CPU even if mismatch" (default setting).

For ET 200MP distributed I/O system:

- STEP 7 Professional Version V13 or higher
- IM 155-5 PN ST/HF
- The startup parameter "Comparison preset to actual module" is set to "Startup CPU even if mismatch" (default setting).
- You have assigned the interface module to an IO controller/DP master in STEP 7

Required steps

1. Enable the "Allow to reconfigure the device via the user program" parameter when configuring the CPU/interface module.
   - The "Allow to reconfigure the device via the user program" parameter is located in the "Configuration control" area for an S7-1500 CPU.
   - The "Allow to reconfigure the device via the user program" parameter is located in the "Module parameter" area under "General" for an IM 155-5 PN interface module.

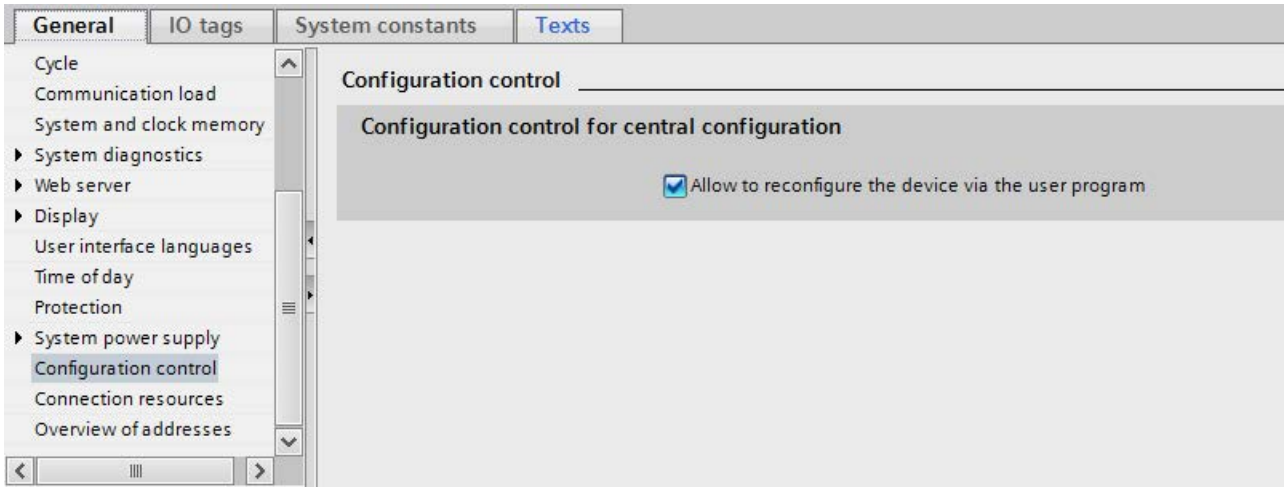


Figure 9-2 Enabling configuration control using an S7-1500 CPU as an example

2. Create a control data record (e.g., in a data block) according to the current configuration based on the sample described below for the control data record. The control data record has the number 196. Please note that you first have to create a PLC data type containing the structure of the control data record. The data block is based on this PLC data type.

ConfDB

Name	Data type	Start value	...	...	...	...	Comment
Static							
ConfigControl	Struct			✓	✓		
Block_Length	USInt	9		✓	✓		4+number of slots
Block_ID	USInt	196		✓	✓		
Version	USInt	4		✓	✓		
Subversion	USInt	0		✓	✓		
Slot_0	USInt	0		✓	✓		configured slot 0 / assigned "real" slot
Slot_1	USInt	1		✓	✓		configured slot 1 / assigned "real" slot
Slot_2	USInt	2		✓	✓		configured slot 2 / assigned "real" slot
Slot_3	USInt	16#FF		✓	✓		configured slot 3 / assigned "real" slot
Slot_4	USInt	3		✓	✓		configured slot 4 / assigned "real" slot

Figure 9-3 Creating control data record 196 using an S7-1500 CPU as an example

3. Transfer the control data record with the WRREC instruction.
   For the CPU:
   The configuration control for the centrally inserted modules is only effective when the operating state of the CPU changes from STOP to RUN. This means you have to call the extended WRREC instruction (write data record) in the startup OB and transfer the created control data record to the CPU.
   If no valid control data record is transferred in the startup OB, the configuration control is not ready. The CPU returns from startup to STOP in this case.
   A description of how to transfer the control data record for a CPU is available in the section Transferring control data record in the startup program of the CPU (Page 136).

9.2.6 Transferring control data record in the startup program of the CPU

The CPU processes the WRREC instruction for transfer of the control data record asynchronously. For this reason, you must call WRREC in the startup OB repeatedly in a loop until the output parameters "BUSY" or "DONE" indicate that the data record has been transferred.

Tip: To program the loop, use the SCL programming language with the REPEAT ... UNTIL instruction.

```
REPEAT

    "WRREC_DB"(REQ := "start_config_control",

               ID := 33,

               INDEX := 196,

               LEN := "conf_LEN",

               DONE => "conf_DONE",

               BUSY => "conf_BUSY",

               ERROR => "conf_ERROR",

               RECORD := "ConfDB",

               STATUS => "conf_STATUS");

UNTIL NOT "conf_BUSY"

END_REPEAT;
```

In the graphic programming languages, you implement the loop using instructions for program control.

Example in FBD: Use the LABEL (jump label) and JMP (jump at RLO=1) instructions to program a loop.

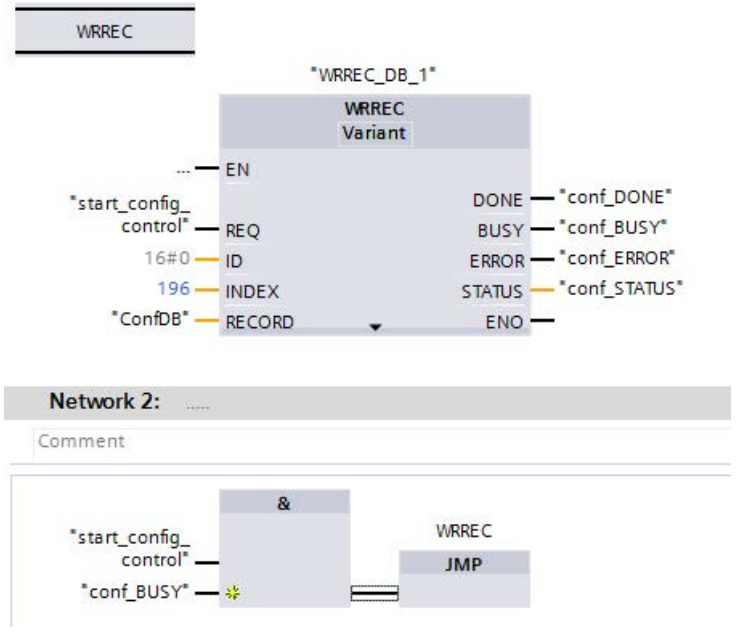


Figure 9-4 Transferring control data record in the startup program

Below, you will find explanations of individual parameters of the WRREC instruction which you must supply with specific values in the configuration control context. You can find additional information on the WRREC instruction in the STEP 7 online help.

ID — Hardware identifier

- HW identifier is always 33 (decimal) for configuration control for centrally arranged modules.
- Use the HW identifier of the interface module for the configuration control for distributed I/O.
  If you have selected the interface module in the network view or device view, the HW identifier is available in the **System constants** tab of the Inspector window. Use the value of the system constant '<Name_of_the_interface_module>~Head'.

INDEX — Data record number: 196 (decimal)

RECORD — Control data record to be transferred.

See the section "Control data record" for the structure of the control data record.

Tip: The block parameter "RECORD" of the WRREC instruction (as of V1.1) is of the "VARIANT" data type and you cannot therefore interconnect a global DB directly to the block parameter "RECORD". "Variant" as interconnection parameter requires a tag with data type. A global DB has no data type as property. Instead you have to generate a DB which derives from a data type.

Proceed as follows:

1. First, create a new PLC data type (user data type) with the structure of the control data record and name it, for example, "ConfDB".
2. Create a new data block. Select the newly created user data type, for example, "ConfDB", as type for this data block.

9.2.7 Behavior during operation

Effect of discrepancy between station master and station option:

- For the online display and for the display in the diagnostics buffer (module OK or module faulty), the station master is always used and not the differing station option.

  Example: A module outputs diagnostics data. This module is configured in slot 4 in the station master, but is inserted in slot 3 in the station option (missing module; see example in the next section). In the online view (station master), slot 4 is indicated as faulty. In the real configuration, the module at slot 3 indicates an error via an LED display.

If modules are entered as not present in the control data record, the automation system behaves as follows:

- Modules designated as not present in the control data record do not supply diagnostics and their status is always OK. The value status is OK.
- Direct writing access to the outputs that are not present or writing access to the process image of outputs that are not present: Remains without effect; no access error is signaled.
- Direct reading access to the inputs that are not present or reading access to the process image of inputs that are not present: Value "0" is supplied; no access error is signaled.
- Write data record to module that is not present: Remains without effect; no error is signaled.
- Read data record from module that is not present: An error is signaled because a valid data record cannot be returned.

9.2.8 Example of a configuration control

A station master consisting of a system power supply, CPU, and three I/O modules is configured in STEP 7 in the following section.

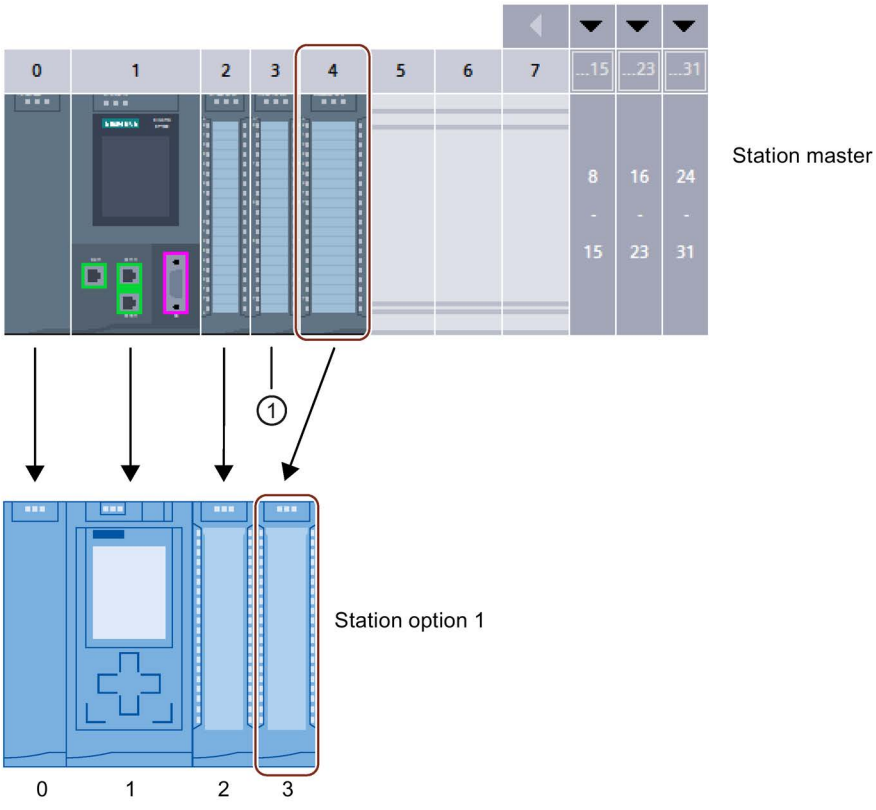
The module at slot 3 is not present in the station option 1 and is "hidden" by the configuration control.

In the station option 2 the module that was initially hidden is located in the last slot. The added slot is made known to the CPU by a modified control data record.

Station option 1 with module that is not present

The station master contains all modules that can be present in a final configuration stage.

The module that is located in slot 3 in the station master is not present in the station option 1. Slot 3 must be designated in the control data record accordingly with "FF $_H$" (= not present).



ConfCtrlREC_DB1

	Name	Data type	Start value	...	...	...	...	Comment
	Static							
	ConfigControl	Struct						
	Block_Length	USInt	9					4+number of slots
	Block_ID	USInt	196					
	Version	USInt	4					
	Subversion	USInt	0					
	Slot_0	USInt	0					configured slot 0 < real slot 0
	Slot_1	USInt	1					configured slot 1 < real slot 1
	Slot_2	USInt	2					configured slot 2 < real slot 2
	Slot_3	USInt	255					configured slot 3 < not used
	Slot_4	USInt	3					configured slot 4 < real slot 3

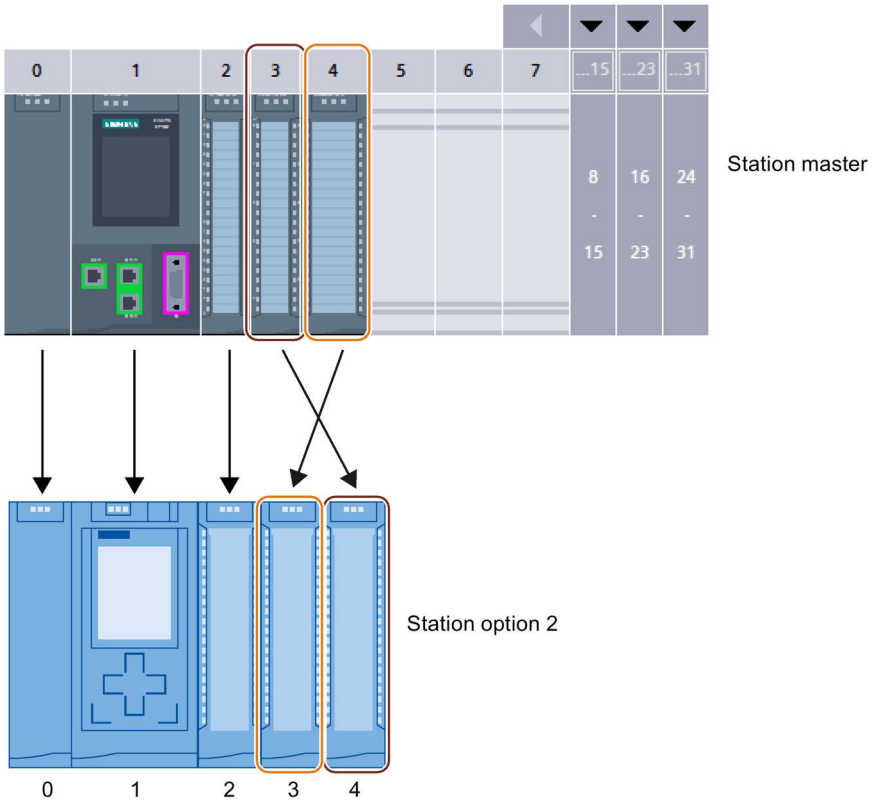
① Module is not present in the station option 1.

Figure 9-5 Example: Hardware configuration of station option 1 with the associated control data record in STEP 7

Station option 2 with subsequently added module

The module present in slot 3 in the station master is added "to the back" of the station option 2 by inserting it as the last module in slot 4.

Adapt the control data record accordingly.



	Name	Data type	Start v..	...	...	...	...	Comment
	Static							
	ConfigControl	Struct			☑	☑		
	Block_Length	USInt	9		☑	☑		4+number of slots
	Block_ID	USInt	196		☑	☑		
	Version	USInt	4		☑	☑		
	Subversion	USInt	0		☑	☑		
	Slot_0	USInt	0		☑	☑		configured slot 0 < real slot 0
	Slot_1	USInt	1		☑	☑		configured slot 1 < real slot 1
	Slot_2	USInt	2		☑	☑		configured slot 2 < real slot 2
	Slot_3	USInt	4		☑	☑		configured slot 3 < real slot 4
	Slot_4	USInt	3		☑	☑		configured slot 4 < real slot 3

Figure 9-6 Example: Hardware configuration of station option 2 with the associated control data record in STEP 7

Commissioning 10

10.1 Overview

Introduction

This section includes information on the following topics:

- Check before powering on for the first time
- Removing/inserting the SIMATIC memory card
- First power-on of the CPU
- Commissioning the ET 200MP for PROFINET IO
- Commissioning the ET 200MP for PROFIBUS DP
- Operating modes of the CPU
- CPU memory reset
- Identification and maintenance data

Commissioning requirements

Note

Performing tests

You must ensure the safety of your plant. You therefore need to perform a complete functional test and the necessary safety checks before the final commissioning of a plant.

Also allow for any possible foreseeable errors in the tests. In this way, you avoid endangering persons or plants during operation.

PRONETA

SIEMENS PRONETA PC-based software tool that is provided free-of-charge, which simplifies the commissioning of PROFINET systems by performing the following tasks:

- Topology overview that automatically scans PROFINET and displays all connected components. This overview can be exported in the form of a device list. You have the option of "Initializing" the components and performing other simple configuration tasks, as well as comparing the actual configuration with a required configuration.
- IO check to quickly test the wiring of a plant and the module configuration of the components. By reading and writing the inputs and outputs, PRONETA makes sure that the distributed I/O devices with their sensors and actuators are correctly wired. PRONETA can create test profile templates and store test logs, to document the test results.
- All tasks can be performed before a CPU is integrated into the network. Moreover, since no other engineering tools or hardware are required, PRONETA enables a fast and convenient checking of a plant's configuration at an early stage.

Additional information about PRONETA can be found here (http://support.automation.siemens.com/WW/view/en/67460624).

10.2 Check before powering on for the first time

Check before powering on for the first time

Before the first power-on, check the installation and the wiring of the S7-1500 automation system/ET 200MP distributed I/O system.

Questions for the check

The following questions provide guidance for the review of your S7-1500 automation system/ET 200MP distributed I/O system in the form of a checklist.

Racks

- Are the mounting rails firmly installed on the wall, in the framework, or in the cabinet?
- Are the cable ducts correctly installed?
- Have the minimum clearances been observed?

Grounding and chassis concept

- Is the mounting rail connected to the protective conductor?
- Has the connection between reference ground and ground been correctly made on all mounting rails?
- Are the required equipotential bonding cables connected with low impedance to the affected plant units?

Module installation and wiring

- Are all the modules inserted / installed in accordance with the mounting plan and corresponding to the configuration with STEP 7 and screwed firmly to the mounting rail?
- Are all the front connectors wired according to the circuit diagram, in the final position, and inserted on the correct module?
- Are the correct modules installed and connected to each other with U connectors?
- Are U connectors projecting either at the left-hand or right-hand over the outer modules on the S7-1500 automation system/ET 200MP distributed I/O system?

System power supply or load current supply

- Are all system power supplies and load current supplies switched off?
- Is the power cable connector correctly wired?
- Has the connection to line voltage been made?

10.3 Procedure for commissioning the S7-1500 automation system

Requirements

- The CPU is in the "Factory settings" state or has been reset to factory settings (see Reset CPU to factory settings (Page 193)).
- The SIMATIC memory card is as delivered or has been formatted.

Commissioning procedure

For the first commissioning of an S7-1500 automation system, we recommend the following procedure:

Table 10- 1 Procedure for commissioning the SIMATIC S7-1500

Step	Procedure	See...
1	Configure hardware in STEP 7 and perform power balance calculation (see also "Requirements: CPU as bus device")	Section Power balance calculation (Page 34)
2	Create user program	STEP 7 online help
3	Insert required modules	Section Installation (Page 37)
4	Wiring the assembly (system power supplies, front connectors, etc.)	Section Wiring (Page 51)
5	Insert SIMATIC memory card in the CPU	Section Removing/inserting a SIMATIC memory card on the CPU (Page 147)
6	Switch on the CPU and system power supply	See section First power-on of the CPU (Page 149)
7	Check LEDs	The meaning of the LEDs can be found in the manuals of the modules.
8	Evaluate information on the CPU's display	Section CPU display (Page 173)
9	Configure hardware in STEP 7 and download to the CPU	Online and diagnostics functions in STEP 7
10	Test inputs and outputs	The following functions are helpful: Monitoring and modifying tags, testing with program status, forcing, modifying the outputs in STOP mode. See section Test functions and fault resolution (Page 198)

Requirements: CPU as bus device

Note the following requirements for operation of a CPU as bus device:

- PROFIBUS interface
  - The integrated PROFIBUS interface of the CPU is configured using STEP 7 (device address and bus parameters configured).
  - The CPU is connected to the subnet.
  - The terminating resistors at the segment boundaries are switched on.

  See the PROFIBUS Function Manual (http://support.automation.siemens.com/WW/view/en/59193579)
- PROFINET interface
  - The integrated PROFINET interface of the CPU is configured using STEP 7 (IP address and device name configured).
  - The CPU is connected to the subnet.

  See the PROFINET Function Manual (http://support.automation.siemens.com/WW/view/en/49948856)

10.3.1 Removing/inserting a SIMATIC memory card on the CPU

Requirements

The CPU only supports pre-formatted SIMATIC memory cards. If applicable, delete all previously stored data before using the SIMATIC memory card. Additional information about deleting the contents of the SIMATIC memory card can be found in the section, SIMATIC memory card - overview (Page 167).

In order to work with the SIMATIC memory card, first ensure that the SIMATIC memory card is not write-protected. For this purpose, slide the slider on the SIMATIC memory card out of the lock position.

If the inserted SIMATIC memory card is write-protected, the CPU display outputs the ⚠ symbol in the "Memory card" menu under "Overview" and writes a corresponding alarm to the lower level of the menu.

Inserting the SIMATIC memory card

To insert a SIMATIC memory card, follow these steps:

1. Open the front cover of the CPU.
2. Ensure that the CPU is either switched off, or in the STOP mode.
3. Insert the SIMATIC memory card, as depicted on the CPU, into the slot for the SIMATIC memory card.

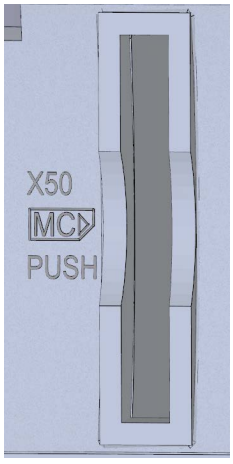


Figure 10-1 Slot for the SIMATIC memory card

4. Insert the SIMATIC memory card with light pressure into the CPU, until the SIMATIC memory card latches.

Removing the SIMATIC memory card

To remove a SIMATIC memory card, follow these steps:

1. Open the front cover.
2. Switch the CPU into STOP mode.
3. Press the SIMATIC memory card into the CPU with light pressure. After audible unlatching of the SIMATIC memory card, remove it.

Reactions after removing/inserting the SIMATIC memory card

Inserting and removing the SIMATIC memory card in STOP, STARTUP or RUN mode triggers a re-evaluation of the SIMATIC memory card. The CPU hereby compares the content of the configuration on the SIMATIC memory card with the backed-up retentive data. If the backed-up retentive data matches the data of the configuration on the SIMATIC memory card, the retentive data is retained. If the data differs, the CPU automatically performs a memory reset (which means the retentive data is deleted) and then goes to STOP.

The CPU evaluates the SIMATIC memory card and indicates this by flashing the RUN/STOP LED.

Reference

Additional information on the SIMATIC memory card can be found in the SIMATIC memory card (Page 167) section.

10.3.2 First power-on of the CPU

Requirements

- An S7-1500 automation system is installed and wired.
- The SIMATIC memory card is inserted in the CPU.

Procedure

To commission a CPU, follow these steps:

1. Switch on the system power supply and load current supply.

Result:

- The CPU executes a flash test:
  - All LEDs flash at 2 Hz
  - RUN/STOP LED flashes alternately yellow/green
  - ERROR LED flashes red
  - MAINT LED flashes yellow
- The CPU runs the system initialization and evaluates the SIMATIC memory card:
  - RUN/STOP LED flashes yellow at 2 Hz
- After the system initialization has been completed, the CPU goes to STOP mode:
  - The RUN/STOP LED lights up yellow

10.4 Procedure for commissioning the ET 200MP distributed I/O system

10.4.1 Commissioning the ET 200MP for PROFINET IO

Introduction

The commissioning of your automation system depends on the plant configuration.

The following procedure describes the commissioning of the distributed I/O system on an IO controller.

Commissioning procedure

To commission the ET 200MP as an IO device for PROFINET IO, we recommend the following procedure:

Table 10- 2 Procedure for commissioning the ET 200MP as an IO device for PROFINET IO

Step	Procedure	See...
1	Install ET 200MP	Section Installation (Page 37)
2	Connect ET 200MP • Supply voltages • PROFINET IO • Sensors and actuators	Section Wiring (Page 51)
4	Configure IO controller	Documentation of the IO controller
5	Switch on supply voltages for IO controller	Documentation of the IO controller
6	Switch on supply voltages for IO devices	Interface module (http://support.automation.siemens.com/WW/view/en/67295970/133300) manual
7	Download configuration to the IO controller	STEP 7 online help
8	Switch IO controller to RUN mode	Documentation of the IO controller
9	Check LEDs	Interface module (http://support.automation.siemens.com/WW/view/en/67295970/133300) manual
10	Test inputs and outputs	The following functions are helpful: Monitoring and modifying tags, testing with program status, forcing, modifying the outputs. See section Test functions and fault resolution (Page 198)

Note

The operating mode transitions for the IO controller from RUN to STOP or from STOP to RUN can take several milliseconds, until the mode transition for the inputs and outputs of all I/O modules for the ET 200MP station is completed. This delay also applies to isochronous mode.

10.4.2 Commissioning the ET 200MP for PROFIBUS DP

Introduction

The commissioning of your automation system depends on the plant configuration.

The following procedure describes the commissioning of the ET 200MP distributed I/O system on a DP master.

Commissioning procedure

To commission the ET 200MP as a DP slave for PROFIBUS DP, we recommend the following procedure:

Table 10- 3 Procedure for commissioning the ET 200MP as a DP slave for PROFIBUS DP

Step	Procedure	See...
1	Install ET 200MP (with IM 155-5 DP ST)	Section Installation (Page 37)
2	Set the PROFIBUS address on the interface module	Interface module IM 155-5 DP ST (http://support.automation.siemens.com/WW/view/en/77910801/133300) manual
3	Connect ET 200MP • Supply voltages • PROFIBUS DP • Sensors and actuators	Section Wiring (Page 51)
4	Configure DP master (including PROFIBUS address)	Documentation of the DP master
5	Switch on supply voltages for DP master	Documentation of the DP master
6	Switch on supply voltages for DP slaves	Interface module IM 155-5 DP ST (http://support.automation.siemens.com/WW/view/en/77910801/133300) manual
7	Download configuration to the DP master	STEP 7 online help
8	Switch DP master to RUN	Documentation of the DP master
9	Check LEDs	Interface module IM 155-5 DP ST (http://support.automation.siemens.com/WW/view/en/77910801/133300) manual
10	Test inputs and outputs	The following functions are helpful: Monitoring and modifying tags, testing with program status, forcing, modifying the outputs. See section Test functions and fault resolution (Page 198)

Note

During operating mode transitions of the DP master from RUN to STOP or from STOP to RUN, it can take several milliseconds until the mode transition for the inputs and outputs of all I/O modules of the ET 200MP is complete.

10.5 Operating modes of the CPU

Introduction

Operating modes describe the states of the CPU. The following operating states are possible via the mode selector:

- STARTUP
- RUN
- STOP

In these operating modes, the CPU can communicate, for example, via the PROFINET IO interface (X1).

The status LEDs on the front side of the CPU indicate the current operating mode.

10.5.1 STARTUP mode

Function

Before the CPU starts to execute the cyclic user program, a startup program is executed.

By suitably programming startup OBs, you can specify initialization tags for your cyclic program in the startup program. That is, you can set up one or several startup OBs in your program, or none at all.

Special features in Startup mode

- All outputs are disabled or react according to the parameter settings for the respective module: They provide a substitute value as set in the parameters or retain the last value output and bring the controlled process to a safe operating mode.
- The process image is initialized.
- The process image is not updated.
  In order to read the current state of inputs during STARTUP, you can access inputs by direct I/O access.
  In order to initialize outputs during STARTUP, you can write the values via the process image or via direct I/O access. The values are output at the outputs during the transition to the RUN mode.
- The CPU always starts up in a warm restart.
  - The non-retentive bit memories, timers and counters are initialized.
  - The non-retentive tags in data blocks are initialized.
- During startup, no cycle time monitoring is running yet.

- The CPU processes the startup OBs in the order of the startup OB numbers. The CPU processes all programmed startup OBs regardless of the selected startup mode.
- If a corresponding event occurs, the CPU can start the following OBs in startup:
  - OB 82: Diagnostics interrupt
  - OB 83: Pull/plug interrupt for modules
  - OB 86: Rack error
  - OB 121: Programming error (only for global error handling)
  - OB 122: Time-out (for global error handling only)
    You can find a description of how to use global and local error handling in the STEP 7 online help.

  The CPU cannot start all other OBs until after the transition to RUN mode.

Response when expected and actual configurations do not match

The configuration downloaded to the CPU represents the expected configuration. The actual configuration is the actual configuration of the automation system. If the expected configuration and actual configuration deviate from one another, the CPU's behavior is specified by the setting of the hardware compatibility. For additional information about the hardware compatibility, see the section Operating mode transitions (Page 157).

Canceling a startup

If errors occur during startup, the CPU cancels the startup and returns to STOP mode.

The CPU does not perform startup or interrupts startup under the following conditions:

- You have not inserted a SIMATIC memory card or an invalid one is inserted.
- You have not downloaded a hardware configuration to the CPU.

Parameter assignment of startup behavior

You can assign parameters for the behavior of the CPU in the Startup group of the CPU properties.

Setting the startup behavior

To set the startup behavior, follow these steps:

1. Select the CPU in the device view of the STEP 7 hardware network editor.
2. In the properties under "General" select the "Startup" area.

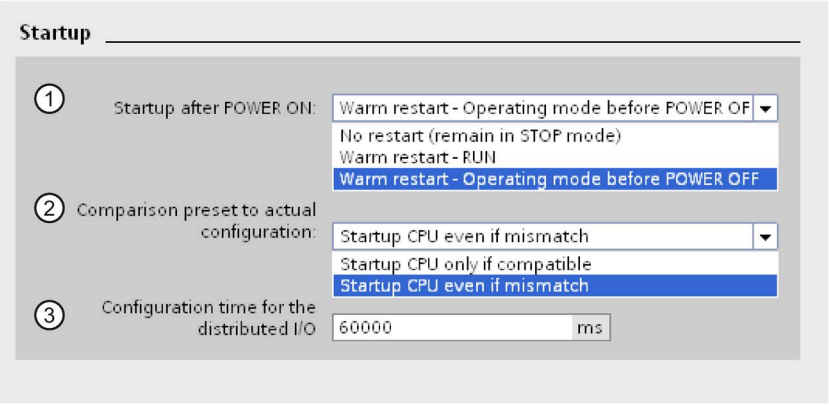


Figure 10-2 Setting the startup behavior

① Sets the startup type after POWER ON

② Defines the startup behavior for the case where a module in a slot does not correspond to the configured module. This parameter applies to the CPU and to all the modules for which no other setting was selected.

- Startup CPU only if compatible: In this setting a module on a configured slot has to be compatible with the configured module. Compatible means that the module matches the number of inputs and output and must match with respect to its electrical and functional properties.
- Startup CPU even if mismatch: At this setting the CPU starts up irrespective of the type of module plugged.

For locally used modules you can configure the hardware compatibility in the parameter "Comparison preset to actual module" individually for each slot. When you change the setting of the hardware compatibility for a module, the setting made at the CPU does not apply for this module.

③ Specifies a maximum period (default: 60000 ms) in which the central and distributed I/O must be ready for operation. The communications modules (CM/CP) are supplied with voltage and communication parameters during the CPU startup. This parameter assignment time grants a period within which the I/O modules connected to the communication module (CM/CP) must be operationally ready.
The CPU goes into RUN mode when the central and the distributed I/O is operationally ready within the parameter assignment time.

If the central and distributed I/O is not ready for operation within the configuration time, the startup characteristics of the CPU depends on the setting of the hardware compatibility.

Example for the "Comparison preset to actual configuration" parameter

"Startup CPU only if compatible"

The DI 32x24VDC HF input module with 32 digital inputs can be a compatible replacement for a DI 16x24VDC HF input module with 16 digital inputs. The pin assignment and all electrical and functional properties are identical.

"Startup CPU even if mismatch"

Instead of a configured digital input module, you insert an analog output module or no module is present in this slot and thus in all subsequent slots. Although the configured inputs cannot be accessed, the CPU starts up.

Note that the user program cannot function correctly in this case and take the appropriate measures.

10.5.2 STOP mode

Function

The CPU does not execute the user program in STOP mode.

All outputs are disabled or react according to the parameter settings for the respective module: They provide a substitute value as set in the parameters or retain the last value output and thus hold the controlled process in a safe operating mode.

10.5.3 RUN mode

Function

In "RUN" mode the cyclic, time-driven, and interrupt-driven program execution is performed. Addresses that are in the "Automatic Update" process image are automatically updated in each program cycle. See also the Process images and process image partitions (Page 90) section.

Execution of the user program

Once the CPU has read the inputs, the cyclic program is executed from the first instruction to the last instruction.

If you have configured a minimum cycle time, the CPU will not end the cycle until this minimum cycle time has expired, even if the user program is completed sooner.

A cycle monitoring time is set to ensure that the cyclic program is completed within a specified time. You can change the cycle monitoring time to suit your requirements. If the cyclic program has not finished running within this time, the system responds with a time error.
Further events such as hardware interrupts, diagnostics interrupts and communication can interrupt the cyclic program flow and prolong the cycle time.

Reference

Further information about cycle and response times is available in the Function Manual Cycle and response times (http://support.automation.siemens.com/WW/view/en/59193558).

10.5.4 Operating mode transitions

Operating modes and operating mode transitions

The following figure shows the operating modes and the operating mode transitions:

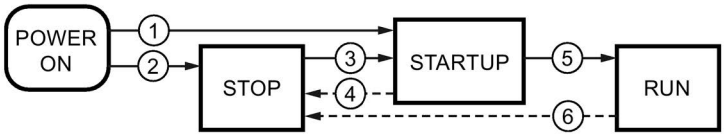


Figure 10-3 Operating modes and operating mode transitions

The table below shows the effects of the operating mode transitions:

Table 10- 4 Operating mode transitions

No.	Operating mode transitions		Effects
①	POWER ON → STARTUP	After switching on, the CPU switches to "STARTUP" mode if: • The hardware configuration and program blocks are consistent. • The "Warm restart-RUN" startup type is set or • The "Warm restart mode before POWER OFF" is set and was in RUN mode before POWER OFF.	Non-retentive memory is cleared, and the content of non-retentive DBs is reset to the start values of the load memory. Retentive memory and retentive DB contents are retained.
②	POWER ON → STOP	After switching on, the CPU goes to "STOP" mode if: • The hardware configuration and program blocks are inconsistent or • The "No restart" startup type is set.	Non-retentive memory is cleared, and the content of non-retentive DBs is reset to the start values of the load memory. Retentive memory and retentive DB contents are retained.
③	STOP → STARTUP	The CPU switches to "STARTUP" mode if: • The hardware configuration and program blocks are consistent. • The programming device sets the CPU to "RUN" and the mode selector is in the RUN setting or • The mode selector is switched from STOP to RUN.	Non-retentive memory is cleared, and the content of non-retentive DBs is reset to the start values of the load memory. Retentive memory and retentive DB contents are retained.
④	STARTUP → STOP	The CPU returns to the "STOP" mode in the following cases of "STARTUP": • The CPU detects an error during startup. • The programming device or the mode selector sets the CPU to "STOP". • A STOP command is executed in the Startup OB.	

No.	Operating mode transitions		Effects
⑤	STARTUP → RUN	The CPU goes to the "RUN" mode in the following cases of "START-UP": • The CPU has initialized the PLC tags. • The CPU has executed the startup blocks successfully.	
⑥	RUN → STOP	The CPU returns to the "STOP" mode in the following cases of "RUN": • An error is detected that prevents continued processing. • A STOP command is executed in the user program. • The programming device or the mode selector sets the CPU to "STOP".	

10.6 CPU memory reset

Basics of a memory reset

A memory reset on the CPU is possible only in the STOP mode.

During memory reset, the CPU is changed to a so-called "initial status".

This means that:

- An existing online connection between your programming device/PC and the CPU is terminated.
- The content of the work memory and the retentive and non-retentive data (applies only to manual memory reset by the user) are deleted.
- The diagnostics buffer, time of day, and IP address are retained.
- Subsequently the CPU is initialized with the loaded project data (hardware configuration, code and data blocks, force jobs). The CPU copies this data from the load memory to the work memory.

  Result:

  – If you set an IP address in the hardware configuration ("Set IP address in the project" option) and a SIMATIC memory card with the project is in the CPU, this IP address is valid after the memory reset.

  – Data blocks no longer have current values but rather their configured start values.

  – Force jobs remain active.

How can I tell if the CPU is performing a memory reset?

The RUN/STOP LED flashes yellow at 2 Hz. After completion the CPU goes into STOP mode, and the RUN/STOP LED is switched on (unchanging yellow).

Result after memory reset

The following table provides an overview of the contents of the memory objects after memory reset.

Table 10- 5 Memory objects after memory reset

Memory object	Contents
Actual values of the data blocks, instance data blocks	Initialized
Bit memories, timers and counters	Initialized
Certain retentive tags of technology objects (for example, calibration values of absolute encoders)*	Retained
Diagnostics buffer entries (retentive area)	Retained
Diagnostics buffer entries (non-retentive area)	Initialized
IP address	Retained
Counter readings of the runtime meters	Retained
Time of day	Retained

* The retentive tags of technology objects are retained, but the contents of certain tags are partially reinitialized.

10.6.1 Automatic memory reset

Possible cause of automatic memory reset

The CPU executes an automatic memory reset if an error occurs that prevents normal further processing.

Causes for such errors can be:

- User program is too large, and can't be completely loaded into work memory.
- The project data on the SIMATIC memory card are damaged, for example because a file was deleted.
- If you remove or insert the SIMATIC memory card and the backed-up retentive data differs in structure from that of the configuration on the SIMATIC memory card.

10.6.2 Manual memory reset

Reason for manual memory reset

Memory reset is required to reset the CPU to its "original state".

CPU memory reset

There are three options for performing a CPU memory reset:

- Using the mode selector
- Using the display
- Using STEP 7

Procedure using the mode selector

Note

Memory reset ↔ Reset to factory settings

The procedure described below also corresponds to the procedure for resetting to factory settings:

- Selector operation with inserted SIMATIC memory card: CPU executes a memory reset
- Selector operation without inserted SIMATIC memory card: CPU executes reset to factory settings

To perform a memory reset of the CPU using the mode selector, follow these steps:

1. Set the mode selector to the STOP position.

   Result: The RUN/STOP LED lights up yellow.

2. Set the mode selector to the MRES position. Hold the selector in this position until the RUN/STOP LED lights up for the 2nd time and remains continuously lit (this takes three seconds). After this, release the selector.

3. Within the next three seconds, switch the mode selector back to the MRES position, and then back to STOP again.

Result: The CPU executes memory reset.

For information on resetting the CPU to factory settings, refer to the chapter Reset CPU to factory settings (Page 193).

Procedure using the display

To navigate to the desired "Memory reset" menu command, select the following sequence of menu commands and confirm after each selection with "OK".

- Settings → Reset → Memory reset

Result: The CPU executes memory reset.

Procedure using STEP 7

To perform a memory reset of the CPU via STEP 7, follow these steps:

1. Open the "Online Tools" task card of the CPU.
2. Click the "MRES" button in the "CPU control panel" pane.
3. Click "OK" in response to the confirmation prompt.

Result: The CPU is set to STOP mode and performs memory reset.

10.7 Identification and maintenance data

10.7.1 Reading out and entering I&M data

I&M data

Identification and maintenance data (I&M data) is data saved on the module as read-only (I data) or read/write (M data) information.

Identification data (I&M0): Manufacturer information about the module that can only be read and is in part also printed on the housing of the module, for example, article number and serial number.
Maintenance data (I&M1, 2, 3): Plant-dependent information, e.g. installation location. Maintenance data for the S7-1500/ET 200MP is created during configuration and downloaded to the automation system/distributed I/O system.

All modules of the S7-1500/ET 200MP support identification data (I&M0 through I&M3).

The I&M identification data supports you in the following activities:

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

Modules can be clearly identified online using the I&M identification data.

You can read out the identification data with STEP 7 (see online help for STEP 7).

Options for reading out I&M data

- Via the user program
- Using the display of the CPU
- Via STEP 7 or HMI devices
- Via the CPU web server

Procedure for reading I&M data via the user program

To read the modules' I&M data in the user program, use the RDREC instruction.

The record structure for centrally inserted modules as well as for distributed modules that are accessible via PROFINET IO/PROFIBUS DP, is described in the chapter Record structure for I&M data (Page 164).

Reference

The description of the instructions can be found in the STEP 7 online help.

Procedure for reading I&M data via the display

To read the I&M data "Plant designation" or "Location identifier" of the CPU via the display, follow these steps:

1. Navigate to the "Overview/PLC" menu on the display of the CPU.
2. Select "Plant designation" or "Location identifier" and confirm with "OK".

To read the I&M data "Plant designation" or "Location identifier" of a centrally used module, follow these steps:

1. Navigate to the "Modules" menu on the display of the CPU.
2. Select the menu command "Local modules" and confirm with "OK".
3. Select the slot of the module (e.g., slot 3: DI 32 x 24VDC HF) and confirm with "OK".
4. Select the "Status" and confirm with OK.
5. Select "Plant designation" or "Location identifier" and confirm with "OK".

To read the I&M data "Plant designation" or "Location identifier" of a module used in distributed mode, follow these steps:

1. Navigate to the "Modules" menu on the display of the CPU.
2. Select the corresponding distributed I/O system (for example PROFINET IO system) and confirm with "OK".
3. Select the corresponding device (for example ET 200SP-Station_1) and confirm with "OK".
4. Select the slot of the module (e.g., slot 1: DI 16 x DC24V ST_1) and confirm with "OK".
5. Select the "Status" and confirm with OK.
6. Select "Plant designation" or "Location identifier" and confirm with "OK".

Procedure for reading I&M data via STEP 7

Requirement: There must be an online connection to the CPU/interface module.

To read I&M data using STEP 7, follow these steps:

1. In the project tree, select the CPU/interface module and go to "Online & diagnostics".
2. In the "Diagnostics" folder, select the "General" area.

Procedure for entering maintenance data via STEP 7

STEP 7 assigns a default module name. You can enter the following information:

- Plant designation (I&M 1)
- Location identifier (I&M 1)
- Installation date (I&M 2)
- Additional information (I&M 3)

To enter maintenance data via STEP 7, follow these steps:

1. In the device view of STEP 7, select the CPU/interface module or a module.
2. In the properties under "General" select the "Identification & Maintenance" area, and enter the data.

During the loading of the hardware configuration, the maintenance data (I&M 1, 2, 3) are also loaded.

Procedure for reading I&M data via the Web server

The procedure is described in detail in the Web server Function Manual (http://support.automation.siemens.com/WW/view/en/59193560).

10.7.2 Record structure for I&M data

Reading I&M records via user program (centrally and distributed via PROFINET IO)

Use **Read data record** ("RDREC" instruction) to access specific identification data. Under the associated record index you obtain the corresponding part of the identification data.

The records are structured as follows:

Table 10- 6 Basic structure of data records with I&M identification data

Contents	Length (bytes)	Coding (hex)
Header information		
BlockType	2	I&M0: 0020_H I&M1: 0021_H I&M2: 0022_H I&M3: 0023_H
BlockLength	2	I&M0: 0038_H I&M1: 0038_H I&M2: 0012_H I&M3: 0038_H
BlockVersionHigh	1	01
BlockVersionLow	1	00
Identification data		
Identification data (see table below)	I&M0/Index $AFF0_H$: 54 I&M1/Index $AFF1_H$: 54 I&M2/Index $AFF2_H$: 16 I&M3/Index $AFF3_H$: 54	- - - -

Table 10- 7 Record structure for I&M identification data

Identification data	Access	Example	Explanation
Identification data 0: (record index AFF0$_H$)			
VendorIDHigh	read (1 bytes)	0000$_H$	Vendor name (002A$_H$ = SIEMENS AG)
VendorIDLow	read (1 bytes)	002A$_H$	
Order_ID	read (20 bytes)	6ES7516-3AN00-0AB0	Part number of the module (e.g. CPU 1516-3 PN/DP)
IM_SERIAL_NUMBER	read (16 bytes)	-	Serial number (device-specific)
IM_HARDWARE_REVISION	read (2 bytes)	1	corresponds to hardware version (e.g. 1)
IM_SOFTWARE_REVISION	read	Firmware version	Provides information about the firmware version of the module (e.g. V1.0.0)
• SWRevisionPrefix	(1 byte)	V	
• IM_SWRevision_Functional_ Enhancement	(1 byte)	0000$_H$ - 00FF$_H$	
• IM_SWRevision_Bug_Fix	(1 byte)	0000$_H$ - 00FF$_H$	
• IM_SWRevision_Internal_ Change	(1 byte)	0000$_H$ - 00FF$_H$	
IM_REVISION_COUNTER	read (2 bytes)	0000$_H$	Provides information about parameter changes on the module (not used)
IM_PROFILE_ID	read (2 bytes)	0000 $_H$	Generic Device
IM_PROFILE_SPECIFIC_TYPE	read (2 bytes)	0001$_H$	CPU
		0003$_H$	I/O modules
IM_VERSION	read	0101$_H$	Provides information on the ID data version (0101$_H$ = Version 1.1)
• IM_Version_Major	(1 byte)		
• IM_Version_Minor	(1 byte)		
IM_SUPPORTED	read (2 bytes)	000E$_H$	provides information about the available identification and maintenance data (I&M1 to I&M3)
Maintenance data 1: (Record index AFF1$_H$)			
IM_TAG_FUNCTION	read/write (32 bytes)	-	Enter an identifier for the module here, that is unique plant-wide.
IM_TAG_LOCATION	read/write (22 bytes)	-	Enter the installation location of the module here.
Maintenance data 2: (Record index AFF2$_H$)			
IM_DATE	read/write (16 bytes)	YYYY-MM-DD HH:MM	Enter the installation date of the module here.
Maintenance data 3: (Record index AFF3$_H$)			
IM_DESCRIPTOR	read/write (54 bytes)	-	Enter a comment about the module here.

Reading I&M records with record 255 (distributed configuration via PROFIBUS)

Use **Read data record** ("RDREC" instruction) to access specific identification data.

The modules support standardized access to identification data using DR 255 (index 65000 to 65003). For further information on the DS 255 data structure, refer to the specifications of the Profile Guidelines Part 1: Identification & Maintenance Functions - Order no.: 3.502, Version 1.2, October 2009.

10.8 Shared commissioning of projects

Team Engineering

In Team Engineering several users from various engineering systems work on a project at the same time and access one S7-1500 CPU.

The users can edit separate parts of a master project independently of one another at the same time. The changes of the other editors are displayed in a synchronization dialog during the loading of the configuration in the CPU and synchronized automatically, if possible.

Certain online functions can also be executed at the same time from several engineering systems on a shared CPU, such as:

- Monitoring blocks on the CPU
- Modifying blocks on the CPU
- Trace functions

You can find detailed information on the topic of Team Engineering in the STEP 7 online help.

SIMATIC memory card 11

11.1 SIMATIC memory card - overview

Introduction

The S7-1500 automation system uses a SIMATIC memory card as the program memory. The SIMATIC memory card is a preformatted memory card compatible with the Windows file system. The memory card is available in different memory sizes and can be used for the following purposes:

- Transportable data carrier
- Program card
- Firmware update card
- Service data cards

If you transfer the user program to the CPU via an online connection, it is written to the load memory of the SIMATIC memory card, which must be in the card slot of the CPU for this to work.

You can also write the SIMATIC memory card in the PG/PC. A commercially available SD card reader is required to write / read the SIMATIC memory card with the programming device / PC. This is used to copy files directly to the SIMATIC memory card using the Windows Explorer, for example.

A SIMATIC memory card is absolutely required in order to operate the CPU.

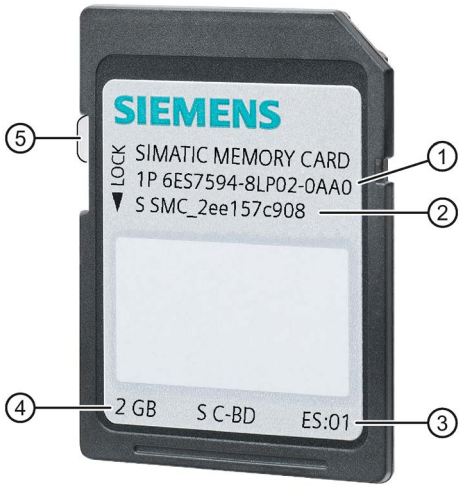
Note

Memory size of the SIMATIC memory card

Please note that a SIMATIC memory card with a memory size of 24 MB is not sufficient for a firmware update of the CPU 1518-4 PN/DP and CPU 1517-3 PN/DP.

Therefore, select a SIMATIC memory card with more memory space (e.g. 2 GB) for the firmware update of a CPU 1518-4 PN/DP or a CPU 1517-3 PN/DP.

Labeling of the SIMATIC memory card



① Part number
② Serial number
③ Product version
④ Memory size
⑤ Slider for enabling write protection:
- Slider up: not write-protected
- Slider down: write-protected

Figure 11-1 Labeling of the SIMATIC memory card

Folders and files on the SIMATIC memory card

The following folders and files can be found on the SIMATIC memory card:

Table 11- 1 Folder structure

Folder	Description
FWUPDATE.S7S	Firmware update files for CPU and I/O modules
SIMATIC.S7S	User program, i.e. all blocks (OBs, FCs, FBs, DBs) and system blocks, project data of the CPU
SIMATIC.HMI	HMI-relevant data
DataLogs	DataLog files
Recipes	Recipe files

Table 11- 2 File structure

File type	Description
S7_JOB.S7S	Job file
SIMATIC.HMI\Backup*.psb	Panel backup files
SIMATICHMI_Backups_DMS.bin	Protected file (required to use panel backup files in STEP 7)
__LOG__	Protected system file (required in order to use the card)
crdinfo.bin	Protected system file (required in order to use the card)
DUMP.S7S	Service data file
*.pdf, *.txt, *.csv, ...	Further files with different formats that you can also store in folders of the SIMATIC memory card

Use the serial number for copy protection

You can set up copy protection for CPUs which binds execution of the block to a specific SIMATIC memory card. Configuration is carried out in STEP 7 in the properties of the block "Bind to serial number of the SIMATIC memory card".

You can then only execute the block if it is on the SIMATIC memory card with the specified serial number.

Removing the SIMATIC memory card

Only remove the SIMATIC memory card in the POWER OFF or STOP operating modes of the CPU. Ensure that no writing functions (e.g. loading/deleting a block) are active in STOP mode, or were active in POWER OFF mode. For this purpose, disconnect the communication connections.

If you remove the SIMATIC memory card during a write process, the following problems can occur:

- The data contents of a file are incomplete.
- The file is no longer readable, or no longer exists.
- The entire content of the card is corrupted.

Removing the SIMATIC memory card from the CPU in STOP, STARTUP or RUN mode triggers a re-evaluation of the SIMATIC memory card. The CPU hereby compares the content of the configuration on the SIMATIC memory card with the backed-up retentive data. If the backed-up retentive data matches the data of the configuration on the SIMATIC memory card, the retentive data is retained. If the data differs, the CPU automatically performs a memory reset (which means the retentive data is deleted) and then goes to STOP.

Removing the SIMATIC memory card from Windows computers

If you are using the card in a commercially available card reader under Windows, use the "Eject" function before you remove the card from the card reader. If you remove the card without using the "Eject" function, you may lose data.

Deleting the contents of the SIMATIC memory card

You have the following options for deleting the contents of the SIMATIC memory card:

- Delete files using Windows Explorer
- Format with STEP 7

Note

If you format the card with Windows utilities, you will render the SIMATIC memory card unusable as a storage medium for a CPU.

Deletion of files and folders is permitted, with the exception of the "__LOG__" and "crdinfo.bin" system files. The CPU needs these system files. If you delete the files, you will no longer be able to use the SIMATIC memory card with the CPU.

If you have deleted the "__LOG__" and "crdinfo.bin" system files, format the SIMATIC memory card as described in the following section.

Formatting the SIMATIC memory card

Note

You may only format a SIMATIC memory card in the CPU; otherwise, the SIMATIC memory card cannot be used in the CPU.

If you want to format the SIMATIC memory card using STEP 7, an online connection to the relevant CPU must exist. The relevant CPU is in the STOP mode.

Proceed as follows to format a SIMATIC memory card:

1. Open the Online and Diagnostics view of the CPU (either from the project context or via "Accessible devices").
2. In the "Functions" folder, select the "Format memory card" group.
3. Click the "Format" button.
4. Click "Yes" in response to the confirmation prompt.

Result:

- The SIMATIC memory card is formatted for use in the CPU.
- The data on the CPU is deleted with the exception of the IP address.

Service life of a SIMATIC memory card

The service life of a SIMATIC memory card depends essentially on the following factors:

- Number of delete/write cycles
- External influences, such as ambient temperature

With an ambient temperature of up to 60 °C, at least 100,000 delete/write processes are possible on the SIMATIC memory card.

11.2 Setting the card type

Introduction

You can use the SIMATIC memory card as a program card or as a firmware update card.

Procedure

1. To set the card type, insert the SIMATIC memory card into the card reader of the programming device.
2. Select the "SIMATIC Card Reader" folder in the project tree.
3. In the properties of the selected SIMATIC memory card, specify the card type:

- **Program card**

  You use a program card as an external load memory for the CPU. It contains the entire user program for the CPU. The CPU transfers the user program from the load memory to the work memory. The user program runs in the work memory. If you remove the SIMATIC memory card with the user program, the CPU goes into STOP mode.

  The following folder is created on the SIMATIC memory card: SIMATIC.S7

- **Firmware update card**

  You can save firmware for CPUs and for I/O modules on a SIMATIC memory card. You can perform a firmware update with the help of a specially prepared SIMATIC memory card.

  The following folder is created on the SIMATIC memory card: FWUPDATE.S7S

Reference

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

11.3 Data transfer with SIMATIC memory cards

Transferring objects from the project to a SIMATIC memory card

When the SIMATIC memory card is inserted in the programming device or in an external card reader, you can transfer the following objects from the project tree (STEP 7) to the SIMATIC memory card:

- Individual blocks (multiple selection possible)

  In this case, the transfer is consistent, which means that the function takes dependencies between blocks due to block calls into account.

- CPU folder

  In this case, all runtime-relevant objects including blocks and the hardware configuration are transferred onto the SIMATIC memory card - just as when downloading.

To perform a transfer, you can transfer the objects by dragging and dropping, or use the "Card Reader/USB memory > Write to memory card" command in the "Project" menu.

Firmware update via SIMATIC memory card

You can find information on how to perform a firmware update via SIMATIC memory card in the Firmware update (Page 190) section.

Reference

For additional information about the SIMATIC memory card, refer to the STEP 7 online help.

CPU display

12

Introduction

The section below gives an overview of the mode of operation of the CPU display. Detailed information on the individual options, a training course and a simulation of the selectable menu items is available in the SIMATIC S7-1500 Display Simulator (http://www.automation.siemens.com/salesmaterial-as/interactive-manuals/getting-started_simatic-s7-1500/disp_tool/start_en.html).

Display

The S7-1500 CPU has a front cover with a display and operating keys. The display of the CPU shows you the control and status information in different menus. You use operating keys to navigate through the menus and make a variety of settings in the process.

Benefits

The display of the CPU offers the following advantages:

- Reduced downtimes through diagnostics alarms in plain text
- Changing of the interface settings on site without programming device
- Password assignment for display operation is possible via STEP 7
- Shorter downtimes due to read and write access to force tables and read access to watch tables:
  The watch tables and force tables allow the current values of the individual tags of a user program or a CPU to be monitored and modified on the display. You can find additional information on the watch and force tables in the section Test functions and fault correction (Page 198) and in the STEP 7 online help.
- IP addresses of CPU and connected CMs/CPs are adjustable
- For F-CPUs: Overview of status of safety mode and of F-parameters of F-CPU and F-I/O

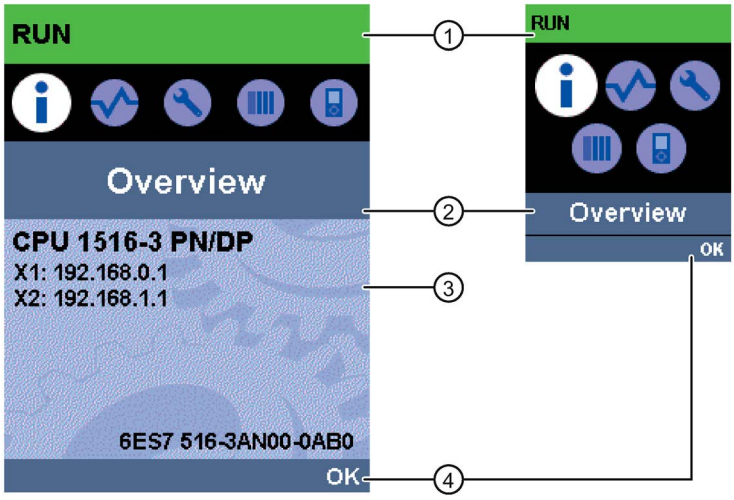
Operating temperature for the display

To increase the service life of the display, the display switches off when the permitted operating temperature is exceeded. When the display has cooled down again, it switches on automatically again. When the display is switched off, the LEDs continue to show the status of the CPU.

Further information about the temperatures at which the display switches off and back on again is available in the technical data of the manuals of the CPUs.

Display

The figures below show an example view of the displays of a CPU 1515-2 PN, CPU 1516-3 PN/DP, CPU 1517-3 PN/DP or CPU 1518-4 PN/DP on the left and a CPU 1511-1 PN or CPU 1513-1 PN on the right.



① CPU status information
② Names of the menus
③ Data display field
④ Navigation aid, e.g. OK/ESC or the page number

Figure 12-1 Example views of the displays

Regarding ①: CPU status information

The following table shows the CPU status information that can be retrieved via the display.

Table 12- 1 CPU status information

Color and icons for the status data	Meaning
Green	RUN
Orange	• STOP • STOP - firmware update
Red	FAULT
White	• Connection establishment between CPU and display
	Protection level configured
	• At least one interrupt is active in the CPU. • No SIMATIC memory card inserted in the CPU. • The serial number to which a know-how-protected block is bound, does not match the serial number of the CPU or the SIMATIC memory card. • No user program loaded
	Force job is active in the CPU
	F-capability activated Safety operation active (for fail-safe CPUs) The symbol is grayed out when safety mode is deactivated.
	Fail-safe CPU (for fail-safe CPUs)

Regarding ②: Names of the menus

The following table shows the available menus of the display.

Table 12- 2 Names of the menus

Main menu items	Meaning	Description
	Overview	The "Overview" menu contains information about the properties of the CPU and the properties of the inserted SIMATIC memory card, as well as information on whether a know-how protection or a linking of the serial number exists. For F-CPUs, the status of the safety mode, the collective signature and the date of the last change in the F-CPU is displayed.
	Diagnostics	The "Diagnostics" menu includes: • Display of diagnostics alarms • Read and write access to force tables and read access to watch tables • Display of cycle time • Display of the CPU memory utilization • Display of the interrupts
	Settings	In the "Settings" menu, you can: • Assign the IP addresses and the PROFINET device names of the CPU • Network properties of each CPU interface • Set the date, time, time zones, operating states (RUN/STOP) and protection levels • Disable/Enable display with display password • Perform a CPU memory reset • Perform the reset to factory settings • View the status of the firmware update.
	Modules	The "Modules" menu contains information about the central and distributed modules that are used in your configuration. Peripherally deployed modules are connected to the CPU via PROFINET and/or PROFIBUS. You can set the IP addresses for the CPU or a CP/CM here. Fail-safe parameters are displayed for F-modules.
	Display	In the "Display" menu you can configure settings related to the display, such as language setting, brightness and energy-saving mode. The energy-saving mode dims the display. The standby mode selectors the display off.

Menu icons

The following table shows the icons that are displayed in the menus.

Table 12- 3 Menu icons

Icon	Meaning
	Editable menu item
	Select the desired language here.
	There is an alarm in the next lower level object.
	There is a fault in the next lower level object.
	The marked module cannot be reached.
	Navigate to next sublevel
	In edit mode you make the selection using two arrow keys: • down/up: jumps to a selection, or serves for selecting desired digits / options
	In edit mode you make the selection using four arrow keys: • down/up: jumps to a selection, or serves for selecting desired digits • left/right: jumps one spot forward or backward

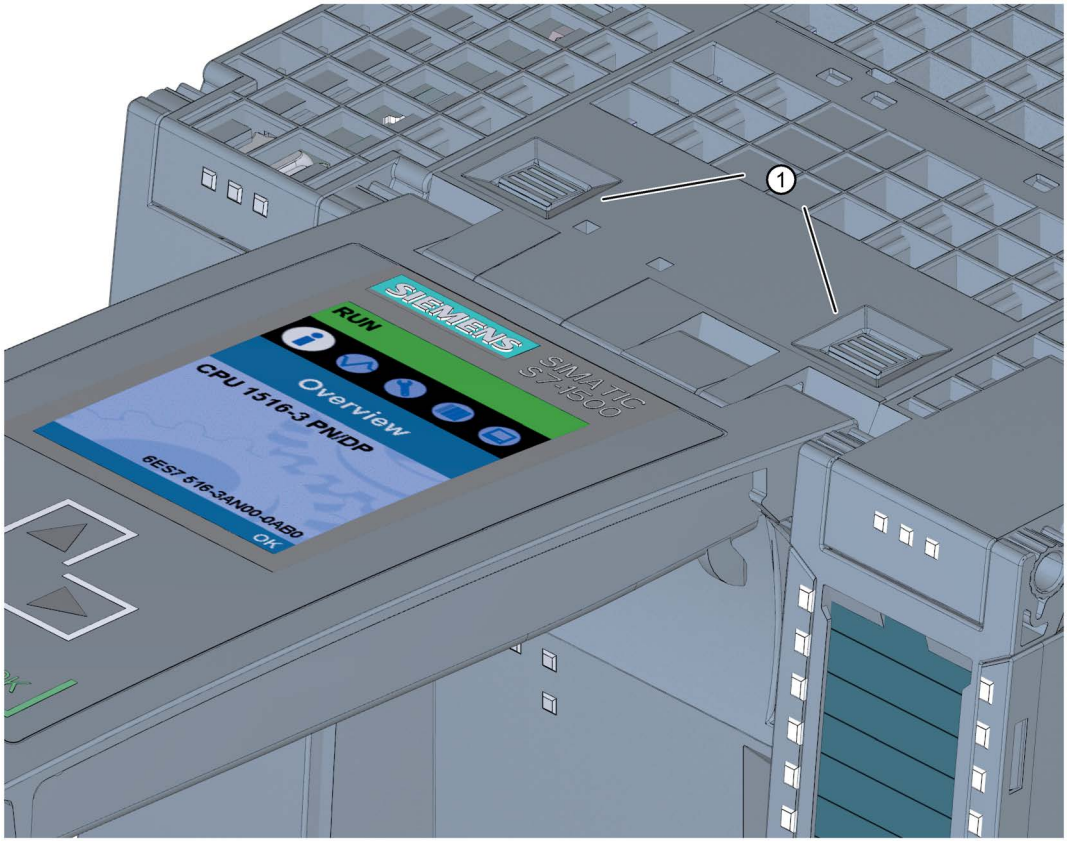
Handling the front cover

The front cover is pluggable. You can remove or replace the front cover during operation (RUN). Removing or replacing the front cover has no effect on the running CPU.

To remove the front cover from the CPU, follow these steps:

1. Flip up the front cover until the front cover stands at a 90° angle to the front of the module.
2. In the upper area of the front cover simultaneously press on the anchor(s) and pull the front cover forward and away.

The figure below shows an exemplary view of the CPU 1516-3 PN/DP.



① Fasteners for removing and fitting the front panel

Figure 12-2 Removing and fitting the front panel

WARNING

Personal injury or material damage can occur in zone 2 hazardous areas

Personal injury or material damage can occur in hazardous are zone 2 if you remove or fit the front panel while the S7-1500 automation system is running.

Before you remove or fit the front panel, always switch off the power supply to the S7-1500 automation system in hazardous area zone 2.

Control keys

The following keys are available on the CPU's display:

- Four arrow buttons: "up", "down", "left", "right"
  An automatic scroll function occurs if you hold the arrow button pressed for two seconds
- One ESC key
- One OK key

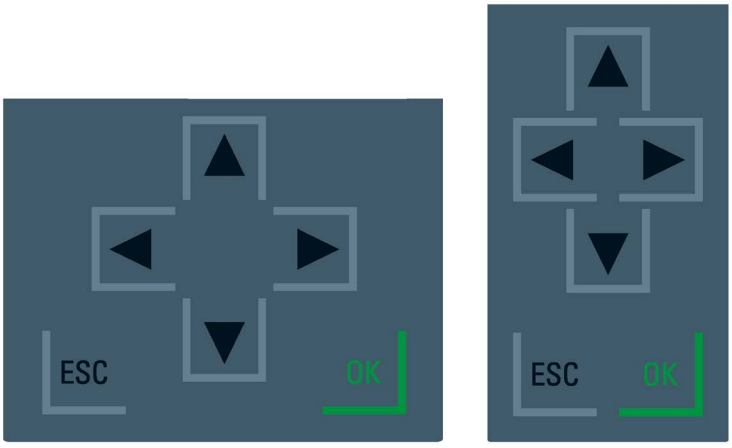


Figure 12-3 Control keys

Note

If the display is in energy-saving mode or in standby mode, you can exit this mode by pressing any key.

Functions of the "OK" and "ESC" keys

- For menu commands in which an entry can be made:
  - OK → valid access to the menu command, confirmation of input, and exit from the edit mode
  - ESC → set the original content (which means changes are not saved) and exit from edit mode
- For menu commands in which no entry can be made:
  - OK → to next submenu command
  - ESC → back to previous menu command

If you hold ESC for around three seconds on any screen of the display, you jump automatically to the home page.

Tooltips

Some of the values shown on the display (e.g., station name, plant designation, location identifier, PROFINET device name, etc.) can exceed the available display width. This applies in particular to the display of the CPU 1511-1 PN or CPU 1513-1 PN. A tooltip appears when you focus on the respective value on the display and then press the "Left" arrow key. The tooltip shows the name of the value in complete length. The tooltip is hidden again if you again press the "Left" arrow or the ESC key.

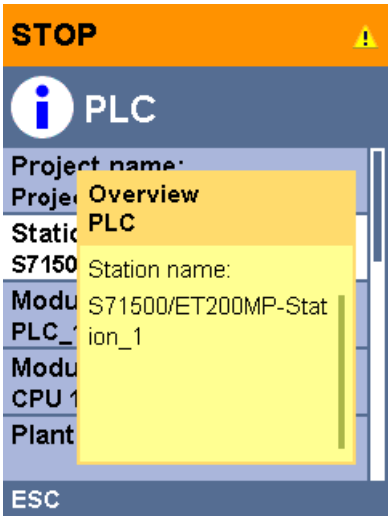


Figure 12-4 Tooltip function

Uploading image to the display via STEP 7

You can use the "User-defined logo" function under "Display" in the device view of the CPU to load an image from your file system into the display of the CPU via STEP 7.

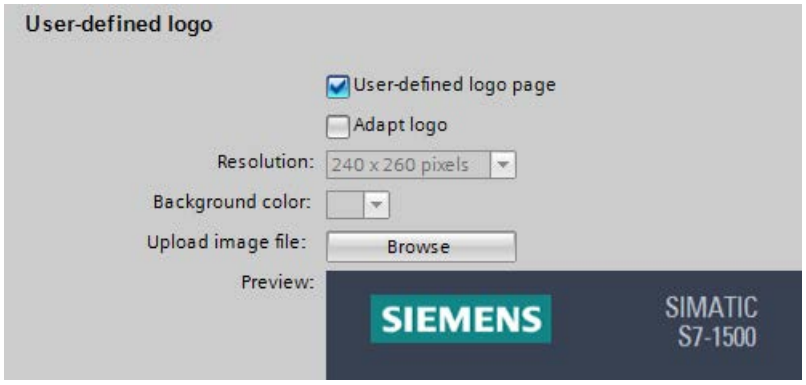


Figure 12-5 Uploading image to CPU

To correctly show the aspect ratio of the uploaded image, use the following dimensions depending on the CPU images.

Table 12- 4 Dimensions

CPU	Dimensions	Supported formats
CPU 1511-1 PN	128 x 120 pixels	Bitmap, JPEG, GIF, PNG
CPU 1513-1 PN	128 x 120 pixels	Bitmap, JPEG, GIF, PNG
CPU 1515-2 PN	240 x 260 pixels	Bitmap, JPEG, GIF, PNG
CPU 1516-3 PN/DP	240 x 260 pixels	Bitmap, JPEG, GIF, PNG
CPU 1517-3 PN/DP	240 x 260 pixels	Bitmap, JPEG, GIF, PNG
CPU 1518-4 PN/DP	240 x 260 pixels	Bitmap, JPEG, GIF, PNG

If the uploaded image exceeds the specified dimensions, the display shows only part of the image. The "Adapt logo" option in STEP 7 provides you with the option of scaling the image to the specified dimensions. However, note that the original aspect ratio of the image is not retained in such cases.

Displaying image on the display

To display the uploaded image on the display of the CPU, press the ESC key in the main screen of the display. When you upload an image and are in the main screen, the display automatically shows the image after 60 seconds. To hide the image again, press any key on the display.

Available language settings

You can set the following languages separately for menu and alarm texts:

- Chinese
- German
- English
- French
- Italian
- Japanese
- Korean
- Portuguese (Brazil)
- Russian
- Spanish
- Turkish

You select the required language directly at the display in the "Display" menu or in STEP 7 in the hardware configuration of the CPU under User interface languages".

To display alarm texts on the display, these have to be loaded into the CPU as a software component. To do so, select the "Consistent download" option under "Text libraries" in the "Load preview" dialog.

Maintenance 13

13.1 Removing and inserting I/O modules

Requirement

Remove or insert front connectors and I/O modules only when the voltage is switched off.

NOTICE
Physical damage can occur If you install or uninstall front connectors and/or I/O modules with switched-on voltage, this can lead to undefined conditions in your plant. The S7-1500 automation system/ET 200MP distributed I/O system may be damaged as a result. Therefore only install/uninstall front connectors and/or I/O modules with switched-off voltage. Therefore during the planning of a plant always make sure to comply with the necessary, pertinent standards and safety guidelines.

13.2 Replacement of I/O modules and front connectors

13.2.1 Coding element on the I/O module and on the front connector

Function

All front connectors for the I/O modules of the S7-1500 automation system/ET 200MP distributed I/O system are identical. The coding element prevents a front connector from being inserted on a module with a different electrical pin assignment.

Delivery state of the I/O module

In the delivery state, the coding element is located in the I/O module.

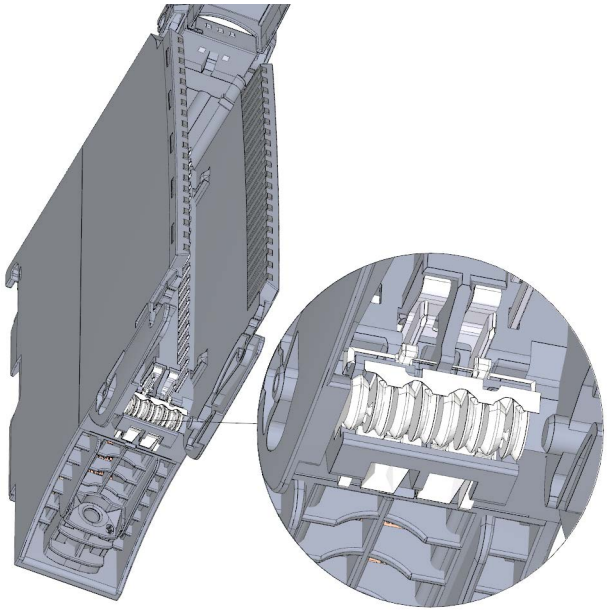


Figure 13-1 Coding element in the I/O module (delivery condition)

Coding element in the front connector

When the front connector is inserted into the I/O module for the first time, one half of the coding element latches into the front connector. When you remove the front connector from the I/O module, this half of the coding element remains in the front connector, while the other half remains in the I/O module.

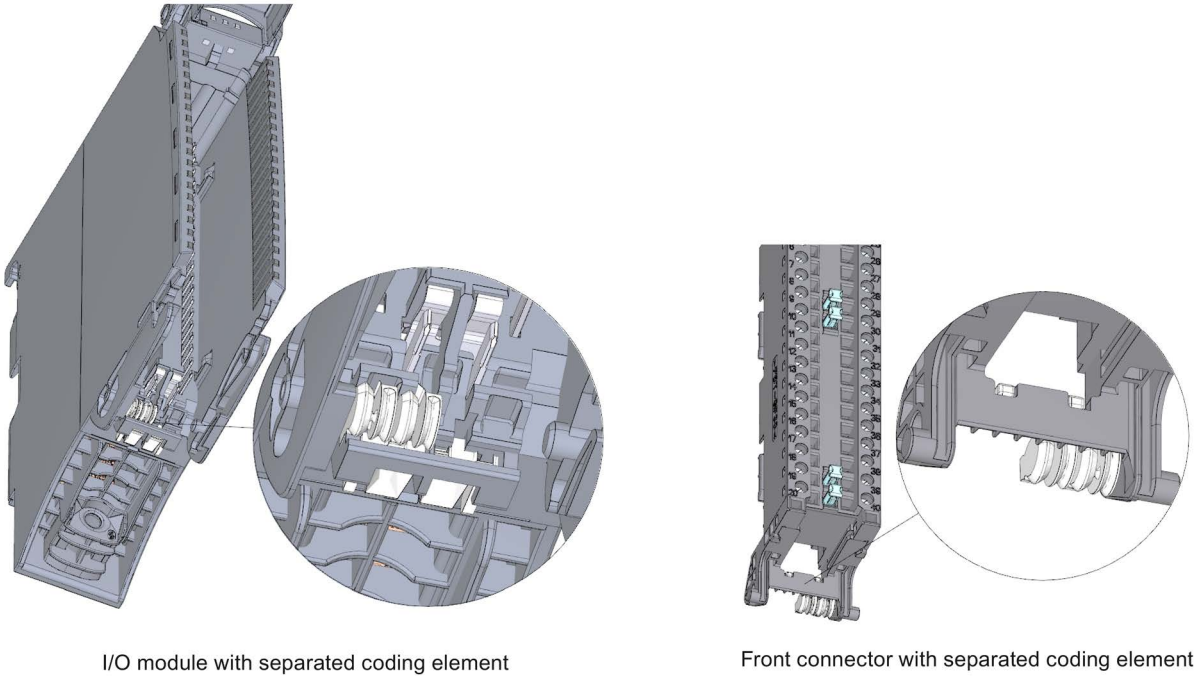


Figure 13-2 Coding element in the I/O module/front connector

You can insert a coded front connector on modules with the same electrical pin assignment.

Please note the Application Planning (Page 23) section.

NOTICE
Physical damage can occur If the coding element is changed or removed, it will be possible to insert the front connector on modules in which the electrical connection is not properly wired. This can destroy the module and/or the connected sensors and actuators. Even hazardous plant states are possible. Do not change the coding element unless you want to use the front connector on a different module and you change the process wiring accordingly.

Use cases for replacing the coding element

- Replacing an I/O module, for example, due to a defect or incorrect configuration
- Replacing a front connector

13.2.2 Replacing an I/O module

Introduction

When the front connector is first inserted into the I/O module, a part of the coding element clips onto the front connector. When you replace an I/O module with the same type of module, the correct coding element is already present in the front connector.

Procedure

To replace the I/O module, follow these steps:

You have already uninstalled the I/O module.

1. With a new I/O module, use a screwdriver to break out the half of the coding element that is designated for the front connector.

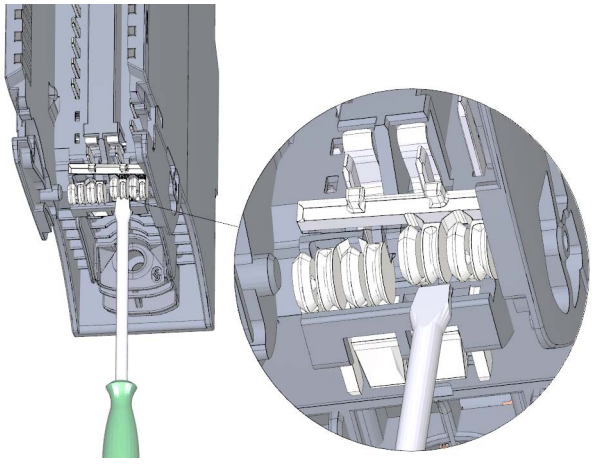


Figure 13-3 Breaking the coding element out of the I/O module

2. Insert the existing front connector into the new I/O module (same module type) until your hear it click into place.

13.2.3 Replacing a front connector

Introduction

When the front connector is first inserted into the I/O module, a part of the coding element clips onto the front connector. When you replace a defective front connector with a new front connector, then you must transfer the coding element into the new front connector.

Procedure

You have already removed the front connector from the module and loosened the wiring. If you are using the front connector for an analog module, you also need to remove the power supply element and shield element. Proceed as follows to replace the front connector:

1. Carefully remove the coding element from the front connector. Take care not to damage the coding element.

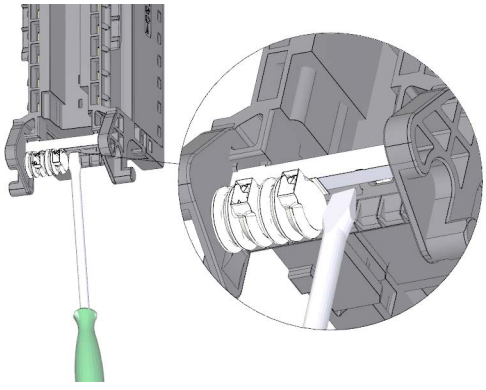


Figure 13-4 Removing the coding element from the front connector

2. Insert the removed coding element into the new front connector.

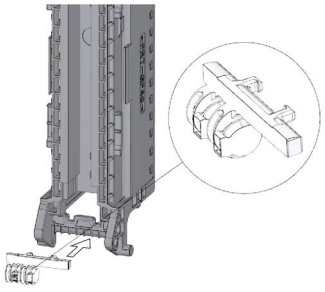


Figure 13-5 Inserting the coding element into the front connector

3. Insert the new front connector into the existing I/O module, until your hear it click into place.
4. Wire the new front connector.

13.3 Replacing the coding element at the power connector of the system power supply and load current supply

Introduction

The coding consists of a 2-part coding element.

Ex factory a part of the coding element is inserted into the back side of the power connector. The other part is firmly inserted in the system power supply or load current supply.

This prevents the insertion of a power connector of a system power supply or load current supply into a module of a different type.

⚠ DANGER

Do not manipulate the coding element, or leave it off

- If you undertake changes to the coding element or replace it, then this can lead to dangerous conditions in your plant.
- In order to prevent damage, you must not change or replace the coding.
- The coding element may not be left off.

Replacement parts scenario

Insertion of the coding element into a new power connector in the case of a replacement part.

⚠ DANGER

Dangerous voltage

When installing the coding element, you must take into account the supply voltage of the system power supply and load current supply, 24 V DC, 24/48/60 V DC or 120/230 V AC/DC.

Only install the coding element with switched-off voltage.

You must insert the coding element in such a way that the power connector matches the power supply module in terms of voltage.

Procedure

To replace the coding element on the power connector of the system power supply and load current supply, follow these steps:

1. Orient yourself using the labeling on the power cable connection.

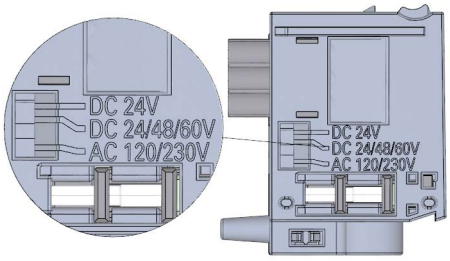


Figure 13-6 Labeling on the power connector

2. Orient yourself using the red marking on the coding element.
3. The coding element has 3 red markings. Turn the coding element in such a way that one of the 3 red markings corresponds to the voltage indicated on the connector.
4. Insert the coding element into the back side of the power cable connector, until you hear it click into place. The figure below shows you how to insert a coding element into a power cable connector for 24 V DC.

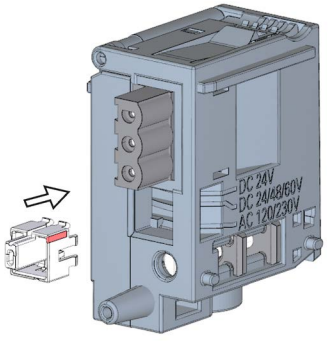


Figure 13-7 Inserting a coding element into a power connector

13.4 Firmware update

Introduction

During operation, it may be necessary to update the firmware (e.g. due to function extensions).

Update the firmware of the CPU/interface module, display and the I/O modules using firmware files. The retentive data is retained after the execution of the firmware update.

Requirement

- You have downloaded the file(s) for the firmware update from the Product Support (http://support.automation.siemens.com/WW/view/en/4000024) web page.

  On this web site, select:

  – For the S7-1500 automation system: Automation technology > Automation systems > SIMATIC industrial automation system > Controllers > SIMATIC S7 modular controllers > SIMATIC S7-1500.

  – For the distributed I/O system ET 200MP: Automation technology > Automation systems > SIMATIC industrial automation systems > SIMATIC ET 200 distributed I/O > ET 200 systems for the control cabinet > ET 200MP

  From there, navigate to the specific type of module that you want to update. To continue, click on the "Software downloads" link under "Support". Save the desired firmware update files.

- Before installing the firmware update, ensure that the modules are not being used.

Options for the firmware update

There are three options for performing a firmware update:

- Online via STEP 7
- Via SIMATIC memory card (possible for CPU, display, and all centrally inserted modules)
- Via the integrated Web server

The table below provides an overview of the media that can be used to update the firmware of a specific module.

Table 13- 1 Overview of firmware update options

Firmware update	CPU	Central I/O module	Interface module	Distributed I/O module
STEP 7 (TIA Portal V12 or higher)	✓	✓	✓	✓
SIMATIC memory card	✓	✓	--	--
Web server of the CPU	✓	✓	✓	✓

Installation of the firmware update

⚠ WARNING

Impermissible plant states possible

The CPU switches to STOP mode or the interface module to "station failure" as a result of the firmware update being installed. STOP or station failure can have an adverse effect on the operation of an online process or a machine.

Unexpected operation of a process or a machine can lead to fatal or severe injuries and/or to material damages.

Ensure before installing the firmware update, that the CPU is not executing any active process.

Procedure using STEP 7

Proceed as follows to perform an online firmware update via STEP 7:

1. Select the module in the device view.
2. Select the "Online & diagnostics" command from the shortcut menu.
3. In the "Functions" folder, select the "Firmware update" group.
   For a CPU, you can select whether you want to update the CPU or the CPU's display.
4. Click the "Browse" button to select the firmware update files in the "Firmware update" area.
5. Select the matching firmware file. The table in the firmware update area lists all modules for which an update is possible with the selected firmware file.
6. Click the "Run update" button. If the module can interpret the selected file, the file is downloaded to the module. If you must change the CPU mode, STEP 7 prompts you to do so with dialogs.

Updating the firmware

The "Run firmware after update" check box is always selected.

After a successful loading process the CPU includes imports the firmware and subsequently operates with the new firmware.

Note

If a firmware update is interrupted, you need to remove and insert the module before starting the firmware update again.

Procedure via the SIMATIC memory card

Proceed as follows perform a firmware update via the SIMATIC memory card:

1. Insert a SIMATIC memory card into an SD card reader of your programming device / computer.
2. To store the update file on the SIMATIC memory card, select the SIMATIC memory card in the "Card Reader/USB memory" folder in the project tree.
3. Select the "Card Reader/USB memory > Create firmware update memory card" command in the "Project" menu.
4. Use a file selection dialog to navigate to the firmware update file. In an additional step, you can decide whether you want to delete the contents of the SIMATIC memory card

   or add the firmware update files to the SIMATIC memory card.
5. Insert the SIMATIC memory card with the firmware update files into the CPU.

   The firmware update begins shortly after the SIMATIC memory card has been plugged.

   The display indicates that the CPU is in STOP mode, and that a firmware update is being executed: "STOP - FW UPDATE". It displays the progress of the firmware update. The CPU shows any errors that occur during the firmware update on the display.

   The display shows a results screen after the completion of the firmware update.
6. Remove the SIMATIC memory card after the firmware update has been completed. The RUN LED on the CPU lights up yellow, the MAINT LED flashes yellow.

If you then use the SIMATIC memory card as program card, delete the firmware update files manually.

Note

If your hardware configuration contains several modules, the CPU updates all affected module in the slot sequence, i.e. in ascending order of the module position in the STEP 7 device configuration.

Procedure using the Web server

The procedure is described in the Web server (http://support.automation.siemens.com/WW/view/en/59193560) Function Manual.

Special feature at a firmware update of analog modules

If you want to carry out a firmware update for analog modules, you have to supply 24 V DC load supply to the module through the power supply element.

Reference

Further information on the procedure can be found in the STEP 7 online help.

13.5 Reset to factory settings

13.5.1 Resetting the CPU to factory settings

Function

The CPU can be reset to its factory state using "Reset to factory settings". The function deletes all information that was stored internally on the CPU.

Recommendation:

If you want to remove a PROFINET CPU and use it elsewhere with a different program, or put it into storage, restore the CPU to the factory state. When resetting to factory settings, remember that the IP address parameters are also deleted.

Options for resetting a CPU to factory settings

There are three options for resetting the CPU to the as-delivered condition:

- Using the mode selector
- Using the display
- Using STEP 7

Procedure using the mode selector

Make sure that the CPU is in STOP mode (the CPU display shows STOP mode or RUN/STOP LED lights up yellow).

Note

Reset to factory settings ↔ Memory reset

The procedure described below also corresponds to the procedure for a memory reset:

- Selector operation with inserted SIMATIC memory card: CPU executes a memory reset
- Selector operation without inserted SIMATIC memory card: CPU executes reset to factory settings

Perform a reset to factory settings as follows:

1. Set the mode selector to the STOP position.

   Result: The RUN/STOP LED lights up yellow.

2. Set the mode selector to the MRES position. Hold the mode selector in this position until the RUN/STOP LED lights up for the 2nd time and remains continuously lit (this takes three seconds). After this, release the selector.

3. Within the next three seconds, switch the mode selector back to the MRES position, and then back to STOP again.

Result: The CPU executes a "Reset to factory settings", during which time the RUN/STOP LED flashes yellow. When the RUN/STOP LED lights up yellow, then the CPU has been reset to factory settings, and is in the STOP mode. The "Reset to factory settings" event is entered into the diagnostics buffer.

Note

The IP address of the CPU is also deleted when the CPU is reset to the factory settings through the mode selector.

Procedure using the display

Make sure that the CPU is in STOP mode (CPU shows STOP mode or RUN/STOP LED lights up yellow).

To navigate to the desired "Factory settings" menu command, select the following sequence of menu commands and confirm after each selection with "OK".

- Settings → Reset → Factory settings

Result: The CPU executes a "Reset to factory settings", during which time the RUN/STOP LED flashes yellow. When the RUN/STOP LED lights up yellow, then the CPU has been reset to factory settings, and is in the STOP mode. The "Reset to factory settings" event is entered into the diagnostics buffer.

Note

The IP address of the CPU is also deleted when the CPU is reset to the factory settings through the display.

Procedure using STEP 7

To reset a CPU to factory settings via STEP 7, follow these steps:

Make sure that there is an online connection to the CPU.

1. Open the Online and Diagnostics view of the CPU.
2. In the "Functions" folder, select the "Reset to factory settings" group.
3. If you want to keep the IP address, select the "Keep IP address" option button. If you want to delete the IP address, select the "Delete IP address" option button.
4. Click the "Reset" button.
5. Click "OK" in response to the confirmation prompts.

Result: The CPU executes a "Reset to factory settings", during which time the RUN/STOP LED flashes yellow. When the RUN/STOP LED lights up yellow, then the CPU has been reset to factory settings, and is in the STOP mode. The "Reset to factory settings" event is entered into the diagnostics buffer.

Result after resetting to factory settings

The following table provides an overview of the contents of the memory objects after the reset to factory settings.

Table 13- 2 Result after resetting to factory settings

Memory object	Contents
Actual values of the data blocks, instance data blocks	Initialized
Bit memories, timers and counters	Initialized
Certain retentive tags from technology objects (for example, adjustment values of absolute encoders)	Initialized
Diagnostics buffer entries (retentive area)	Initialized
Diagnostics buffer entries (non-retentive area)	Initialized
IP address	Depends on the procedure: • Using mode switch: is deleted • Using display: is deleted • Using STEP 7: Depending on the setting of the "Keep IP address"/"Delete IP address" option buttons
Counter readings of the runtime meters	Initialized
Time of day	Initialized

If a SIMATIC memory card was inserted prior to the reset to factory settings, the CPU downloads the configuration contained on the SIMATIC memory card (hardware and software). A configured IP address is then valid again.

Reference

Additional information on "Reset to factory settings" can be found in the Function Manual Structure and use of the CPU memory (http://support.automation.siemens.com/WW/view/en/59193101) in the section on memory areas and retentivity, and in the online help for STEP 7. For information on the memory reset of the CPU, refer to the chapter CPU memory reset (Page 158).

13.5.2 Resetting interface module (PROFINET IO) to factory settings

Function

"The interface module can be reset to its factory state using "Reset to factory settings".

Method of resetting an interface module to factory settings

- Via STEP 7 (online via PROFINET IO)

Procedure using STEP 7

To reset an interface module to factory settings via STEP 7, follow these steps:

Make sure that an online connection to the interface module exists.

1. Open the online and diagnostics view of the interface module.
2. In the "Functions" folder, select the "Reset to factory settings" group.
3. Click the "Reset" button.
4. Click "OK" in response to the confirmation prompts.

Result: The interface module then performs a "Reset to factory settings".

Result after resetting to factory settings

Table 13- 3 Properties of the interface module when shipped

Properties	Value
Parameter	Default setting
IP address	Not present (can be set when resetting: "Keep IP address"/"Delete IP address")
Device name	Not present
MAC address	Present
I&M data	Identification data (I&M0) present Maintenance data (I&M1, 2, 3) not present
Firmware version	Present

Note

Failure of downstream stations is possible

Stations downstream from the interface module can fail when the factory settings are restored on an interface module.

Note

Substitute value behavior of the installed I/O modules during reset to factory settings

With "Reset to factory settings", the I/O modules in the station change to the non-configured state, which means that no input data is acquired and no output data is output.

Reference

You will find more information on the procedure in the STEP 7 online help.

Test functions and fault resolution 14

14.1 Test functions

Introduction

You have the option of testing the operation of your user program on the CPU. You can then monitor signal states and values of tags and can assign values to tags to simulate specific situations in the running of the program.

Note

Using test functions

The use of test functions can influence the program execution time and thus the cycle and response times of the controller to a slight extent (a few milliseconds).

Requirements

- There is an online connection to the relevant CPU.
- An executable user program is available in the CPU.

Test options

- Testing with program status
- Testing with a watch table
- Testing with a force table
- Testing with the LED flash test
- Testing with a trace function

Testing with program status

The program status allows you to monitor the execution of the program. You can display the values of operands and the results of logic operations (RLO) allowing you to recognize and fix logical errors in your program.

Note

Restrictions with the "Program status" function

The monitoring of loops can increase the cycle time significantly, depending in each case on the number of tags to be monitored and on the actual number of loops processed.

⚠ WARNING

Testing with program status

A test with the "Program status" function can cause serious damage to property or injury to persons if there are functional disturbances or program errors.

Make sure that no dangerous situations can arise before you conduct a test with the "Program status" function.

Testing with watch tables

The following functions are available in the watch table:

- Monitoring of tags

  You can use the watch tables to monitor the current values of the individual tags of a user program or a CPU on the programming device/PC, on the display of the CPU, and on the web server. A symbolic name for the tags must be specified in the "Name" column of the watch table to allow the display of the CPU and the web server to show the value of the tags.

  You can monitor the following operand areas:

  – Inputs and outputs (process image) and bit memory
  – Contents of data blocks
  – Peripheral inputs and peripheral outputs
  – Timers and counters

- Modifying tags

  Use this function to assign fixed values to the individual tags of a user program or CPU on the PG/PC. Modifying is also possible with Test with program status.

  The following operand areas are modifiable:

  – Inputs and outputs (process image) and bit memory
  – Contents of data blocks
  – Peripheral inputs and peripheral outputs (for example, %I0.0:P, %Q0.0:P)
  – Timers and counters

- "Enable peripheral outputs" and "Modify now"

  These two functions enable you to assign fixed values to individual peripheral outputs of a CPU in the STOP mode. You can also use them to check your wiring.

Testing with a force table

The following functions are available in the force table:

- Monitoring of tags

  You can use the force tables to display the current values of the individual tags of a user program or a CPU on the programming device/PC, on the display of the CPU, and on the web server. You can monitor the table with or without trigger condition.
  A symbolic name for the tags must be specified in the "Name" column of the force table in order that the display of the CPU and the web server can display the value of the tags.

  You can monitor the following tags:

  – Bit memory
  – Contents of data blocks
  – Peripheral inputs

- Modifying tags

  You use this function to assign fixed values to individual tags of a user program or a CPU on the programming device/PC or on the display of the CPU. Modifying is also possible with Test with program status.

  The following tags are modifiable:

  – Bit memory
  – Contents of data blocks
  – Peripheral inputs (e.g. %I0.0:P)

- Forcing of peripheral inputs and peripheral outputs

  You can force individual peripheral inputs or peripheral outputs.

  – Peripheral inputs: Forcing of peripheral inputs (for example %I0.0:P) is a "bypassing" of sensors / inputs by the specification of fixed values to the program. The program receives the force value instead of the actual input value (via process image or via direct access).
  – Peripheral outputs: Forcing of peripheral outputs (for example %Q0.0:P) is a "bypassing" of the complete program by the specification of fixed values to the actuators.

One advantage of the force table is that you can simulate different test environments and overwrite tags in the CPU with a permanent value. This enables you to intervene in the ongoing process for regulating purposes.

Difference between modifying and forcing

The fundamental difference between the modifying and forcing functions consists in the storage behavior:

- Modifying: Modifying of tags is an online function and is not stored in the CPU. You can end modifying of tags in the watch table or force table or by terminating the online connection.
- Forcing: A force job is written to the SIMATIC memory card and is retained after a POWER OFF. The S7-1500 CPU displays an active force job with a corresponding symbol. You can only end the forcing of peripheral inputs and peripheral outputs in the force table.

Testing with the LED flash test

In many online dialogs, you can perform an LED flash test. This function is useful, for example, when you are not sure which device in the hardware configuration corresponds to the station currently selected in the software.

When you click the "Flash LED" button, an LED flashes at the currently selected station. On the CPU, the following LEDs flash: RUN/STOP LED, ERROR LED and MAINT LED. The LEDs continue to flash until you terminate the flash test.

Testing with a trace function

The trace function is used to record the CPU tags, depending on the settable trigger conditions. Tags are, for example, drive parameters or system and user tags of a CPU. The CPU saves the recordings. You can display and evaluate the recordings with STEP 7, if necessary.

The trace function can be called from the CPU's folder in the project tree, under the name "Traces".

With regard to the trace functions, also note the FAQ with the entry ID 102781176 on the Service&Support Internet page (http://www.siemens.com/automation/service&support).

Simulation

With STEP 7 you can run and test the hardware and software of the project in a simulated environment. Start the simulation using the menu command "Online" > "Simulation" > "Start".

Reference

Further information on the test functions can be found in the STEP 7 online help.

Further information about testing with trace functions is available in the Function Manual Using the trace and logic analyzer function (http://support.automation.siemens.com/WW/view/en/64897128).

14.2 Reading out/saving service data

Service data

In addition to the contents of the diagnostics buffer, the service data contain numerous additional data points about the internal status of the CPU. If a problem occurs with the CPU that cannot be solved with other methods, send the service data to our Service & Support team. The service data allow Service & Support to analyze problems that have occurred rapidly.

Methods of reading service data

You can read out service data with:

- The Web server
- STEP 7
- The SIMATIC memory card

Procedure using the Web server

To read service data using the Web server, follow these steps:

1. Open a web browser that is suitable for communication with the CPU.
2. Enter the following address in the address bar of the web browser: https://<CPU IP address>/save_service_data, e.g., https://172.23.15.3/save_service_data
3. The service data page will appear on your screen, with a button for saving the service data.

Figure 14-1 Reading out service data via the web server

4. Save the service data locally on your PC/programming device, by clicking "Save ServiceData".

Result: The data are saved in a .dmp file with the following naming convention: "<Part number> <serial number> <time stamp>.dmp". The file name can be changed.

Note

If you have defined your user page as the home page of the Web server, direct access to the service data by inputting the IP address of the CPU is not possible. For more information on reading out service data via a user-defined page, refer to the Web server (http://support.automation.siemens.com/WW/view/en/59193560) function manual.

Procedure using STEP 7

A description of how to save service data is available under the keyword "Save service data" in STEP 7 online help.

Procedure via the SIMATIC memory card

Use the SIMATIC memory card to read out the service data only if you are no longer able to communicate with the CPU via Ethernet. In all other cases it is preferable to read out the service data via the Web server or STEP 7.

To read service data using the SIMATIC memory card, follow these steps:

1. Insert the SIMATIC memory card into the card reader of your PC / programming device.
2. Open the job file S7_JOB.S7S in an editor.
3. Overwrite the entry PROGRAM with the string DUMP in the editor.
   To ensure that the file size is exactly 4 bytes, do not use any spaces/line breaks/quotation marks.
4. Save the file under the existing file name.
5. Make sure that the SIMATIC memory card is not write-protected and insert it in the slot on the CPU.
   (for the CPU 1518-4 PN/DP and CPU 1517-3 PN/DP, you need a card ≥ 2 GB, and for the CPU 1511-1 PN, CPU 1513-1 PN, CPU 1515-2 PN and CPU 1516-3 PN/DP, a card ≥ 32 MB)

Result: The CPU writes the service data file DUMP.S7S to the SIMATIC memory card and remains in STOP mode.

The transfer of the service data has been completed as soon as the STOP LED stops flashing and lights up continuously. If the transfer was successful, only the STOP LED lights up. If the transfer was not successful, the STOP LED lights up and the ERROR LED flashes. In case of an error, the CPU stores a text file with a note on the error that occurred in the DUMP.S7S folder.

Technical specifications

15

Introduction

This chapter lists the technical specifications of the system:

- The standards and test values which the modules of the S7-1500 automation system/ET 200MP distributed I/O system comply with and fulfill.
- The test criteria according to which the S7-1500 automation system/ET 200MP distributed I/O system was tested.

Technical specifications for the modules

The technical specifications of the individual modules can be found in the manuals of the modules themselves. In the event of deviations between the statements in this document and the manuals, the statements in the manuals take priority.

15.1 Standards and Approvals

Currently valid markings and authorizations

Note

Details on the components of the S7-1500 automation system/ET 200MP distributed I/O system

The currently valid markings and approvals are printed on the components of the S7-1500 automation system/ET 200MP distributed I/O system.

Safety information

⚠ WARNING

Personal injury and damage to property may occur

In hazardous areas, injury to persons and material damage may occur if you disconnect plug-in connections during operation of an S7-1500 automation system/ET 200MP distributed I/O system.

Always switch off the power to the S7-1500 automation system/ET 200MP distributed I/O system when disconnecting plug-in connections in hazardous atmospheres.

⚠ WARNING

Explosion hazard

If you replace components, compliance with Class I, DIV. 2 could be compromised.

⚠ WARNING

Deployment requirements

This device is only appropriate for use in Class I, Div. 2, Group A, B, C, D, or in non-hazardous areas.

CE mark

The S7-1500 automation system/ET 200MP distributed I/O system meets the requirements and protection targets of the following EC guidelines and complies with the harmonized European standards (EN) for programmable logic controllers published in the official gazettes of the European Community:

- 2006/95/EC "Electrical Equipment Designed for Use within Certain Voltage Limits" (LowVoltage Directive)
- 2004/108/EC "Electromagnetic Compatibility" (EMC Directive)
- 94/9/EC on "equipment and protective systems for use in hazardous areas" (explosion protection directive)

The EC declaration of conformity is held on file available to competent authorities at:

Siemens AG
Digital Factory

Factory Automation
DF FA AS DH AMB
Postfach 1963
D-92209 Amberg

These files are also available for download on the Customer Support Internet pages, under the keyword "Declaration of Conformity".

cULus approval

Underwriters Laboratories Inc. in accordance with

- UL 508 (Industrial Control Equipment)
- C22.2 No. 142 (Process Control Equipment)

OR

cuLus HAZ LOC approval

HAZ. LOC.

Underwriters Laboratories Inc. in accordance with

- UL 508 (Industrial Control Equipment)
- CSA C22.2 No. 142 (Process Control Equipment)
- ANSI/ISA 12.12.01
- CSA C22.2 No. 213 (Hazardous Location)

APPROVED for use in
Class I, Division 2, Group A, B, C, D Tx;
Class I, Zone 2, Group IIC Tx

Installation Instructions for cULus haz.loc.

- 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 Zone 2.
- This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D; Class I, Zone 2, Group IIC; or non-hazardous locations.
- These products need to be connected by means of the front connector Cat. No. 6ES7592-1AM00-0XB0

WARNING: EXPOSURE TO SOME CHEMICALS MAY DEGRADE THE SEALING PROPERTIES OF MATERIALS USED IN THE RELAYS.

FM approval

Factory Mutual Research (FM) according to

- Approval Standard Class Number 3611, 3600, 3810
- ANSI/ISA 82.02.01 (IEC 61010-1)
- CSA C22.2 No. 213
- CSA 22.2 No. 1010.1

APPROVED for use in Class I, Division 2, Group A, B, C, D Tx;
Class I, Zone 2, Group IIC Tx

ATEX approval

In accordance with EN 60079-15 (Electrical apparatus for potentially explosive atmospheres; Type of protection "n") and EN 60079-0 (Electrical apparatus for potentially explosive gas atmospheres - Part 0: General Requirements)

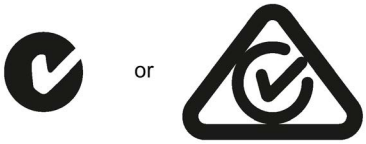
II 3 G Ex nA IIC Tx Gc
DEKRA 12ATEX0004X

IECEx approval

According to IEC 60079-15 (Explosive atmospheres - Part 15: Equipment protection by type of protection "n") and IEC 60079-0 (Explosive atmospheres - Part 0: Equipment - General requirements)

Ex nA IIC Tx Gc
IECEx DEK 13.0010X

Tick mark for Australia and New Zealand



The S7-1500 automation system/ET 200MP distributed I/O system meets the requirements of the standard AS/NZS CISPR 16.

Korea Certification

KC registration number: KCC-REM-S49-S71500

Please note that this device corresponds to limit value class A in terms of the emission of radio frequency interference. This device can be used in all areas, except residential areas.

이 기기는 업무용(A급) 전자파 적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며 가정 외의 지역에서 사용하는 것을 목적으로 합니다.

Marking for the Eurasian Customs Union

EAC (Eurasian Conformity)

Customs Union of Russia, Belarus and Kazakhstan

Declaration of conformity with the technical requirements of the Customs Union (TR CU).

IEC 61131

The S7-1500 automation system/ET 200MP distributed I/O system meets the requirements and criteria of the standard IEC 61131-2
(programmable logic controllers, Part 2: Equipment requirements and tests).

PROFINET standard

The S7-1500 automation system/ET 200MP distributed I/O system is based on standard IEC 61158 Type 10.

PROFIBUS standard

The S7-1500 automation system/ET 200MP distributed I/O system is based on standard IEC 61158 Type 3.

Shipbuilding approval

Classification societies:

- ABS (American Bureau of Shipping)
- BV (Bureau Veritas)
- DNV (Det Norske Veritas)
- GL (Germanischer Lloyd)
- LRS (Lloyds Register of Shipping)
- Class NK (Nippon Kaiji Kyokai)

Industrial use

SIMATIC products are designed for industrial applications.

Table 15- 1 Industrial use

Area of application	Interference emission requirements	Interference immunity requirements
Industry	EN 61000-6-4: 2011	EN 61000-6-2: 2005

Use in residential areas

Note

The S7-1500 automation system/ET 200MP distributed I/O system is intended for use in industrial areas; use in residential areas may have an impact on radio/TV reception.

If you use the S7-1500 automation system/ET 200MP distributed I/O system in residential areas, you must comply with limit value class B according to EN 55011.

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

- Installation of the S7-1500 automation system/ET 200MP distributed I/O system in grounded control cabinets/control boxes
- Use of noise filters in the supply lines

Reference

The certificates for the markings and approvals can be found on the Internet under Service&Support (http://www.siemens.com/automation/service&support).

15.2 Electromagnetic compatibility

Definition

Electromagnetic compatibility (EMC) is the ability of an electrical installation to function satisfactorily in its electromagnetic environment without interfering with that environment.

Among other things, the S7-1500 automation system/ET 200MP distributed I/O system also meets the requirements of the EMC legislation for the European single market. The prerequisite for this is that the S7-1500/ET 200MP system complies with the requirements and guidelines relating to electrical equipment.

EMC in accordance with NE21

The S7-1500 automation system/ET 200MP distributed I/O system meets the EMC specifications of the NAMUR guideline NE21.

Pulse-shaped disturbances

The following table shows the electromagnetic compatibility of the S7-1500 automation system/ET 200MP distributed I/O system with regard to pulse-shaped disturbances.

Table 15- 2 Pulse-shaped disturbances

Pulse-shaped disturbance	Test voltage	Corresponds with degree of severity
Electrostatic discharge in accordance with IEC 61000-4-2.	Air discharge: ±8 kV Contact discharge: ±6 kV	3 3
Burst pulses (high-speed transient disturbances) in accordance with IEC 61000-4-4.	±2 kV (power supply lines) ±2 kV (signal lines > 30 m) ±1 kV (signal lines < 30 m)	3 3
High-energy single pulse (surge) in accordance with IEC 61000-4-5 External protective circuit required (not for 230 V modules) (see the Defining interference-free controllers (http://support.automation.siemens.com/WW/view/en/59193566) Function Manual)		3
• asymmetric coupling	±2 kV (power supply lines) DC with protective elements ±2 kV (signal/data line only > 30 m), with protective elements	
• symmetric coupling	±1 kV (power supply lines) DC with protective elements ±1 kV (signal/data line only > 30 m), with protective elements	

Sinusoidal disturbances

The following table shows the electromagnetic compatibility of the S7-1500 automation system/ET 200MP distributed I/O system with regard to sinusoidal disturbances (RF radiation).

Table 15- 3 Sinusoidal disturbances with RF radiation

RF radiation in accordance with IEC 61000-4-3/NAMUR 21 **Electromagnetic RF field, amplitude-modulated**		**Corresponds with degree of severity**
80 to 1000 MHz; 1.4 to 2 GHz	2.0 GHz to 2.7 GHz	3
10 V/m	1 V/m	
80 % AM (1 kHz)		

The following table shows the electromagnetic compatibility of the S7-1500 automation system/ET 200MP distributed I/O system with regard to sinusoidal disturbances (RF coupling).

Table 15- 4 Sinusoidal disturbances with RF coupling

RF coupling in accordance with IEC 61000-4-6	**Corresponds with degree of severity**
from 10 kHz	3
10 V_{rms}	
80 % AM (1 kHz)	
150 Ω source impedance	

Emission of radio interference

Interference emission of electromagnetic fields in accordance with EN 55016: Limit value class A, group 1 (measured at a distance of 10 m).

Table 15- 5 Interference emission of electromagnetic fields

Frequency	Interference emission
30 MHz to 230 MHz	< 40 dB (µV/m) QP
230 MHz to 1000 MHz	< 47 dB (µV/m) QP

Interference emission via the AC power supply in accordance with EN 55016: Limit value class A, Group 1.

Table 15- 6 Interference emission via the AC power supply

Frequency	Interference emission
0.15 MHz to 0.5 MHz	< 79 dB (µV/m)Q < 66 dB (µV/m) M
0.5 MHz to 30 MHz	< 73 dB (µV/m)Q < 60 dB (µV/m) M

15.3 Shipping and storage conditions

Introduction

With respect to transportation and storage conditions, the S7-1500 automation system/ET 200MP distributed I/O system fulfills the requirements in accordance with IEC 61131-2. The following statements apply to modules that are transported and stored in the original packaging.

Shipping and storage conditions for modules

Table 15- 7 Shipping and storage conditions

Type of condition	Permissible range
Free fall (in shipping package)	≤ 1 m
Temperature	from -40 °C to +70 °C
Barometric pressure	1080 hPa to 660 hPa (corresponds to an altitude of -1000 m to 3500 m)
Relative humidity	5% to 95%, without condensation
Sinusoidal vibrations in accordance with IEC 60068-2-6	5 - 9 Hz: 3.5 mm 9 - 500 Hz: 9.8 m/s^2
Shock in accordance with IEC 60068-2-27	250 m/s^2, 6 ms, 1000 shocks

15.4 Mechanical and climatic ambient conditions

Operating conditions

The S7-1500 automation system/ET 200MP distributed I/O system is suitable for use in weather-proof, fixed locations. The operating conditions exceed requirements according to DIN IEC 60721-3-3:

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

Test of mechanical ambient conditions

The table below provides important information with respect to the type and scope of the test of ambient mechanical conditions.

Table 15- 8 Test of mechanical ambient conditions

Condition tested	Test Standard	Comment
Vibration	Vibration test according to IEC 60068-2-6 (Sinus)	Type of oscillation: Frequency sweeps with a rate of change of 1 octave/minute. 5 Hz ≤ f ≤ 8.4 Hz, constant amplitude 7 mm 8.4 Hz ≤ f ≤ 150 Hz, constant acceleration 2 g Duration of oscillation: 10 frequency sweeps per axis, along each of the 3 mutually perpendicular axes
Shock	Shock, tested according to IEC 60068-2-27	Type of shock: Half-sine Shock intensity: 15 g max., duration 11 ms Direction of shock: 3 shocks each in (+/-) direction, along each of the 3 mutually perpendicular axes
Continuous shock	Shock, tested according to IEC 60068-2-27	Type of shock: Half-sine Shock intensity: 250 m/s^2 peak value, 6 ms duration Direction of shock: 1000 shocks each in (+/-) direction, along each of the 3 mutually perpendicular axes

Reduction of vibrations

If your S7-1500 automation system/ET 200MP distributed I/O system is exposed to severe shock or vibration, take appropriate measures to reduce the acceleration or the amplitude.

We recommend the installation of the S7-1500 automation system/ET 200MP distributed I/O system on damping materials (for example, rubber-bonded metal mounting).

Climatic ambient conditions

The following table shows the permissible climatic ambient conditions for the S7-1500 automation system/ET 200MP distributed I/O system:

Table 15- 9 Climatic ambient conditions

Ambient conditions	Permissible range	Comments
Temperature: horizontal mounting position: vertical mounting position:	 0 °C to 60 °C 0 °C to 40 °C	To increase the service life of the display, the display switches off when the permitted operating temperature is exceeded. Further information about the temperatures at which the display switches off and back on again is available in the technical specifications of the manuals of the CPUs.
Temperature variation	10 K/h	-
Relative humidity	from 10 % to 95 %	Without condensation, corresponds to relative humidity (RH) class 2 in accordance with IEC 61131 part 2
Barometric pressure	from 1080 hPa to 795 hPa	corresponds to an altitude of -1000 m to 2000 m
Pollutant concentration	SO_2: <0.5 ppm; RH <60%, no condensation H_2S: < 0.1 ppm; RH < 60 %, no condensation	-
	ISA-S71.04 severity level G1; G2; G3	-

15.5 Information on insulation tests, protection class, degree of protection and rated voltage

Insulation

The insulation is designed in accordance with the requirements of EN 61131-2: 2007.

Note

For modules with 24 V DC supply voltage, the galvanic isolation is designed for max. 60 V AC/75 V DC and basic insulation is designed according to EN 61131-2: 2007 .

Pollution degree/overvoltage category according to IEC 61131-2: 2007

- Pollution degree 2
- Overvoltage category: II

Protection class according to IEC 61131-2: 2007

Protection class I or III, depending on module type

Degree of protection IP20

Degree of protection IP20 in accordance with IEC 60529 for all modules of the S7-1500 automation system/ET 200MP distributed I/O system, i.e.:

- Protection against contact with standard test finger
- Protection against foreign objects with diameters in excess of 12.5 mm
- No protection against water

Rated voltage for operation

The S7-1500 automation system/ET 200MP distributed I/O system works with the rated voltages and corresponding tolerances listed in the following table.

Note the supply voltage of each module when selecting the rated voltage.

Table 15- 10 Rated voltage of all modules of the S7-1500 automation system/ET 200MP distributed I/O system for operation

rated voltage	Tolerance range
24 V DC	19.2 V DC to 28.8 V DC [1]
48 V DC	40.8 to 57.6 V DC
60 V DC	51.0 to 72.0 V DC
120 V AC	93 V AC to 132 V AC
230 V AC	187 V AC to 264 V AC

[1] Static value: Creation as functional extra-low voltage with safe galvanic isolation according to IEC 60364-4-41.

15.6 Use of the S7-1500/ET 200MP in zone 2 hazardous areas

Reference

See product information Deployment of the modules in zone 2 hazardous atmospheres (http://support.automation.siemens.com/WW/view/en/19692172).

Dimension drawings

A

A.1 Dimension drawings of the mounting rails

Mounting rail 160 mm

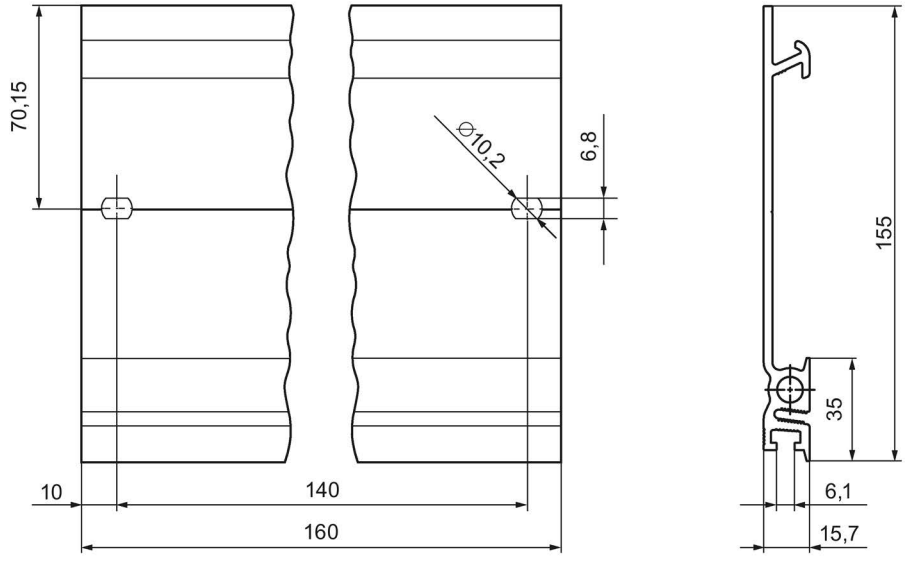


Figure A-1 Mounting rail 160 mm

Mounting rail 245 mm

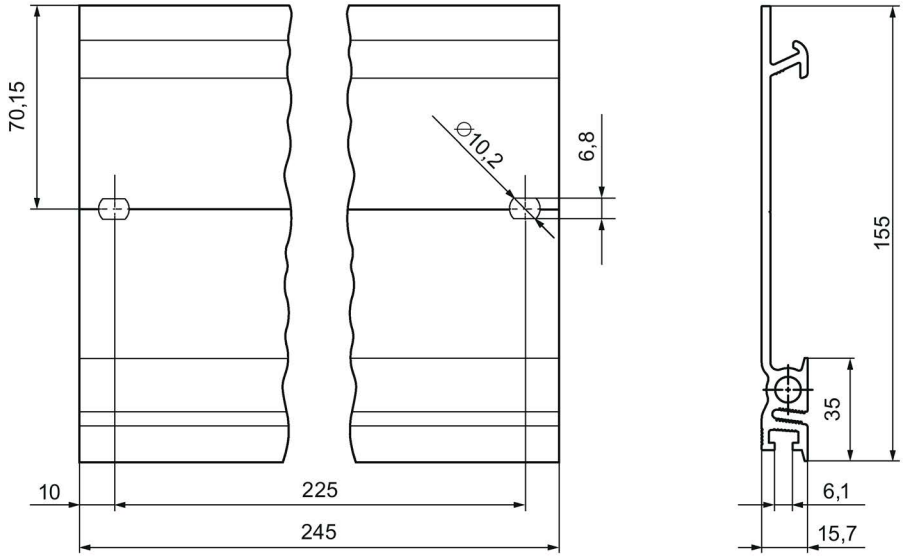


Figure A-2 Mounting rail 245 mm

Mounting rail 482.6 mm

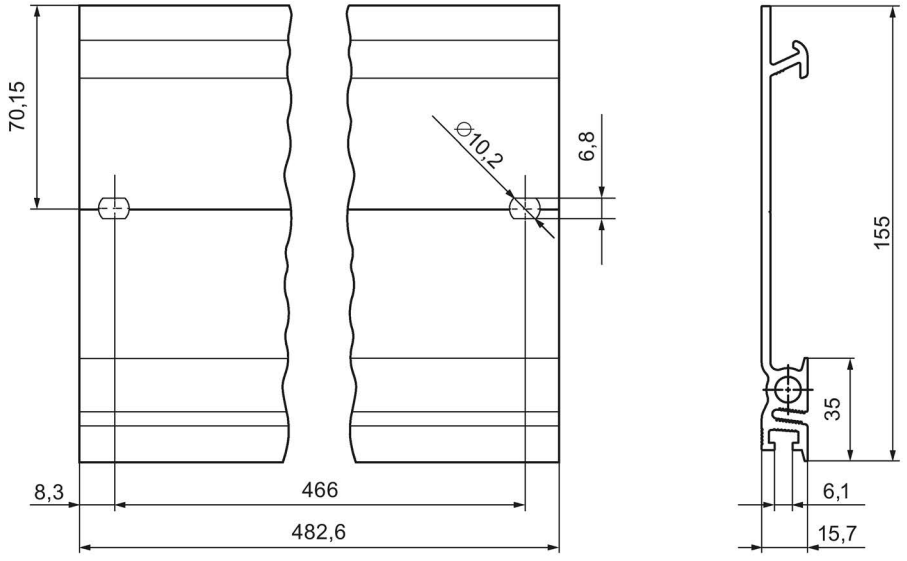


Figure A-3 Mounting rail 482.6 mm

Mounting rail 530 mm

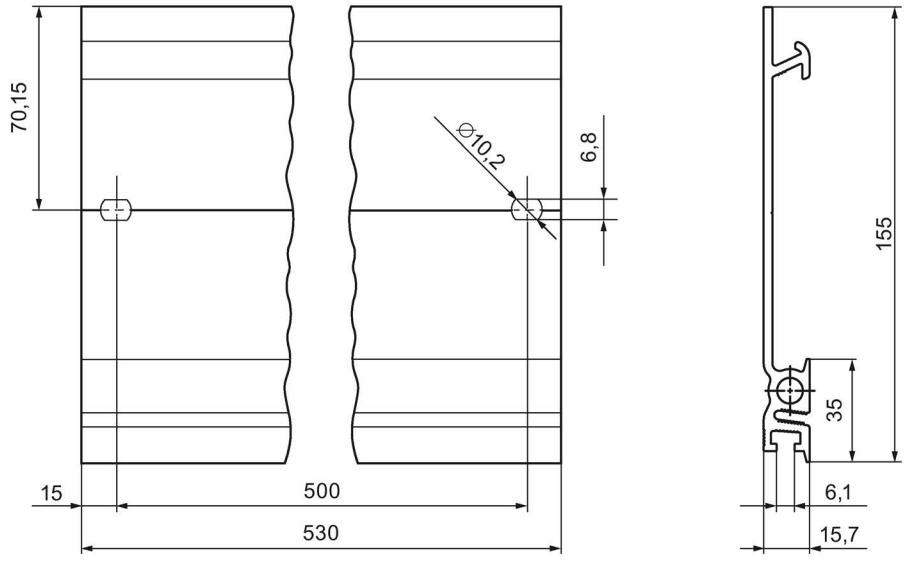


Figure A-4 Mounting rail 530 mm

Mounting rail 830 mm

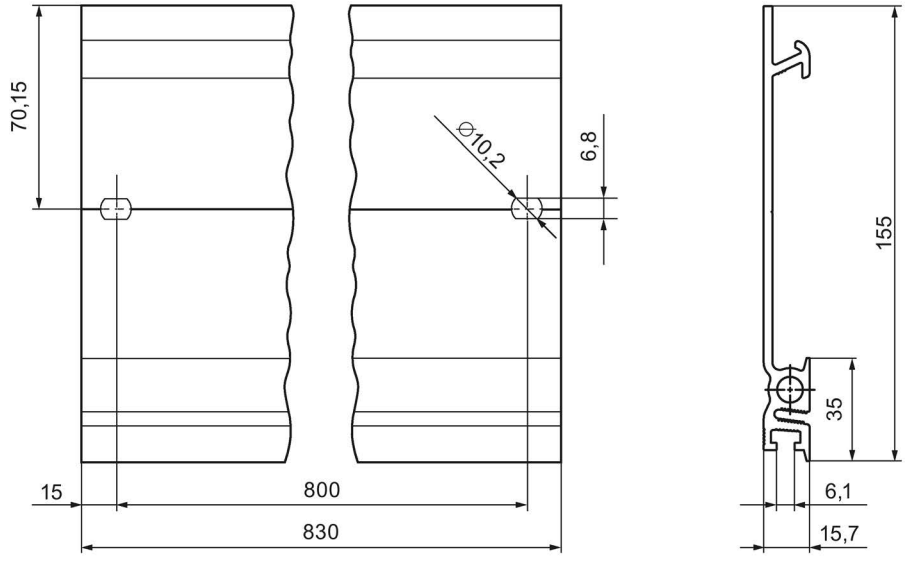


Figure A-5 Mounting rail 830 mm

Mounting rail 2000 mm

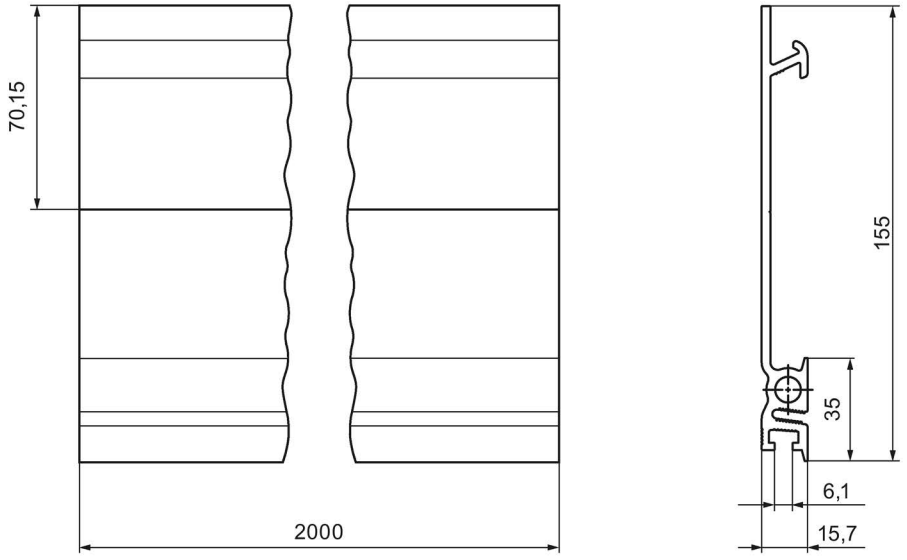


Figure A-6 Mounting rail 2000 mm

A.2 Dimension drawing of shielding bracket for 35 mm modules

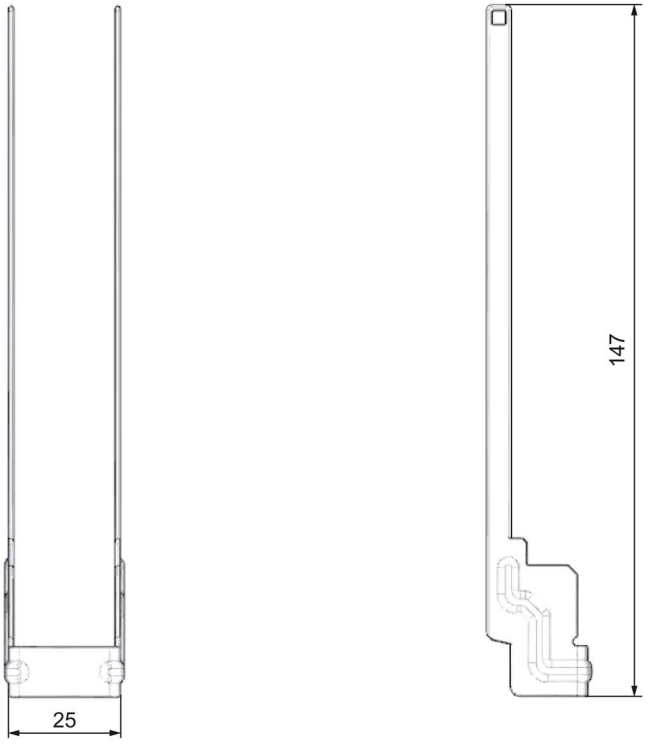


Figure A-7 Dimension drawing of shielding bracket for 35 mm modules

A.3 Dimension drawing of shielding bracket for 25 mm modules

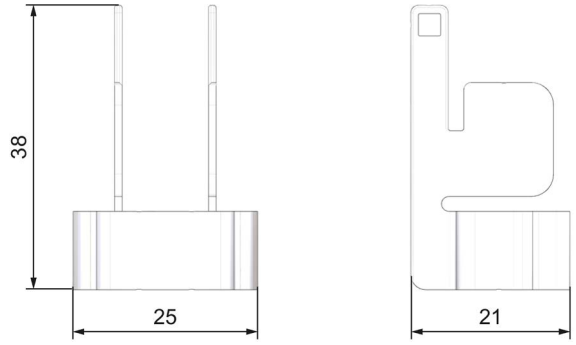


Figure A-8 Dimension drawing of shielding bracket for 25 mm modules

A.4 Dimension drawing of shielding bracket for 35 mm modules

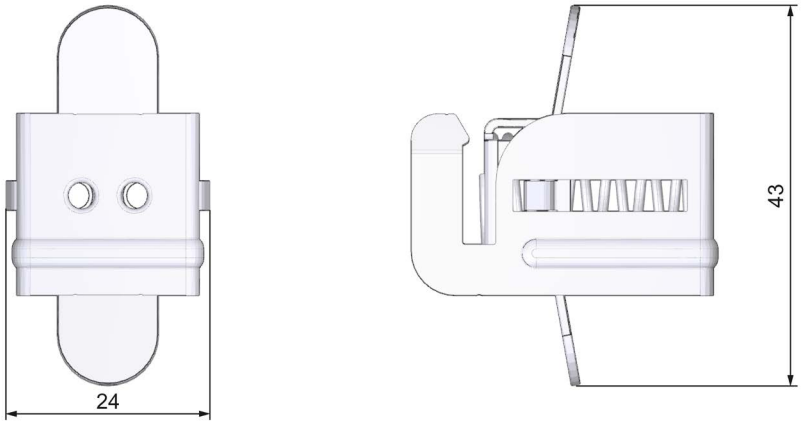


Figure A-9 Dimension drawing of shielding bracket for 35 mm modules

A.5 Dimension drawing of shielding bracket for 25 mm modules

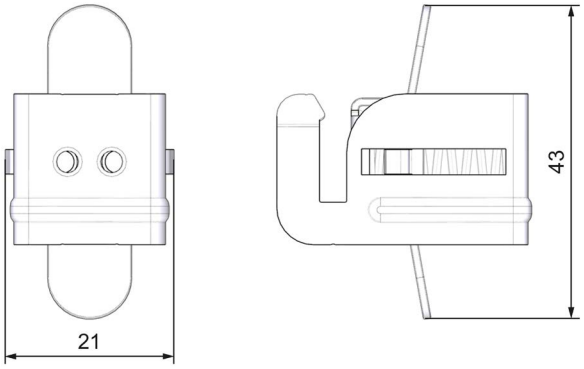


Figure A-10 Dimension drawing of shielding bracket for 25 mm modules

A.6 Dimension drawing of shielding bracket for 35 mm modules

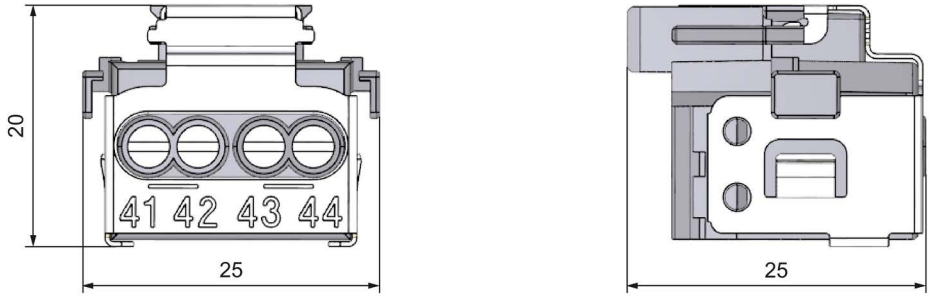


Figure A-11 Dimension drawing of shielding bracket for 35 mm modules

A.7 Dimension drawing of shielding bracket for 25 mm modules

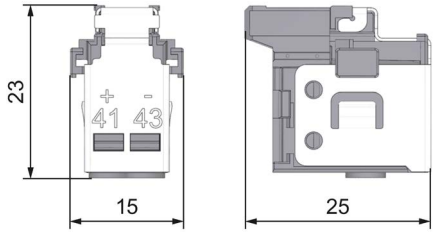


Figure A-12 Dimension drawing of shielding bracket for 25 mm modules

A.8 Dimension drawings of the labeling strips

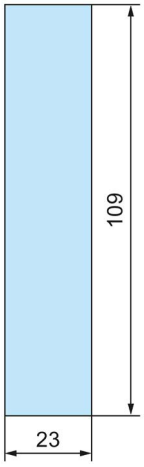


Figure A-13 Dimension drawing labeling strips for 35 mm modules

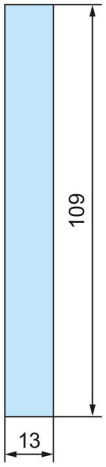


Figure A-14 Dimension drawing labeling strips for 25 mm modules

Accessories/spare parts

B

Accessories for the S7-1500 automation system/ET 200MP distributed I/O system

Table B- 1 General accessories

Description	Part number
Mounting rail	
• Mounting rail, 160 mm (with drill holes)	6ES7590-1AB60-0AA0
• Mounting rail, 245 mm (with drill holes)	6ES7590-1AC40-0AA0
• Mounting rail, 482 mm (with drill holes)	6ES7590-1AE80-0AA0
• Mounting rail, 530 mm (with drill holes)	6ES7590-1AF30-0AA0
• Mounting rail, 830 mm (with drill holes)	6ES7590-1AJ30-0AA0
• Mounting rail, 2000 mm (without drill holes) for cutting to length	6ES7590-1BC00-0AA0
PE connection element for mounting rail, 2000 mm (spare part), 20 units	6ES7590-5AA00-0AA0
Front connector (incl. four potential bridges, cable tie, and individual labeling strip) for 35 mm modules	
• Screw-type terminals, 40-pin	6ES7592-1AM00-0XB0
Front connector (incl. four potential bridges, cable tie, and individual labeling strip) for 35 mm modules	
• Push-in terminal (40-pin)	6ES7592-1BM00-0XB0
Front connector (incl. cable tie and individual labeling strip) for 25 mm modules	
• Push-in terminal (40-pin)	6ES7592-1BM00-0XA0
4-pole connection plug for supply voltage (spare part), 10 units	6ES7193-4JB00-0AA0
DIN A4 labeling sheet (10 x for labeling the 35 mm I/O modules)	
• Pre-perforated, AI gray	6ES7592-2AX00-0AA0
DIN A4 labeling sheet (10 x for labeling the 25 mm I/O modules)	
• Pre-perforated, AI gray	6ES7592-1AX00-0AA0
U connector (spare part), 5 units	6ES7590-0AA00-0AA0
I/O shielding set for 35 mm modules (consists of: power supply element, shielding bracket, and shield clamp), (spare part), 5 units	6ES7590-5CA00-0AA0
I/O shielding set for 25 mm modules (consists of: power supply element, shielding bracket, and shield clamp), (spare part), 4 units	6ES7590-5CA10-0XA0
Shield clamp (spare part), 10 units	6ES7590-5BA00-0AA0
70 mm display for CPU (spare part)	6ES7591-1BA00-0AA0
35 mm display for CPU (spare part)	6ES7591-1AA00-0AA0

Description	Part number
Power cable connector with coding element for power supplies (spare part), 10 units	6ES7590-8AA00-0AA0
Potential bridge for front connector (spare part), 20 units	6ES7592-3AA00-0AA0
Universal front cover for 35 mm I/O modules (spare part), 5 units	6ES7528-0AA00-7AA0 Consists of: • 5 x front cover • 5 x front labeling strip (per module - part number) • 5 x wiring plan (per module part number)
Universal front cover for 25 mm I/O modules (spare part), 5 units	6ES7528-0AA00-0AA0 Consists of: • 5 x front cover • 5 x front labeling strip (per module - part number) • 5 x wiring plan (per module part number)
Universal front cover for interface module (spare part), 5 units	6ES7528-0AA70-7AA0 Consists of: • 5 x front cover
Industrial Ethernet FastConnect RJ45 plug 180 degrees, 1 unit	6GK1901-1BB10-2AA0
Industrial Ethernet FastConnect RJ45 plug 180 degrees, 10 units	6GK1901-1BB10-2AB0
Industrial Ethernet FastConnect RJ45 plug 90 degrees, 1 unit	6GK1901-1BB20-2AA0
Industrial Ethernet FastConnect RJ45 plug 90 degrees, 10 units	6GK1901-1BB20-2AB0
PROFIBUS-FastConnect bus connector without programming device socket, up to 12 MBaud, 1 unit	6ES7972-0BA70-0XA0
PROFIBUS FastConnect bus connector with programming device socket, up to 12 MBaud, 1 unit *	6ES7972-0BB70-0XA0
PROFIBUS FastConnect bus connector without programming device socket, up to 12 MBaud, 1 unit	6ES7972-0BA52-0XA0
PROFIBUS FastConnect bus connector with programming device socket, up to 12 MBaud, 1 unit	6ES7972-0BB52-0XA0

* The PROFIBUS FastConnect bus connector 0BB70 is supplied with the IM 155-5 DP ST interface module and can also be ordered as a spare part.

SIMATIC memory card

Table B- 2 SIMATIC memory card accessories

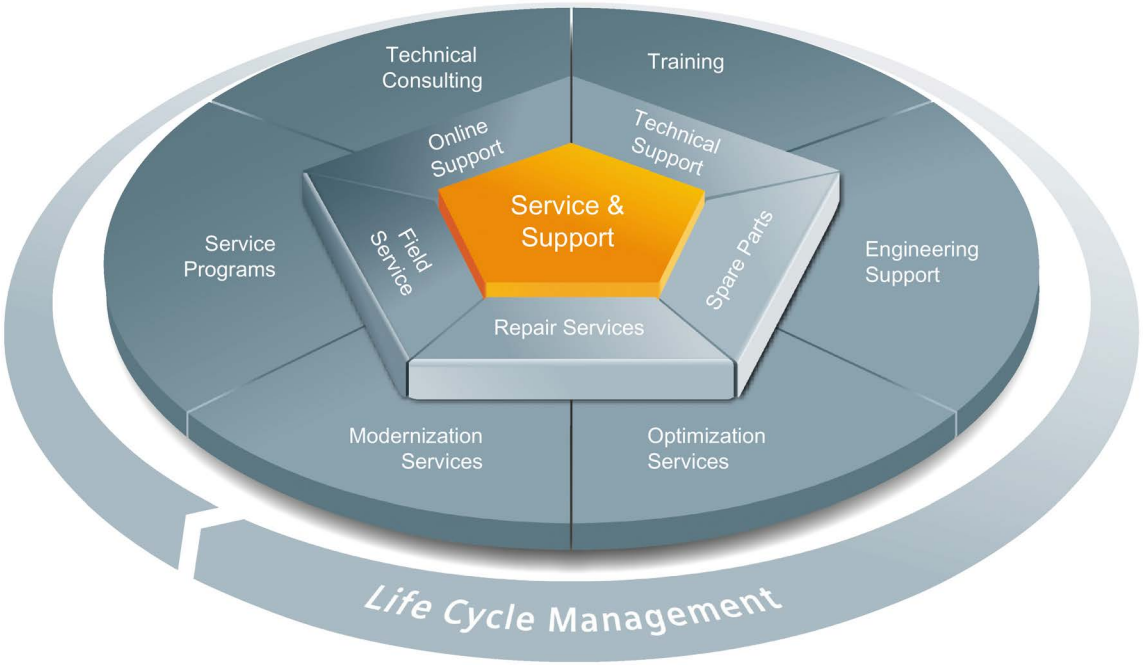
Part number	Capacity
6ES7954-8LCxx-0AA0	4 MB
6ES7954-8LExx-0AA0	12 MB
6ES7954-8LFxx-0AA0	24 MB
6ES7954-8LL02-0AA0	256 MB
6ES7954-8LP01-0AA0	2 GB

Online catalog

Other article numbers for the S7-1500 automation system/ET 200MP distributed I/O system can be found on the Internet (https://mall.industry.siemens.com) in the online catalog and the online order system.

Service & Support

C



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You can find Technical Support on the Internet at the following address: Internet (http://www.siemens.com/automation/support-request).

Training

Extend your competitive edge – through practical know-how directly from the manufacturer.

You can find the training courses we offer on the Internet at the following address: Internet (http://www.siemens.com/sitrain).

Engineering Support

Support during project engineering and development with services fine-tuned to your requirements, from configuration through to implementation of an automation project.

Field Service

Our Field Service offers you services for commissioning and maintenance – to ensure that your machines and plants are always available.

Spare parts

In every sector worldwide, plants and systems are required to operate with constantly increasing reliability. We will provide you with the support you need to prevent a standstill from occurring in the first place: with a worldwide network and optimum logistics chains.

Repairs

Downtimes cause problems in the plant as well as unnecessary costs. We can help you to reduce both to a minimum – with our worldwide repair facilities.

Optimization

During the service life of machines and plants, there is often a great potential for increasing productivity or reducing costs.

To help you achieve this potential, we are offering a complete range of optimization services.

Modernization

You can also rely on our support when it comes to modernization – with comprehensive services from the planning phase all the way to commissioning.

Service programs

Our service programs are selected service packages for an automation and drives system or product group. The individual services are coordinated with each other to ensure smooth coverage of the entire life cycle and support optimum use of your products and systems.

The services of a Service Program can be flexibly adapted at any time and used separately.

Examples of service programs:

- Service contracts
- Plant IT Security Services
- Life Cycle Services for Drive Engineering
- SIMATIC PCS 7 Life Cycle Services
- SINUMERIK Manufacturing Excellence
- SIMATIC Remote Support Services

Advantages at a glance:

- Reduced downtimes for increased productivity
- Optimized maintenance costs due to a tailored scope of services
- Costs that can be calculated and therefore planned
- Service reliability due to guaranteed response times and spare part delivery times
- Customer service personnel will be supported and relieved of additional tasks
- Comprehensive service from a single source, fewer interfaces and greater expertise

Contact

At your service locally, around the globe: your partner for consultation, sales, training, service, support, spare parts... for the entire range of products supplied by Industry Automation and Drive Technologies.

You can find your personal contact in our contacts database at: Internet (http://www.siemens.com/automation/partner).

Glossary

Actuator

Actuators can be power relays or contactors for switching on loads, or they can be loads themselves (e.g., directly controlled solenoid valves).

Automation system

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

Baud rate

Data transmission rate indicates the number of bits transmitted per second (baud rate = bit rate).

Bus

A common transfer route to which all nodes of a field bus system are connected; it has two defined ends.

Bus cable connector

Physical connection between the bus node and the bus cable.

Bus, self-assembling

The modules are lined up on the mounting rail, and are mechanically and electrically connected to each other with a U connector as they are swiveled into position. In this way the bus is extended with each module.

Configuration

Systematic arrangement of the individual modules (configuration).

Connection plug

Physical connection between device and cable.

CPU

The CPU uses the integrated system power supply to supply the electronics of the modules via the backplane bus. The CPU contains the operating system and executes the user program. The user program is located on the SIMATIC memory card and is processed in the work memory of the CPU. The PROFINET interfaces on the CPU allow simultaneous communication with PROFINET devices, PROFINET controllers, HMI devices, programming devices, other controllers and other systems. The S7-1500 CPUs support operation as an IO controller and I-device. Similarly to the PROFINET interface, the PROFIBUS interface available on some of the S7-1500 CPUs allows communication with other devices. When the interface is used as PROFIBUS DP interface, the CPU on the PROFIBUS DP also assumes the role of a DP master.

Crimping

Procedure whereby two components joined together, e.g. wire end ferrule and cable, are connected with one another through plastic strain.

Device names

Before an IO device can be addressed by an IO controller, it must have a device name. This approach was chosen for PROFINET because names are easier to administer than complex IP addresses.

An IO device has no device name upon delivery. An IO device can only be addressed by an IO controller - e.g., for transferring configuration data (including the IP address) during startup, or for user data exchange during cyclic operation - after it has been assigned a device name with the programming device/PC.

Diagnostics

Monitoring functions for the detection, localization, classification, display, and further evaluation of errors, faults, and alarms. They run automatically while the system is in operation. This increases the availability of systems by reducing commissioning times and downtimes.

Distributed I/O system

System with I/O modules that are configured on a distributed basis, at a large distance from the CPU controlling them.

DP

Distributed I/O

Equipotential bonding

Electrical connection (potential equalization conductor) that brings the bodies of electrical equipment and other conductive bodies to the same or almost the same potential, in order to prevent disruptive or dangerous voltages between these bodies.

F-CPU

An F-CPU is a central processing unit with fail-safe capability that is permitted for use in SIMATIC Safety. A standard user program can also be run on the F-CPU.

Firmware update

Updating the firmware of modules (interface modules, I/O modules, etc.), for example after functional expansions, to the latest firmware version (update).

Functional ground

The functional ground is a low-impedance current path between electric circuits and ground. It is not designed as a safety measure but instead, for example, as a measure to improve noise immunity.

Ground

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

All interconnected, inactive parts of a piece of equipment that cannot accept any dangerous contact voltage, even in the event of a fault.

Ground

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

All interconnected, inactive parts of a piece of equipment that cannot accept any dangerous contact voltage, even in the event of a fault.

Grounding

Grounding means connecting an electrically conductive part to a grounding electrode by means of a grounding system.

GSD file

As a Generic Station Description, this file contains all properties of a PROFINET or PROFIBUS device that are necessary for its configuration.

I/O modules

All modules that can be operated with a CPU or an interface module.

Identification data

Information that is saved in modules, and that supports the user in reviewing the system configuration and locating hardware changes.

Interface module

Module in the distributed I/O system. The interface module connects the distributed I/O system to the CPU (IO controller) via a fieldbus, and prepares the data for and from I/O modules.

Isolated modules

In the case of isolated input/output modules, the reference potentials of the control and load circuits are galvanically isolated, e.g. by means of optical isolators, relays or transformers. Input/output circuits can be connected to common potential.

Load current supply

Supply of the module's input and output electric circuits.

MAC address

worldwide, clear device identification, which is already assigned to each PROFINET device in the factory. The 6 bytes of the address consist of a 3-byte manufacturer ID and a 3-byte device ID (serial number). The MAC address is usually clearly legible on the device.

Nodes

Device that can send, receive or amplify data via the bus, e.g., I/O device via PROFINET IO.

Non-isolated modules

In the case of non-isolated input and output modules, the reference potentials of the control and load circuits are electrically connected.

Parameter assignment

Parameter assignment is the transfer of parameters from the IO controller / DP master to the IO device / DP slave.

PELV

Protective **E**xtra **L**ow **V**oltage = grounded extra low voltage with safe isolation

Pre-wiring

Wiring of the electrical system on the front connector before the front connector is used on the I/O module.

Process image (I/O)

The CPU transfers the values from the input and output modules in this memory area. At the start of the cyclic program the signal states of the input modules are transmitted to the process image of the inputs. At the end of the cyclic program the process image of the outputs is transmitted as signal state to the output modules.

Product version (PV) = Function version (FV)

The product version or function version provides information on the hardware version of the module.

PROFIBUS

PROcess FIeld BUS, process and fieldbus standard that is specified in IEC 61158 Type 3. It specifies functional, electrical and mechanical characteristics for a bit-serial field bus system.

PROFIBUS supports the protocols DP (= Distributed I/O), FMS (= Fieldbus Message Specification), PA (= Process Automation), or TF (= Technological Functions).

PROFINET

PROcess FIeld NETwork, open industrial Ethernet standard which further develops PROFIBUS and industrial Ethernet. A cross-manufacturer communication, automation, and engineering model defined by PROFIBUS International e.V. as an automation standard.

PROFINET component

A PROFINET component includes the entire data of the hardware configuration, the parameters of the modules, and the corresponding user program. The PROFINET component consists of:

- Technological function

  The (optional) technological (software) function comprises the interface to other PROFINET components in the form of interconnectable inputs and outputs.

- Device

  The device is the representation of the physical automation device or field device including the I/O, sensors and actuators, mechanics, and device firmware.

PROFINET IO

Communication concept for the realization of modular, distributed applications within the scope of PROFINET.

PROFINET IO controller

Device used to address connected I/O devices (e.g. distributed I/O systems). This means that: The IO controller exchanges input and output signals with assigned I/O devices. The IO controller often corresponds to the CPU in which the automation program is running.

PROFINET IO device

Distributed field device that can be assigned to one or more IO controllers (e.g. distributed I/O system, valve terminals, frequency converters, switches).

Push-in terminal

Terminal for the tool-free connection of wires.

Reference potential

Potential from which the voltages of the circuits involved are observed and/or measured.

Restart

During a restart (warm restart), all non-retentive bit memory is deleted and non-retentive DB contents are reset to the initial values from load memory. Retentive bit memory and retentive DB contents are retained. Program execution begins at the call of the first startup OB.

Row

All the modules attached to a mounting rail.

SELV

Safety **E**xtra **L**ow **V**oltage = Safety extra-low voltage

Sensor

Sensors are used for accurate detection of digital and analog signals as well as routes, positions, velocities, rotational speeds, masses, etc.

Slave station

A slave may only exchange data with a master after being requested to by the master.

SNMP

SNMP (Simple Network Management Protocol) is the standardized protocol for performing diagnostics on and assigning parameters to the Ethernet network infrastructure.

In the office setting and in automation engineering, devices from many different vendors support SNMP on the Ethernet.

SNMP-based applications can be operated on the same network in parallel to applications with PROFINET.

The scope of supported functions varies depending on the device type. For example a switch has more functions than a CP 1616.

Switch

PROFIBUS is a linear network. The communication nodes are linked by means of a passive cable - the bus.

By contrast, Industrial Ethernet consists of point-to-point connections: each communication node is interconnected directly with precisely one other communication node.

If a communication node is linked to several communication nodes, this communication node is connected to the port of an active network component - the switch. Additional communication nodes (including switches) can now be connected to the other ports of the switch. The connection between a communication node and the switch remains a point-to-point connection.

A switch thus has the task of regenerating and distributing received signals. The switch "learns" the Ethernet address(es) of a connected PROFINET device or additional switches and only forwards those signals that are intended for the connected PROFINET device or switch.

A switch has a specific number of connections (ports). You connect at most one PROFINET device or additional switch to each port.

System power supply

Consists of the integrated system power supply of the CPU/interface module and additional power supplies (PS), if necessary. The system power supply serves exclusively to supply the I/O modules via the backplane bus.

Technology object

A technology object supports you in the configuration and commissioning of a technological function.

The properties of real objects are represented by the technology objects in the controller. Real objects can be, for example, controlled systems or drives.

The technology object includes all data of the real object that is required for its open- or closed-loop control, and it signals the status information.

TIA Portal

Totally Integrated Automation Portal

The TIA Portal is the key to the full performance capability of Totally Integrated Automation. The software optimizes operating, machine and process sequences.

Value status

The value status is a binary additional information of a digital input signal. The value status is entered simultaneously with the process signal in the process image input and provides information about the validity of the signal.

Warm restart

See "Restart"

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