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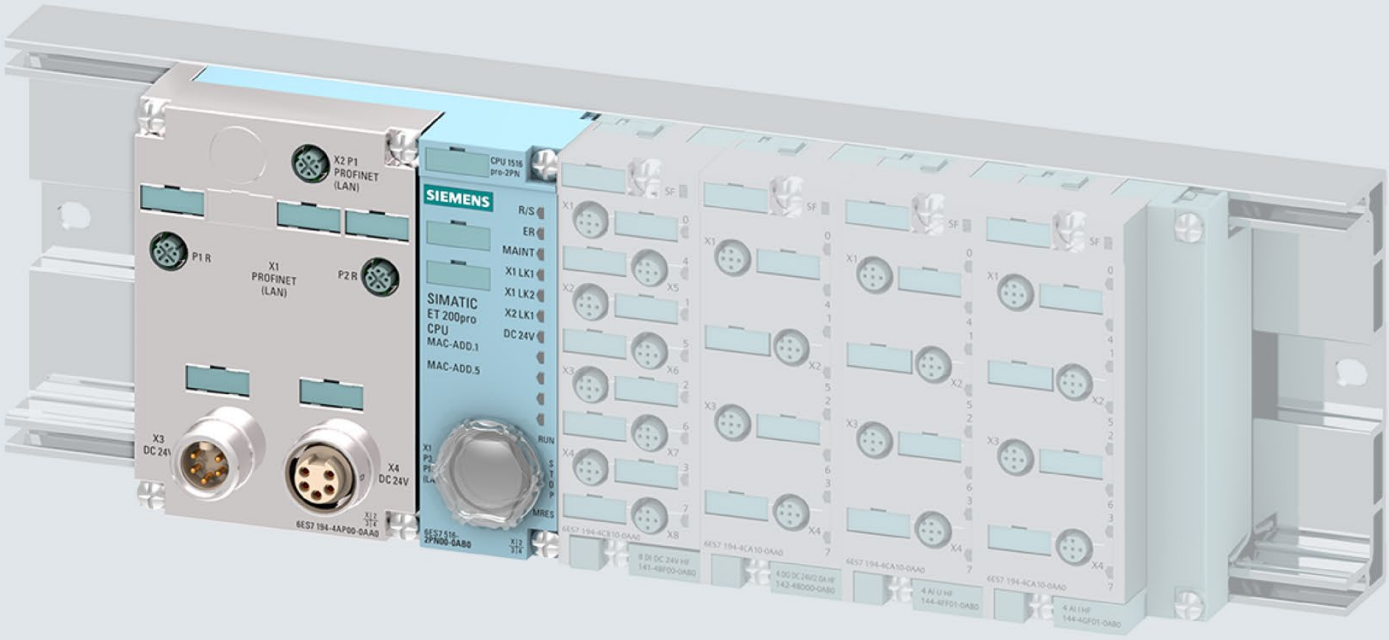

Operating instructions

SIMATIC

ET 200pro

CPU 1516pro-2 PN (6ES7516-2PN00-0AB0)

Edition 11/2019

support.industry.siemens.com

SIEMENS

SIMATIC

ET 200pro
CPU 1516pro-2 PN
(6ES7516-2PN00-0AB0)

Operating Instructions

11/2019
A5E35873416-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

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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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A5E35873416-AC
℗ 10/2019 Subject to change

Preface

Purpose of the operating instructions

This CPU 1516pro-2 PN operating instructions manual supplements the operating instructions of the ET 200pro decentralized I/O system.

The information provided in this manual and the operating instructions of the ET 200pro enables you to commission the CPU 1516pro-2 PN.

Basic knowledge required

General knowledge in the field of automation engineering is required to understand this documentation.

Validity of the documentation

This documentation applies to the CPU 1516pro-2 PN of the ET 200pro distributed I/O system.

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 the operational safety of your plant

Plants with safety-related features are subject to special operational safety requirements on the part of the operator. The supplier is also required to comply with certain measures for product monitoring. Siemens informs system operators in the form of personal notifications about product developments and properties which may be or become important issues in terms of operational safety.

You need to subscribe to the corresponding notifications 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.

Log on to Industry Online Support. Follow the links below and click on "Email on update" on the right-hand side in each case:

- SIMATIC S7-300/S7-300F (https://support.industry.siemens.com/cs/ww/en/ps/13751)
- SIMATIC S7-400/S7-400H/S7-400F/FH (https://support.industry.siemens.com/cs/ww/en/ps/13828)
- SIMATIC WinAC RTX (F) (https://support.industry.siemens.com/cs/ww/en/ps/13915)
- SIMATIC S7-1500/SIMATIC S7-1500F (https://support.industry.siemens.com/cs/ww/en/ps/13716)
- SIMATIC S7-1200/SIMATIC S7-1200F (https://support.industry.siemens.com/cs/ww/en/ps/13883)
- Distributed I/O (https://support.industry.siemens.com/cs/ww/en/ps/14029)
- STEP 7 (TIA Portal) (https://support.industry.siemens.com/cs/ww/en/ps/14340)

Note

When using F-CPUs in safety mode, note the description of the fail-safe system SIMATIC Safety Programming and Operating Manual SIMATIC Safety - Configuring and Programming (https://support.industry.siemens.com/cs/es/en/view/54110126).

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.

Security information

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

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

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

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

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

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed visit (https://www.siemens.com/industrialsecurity).

Siemens Industry Online Support

You can find current information on the following topics quickly and easily here:

- **Product support**

  All the information and extensive know-how on your product, technical specifications, FAQs, certificates, downloads, and manuals.

- **Application examples**

  Tools and examples to solve your automation tasks – as well as function blocks, performance information and videos.

- **Services**

  Information about Industry Services, Field Services, Technical Support, spare parts and training offers.

- **Forums**

  For answers and solutions concerning automation technology.

- **mySupport**

  Your personal working area in Industry Online Support for messages, support queries, and configurable documents.

This information is provided by the Siemens Industry Online Support in the Internet (https://support.industry.siemens.com).

Industry Mall

The Industry Mall is the catalog and order system of Siemens AG for automation and drive solutions on the basis of Totally Integrated Automation (TIA) and Totally Integrated Power (TIP).

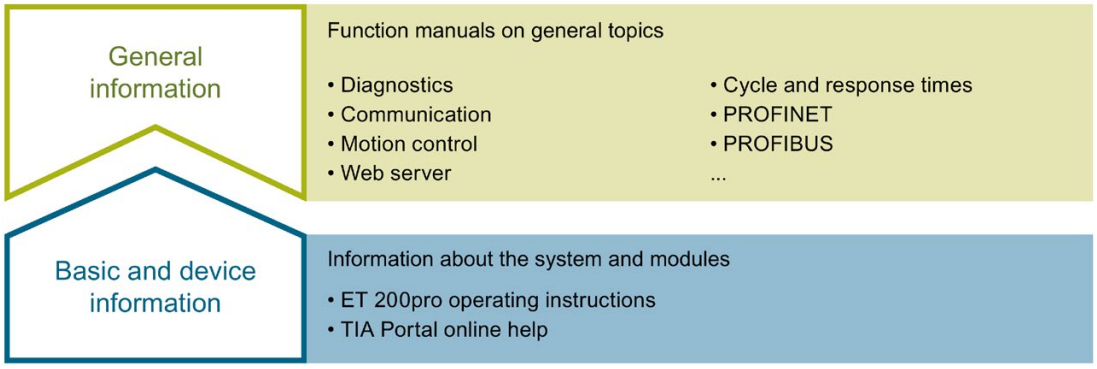
You can find catalogs for all automation and drive products on the Internet (https://mall.industry.siemens.com).

Table of contents

ET 200pro Documentation Guide

1

The documentation for the ET 200pro distributed I/O system and for the 1513/1516pro-2 PN CPUs based on S7-1500 is arranged into various areas. This arrangement enables you to access the specific content you require.



Basic and device information

The operating instructions describe in detail the configuration, installation, wiring and commissioning of the ET 200pro distributed I/O system. In addition, the operating instructions also contain device information such as properties, wiring diagrams, characteristics, and technical specifications. The STEP 7 online help supports you in the configuration and programming.

General information

The function manuals contain detailed descriptions on general topics such as diagnostics, communication, Motion Control, Web server, OPC UA.

You can download the documentation free of charge from the Internet (https://w3.siemens.com/mcms/industrial-automation-systems-simatic/en/manual-overview/Pages/Default.aspx).

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

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With "mySupport", your personal workspace, you make the best out of your Industry Online Support.

In "mySupport", you can save filters, favorites and tags, request CAx data and compile your personal library in the Documentation area. In addition, your data is already filled out in support requests and you can get an overview of your current requests at any time.

You must register once to use the full functionality of "mySupport".

You can find "mySupport" on the Internet (https://support.industry.siemens.com/My/ww/en).

Application examples

The application examples support 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 on individual products.

You will find the application examples on the Internet (https://support.industry.siemens.com/sc/ww/en/sc/2054).

New properties / functions

2

What's new in the operating instructions CPU 1516pro-2 PN, Version 12/2019 compared to Version 12/2017

What's new?		What are the customer benefits?	Where can I find information?
New contents	Example: Read out firmware version of the CPU with Get_IM_Data	You want to check whether the modules in your automation system have the current firmware. To read out the I&M0 data, use the "Get_IM_Data" instruction. You read the I&M0 data of all the modules in the user program of the CPU via "Get_IM_Data" instructions and store them in a data block.	Section Example: Read out firmware version of the CPU with Get_IM_Data (Page 94)
	Direct data exchange between IO controllers	Real-time communication between IO controllers with PROFINET IO IRT. Application examples: • Motion control • Project trace	Communication (https://support.industry.siemens.com/cs/ww/en/view/59192925) function manual
	OPC UA client	With instructions largely implemented according to specification "PLCopen OPC UA Client for IEC 61131-3", the CPU 1516pro-2 PN takes over the active and leading part of the communication to OPC UA servers of other process devices. STEP 7 as of V15.1 facilitates and accelerates the program-specific implementation of this communication task by allowing you to import NodeSets from OPC UA servers and to parameterize the OPC UA client instructions in a user-guided manner. Similarly, CPU 1516pro-2 PN, acting as an OPC UA client, can call up methods of an OPC UA server (for example of an MES/ERP system), for example, to fetch new productions orders from this system.	
Changed contents	Expansion width 1.2 m	Maximum 1.2 m expansion width without module rack. You can mount more wider modules (e.g. motor starters) on the module rack. The maximum number of modules is still limited to 16.	Section Technical specifications (Page 119)

What's new in the operating instructions CPU 1516pro-2 PN, Version 12/2017 compared to Version 09/2016

What's new?		What are the customer benefits?	Where can I find information?
New contents	Importing the configuration	When there is a connection to an existing CPU, you can use the "Hardware detection" function to read the configuration of the CPU and apply the configuration in your project. Thanks to the automatic import of the hardware configuration, you do not need to manually configure the CPU. This saves you time and avoids input errors.	Section Importing the configuration (Page 34)
	Password provider	As an alternative to manual password entry, you can link a password provider to STEP 7. A password provider provides the following advantages: • Convenient handling of passwords. STEP 7 automatically reads in the password for the blocks. This saves you time • Optimal block protection because the operators do not know the actual password	Section Know-how protection (Page 64)
	Instruction GetSMCinfo	Using the GetSMCinfo instruction, you can respond to information provided by the memory card in the user program and, if necessary, replace the memory card as a precautionary measure. This makes sense in particular if you write to the card often in your application, for example if you use data logs.	Section SIMATIC memory card - overview
	Testing with breakpoints	When testing with breakpoints, you run a program from breakpoint to breakpoint. Testing with breakpoints offers the following advantages: • Testing SCL and STL program code using breakpoints • Narrowing down logic errors step-by-step • Simple and rapid analysis of complex programs before actual commissioning • Acquisition of actual values within individual loop passes • Utilization of breakpoints for program validation also possible in SCL networks with LAD / FBD possible	Section Test functions (Page 105)

What's new?		What are the customer benefits?	Where can I find information?
Changed contents	UDP	The maximum data length of the connectionless network protocol UDP (UDP-Unicast and UDP-Multicast) amounts to 2 KB. You transfer a larger amount of data per UDP packet via Industrial Ethernet.	Section Technical specifications (Page 119)
	Fetching the identification and maintenance data with the Get_IM_Data instruction	Using the Get_IM_Data instruction, you can read the identification and maintenance data of the modules with little programming work. With the Get_IM_Data instruction you can access identification and maintenance data (I&M) of a module in the user program. I&M data is stored information in a module. This allows you to • Check the system configurations • React to hardware changes • React to hardware faults in the user program. Finding and elimination of hardware errors is easier.	Section Fetching and entering I&M data (Page 90)

Product overview

3

3.1 Application

The CPU 1516pro-2 PN is a component of the ET 200pro distributed I/O system in degree of protection IP65, IP66 and IP67. The CPU provides you with maximum performance combined with excellent usability. It is suitable for a variety of demanding applications and communication tasks in automation engineering. It features:

- Integrated PROFINET interfaces
- Integrated Web server
- Integrated functionalities:
  - Trace
  - Motion control
  - Closed-loop control functions
- OPC UA functionalities:
  - OPC UA server
  - OPC UA client

Integrated technological functions

The CPU supports motion control functions. STEP 7 provides PLCopen standardized blocks for configuring and connecting a drive to the CPU. Motion control functionalities support speed-controlled, positioning and synchronous axes as well as external encoders.

For effective commissioning and fast optimization of drives and closed-loop controls, the CPU supports extensive trace functions.

In addition to drive integration, the CPU has extensive closed-loop control functions, such as easy-to-configure blocks for automatic optimization of the controller parameters for optimized control quality.

Due to the supported technology functions, the CPU is suitable for controlling pumps, fans, mixers, conveyor belts, lifting platforms, gate control systems, building management systems, synchronized axes, cross cutters, etc.

Security Integrated

The CPU provides, in conjunction with STEP 7, password-based know-how protection against unauthorized reading out or modification of the program blocks.

The copy protection provides reliable protection against unauthorized reproduction of program blocks. With copy protection you associate individual blocks with the serial number of the CPU or SIMATIC memory card.

In addition, you can assign various access rights to different user groups using four different authorization levels.

Through an improved manipulation protection, the CPU detects modified or unauthorized transmissions of engineering data.

Safety Integrated

The fail-safe CPU is intended for users who want to implement demanding standard and fail-safe applications both centrally and decentrally.

The fail-safe CPU enables the processing of standard and safety programs on a single CPU. This allows you to evaluate fail-safe data in the standard user program. As a result of this integration, the system advantages and the extensive functionality of SIMATIC are also available for fail-safe applications.

The fail-safe CPU is certified for use in safety mode up to:

- Safety class (Safety Integrity Level) SIL 3 according to IEC 61508:2010
- Performance Level (PL) e and Category 4 according to ISO 13849-1:2015 or according to EN ISO 13849-1:2015

Additional password protection for F-configuration and F-program is set up for IT security.

System diagnostics

Integrated system diagnostics is enabled by default for the CPUs. The different diagnostic types are configured instead of programmed. System diagnostics information is shown uniformly and in plain text on the display of the CPU, in STEP 7, on the HMI and on the Web server, even for messages related to drives. This information is available in RUN mode or in STOP mode of the CPU. The CPU automatically updates diagnostic information when you have configured new hardware components.

OPC UA

OPC UA is an open and vendor-neutral communication protocol. The CPU can be used as an OPC UA server or as an OPC UA client. A runtime license is required to operate the OPC UA functions.

3.2 How it works

The CPU contains the operating system and executes the user program. The user program is located on the SIMATIC memory card and runs 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 CPU 1516pro-2 PN supports the (simultaneous) operation as an IO controller and I-device.

IO controller

As an IO controller, the CPU 1516pro-2 PN sends and receives data from the connected IO devices within a PROFINET IO system. You can operate the following IO devices on the PROFINET interfaces of the CPU:

1st PROFINET interface (X1): maximum of 256 IO devices, of which a maximum of 64 in IRT (Isochronous real-time).

2nd PROFINET interface (X2): maximum of 32 PROFINET devices

I-device

The "I-device" (intelligent IO device) functionality allows you to exchange data with an IO controller. The CPU 1516pro-2 PN thus fulfills the role of an intelligent distributed pre-processing unit of sub-processes. The I-device is connected to a "higher-level" IO controller as an IO device.

Advantages:

- Interference-resistant configuration due to short signal and encoder wiring
- Reduced wiring effort for transmission of data via PROFINET

3.3 Properties

Article number

6ES7516-2PN00-0AB0 (CPU 1516pro-2 PN)

6ES7194-4AP00-0AA0 (Connection module CM CPU 2PN M12 7/8")

View of the module

The figure below shows the CPU 1516pro-2 PN.

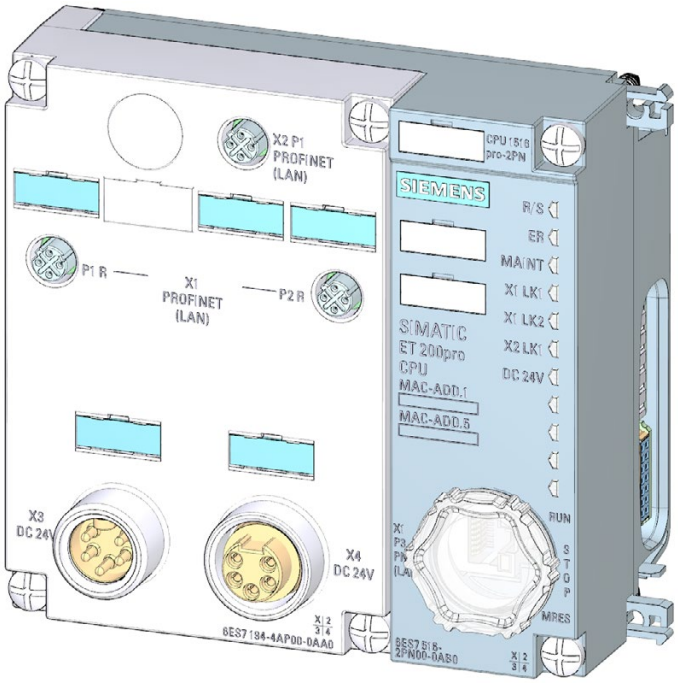


Figure 3-1 CPU 1516pro-2 PN

Properties

CPU 1516pro-2 PN has the following properties:

Property	Description	TextAdditional information
Supply voltage	You connect the 24 VDC supply voltage via the connection module CM CPU 2PN M12, 7/8".	• Section Mounting and connecting (Page 23) • Operating instructions of the ET 200pro Distributed I/O System (https://support.industry.siemens.com/cs/ww/en/view/21210852)
Expansion width	Max. 1.2 m (without module rack)	Section Technical specifications (Page 119)
PROFINET IO		
PROFINET interface X1	The first PROFINET interface (X1) has three ports (P1 R, P2 R and P3). In addition to basic PROFINET functionality, it also supports PROFINET IO RT (real-time) and IRT (isochronous real-time). P1 R and P2 R are M12 circular sockets (with female contact insert). They can also be used as ring ports for the configuration of redundant ring structures in Ethernet (media redundancy). P3 is an RJ45-socket and is suitable, for example, for connecting a PC, programming or HMI device.	PROFINET Function Manual (https://support.industry.siemens.com/cs/ww/en/view/49948856)
PROFINET interface X2	The 2nd PROFINET interface (X2) has one port (P1). P1 is an M12 circular socket (with female contact insert). In addition to basic PROFINET functionality, P1 also supports PROFINET IO RT (real time). IRT (Isochronous real-time) is not supported by this interface.	
Direct data exchange between IO controllers	Real-time communication between IO controllers with PROFINET IO IRT Application examples: • Motion control • Project trace	Communication (https://support.industry.siemens.com/cs/ww/en/view/59192925) function manual

See also

Cycle and response times function manual
(https://support.industry.siemens.com/cs/de/de/view/59193558/en)

Function Manual S7-1500, S7-1200 / S120, G120 Using the trace and logic analyzer function
(https://support.industry.siemens.com/cs/ww/en/view/64897128)

Function Manual S7-1500/S7-1500T Motion Control
(https://support.industry.siemens.com/cs/ww/en/view/109766459)

Sizer (https://w3.siemens.com/mcms/mc-solutions/en/engineering-software/drive-design-tool-sizer/Pages/drive-design-tool-sizer.aspx)

TIA Selection Tool (https://w3.siemens.com/mcms/topics/en/simatic/tia-selection-tool)

Function Manual S7-1500/S7-1500T Axis functions
(https://support.industry.siemens.com/cs/ww/en/view/109766462)

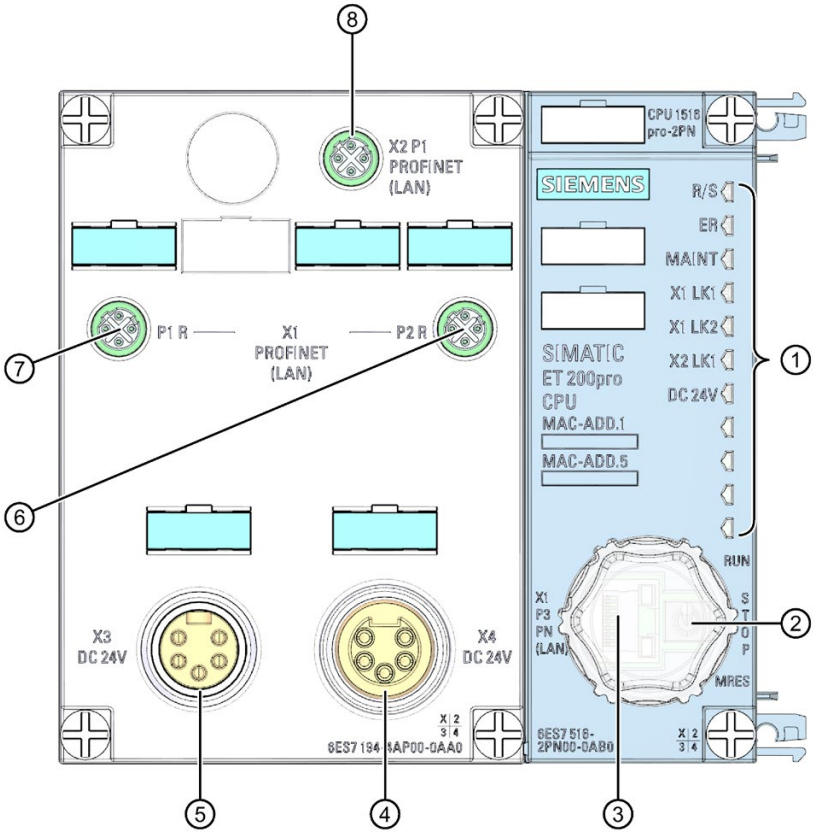
Function Manual S7-1500/S7-1500T Synchronism functions
(https://support.industry.siemens.com/cs/ww/en/view/109766464)

3.4 Operator control and display elements

3.4.1 Front view of the module

Operator control and connection elements

The figure below shows the operator controls and connection elements of the CPU 1516pro-2 PN.



① Status and error displays
② Mode switch
③ RJ45 socket; e.g. for connecting a programming device for service purposes (Port 3 of PROFINET interface X1). This port cannot be used as a ring port.
④ 7/8" circular socket with female contact insert (X4) for loop-through of electronics/encoder supply 1L+ and load voltage supply 2L+
⑤ 7/8" circular socket with male contact insert (X3) for infeed of electronics/encoder supply 1L+ and load voltage supply 2L+
⑥ M12 circular socket with female contact insert for connection to PROFINET (Port 2 of PROFINET interface X1)
R: Ring port for configuring a ring topology with media redundancy
⑦ M12 circular socket with female contact insert for connection to PROFINET (Port 1 of PROFINET interface X1)
R: Ring port for configuring a ring topology with media redundancy
⑧ M12 circular socket with female contact insert for connection to PROFINET (Port 1 of PROFINET interface X2)

Figure 3-2 View of CPU 1516pro-2 PN

Slot for the SIMATIC memory card

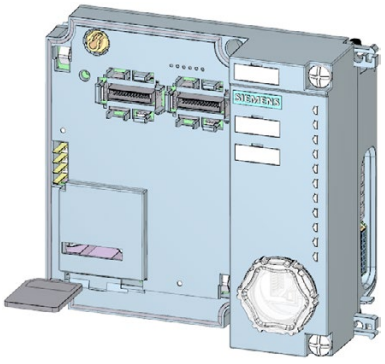


Figure 3-3 Slot for the SIMATIC memory card

CPU 1516pro-2 PN uses a SIMATIC memory card as the memory module. You can use the SIMATIC memory card as load memory or as a portable storage medium. The slot for the SIMATIC memory card is accessible on the front of the CPU after removing the connection module. You can find detailed information on removing and inserting the SIMATIC memory card in section Inserting/replacing SIMATIC memory card (Page 76).

3.5 Mode switch

Use the mode switch to set the CPU operating mode.

The following table shows the position of the switch and the corresponding meaning.

Table 3- 1 Mode switch settings

Position	Meaning	Explanation
RUN	RUN mode	The CPU is executing the user program.
STOP	STOP mode	The CPU is not executing the user program.
MRES	Memory reset	Position for CPU memory reset.

Mounting and connecting

4

4.1 Contents

Where can I find what information?

You can find detailed information on mounting and connecting an ET 200pro in the corresponding sections of the ET 200pro operating instructions (http://support.automation.siemens.com/WW/view/en/21210852).

In the sections below, you will learn the differences and special requirements for setup of an ET 200pro with the CPU 1516pro-2 PN.

4.2 Mounting the CPU and connection module

Introduction

The CPU 1516pro-2 PN connects the ET 200pro to PROFINET IO and exchanges the preprocessed data with the higher-level controller.

Requirements

- The termination module is removed from the CPU.
- The module rack is mounted (see Operating instructions ET 200pro (http://support.automation.siemens.com/WW/view/en/21210852)).

Tools required

Cross-tip screwdriver, size 2

Procedure

1. Insert the CPU onto the module rack until it engages and then move it as needed to the correct position.
2. Screw the CPU to the module rack.

   2 recessed head screws on the front: top and bottom, tightening torque 1.5 Nm.
3. Insert a blank SIMATIC memory card or a memory card with the correct configuration in the card slot.

   You can find information on this in the section Inserting/replacing SIMATIC memory card (Page 76).
4. Insert the connection module CM CPU 2PN M12, 7/8" onto the CPU.
5. Screw the terminal module onto the rack.

   Four recessed head screws on the front, tightening torque 1.5 Nm.
6. Mount the electronic modules, power modules and motor starters. You can find information in the ET 200pro operating instructions (http://support.automation.siemens.com/WW/view/en/21210852).
7. Mount the termination module (see ET 200pro operating instructions (http://support.automation.siemens.com/WW/view/en/21210852) for information on this).

4.3 Connecting the connection module CM CPU 2PN M12 7/8"

Introduction

Connect the supply voltages and PROFINET to the connection module CM CPU 2PN M12, 7/8". The 1st PROFINET interface (X1) is equipped with an internal PROFINET switch. This enables the direct loop-through of PROFINET or the direct connection of another IO device (e.g. ET 200pro with IM 154-4 PN). Use X1 Port 1 and X1 Port 2 for configuring ring topologies. The 2nd PROFINET interface (X2) has only one port.

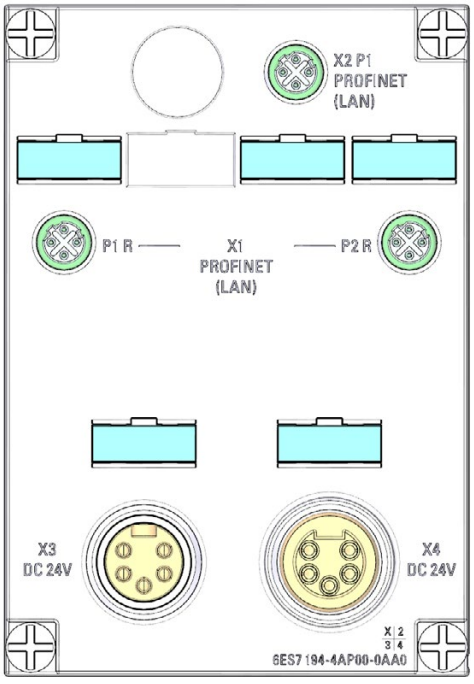


Figure 4-1 View of the connection module CM CPU 2PN M12, 7/8"

X2 P1	M12 circular socket (with female contact insert) for connection of PROFINET
X1 P1 R	M12 circular socket connector (with socket insert) for connection of PROFINET R: Ring port for configuring a ring topology with media redundancy
X1 P2 R	M12 circular socket connector (with socket insert) for connection of PROFINET R: Ring port for configuring a ring topology with media redundancy
X3 DC 24V	7/8" circular socket (with male contact insert) for infeed of electronics/encoder supply 1L+ and load voltage supply 2L+
X4 DC 24V	7/8" circular socket (with female contact insert) for loop-through of electronics/encoder supply 1L+ and load voltage supply 2L+

CAUTION

PROFINET

You may operate modules with PROFINET interfaces only in LAN networks (Local Area Network) in which all the connected nodes are equipped with a SELV/PELV power supply (or equivalent).

A data transfer terminal (modem, for example) is required to access the WAN (Wide Area Network) in order to ensure compliance with this safety standard.

Requirements

The CPU (including bus module) and the connection module CM CPU 2PN M12, 7/8" are mounted on the module rack.

Tools required

- Screwdriver
- Insulation stripping tool for wiring if you are assembling the cables yourself.

Accessories required

- Pre-fabricated cable with M12 and 7/8" connectors The patch cables are available in different lengths.
- To produce your own cable:
  - M12: PROFINET cable (4-wire, shielded) and M12 PROFINET connection plug (d-coded)
  - 7/8": 5-wire patch cable with 7/8" connectors

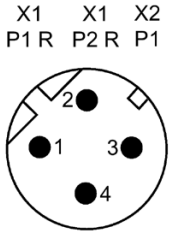
Pin assignment of the M12 connector

M12 circular sockets X1 P1 R and X1 P2 R:

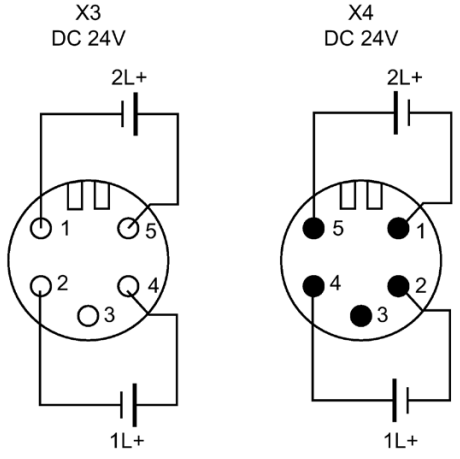
- If autonegotiation is activated, then the M12 circular socket has the switch assignment (MDI-X).
- If autonegotiation is activated, then autocrossing is active and the M12 circular socket has either a device assignment (MDI) or switch assignment (MDI-X).

M12 circular socket X2-P1:

Autocrossing is always active. As a result, the M12 circular socket has either a device assignment (MDI) or switch assignment (MDI-X).

View of M12 connector, d-coded (PROFINET)	Terminal	MDI (device assignment)	MDI-X (switch assignment)
		Assignment	Assignment
	X1 P1 R, X1 P2 R, X2 P1 for connection of PROFINET		
	1	TD_P (Transmit Data +)	RD_P (Receive Data +)
	2	RD_P (Receive Data +)	TD_P (Transmit Data +)
	3	TD_N (Transmit Data –)	RD_N (Receive Data –)
	4	RD_N (Receive Data –)	TD_N (Transmit Data –)
	Thread	Functional ground	

Pin assignment of the 7/8" connector

View of 7/8" connector (supply voltage 1L+ und 2L+)	Terminal	Assignment
	X3 DC 24 V for infeed X4 DC 24 V for loop-through	
	1	Load voltage ground 2M
	2	Ground for electronics/encoder supply 1M
	3	Functional ground
	4	Electronic / encoder supply 1L+
	5	Load voltage supply 2L+

Connecting M12 and 7/8" connectors

1. Press the M12 and 7/8" connection plugs into the corresponding circular sockets on the connection module CM CPU 2PN M12, 7/8". Ensure that the connector and socket are properly engaged.
2. Tighten the connectors with the knurled screw (tightening torque = 1.5 Nm).

NOTICE
It is not permissible to remove the 7/8" connection plug during operation! It is not allowed to remove the 7/8" connector while ET 200pro is in operation! Always switch off the 1L+ electronics/encoder supply and the 2L+ load voltage supply before you pull or plug the 7/8" cable connector.

Note

Removal of the 7/8" connector interrupts the supply to downstream modules.

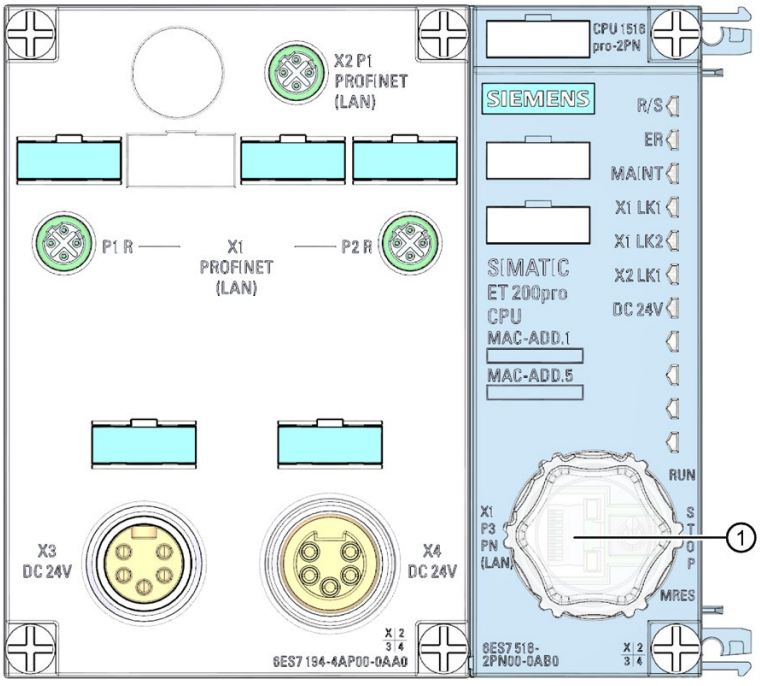
Closing unused sockets

In order to achieve degree of protection IP65, IP66 or IP67, close all unused sockets with M12 and 7/8" cover caps (see section Accessories). You can find the order numbers of the cover caps in appendix Accessories/spare parts (Page 136).

4.4 Connecting an RJ45 socket

Introduction

You can connect, for example, a programming device to the RJ45 socket of the CPU. The PROFINET interface is equipped with an internal switch that allows PROFINET nodes to be connected directly.



① X1 P3 RJ45 socket for connecting to PROFINET

Figure 4-2 RJ45 socket

Requirements

- The CPU (including bus module) and the connection module CM CPU 2PN M12, 7/8" are mounted on the module rack.

Tools required

- 32 mm open-ended wrench

Accessories required

- Pre-assembled PROFINET cable with RJ45 connection plug. The cable is available in different lengths.

Pin assignment of the RJ45 connector

The assignment corresponds to the Ethernet standard for an RJ45 connection plug.

RJ45 socket X1 P3:

- If autonegotiation is activated, then the RJ45 socket has the switch assignment (MDI-X).
- If autonegotiation is activated, then autocrossing is active and the RJ45 socket has either a device assignment (MDI) or switch assignment (MDI-X).

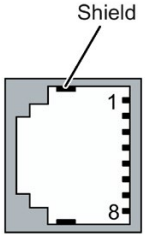


Figure 4-3 View of RJ45 socket

Connect the RJ45 connector

1. Unscrew the screw cap from the CPU.
2. Push the RJ45 connection plug into the socket on the CPU.

Note

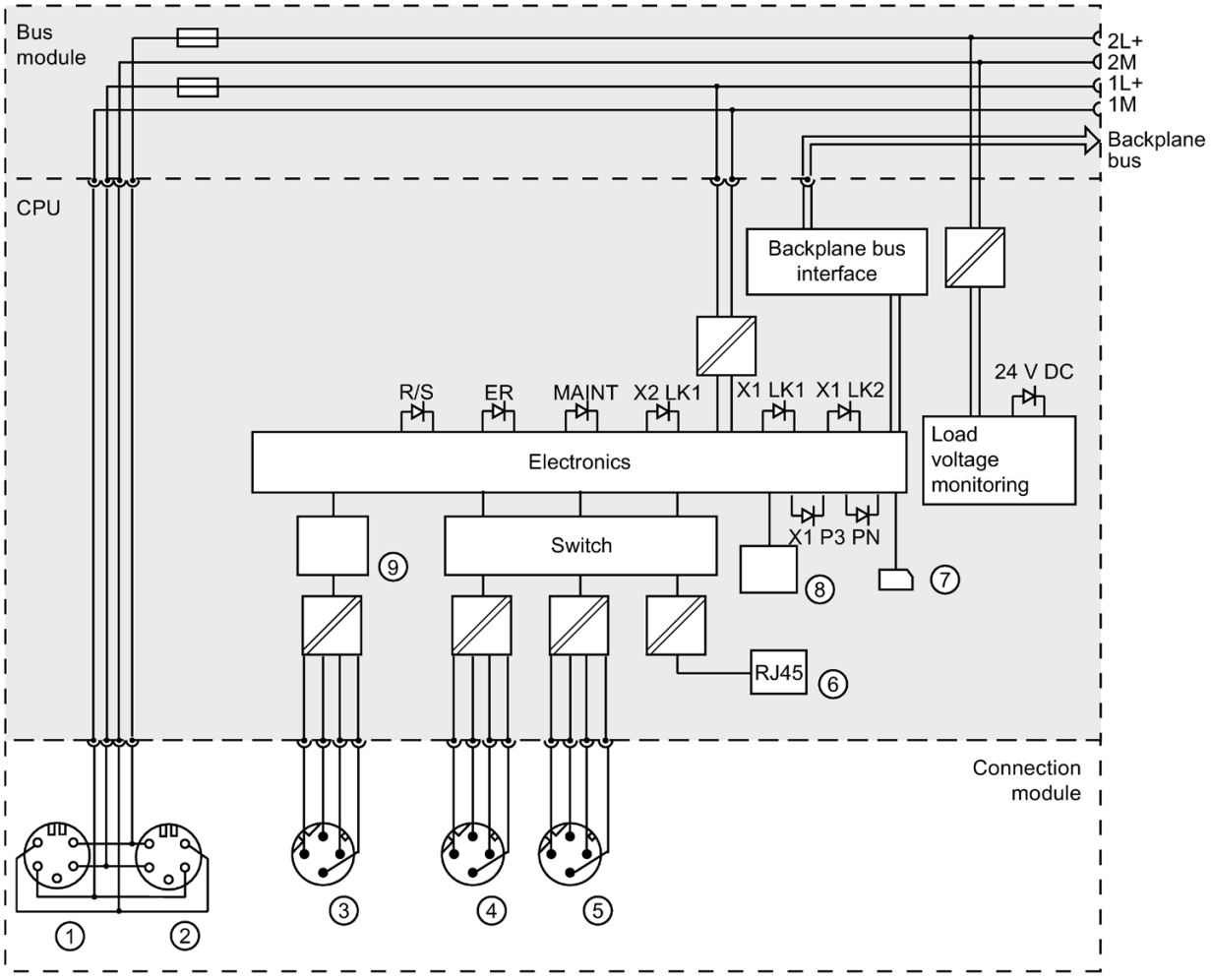
Note that IP65, IP66 and IP67 degree of protection is no longer ensured when the RJ45 connector is plugged in.

Restoring degree of protection IP65, IP66 and IP67 after removing the RJ45 connector

In order to achieve degree of protection IP65, IP66 and IP67, install the screw cap back onto the CPU. Hand-tighten the cap (minimum tightening torque 1.0 Nm).

4.5 Wiring and circuit diagram

The figure below shows the wiring and circuit diagram of the CPU 1516pro-2 PN.



①	Infeed of electronics/encoder supply 1L+ and load voltage supply 2L+ (X3)		
②	Loop-through of electronics/encoder supply 1L+ and load voltage supply 2L+ (X4)		
③	PROFINET interface X2 Port 1 (X2 P1)	R/S	LED operating state (yellow/green)
④	PROFINET interface X1 Port 1 (X1 P1 R)	ERROR	LED diagnostic status (red)
⑤	PROFINET interface X1 Port 2 (X1 P2 R)	MAINT	LED diagnostic status (yellow)
⑥	PROFINET interface X1 Port 3 (X1 P3)	X2 LK1	PROFINET LEDs (yellow/green)
⑦	SIMATIC memory card	X1 LK1	
⑧	Mode switch	X1 LK2	
⑨	Ethernet controller	24 V DC	LED load voltage supply (green)
		X1 P3	PROFINET LED (green)
		PN	LED PROFINET (yellow)

Figure 4-4 Wiring and circuit diagram

Configuring

5

5.1 Introduction to configuring

Introduction

By configuring the individual hardware components, assigning their parameters, and connecting them, you communicate to the ET 200pro distributed I/O system its preset configuration and mode of functioning. You perform the work needed for this in the device and network views in STEP 7 .

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

When modules are inserted, 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.

At startup, the system components compare the configured preset configuration with the actual configuration of the system. By means of parameter assignment, you can specify the response of the CPU to errors in the hardware configuration.

"**Assigning parameters**" is understood to mean setting the properties of the components used (CPU, modules).

STEP 7 compiles the hardware configuration (result of "configuring" and "assigning parameters") and downloads it to the CPU. The CPU then connects to the configured components and transfers their configuration and parameters. Modules can be replaced very easily because STEP 7 transfers the configuration and parameters when a new module it is inserted.

Requirements for configuration of the CPU

Table 5- 1 Requirements for configuring

Configuration software	Information on configuring
STEP 7 (TIA Portal) as of V14	STEP 7 online help

Reference

You can find an overview of the most important documents and links to STEP 7 in an FAQ on the Internet (https://support.industry.siemens.com/cs/de/de/view/65601780/en).

5.2 Configuring the CPU

5.2.1 Reading out the configuration

Introduction

When there is a connection to an existing CPU, you can load the configuration of this CPU, including present modules, from the device into your project using the "Hardware detection" function. You do not need to manually configure the CPU and the present modules, since the physical configuration is read out automatically.

If you have already configured a CPU and the present modules 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 section Backing up and restoring the CPU configuration (Page 87).

Requirements

Note

Take into account that the Hardware detection function only recognizes modules with identification data I&M0 at an ET 200pro distributed I/O system. All modules that do not have access to I&M0 identification data are displayed in the hardware configuration as an empty slot. You have to manually configure and assign parameters to these modules

Table 5- 2 ET 200pro modules without I&M0 identification data (manual configuration and parameter assignment required)

Module	Article number
PM-E DC 24V power module	6ES7148-4CA00-0AA0
PM-O DC 2x24V power module	6ES7148-4CA60-0AA0
8 DI DC 24V electronic module	6ES7141-4BF00-0AA0
16 DI DC 24V electronic module	6ES7141-4BH00-0AA0
4 DO DC 24V/2.0A electronic module	6ES7142-4BD00-0AA0
8 DO DC 24V/0.5A electronic module	6ES7142-4BF00-0AA0
4 DI / 4 DO DC 24V/0.5A electronic module	6ES7143-4BF50-0AA0
4 DIO / 4 DO DC 24V/0.5A electronic module	6ES7143-4BF00-0AA0
16 DO DC 24V CPV10 pneumatic interface module	6ES7148-4EA00-0AA0
16 DO DC 24V CPV14 pneumatic interface module	6ES7148-4EB00-0AA0
Motor starter repair switch module RSM 15A	3RK1304-0HS00-6AA0
Motor starter local repair switch module F-RSM 16A	3RK1304-0HS00-7AA0
Motor starter disconnecting module ASM 400V 25A	3RK1304-0HS00-8AA0

Procedure for reading out an existing configuration

1. Create a new project and configure an "Unspecified ET200pro Plus CPU".

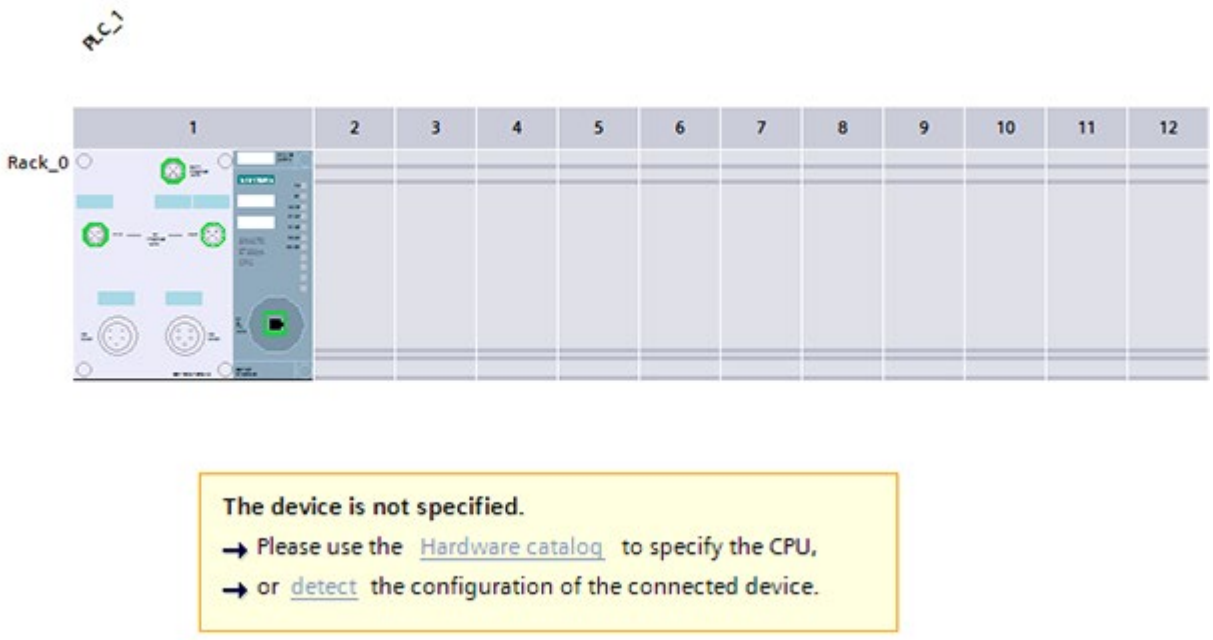


Figure 5-1 Unspecified ET200pro Plus CPU in the device view

Note

To open the "Hardware detection for PLC_x" dialog, click the "Detect" link.

An alternative procedure is described in Step 2 and Step 3.

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

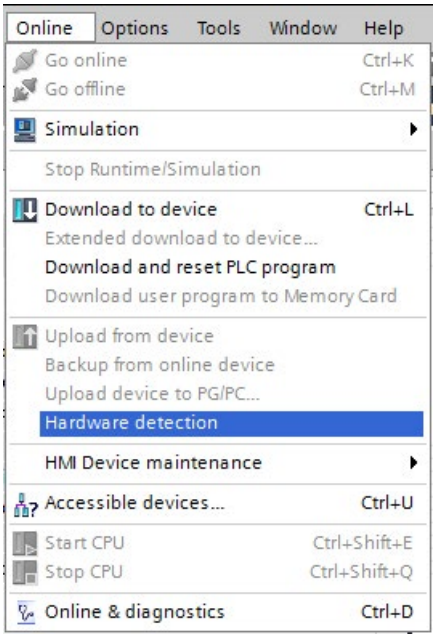


Figure 5-2 Hardware detection in the Online menu

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

3. In the "Hardware detection for PLC_x" dialog box, click "Refresh". Then, select the CPU and click "Detect".

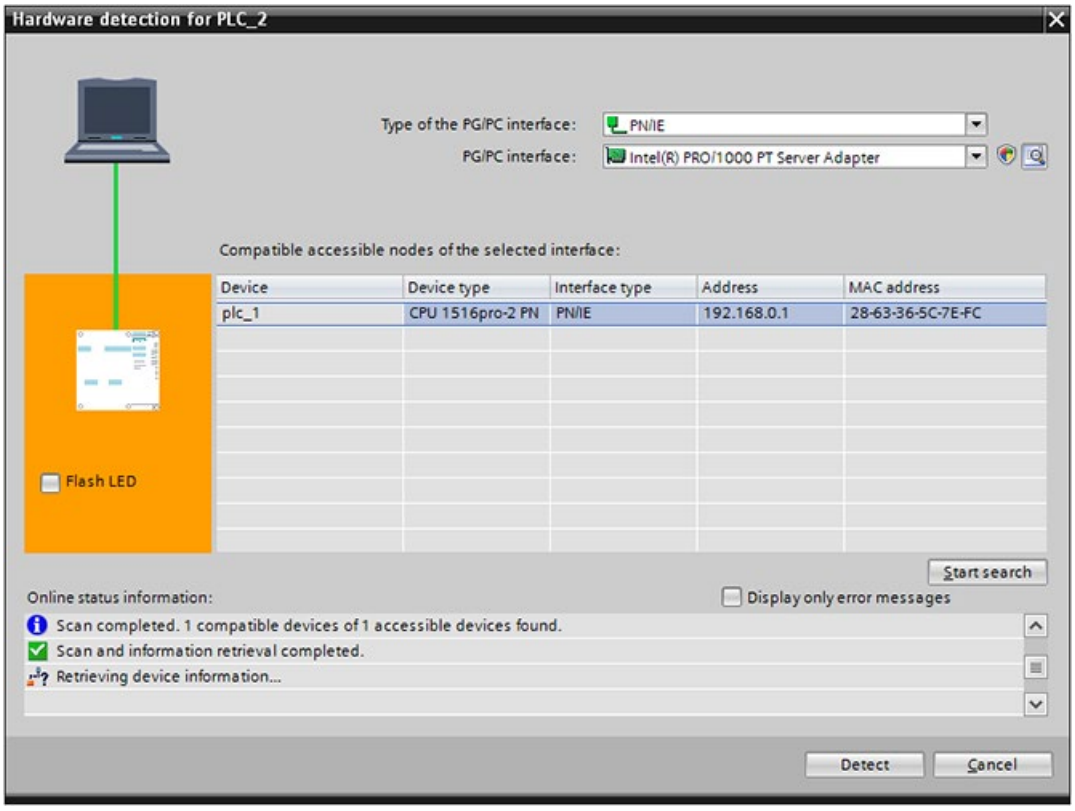


Figure 5-3 Hardware detection dialog box

Result of the hardware detection

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

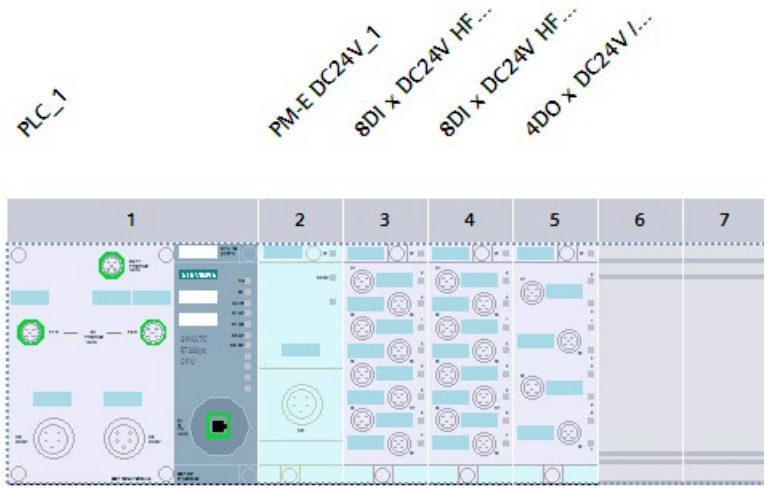


Figure 5-4 Result of the hardware detection in the device view

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 the CPU

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

- Startup characteristics
- Parameter assignment of the interfaces, for example, IP address, subnet mask
- Web server, e.g., activation, user administration, and languages
- OPC UA server
- OPC UA client
- Global Security Certificate Manager
- Cycle times, e.g., maximum cycle time
- System and clock memory
- Protection level for access protection with assigned password parameter
- Time and day settings (daylight saving/standard)

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

You can find additional information on configuring the CPU / I/O modules and the individual settings in the STEP 7 online help.

5.2.2 Address assignment

5.2.2.1 Addressing - overview

Introduction

In order to address the automation components or modules, they must have unique addresses. The following section explains the various address areas.

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 modules are configured. Each module uses a continuous range of input and/or output addresses corresponding to its volume of input and output data.

Module	Rack	Slot	I address	Q address	Type	Article 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 5-5 Example with input/output addresses from STEP 7

STEP 7 assigns the address areas of the modules 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). They are required to address the various devices on a subnet, for example, to download a user program.

Hardware identifier

STEP 7 automatically assigns a hardware identifier (HW identifier) for identification and addressing of 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.

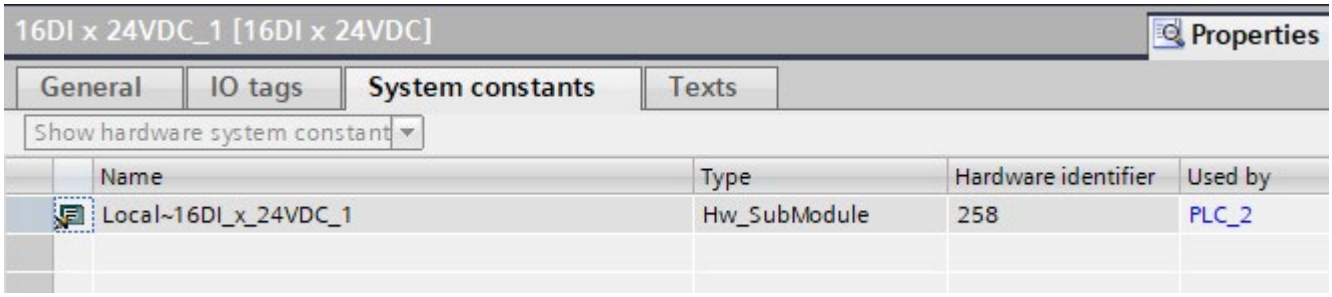


Figure 5-6 Example of a hardware identifier from STEP 7

The "System constants" tab contains all hardware identifiers and their symbolic names (of HW identifier) for the selected module.

The HW identifiers and names of all modules of a device are also available in the default tag table on the "System constants" tab.

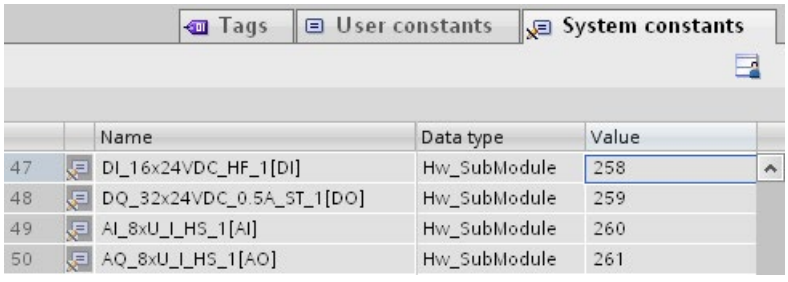


Figure 5-7 Example of a default tag table from STEP 7

5.2.2.2 Addressing digital electronic modules

Introduction

The following section describes the addressing of the digital electronic modules. You need the addresses of the channels of the digital electronic module in the user program.

Addresses of the digital electronic modules

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

Example: **I 1.2**

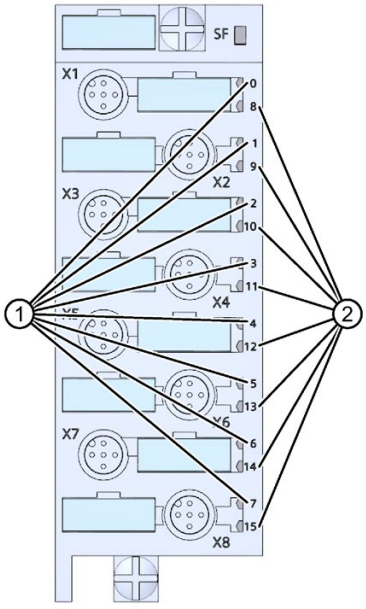
The example consists of:

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 electronic module into a free slot, STEP 7 assigns a default address. You can change the proposed default address in STEP 7.

Example of the assignment of addresses to channels (digital electronic module)

The following figure shows how the addresses of the individual channels of the digital electronic module 16 DI DC 24 V arise.



① Channels 0 to 7; byte address: Module start address
② Channels 8 to 15; byte address: Module start address +1

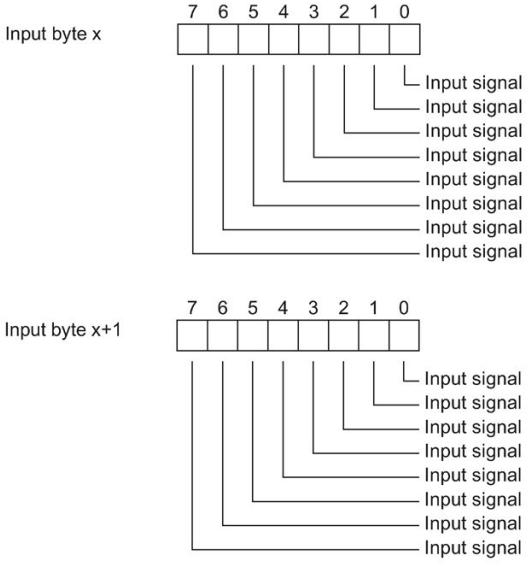
Figure 5-8 Example of the assignment of addresses to channels (digital electronic module)

Note

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

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

Address space using the digital electronic module 16 DI DC 24 V as an example



CM IO 8 x M12D	Channel
X1 at terminal 4	0
X2 at terminal 4	1
X3 at terminal 4	2
X4 at terminal 4	3
X5 at terminal 4	4
X6 at terminal 4	5
X7 at terminal 4	6
X8 at terminal 4	7

CM IO 8 x M12D	Channel
X1 at terminal 2	8
X2 at terminal 2	9
X3 at terminal 2	10
X4 at terminal 2	11
X5 at terminal 2	12
X6 at terminal 2	13
X7 at terminal 2	14
X8 at terminal 2	15

Figure 5-9 Address space 16 DI DC 24 V

Reference

You can find additional information on addressing and address allocation in the operating instructions of the ET 200pro distributed I/O system (https://support.industry.siemens.com/cs/ww/en/view/21210852) and in the STEP 7 online help.

5.2.2.3 Addressing analog electronic modules

Introduction

The following section describes the addressing of analog electronic modules. You need the addresses of the channels of the analog electronic module in the user program.

Analog module addresses

The address of an analog channel is always a word address. The channel address depends on the module start address. STEP 7 assigns the channel addresses automatically during configuration. Based on the module start addresses, STEP 7 assigns the channel addresses in ascending order. The figure below shows the module start address 256.

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

Example of the assignment of addresses to channels (analog electronic module)

The following figure shows how the addresses of the individual channels of the analog electronic module 4 AI RTD High Feature are determined when the module has the start address 256.

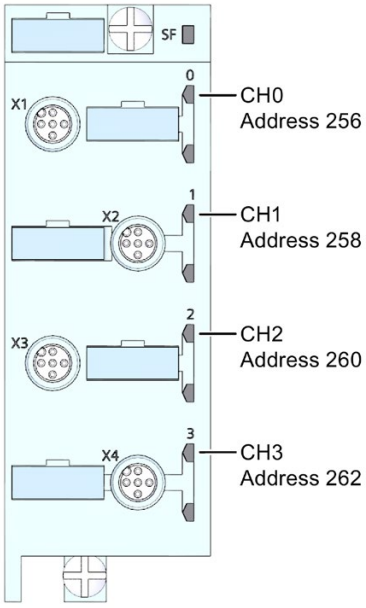


Figure 5-10 Example of the assignment of addresses to channels (analog electronic module)

Note

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

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

Address space using the analog electronic module 4 AI RTD High Feature as an example

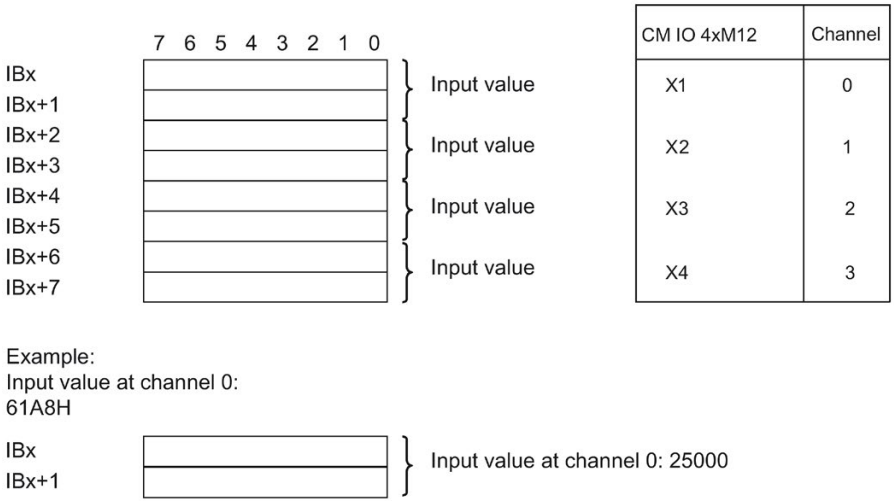


Figure 5-11 Address space 4 AI RTD High Feature

Reference

You can find additional information on addressing and address allocation in the operating instructions of the ET 200pro distributed I/O system (https://support.industry.siemens.com/cs/ww/en/view/21210852) and in the STEP 7 online help.

5.2.3 Process images and process image partitions

5.2.3.1 Process image - overview

Process image of the inputs and outputs

The process images of the inputs and outputs is a map of the signal states. The CPU transfers the values from the input and output modules into the process image of the inputs and outputs. At the start of the cyclic program, the CPU transfers the process image output as a signal state to the output modules. The CPU then transfers the signal states of the input modules to the process image inputs.

Advantages of the process image

A process image accesses a consistent image of the 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 CPU does not update the process image until the next cycle.

32 process image partitions

By means of process image partitions, the CPU synchronizes the updated inputs/outputs of particular modules with defined user program sections.

For the CPU 1516pro-2 PN, the overall process image is subdivided into up to 32 process image partitions (PIP).

The CPU updates PIP 0 (automatic update) automatically in each program cycle and assigns it to OB 1.

You can assign the process image partitions PIP 1 to PIP 31 to the other OBs during configuration of the input/output modules.

The CPU always reads the process image partition of the inputs (PIPI) before processing the associated OB. The CPU outputs the process image of the outputs (PIPQ) at the end of the OB.

The figure below illustrates the updating of a process image partition.

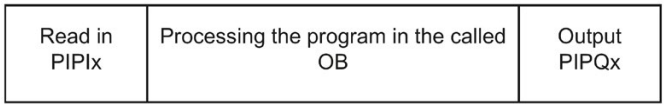


Figure 5-12 Update process image partition

5.2.3.2 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 CPU always reads the process image partition of the inputs (PIPI) before processing the associated OB. The CPU outputs the process image of the outputs (PIPQ) at the end of the OB.

The figure below illustrates the updating of a process image partition.

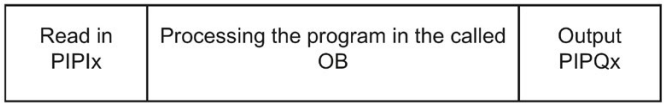


Figure 5-13 Update process image partitions

5.2.3.3 Update process image partitions in the user program

Requirements

Alternatively, you can also use the following instructions to update process images:

- "UPDAT_PI" instruction
- "UPDAT_PO" instruction

You will find the instructions in STEP 7 in the "Instructions" task card under "Extended instructions". The instructions can be called from any point in the user program.

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

- The process image partitions must not be assigned to any OB. This means the process image partitions are not automatically updated.

Note

Updating PIP 0

PIP 0 (automatic update) cannot be updated with the "UPDAT_PI" and "UPDAT_PO" instructions.

UPDAT_PI: Update 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 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 synchronous cycle interrupt OBs you use the "SYNC_PI" and "SYNC_PO" instructions 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. A direct (write) I/O access also writes the process image. This prevents a subsequent output of the process image from again overwriting the value written by direct access.

Reference

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

Basics of program execution

6

6.1 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 CPU executes the default system reaction.

Note

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

Triggers

The table below gives an overview of the possible event sources for start events and their OBs:

Table 6- 1 Triggers

Types of event sources	Possible priorities (default priority)	Possible OB numbers	Default system reaction [1]	Number of OBs
Startup [2]	1	100, ≥ 123	Ignore	0 to 100
Cyclic program [2]	1	1, ≥ 123	Ignore	0 to 100
Time-of-day interrupt [2]	2 to 24 (2)	10 to 17, ≥ 123	Not applicable	0 to 20
Time-delay interrupt [2]	2 to 24 (3)	20 to 23, ≥ 123	Not applicable	0 to 20
Cyclic interrupt [2]	2 to 24 (8 to 17, frequency dependent)	30 to 38, ≥ 123	Not applicable	0 to 20
Hardware interrupt [2]	2 to 26 (16)	40 to 47, ≥ 123	Ignore	0 to 50 [3]
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 1
Time error [4]	22	80	Ignore	0 or 1
Maximum cycle time exceeded once			STOP	
Diagnostics interrupt	2 to 26 (5)	82	Ignore	0 or 1
Removal/insertion of modules	2 to 26 (6)	83	Ignore	0 or 1

Types of event sources	Possible priorities (default priority)	Possible OB numbers	Default system reaction [1]	Number of OBs
Rack error	2 to 26 (6)	86	Ignore	0 or 1
MC servo [5]	17 to 26 (25)	91	Not applicable	0 or 1
MC pre-servo [5]	17 to 26 (25)	67	Not applicable	0 or 1
MC post-servo [5]	17 to 26 (25)	95	Not applicable	0 or 1
MC interpolator [5]	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

1) If you have not configured the OB.

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

3) You can assign a maximum of one hardware interrupt OB to each I/O module in STEP 7.
The start information is displayed in the hardware interrupt OB in the TIA Portal the same as in S7-300/S7-400. You can find additional information on the start information in the STEP 7 online help.

4) If the maximum cycle time has been exceeded twice within a cycle, the CPU always switches to STOP regardless of whether you have configured OB 80.

5) You can find additional information about these event sources and the runtime behavior in the S7-1500 Motion Control function manual.

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.
- For MC-Servo, MC-PreServo, MC-PostServo and MC-Interpolator, STEP 7 automatically assigns OBs 91/92 as soon as a technology object is added.
- For all other types of OB, the assignment is made when the OB is created or 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 CPU does not check whether an OB is assigned to this event when the event arrives, but only before the actual processing of the hardware interrupt.

OB priority and runtime behavior

If you have assigned an OB to the event, the OB has the priority of the event. The CPU supports the priorities 1 (lowest priority) to 26 (highest priority). The following items are essential to the execution of an event:

- Call and execution of the assigned OB
- The update of the process image partition 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

The communication (e.g. test functions with the PG) always works with priority 15. To avoid unnecessarily prolonging the program runtime in the case of time-critical applications, make sure that these OBs are not delayed or interrupted by communication. Assign a priority > 15 for these OBs.

Reference

You can find additional information on organization blocks in the STEP 7 online help.

6.2 Asynchronous instructions

Introduction

In program processing, a differentiation is made between synchronous and asynchronous instructions.

The "synchronous" and "asynchronous" properties relate to the temporal relationship between the call and execution of the instruction.

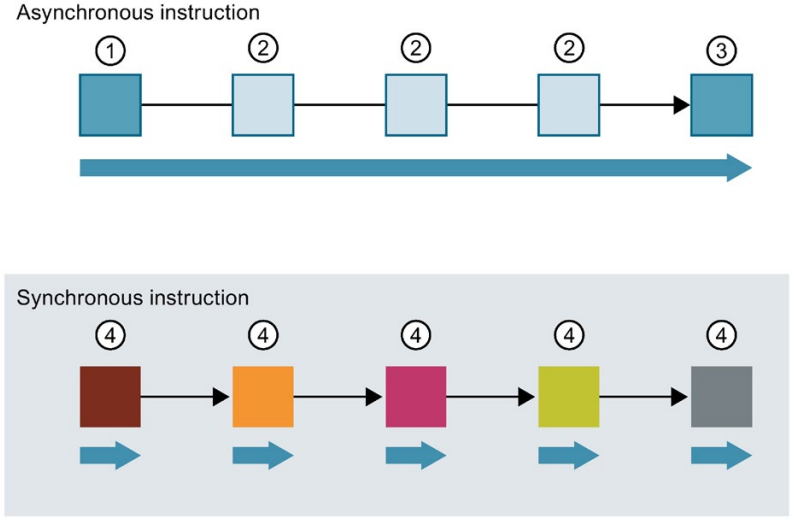
The following applies to synchronous instructions: When the call of a synchronous instruction is complete, execution of the instruction is also complete.

This is different in the case of asynchronous instructions: When the call of an asynchronous instruction is complete, execution of the asynchronous instruction is not necessarily complete yet. This means the execution of an asynchronous instruction can extend over multiple calls. The CPU processes asynchronous instructions in parallel with the cyclic user program. Asynchronous instructions generate jobs in the CPU for their processing.

Asynchronous instructions are usually instructions for transferring data (for example data records for modules, communication data, diagnostics data).

Difference between synchronous/asynchronous instructions

The figure below shows the difference between the processing of an asynchronous instruction and a synchronous instruction. In this figure the CPU calls the asynchronous instruction in five cycles before its execution is complete, e.g. a data record has been completely transferred.



① First call of the asynchronous instruction, start of execution
② Intermediate call of the asynchronous instruction, execution continues
③ Last call of the asynchronous instruction, completion of execution
④ A job is fully processed by a synchronous instruction with each call.
➡ Duration of a fully executed job

Figure 6-1 Difference between asynchronous and synchronous instructions

Parallel processing of asynchronous instruction jobs

A CPU can process several asynchronous instruction jobs in parallel. The CPU processes the jobs in parallel under the following conditions:

- Jobs for an asynchronous instruction are started while other jobs for that instruction are still running.
- The maximum number of simultaneously running jobs for the instruction is not exceeded.

The figure below shows the parallel processing of two jobs of the WRREC instruction. The two instructions are executed simultaneously for a certain duration.

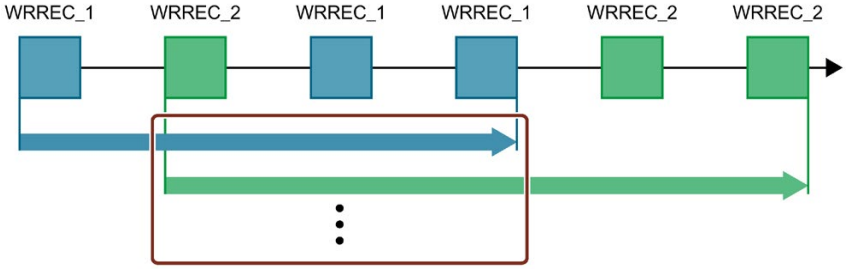


Figure 6-2 Parallel processing of the asynchronous instruction WRREC

Assigning calls of an instruction to a job

To execute an instruction over multiple calls, the CPU must be able to uniquely relate a subsequent call to a running job of the instruction.

To relate a call to a job, the CPU uses one of the following two mechanisms, depending on the type of the instruction:

- Using the instance data block of the instruction (for "SFB" type)
- Using job-identifying input parameters of the instruction. These input parameters must match in each call during processing of the asynchronous instruction.
  Example: A job of the "Create_DB" instruction is identified by input parameters LOW_LIMIT, UP_LIMIT, COUNT, ATTRIB and SRCBLK.

The following table shows which input parameters you use to identify which instruction.

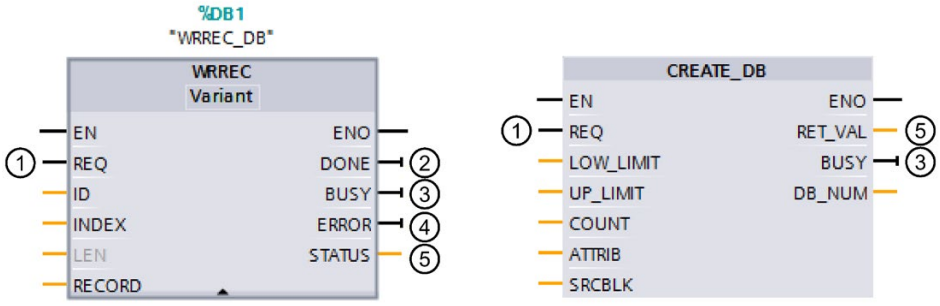
Table 6- 2 Identifying input parameters for asynchronous instructions

Instruction	Job is identified by
DPSYC_FR	LADDR, GROUP, MODE
D_ACT_DP	LADDR
DPNRM_DG	LADDR
WR_DPARM	LADDR, RECNUM
WR_REC	LADDR, RECNUM
RD_REC	LADDR, RECNUM
CREATE_DB	LOW_LIMIT, UP_LIMIT, COUNT, ATTRIB, SRCBLK
READ_DBL	SRCBLK, DSTBLK
WRIT_DBL	SRCBLK, DSTBLK
RD_DPARA	LADDR, RECNUM
DP_TOPOL	DP_ID

Status of an asynchronous instruction

An asynchronous instruction shows its status via the block parameters STATUS/RET_VAL and BUSY. Many asynchronous instructions also use the block parameters DONE and ERROR.

The figure below shows the two asynchronous instructions WRREC and CREATE_DB.



① The input parameter REQ starts the job to execute the asynchronous instruction.

② The output parameter DONE indicates that the job was completed without error.

③ The output parameter BUSY indicates whether the job is currently being executed. When BUSY =1, a resource is allocated for the asynchronous instruction. When BUSY = 0, the resource is free.

④ The output parameter ERROR indicates that an error has occurred.

⑤ The output parameter STATUS/RET_VAL provides information on the status of the job execution. The output parameter STATUS/RET_VAL receives the error information after the occurrence of an error.

Figure 6-3 Block parameters of asynchronous instructions using the instructions WRREC and CREATE_DB as examples.

Summary

The table below provides you with an overview of the relationships described above. It shows in particular the possible values of the output parameters if execution of the instruction is not complete after a call.

Note

You must evaluate the relevant output parameters in your program after each call

Table 6- 3 Relationship between REQ, STATUS/RET_VAL, BUSY and DONE during a "running" job.

Seq. no. of the call	Type of call	REQ	STATUS/RET_VAL	BUSY	DONE	ERROR
-	Idle	0	W#16#7000	0	0	0
1	First call	1	W#16#7001	1	0	0
			Error code (e.g. W#16#80C3 for lack of resources)	0	0	1
2 to (n - 1)	Intermediate call	Not relevant	W#16#7002	1	0	0
n	Last call	Not relevant	W#16#0000, if no errors have occurred.	0	1	0
			Error code if errors occurred.	0	0	1

Use of resources

Asynchronous instructions use resources in the CPU during their execution. The resources are limited depending on the instruction. The CPU can simultaneously process only a maximum number of asynchronous instruction jobs. The resources are available again after a job has been processed successfully or with errors.

Example: For the RDREC instruction, a CPU 1516pro-2 PN can process up to 20 jobs in parallel.

If the maximum number of concurrent jobs for an instruction is exceeded, the following occurs:

- The instruction returns the error code 80C3 (lack of resources) in the block parameter STATUS.
- The CPU does not execute the job until a resource becomes available again.

Note

Lower-level asynchronous instructions

Some asynchronous instructions use one or more lower-level asynchronous instructions for their processing. This dependence is shown in the tables below.

Please note that each lower-level instruction typically occupies one resource in the instruction's resource pool.

Extended instructions: maximum number of simultaneously running jobs

Table 6- 4 Maximum number of simultaneous jobs for asynchronous extended instructions and lower-level instructions used

Extended instructions	CPU 1516pro-2 PN
Distributed I/O	
RDREC	20
RD_REC	10
WRREC	20
WR_REC	10
D_ACT_DP	8
ReconfigIOSystem	uses RDREC, WRREC, D_ACT_DP,
DPSYC_FR	2
DPNRM_DG	8
DP_TOPOL	1
ASI_CTRL	uses RDREC, WRREC
PROFIenergy	
PE_START_END	uses RDREC, WRREC
PE_CMD	uses RDREC, WRREC
PE_DS3_Write_ET200S	uses RDREC, WRREC
PE_WOL	uses RDREC, WRREC, TUSEND, TURCV, TCON, TDISCON
Module parameter assignment	
RD_DPAR	10
RD_DPARA	10
RD_DPARM	10
WR_DPARM	10
Diagnostics	
Get_IM_Data	10
GetStationInfo	10
Recipes and data logging	
RecipeExport	10
RecipeImport	10
DataLogCreate	10
DataLogOpen	10
DataLogWrite	10
DataLogClear	10
DataLogClose	10
DataLogDelete	10
DataLogNewFile	10

Extended instructions	CPU 1516pro-2 PN
Data block functions	
CREATE_DB	10
READ_DBL	10
WRIT_DBL	10
DELETE_DB	10
File handling	
FileReadC	10
FileWriteC	10

Basic instructions: maximum number of simultaneously running jobs

Table 6- 5 Lower-level instructions used for asynchronous basic instructions

Basic instructions	CPU 1516pro-2 PN
Array DB	
ReadFromArrayDBL	uses READ_DBL (see Extended instructions)
WriteToArrayDBL	uses READ_DBL, WRIT_DBL (see Extended instructions)

Communication: maximum number of simultaneously running jobs

Table 6- 6 Maximum number of simultaneous jobs for asynchronous instructions and lower-level instructions used for Open User Communication

Open User Communication	CPU 1516pro-2 PN
TSEND TUSEND	128
TRCV TURCV	128
TCON	128
TDISCON	128
T_RESET	128
T_DIAG	128
T_CONFIG	1
TSEND_C	uses TSEND, TUSEND, TRCV, TCON, TDISCON
TRCV_C	uses TSEND, TUSEND, TRCV, TURCV, TCON, TDISCON
TMAIL_C	uses TSEND, TUSEND, TRCV, TURCV, TCON, TDISCON

Table 6- 7 Lower-level instructions used for asynchronous instructions for MODBUS TCP

MODBUS TCP	CPU 1516pro-2 PN
MB_CLIENT	uses TSEND, TUSEND, TRCV, TURCV, TCON, TDISCON
MB_SERVER	uses TSEND, TUSEND, TRCV, TURCV, TCON, TDISCON

Table 6- 8 Maximum number of simultaneously running jobs for asynchronous instructions for S7 communication. The S7 communication instructions use a common pool of resources.

S7 communication	CPU 1516pro-2 PN
PUT GET USEND URCV BSEND BRCV	384

Table 6- 9 Lower-level instructions used for asynchronous instructions for communication processors

Communications processors	CPU 1516pro-2 PN
PtP communication	
Port_Config	uses RDDEC, WRREC
Send_Config	uses RDDEC, WRREC
Receive_Config	uses RDDEC, WRREC
Send_P2P	uses RDDEC, WRREC
Receive_P2P	uses RDDEC, WRREC
Receive_Reset	uses RDDEC, WRREC
Signal_Get	uses RDDEC, WRREC
Signal_Set	uses RDDEC, WRREC
Get_Features	uses RDDEC, WRREC
Set_Features	uses RDDEC, WRREC
USS communication	
USS_Port_Scan	uses RDDEC, WRREC
MODBUS (RTU)	
Modbus_Comm_Load	uses RDDEC, WRREC
ET 200S serial interface	
S_USSI	uses CREATE_DB
SIMATIC NET CP	
FTP_CMD	uses TSEND, TRCV, TCON, TDISCON

Table 6- 10 Maximum number of simultaneously running jobs for asynchronous instructions for OPC UA.

OPC_UA	CPU 1516pro-2 PN
OPC_UA_Connect	10
OPC_UA_Disconnect	10
OPC_UA_NamespaceGetIndexList	10
OPC_UA_NodeGetHandleList	10
OPC_UA_NodeReleaseHandleList	10
OPC_UA_TranslatePathList	10
OPC_UA_ReadList	50 (maximum 5 per connection)
OPC_UA_WriteList	50 (maximum 5 per connection)
OPC_UA_MethodGetHandleList	10
OPC_UA_MethodReleaseHandleList	10
OPC_UA_MethodCall	50 (maximum 5 per connection)
OPC_UA_ServerMethodPre	50
OPC_UA_ServerMethodPost	50
OPC_UA_ConnectionGetStatus	10

Technology: maximum number of simultaneously running jobs

Table 6- 11 Maximum number of simultaneously running jobs for asynchronous instructions for technology. The instructions for technology use a common pool of resources.

Technology	CPU 1516pro-2 PN
Motion control	
MC_Power MC_Reset MC_Home MC_Halt MC_MoveAbsolute MC_MoveRelative MC_MoveVelocity MC_MoveJog MC_GearIn MC_MoveSuperimposed MC_MeasuringInput MC_MeasuringInputCyclic MC_AbortMeasuringInput MC_OutputCam MC_CamTrack MC_TorqueLimiting	1500

Reference

You can find additional information on block parameter assignment in the STEP 7 online help.

Protection

7

7.1 Overview of the protection functions

Introduction

This section describes the following functions for protection of the ET 200pro distributed I/O system against unauthorized access:

- Access protection
- Know-how protection
- Copy protection

Further measures for protecting the CPU

The following measures also increase the protection against unauthorized access to functions and data of the CPU 1516pro-2 PN, both externally and via the network:

- Deactivation of the Web server
- Deactivation of the OPC UA server (you can find additional information on the security mechanisms for OPC UA servers in the Communication (https://support.industry.siemens.com/cs/de/de/view/59192925/en) Function Manual)
- Deactivation of the time synchronization via an NTP Server
- Deactivation of the PUT/GET communication

When the Web server is used, you protect the ET 200pro distributed I/O system from unauthorized access:

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

7.2 Configuring access protection for the CPU

Introduction

The CPU offers four different 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.

Rules for passwords

Ensure that passwords are sufficiently secure. Passwords must not follow a machine-recognizable pattern. Apply the following rules:

- Assign a password that is at least 8 characters long.
- Use different cases and characters: uppercase/lowercase, numbers and special characters.

Access levels of the CPU

Table 7- 1 Access levels and access restrictions

Access levels	Access restrictions
Complete access (no protection)	Every user can read and change the hardware configuration and the blocks.
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. It is not possible to download either blocks or the hardware configuration to the CPUs without the password. 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, changing the operating mode (RUN/STOP), firmware update and display of online/offline comparison status.
No access (complete protection)	When the CPU has complete protection, no read or write access to the hardware configuration and the blocks is possible (without access authorization in the form of a password). 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.

An enumeration 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 access level of the CPU, unless PUT/GET communication is deactivated in the "No access" (complete protection) access level.

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 on the CPU via network access. Access levels are used to restrict 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 listing the online functions available in the various access levels.

Configuring access levels

To set the access levels for the CPU by means of parameter assignment, follow these steps:

1. Open the properties of the CPU in the Inspector window.
2. Select the "Protection & Security" area.

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

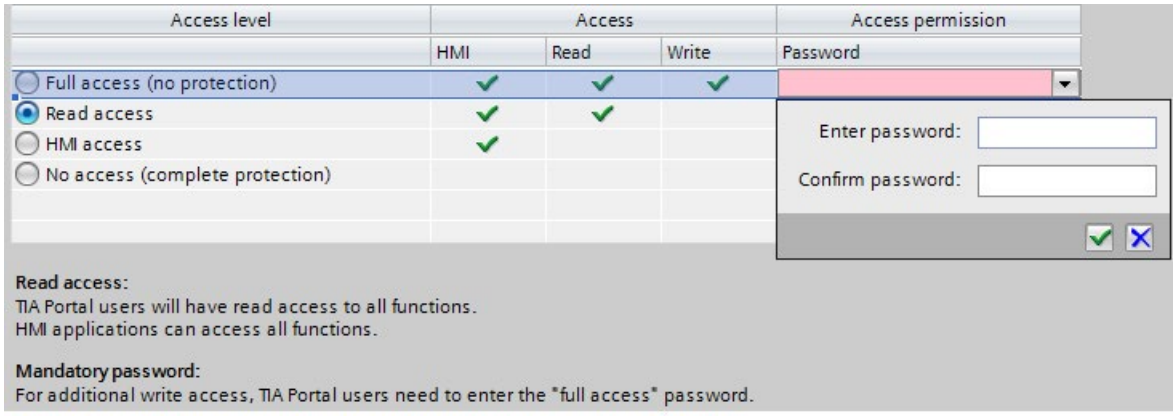


Figure 7-1 Possible access levels

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. In the example (Figure: Possible access levels), read access and HMI access are still possible without a 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.
5. Assign additional passwords as required for other access levels.
6. Download the hardware configuration for the access level to take effect.

The CPU logs the following actions with an entry in the diagnostic buffer:

- Input of the correct or incorrect password
- Changes to access level configuration

Behavior of a password-protected CPU during operation

The CPU protection takes effect for an online connection after you have downloaded the settings to the CPU.

Before an online function is executed, STEP 7 checks the admissibility and, if password protection is configured, prompts the user to enter a password. You can only execute password-protected functions from one programming device / PC at any 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 you have rescinded the access authorization manually with "Online > Delete access rights".

You can limit access to a password-protected CPU in RUN locally on the display. This prevents access even with a password.

Access levels for F-CPU

For the fail-safe CPU, there is an additional access level besides the four access levels described. You can find additional information about this access level in the description of the fail-safe system SIMATIC Safety Programming and Operating Manual SIMATIC Safety - Configuring and Programming (https://support.industry.siemens.com/cs/ww/en/view/54110126).

7.3 Using the user program to set additional access protection

Access protection by means of the user program

There is another option to access protection via the display. You can also restrict access to a password-protected CPU using the ENDIS_PW instruction in STEP 7.

You can find more information on this instruction in the STEP 7 online help under "ENDIS_PW: Limit and enable password legitimation".

7.4 Know-how protection

Application

You can use know-how protection to protect one or more OB, FB or FC blocks as well as global data blocks in your program from unauthorized access. Enter a password to restrict access to a block. The password offers high-level protection against unauthorized reading or manipulation of the block. Know-how protection does not involve the CPU (offline access in STEP 7).

Password provider

As an alternative to manual password input, you can assign a password provider to STEP 7 . When using a password provider, you select a password from a list of available passwords. When a protected block is opened, STEP 7 connects to the password provider and retrieves the corresponding password.

To connect a password provider, you have to install and activate the password provider. A settings file in which you specify the use of a password provider is also required.

A password provider provides the following advantages:

- The password provider defines and manages the passwords. When opening know-how protected blocks, you work with symbolic names for passwords. For example, a password is marked with the symbolic name "Machine_1" n the password provider. The actual password behind "Machine_1" remains hidden to you.
  A password provider therefore offers optimum block protection as the users do not know the password themselves.
- STEP 7 opens know-how protected blocks automatically without direct password entry. This saves you time.

You can find more information on integrating a password provider in the STEP 7 online help.

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 protect global data blocks (global DBs) from unauthorized access with know-how protection. If you do not have the valid password, you can read the global data block but not change it.

Know-how protection is not available for array data blocks (array DBs).

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".

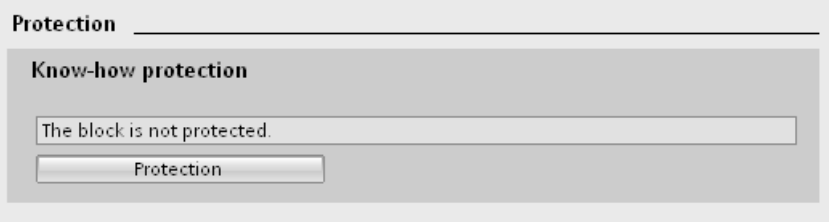


Figure 7-2 Setting up block know-how protection (1)

3. Click "Protection" to display the "Define protection" dialog.

Figure 7-3 Defining protection

4. Enter the new password in the "New password" field. Enter the same password in the "Confirm password" field.
5. Click "OK" to confirm your entry.
6. 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.

Note

Password provider

Alternatively, you can set up know-how protection for blocks with a password provider.

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 block opens.

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. You must enter the password again the next time you open the block. If you close the "Access protection" dialog with "Cancel", the block will open but the block code will not be displayed. It is not possible 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.

Changing block know-how protection

Proceed as follows to change block know-how protection:

1. Select the block for which you want to change 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 "Change protection" dialog.
3. To change the password for know-how protection, enter the current password under "Old password".
4. Now enter a new password under "New password" and confirm the password under "Confirm password".
5. Click "OK" to confirm your entry.

Result: The password for know-how protection of the selected block has been changed.

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 7-4 Removing block know-how protection (1)

4. Enter the password.

Figure 7-5 Removing block know-how protection (2)

5. Click "OK" to confirm your entry.

Result: Know-how protection for the selected block has been canceled.

7.5 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 association with the serial number of a SIMATIC memory card or CPU, you make the use of this program or block 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".

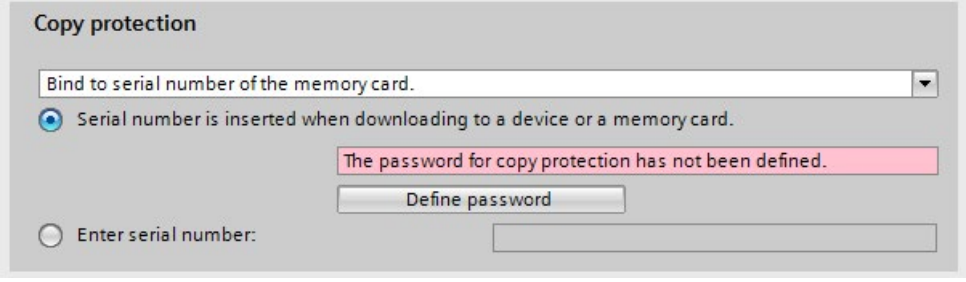


Figure 7-6 Setting up copy protection (1)

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.

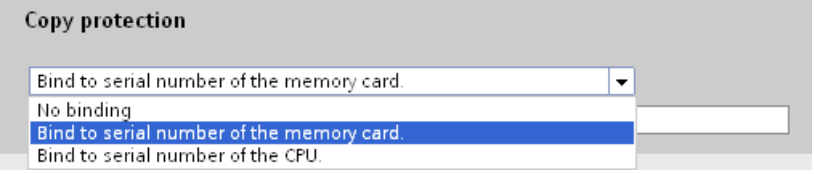


Figure 7-7 Setting up copy protection (2)

4. If STEP 7 is to automatically insert the serial number during loading (dynamic binding), then activate the option "Serial number is inserted when downloading to a device or a memory card". To link the use of a block/program additionally to the input of a password, assign a password using the "Define password" button.
   If you want to manually bind the serial number of the CPU or the SIMATIC memory card to a block (static binding), select the option "Enter serial number".
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 is not possible. This means that you also cannot download blocks without copy protection.

Removing copy protection

To remove copy protection, follow these steps:

1. Remove any existing Know-how protection (Page 64).
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.

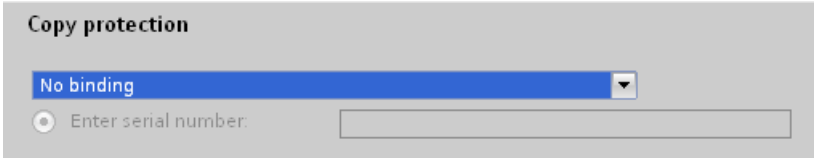


Figure 7-8 Removing copy protection

Commissioning

8

8.1 Overview

Introduction

This section includes information on the following topics:

- Procedure for commissioning the ET 200pro distributed I/O system with CPU
- Commissioning the CPU 1516pro-2 PN on PROFINET IO
- Inserting/replacing the SIMATIC memory card
- Operating modes of the CPU
- CPU memory reset
- Backing up and restoring the configuration
- Identification and maintenance data
- Shared commissioning of projects

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. This avoids endangering persons or equipment during operation.

Software tools for commissioning

The following free software tools support you in commissioning:

- SIEMENS PRONETA in commissioning PROFINET systems.
- SIMATIC automation tool in commissioning the CPU 1516pro-2PN..

You can find more information on SIEMENS PRONETA and the SIMATIC Automation Tool in the section AUTOHOTSPOT

8.2 Procedure for commissioning the ET 200pro distributed I/O system with CPU

8.2.1 Introduction PROFINET IO

Requirements

- The CPU is in the "Factory settings" state or has been reset to factory settings (see section Resetting the CPU to factory settings (Page 101)).
- The SIMATIC memory card is as delivered or has been formatted.
- At the startup of the station with CPU 1516pro-2 PN, the installation must be complete. All bus, solid-state, connection modules and the termination module must be mounted.

Note

Interfaces for operation of the CPU as IO controller or IO device

You can operate the CPU 1516pro-2 PN via both interfaces (X1 and X2) as an IO controller or IO device.

8.2.2 CPU as IO controller

Configuration example

The following configuration example shows the use of the ET 200pro distributed I/O system with the CPU 1516pro-2 PN as an IO controller.

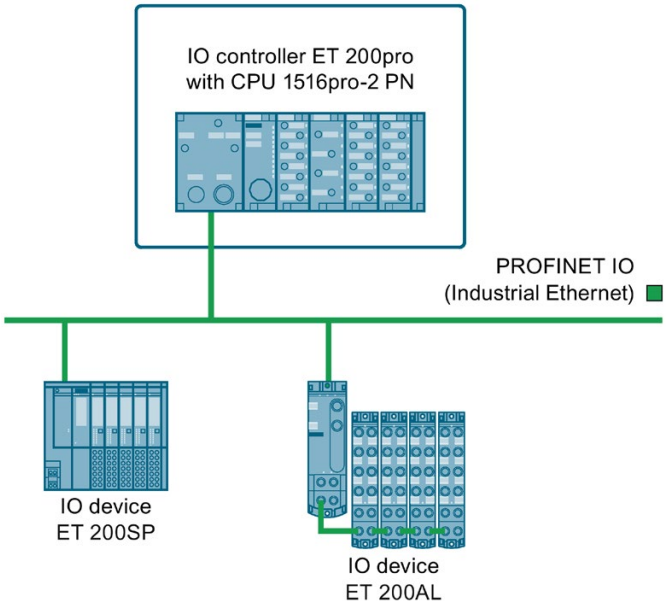


Figure 8-1 CPU 1516pro-2 PN as IO controller

Commissioning procedure

To commission the ET 200pro distributed I/O system as IO controller on PROFINET IO, proceed as follows:

Table 8- 1 Procedure for commissioning the ET 200pro as an IO controller on PROFINET IO

Step	Procedure	See ...
1	Mounting ET 200pro (with CPU 1516pro-2 PN)	Section Mounting and connecting (Page 23) Operating instructions ET 200pro Distributed I/O System (https://support.industry.siemens.com/cs/ww/en/view/21210852)
2	Inserting the SIMATICmemory card into IO controller	Section Inserting/replacing SIMATIC memory card (Page 76)
3	Connecting the ET 200pro • Supply voltages • PROFINET IO • Sensors and actuators	Section Mounting and connecting (Page 23) Operating instructions ET 200pro Distributed I/O System (https://support.industry.siemens.com/cs/ww/en/view/21210852)
4	Configuring the IO controller[1]	Section Configuring the CPU (Page 34)
5	Switch on supply voltages for the IO controller	Section Mounting and connecting (Page 23)
6	Switch on supply voltages for IO devices	Documentation of the IO device
7	Download configuration to the IO controller	STEP 7 online help
8	Switch IO controller to RUN mode	Section RUN mode (Page 81)
9	Check LEDs	Section Interrupts, diagnostics, error messages and system events (Page 114)
10	Test inputs and outputs	The following functions are helpful: Monitoring and modifying tags, testing with program status, forcing, controlling the outputs. See section Test and service functions (Page 105)

[1] The IO devices are configured with the IO controller.

8.2.3 CPU as I-device

Configuration example

The following configuration example shows the use of the ET 200pro distributed I/O system with the CPU 1516pro-2 PN as an I-device.

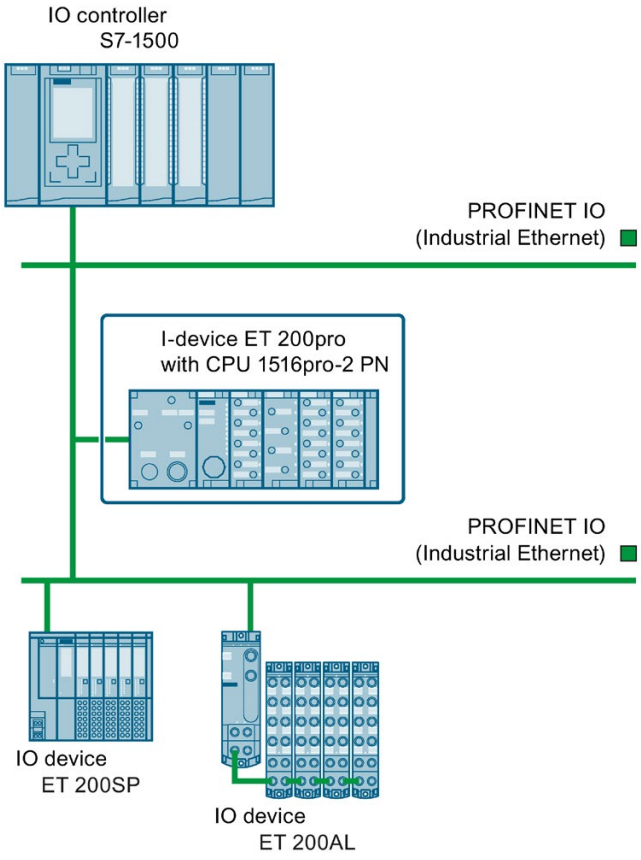


Figure 8-2 CPU 1516pro-2 PN as I-device

Commissioning procedure

To commission the ET 200pro distributed I/O system as I-device on PROFINET IO, proceed as follows:

Table 8- 2 Procedure for commissioning the ET 200pro as an I-device on PROFINET IO

Step	Procedure	See ...
1	Mounting ET 200pro (with CPU 1516pro-2 PN)	Section Mounting and connecting (Page 23) Operating instructions ET 200pro Distributed I/O System (https://support.industry.siemens.com/cs/ww/en/view/21210852)
2	Inserting the SIMATIC memory card into the I-device	Section Inserting/replacing SIMATIC memory card (Page 76)
3	Connecting the ET 200pro • Supply voltages • PROFINET IO • Sensors and actuators	Operating instructions ET 200pro Distributed I/O System (https://support.industry.siemens.com/cs/ww/en/view/21210852)
4	Configuring the I-device	Section Configuring the CPU (Page 34)
5	Switch on supply voltages for the IO controller	Documentation of the IO controller
6	Switch on supply voltages for I-device and IO devices	Section Mounting and connecting (Page 23) and documentation of the IO devices
7	Download configuration to the I-device	STEP 7 online help
8	Switch IO controller and I-device to RUN mode	Documentation of the IO controller and section RUN mode (Page 81)
9	Check LEDs	Section Interrupts, diagnostics, error messages and system events (Page 114)
10	Test inputs and outputs	The following functions are helpful: Monitoring and modifying tags, testing with program status, forcing, controlling the outputs. See section Test and service functions (Page 105)

8.3 Inserting/replacing SIMATIC memory card

The SIMATIC memory card as memory module

The CPU uses a SIMATIC memory card as a memory module. You can use the SIMATIC memory card as load memory or as a portable storage medium.

Note

An inserted SIMATIC memory card is required to operate the CPU.

The SIMATIC memory card is not included in the scope of delivery of the CPU.

WARNING

User program of the SIMATIC memory card

Make sure that the user program on the SIMATIC memory card to be inserted matches the CPU (the system). The wrong user program may have fatal processing effects.

Inserting/replacing the SIMATIC memory card

1. First, switch the CPU to STOP mode.

   NOTICE

   Switching off outputs

   To prevent damage to the ET 200pro, you must switch off the electronic/encoder supply 1L+ and the load voltage supply 2L+ before removing connection modules.

2. Loosen the four screws of the connection module CM CPU 2PN M12, 7/8" and remove it from the CPU.
3. If a SIMATIC memory card is already inserted, press the SIMATIC memory card with light pressure into the card slot. The lock is released by the pressure. Remove the SIMATIC memory card.
4. Insert the ("new") SIMATIC memory card into the card reader until the memory card latches. Ensure that the angled corner of the medium card is on the left side.

5. Insert the connection module onto the CPU again and fasten the connection module with screws.
6. Perform a memory reset (for additional information, see section "CPU memory reset (Page 84)").

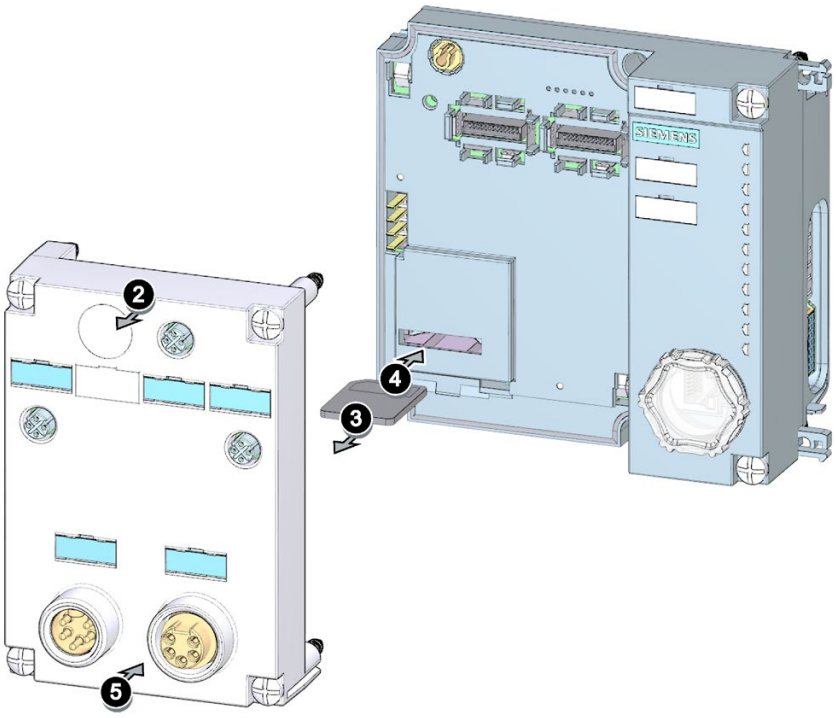


Figure 8-3 Inserting/replacing the SIMATIC memory card

Only remove the SIMATIC memory card in POWER OFF mode of the CPU. Ensure that no writing functions (online functions with the programming device, e.g. loading/deleting a block, test functions) were active before POWER OFF.

Removing and inserting a SIMATIC memory card

If you replace the SIMATIC memory card, the CPU detects:

- A physically identical SIMATIC memory card with modified content
- A new SIMATIC memory card with the same content as the original SIMATIC memory card

After POWER ON, the CPU automatically performs a memory reset.

Reference

You can find additional information on the SIMATIC memory card in the function manual Structure and use of the CPU memory (https://support.industry.siemens.com/cs/de/en/view/59193101) and in the Appendix Accessories/spare parts (Page 136).

8.4 Operating modes of the CPU

8.4.1 Operating modes of the CPU

Introduction

Operating states describe the behavior of the CPU at a specific time. 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.

8.4.2 STARTUP mode

Response

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

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

Points to note

- 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.
  To read the current state of inputs during STARTUP, you can access inputs with direct I/O access.
  To initialize outputs during STARTUP, you can write values via the process image or with direct I/O access. The CPU outputs the values 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 type (Figure "Setting the startup behavior).
- If a corresponding event occurs, the CPU can start the following OBs in startup:
  - OB 82: Diagnostics interrupt
  - OB 83: Removal/insertion of modules
  - OB 86: Rack error
  - OB 121: Programming error (only for global error handling)
  - OB 122: I/O access error (only for global error handling)
    You can a description of the use of global and local error handling in the STEP 7 online help.

  The CPU does not start all other OBs until 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 physical configuration of the ET 200pro distributed I/O system. If the preset and actual configurations are different, the setting of the "Comparison preset configuration to actual configuration" parameter determines the behavior of the CPU (you can find additional information in the section Operating state transitions).

Cancellation of the startup

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

The CPU does not perform startup or interrupts the 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.

Configuring startup behavior

You configure the behavior of the CPU in the Startup group of the CPU properties.

Setting the startup behavior

To set the startup characteristics, follow these steps:

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

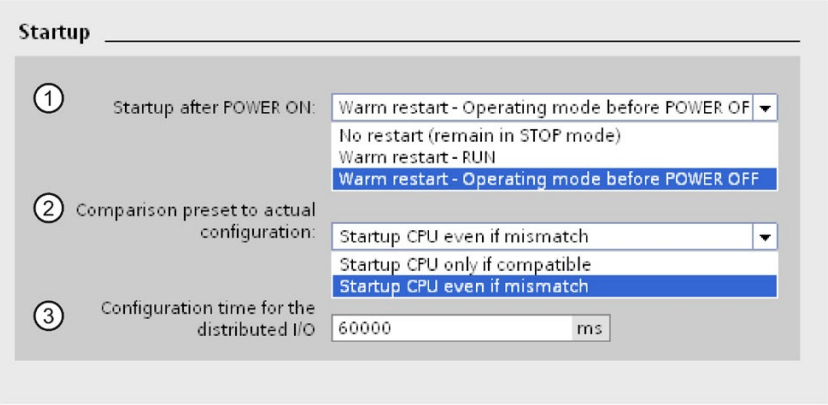


Figure 8-4 Setting the startup characteristics

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 you have not selected any other setting.

- 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 configured module in terms of:
  - Number of inputs/outputs
  - Electrical and functional properties
- Startup CPU even if mismatch: At this setting the CPU starts up irrespective of the type of module plugged.

③ Specifies a maximum period (default: 60 000 ms) in which the I/O must be ready for operation. The CPU changes to RUN.

If the central and distributed I/O are not ready for operation within the configuration time, the startup characteristics of the CPU depend on the setting of the "Comparison preset to actual configuration" parameter.

Example for the "Comparison preset to actual configuration" parameter

"Startup CPU only if compatible"

The pin assignment and all electrical and functional properties must match.

"Startup CPU even if mismatch"

The CPU also starts with the following differences:

- An analog output module is inserted instead of a configured digital input module.

- No module is present in this slot and the following 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.

8.4.3 STOP mode

Response

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.

8.4.4 RUN mode

Response

In "RUN" mode the cyclic, time-driven, and interrupt-driven program execution is performed. The CPU automatically updates addresses located in the "Automatic Update" process image in each program cycle. For additional information, see section Process images and process image partitions (Page 45).

Execution of the user program

Once the CPU has written the outputs and read the inputs, it runs through the cyclic program from the first instruction to the last instruction. Events with higher priority, such as hardware interrupts, diagnostic interrupts and communication, interrupt the cyclic program flow and lengthen the cycle time.

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 CPU has executed the user program in a shorter period.

The operating system monitors the execution time of the cyclic program for a configurable upper limit known as the maximum cycle time. You can restart this time monitoring at any point in your program by calling the RE_TRIGR instruction.

If the cyclic program exceeds the maximum cycle time, the operating system may start the time error OB (OB 80). If the OB is not present, the CPU ignores that the maximum cycle time was exceeded. If the cyclic program exceeds the cycle monitoring time a second time, for example while the time error OB is being processed, the CPU goes to STOP mode.

Reference

Additional information about cycle and response times is available in the Function Manual Cycle and response times (https://support.industry.siemens.com/cs/ww/en/view/59193558).

8.4.5 Operating mode transitions

Operating modes and operating mode transitions

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

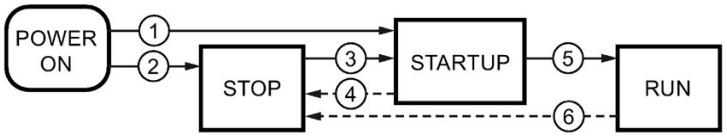


Figure 8-5 Operating modes and operating mode transitions

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

Table 8- 3 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. • Startup type "Warm restart - RUN" is set or • Startup type "Warm restart mode before POWER OFF" is set and the CPU was in RUN mode before POWER OFF.	The CPU clears the non-retentive memory, and resets the content of non-retentive DBs to the start values of the load memory. Retentive memory and retentive DB contents are retained. The 500 most recent entries are retained in the diagnostics buffer.
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. or • Startup type "Warm restart mode before POWER OFF" is set and the CPU was in RUN mode before POWER OFF.	The CPU clears the non-retentive memory, and resets the content of non-retentive DBs to the start values of the load memory. Retentive memory and retentive DB contents are retained. The 500 most recent entries are retained in the diagnostics buffer.

No.	Operating mode transitions		Effects
③	STOP → STARTUP	The CPU switches to "STARTUP" mode if: • The hardware configuration and program blocks are consistent. • You set the CPU to "RUN" mode via the programming device and the mode switch in is RUN position. or • You set the mode switch from STOP to RUN.	The CPU clears the non-retentive memory, and resets the content of non-retentive DBs to the start values of the load memory. Retentive memory and retentive DB contents are retained. The 500 most recent entries are retained in the diagnostics buffer.
④	STARTUP → STOP	In the following cases the CPU returns from "STARTUP" to "STOP" mode when: • The CPU detects an error during startup • You set the the CPU to "STOP" via the programming device or mode switch. • The CPU executes a STOP command in the Startup OB.	These operating mode transitions have no effect on data.
⑤	STARTUP → RUN	In the following cases, the CPU goes from "STARTUP" to "RUN" mode when: • The CPU has initialized the PLC tags. • The CPU has executed the startup blocks successfully.	
⑥	RUN → STOP	In the following cases the CPU returns from "RUN" back to "STOP" mode when: • The CPU recognizes an error that prevents further execution. • The CPU executes a STOP command in the user program. • You set the the CPU to "STOP" via the programming device or mode switch.	

8.5 CPU memory reset

8.5.1 Introduction

Basics of a memory reset

The CPU must be in STOP mode for a memory reset.

A memory reset returns the CPU to the "initial state".

Memory reset means:

- 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 are deleted (with manual memory reset).
- 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.

Detecting a CPU 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 (continuously lit yellow).

Result after memory reset

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

Table 8- 4 Memory objects after memory reset

Memory object	Contents
Actual values of the data blocks, instance data blocks	Initialized
Bit memories, timers and counters	Initialized
Retentive tags of technology objects (e.g. adjustment values of absolute encoders)	Retained
Entries in the diagnostics buffer	Retained
IP address	Retained
Device name	Retained
Counter readings of the runtime meters	Retained
Time of day	Retained

8.5.2 Automatic memory reset

Possible causes of automatic memory reset

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

Causes of such errors are:

- 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.
- You remove or insert the SIMATIC memory card. The backed-up retentive data differs in structure from the data in the configuration on the SIMATIC memory card.

8.5.3 Manual memory reset

Reason for manual memory reset

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

CPU memory reset

Two options are available for performing a CPU memory reset:

- Using the mode selector
- 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 switch in this position until the RUN/STOP LED lights up for the second time and remains continuously lit after three seconds. After this, release the switch.

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 section Resetting the CPU to factory settings (Page 101).

Procedure using STEP 7

To perform a memory reset of the CPU using 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.

8.6 Backing up and restoring the CPU configuration

Backup from online device

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

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 PG/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 data to a project in your PG/PC.

Snapshot of the monitor values

To allow you to restore the actual values at a later date, back up the actual values of the data blocks using the option "Snapshot of the actual values".

Overview of backup types

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

Table 8- 5 Types of backup

	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	--	--	--	--

	Backup from online device	Upload from device (software)	Upload device as new station	Snapshot of the monitor values
Properties of the type of backup				
Backup possible for fail-safe CPU	✓	✓	✓	✓
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

Reference

You can find additional information on the procedure in the STEP 7 online help.

Emergency address (Emergency IP)

The emergency address (emergency IP address) of a CPU is intended for diagnostic and download functions, e.g. when the CPU is no longer accessible via the IP protocol after a wrong project is downloaded. For information on the emergency address, please refer to the Communication (https://support.industry.siemens.com/cs/ww/de/view/59192925/en) function manual.

Storage of multilingual project texts

When you configure a CPU, texts of different categories result, e.g.

- Object names (names of blocks, modules, tags, etc.)
- Comments (for blocks, networks, watch tables, etc.)
- Alarms and diagnostic texts

Texts, such as diagnostic buffer texts, are provided by the system or are created during the configuration, for example, messages.

Texts exist in the project in one language or, after a translation process, in multiple languages. You can maintain project texts in all languages available to you in the project tree (Languages & resources > Project texts). The texts produced when configuring can be downloaded to the CPU.

The following texts containing the project data are loaded into the CPU in the chosen languages and are also used by the Web server:

- Diagnostic buffer texts (cannot be changed)
- Status texts for the module status (cannot be changed)
- Alarm texts with associated text lists
- Comments in watch tables

The following texts containing the project languages are also loaded into the CPU in the chosen languages, but are not used by the Web server:

- Comments in tag tables (for tags and constants)
- Comments in global data blocks
- Comments of elements in block interfaces of FBs, FCs, DBs and UDTs
- Network titles in blocks written in LAD, FBD or STL
- Block comments
- Network comments
- Comments of LAD and FBD elements

The CPU 1516pro-2 PN supports the storage of multilingual project texts in up to three different project languages. The memory space reserved for this on the CPU must be planned to be large enough. However, if the project texts in a specific project language exceed the memory space reserved for them, you cannot load the project into the CPU. The download is aborted with a notice that not enough memory space is available. In such a case, take measures to reduce the required storage space, for example by shortening comments.

The CPU 1516pro-2 PN has a reserved memory space of 7.5 MB for storage of multilingual project texts. The CPU divides the available memory space between the selected project languages because some languages require more memory space than others, for example, Russian texts require more space than English texts. If you use only two project languages instead of three, a memory space of 7.5 MB is available for two project languages instead of three.

Note

Size of the SIMATIC memory card

If, when loading projects, the required memory space is more extensive/larger than the memory space on the SIMATIC memory card used, the loading process into the CPU is canceled. You receive an error message.

Ensure that your SIMATIC memory card has sufficient memory space for downloading projects.

You can find information on reading out the memory usage of the CPU and the SIMATIC memory card in the Structure and Use of the CPU Memory (https://support.industry.siemens.com/cs/de/de/view/59193101/en) Function Manual.

You can find information on parameter assignment of multilingual project texts in STEP 7 in the STEP 7 online help.

8.7 Identification and maintenance data

8.7.1 Reading out and entering I&M data

I&M data

Identification and maintenance data (I&M data) is information saved on the module. The data is:

- Read-only (I data) or
- Readable/writable (M data)

Identification data (I&M0): Manufacturer information about the module that can only be read. Some identification data is also printed on the housing of the module, for example article number and serial number.
Maintenance data (I&M1, 2, 3): Plant-specific information, for example installation location. Maintenance data is created during configuration and loaded to the module.

Note

The CPU supports identification data (I&M0) only for the High Feature (HF) electronic modules.

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.

Options for reading out I&M data

- Via the user program
- Via STEP 7 or HMI devices
- Via the Web server of the CPU

Reading I&M data via the user program

You have the following options for reading module I&M data in the user program:

- Via the instruction RDREC.
  The data set structure for distributed modules accessible over PROFINET IO is described in the section Data record structure for I&M data (Page 92).
- Using the instruction Get_IM_Data (only I&M0 data).

Reading I&M data via STEP 7

Requirements: An online connection to the CPU must exist.

To read the I&M data via STEP 7, follow these steps:

1. In the project tree, select the CPU 1516pro-2 PN .
2. Go to "Online & diagnostics".
3. Select the "General" area in the "Diagnostics" folder.

Enter maintenance data via STEP 7

STEP 7 assigns a default module name. You can enter the following information:

- Plant designation (I&M1)
- Location identifier (I&M1)
- Installation date (I&M2)
- Additional information (I&M3)

To enter maintenance data via STEP 7, follow these steps:

1. In the device view of the hardware network editor of STEP 7, select the CPU, for example.
2. Go to properties, "General", and select the "Identification & Maintenance" area.
3. Enter the data.

During the loading of the hardware configuration, the I&M data is also loaded.

Reading I&M data via the Web server

The procedure is described in detail in the Web server (https://support.industry.siemens.com/cs/ww/en/view/59193560) Function Manual.

8.7.2 Data record structure for I&M data

Reading I&M data records

You selectively access certain identification data via **Read data record** (RDREC instruction). You obtain the corresponding part of the identification data under the relevant data record index.

The data records are structured as follows:

Table 8- 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 8- 7 Data record structure for I&M identification data

Identification data	Access	Default	Explanation
Identification data 0: (data record index AFF0 hex)			
VendorIDHigh	Read (1 byte)	00_H	This is where the name of the manufacturer is stored (42_D = SIEMENS AG).
VendorIDLow	Read (1 byte)	$2A_H$	
Order_ID	Read (20 bytes)	6ES71516-2PN00-0AB0	Article number of module (e.g. CPU)
IM_SERIAL_NUMBER	Read (16 bytes)	-	Serial number (device-specific)
IM_HARDWARE_REVISION	Read (2 bytes)	1	Corresponding HW version
IM_SOFTWARE_REVISION	Read	Firmware version	Provides information about the firmware version of the module
• SWRevisionPrefix	(1 byte)	V	
• IM_SWRevision_Functional_Enhancement	(1 byte)	00 - FF_H	
• IM_SWRevision_Bug_Fix	(1 byte)	00 - FF_H	
• IM_SWRevision_Internal_Change	(1 byte)	00 - FF_H	

Identification data	Access	Default	Explanation
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	Modules
IM_VERSION	Read	0101_H	Provides information on the version of the identification data (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 data (I&M1 to I&M3)
Maintenance data 1: (data record index AFF1 hex)			
IM_TAG_FUNCTION	Read/write (32 bytes)	-	Enter a module identifier here that is unique plant-wide.
IM_TAG_LOCATION	Read/write (22 bytes)	-	Enter the installation location of the module here.
Maintenance data 2: (data record index AFF2 hex)			
IM_DATE	Read/write (16 bytes)	YYYY-MM-DD HH:MM	Enter the installation date of the module here.
Maintenance data 3: (data record index AFF3 hex)			
IM_DESCRIPTOR	Read/write (54 bytes)	-	Enter a comment describing the module.

8.7.3 Example: Read out firmware version of the CPU with Get_IM_Data

Automation task

You want to check whether the modules in your automation system have the current firmware. The firmware version of the modules can be found in the I&M0 data. The I&M0 data are the basic information of a device and contain information such as the manufacturer ID, article number, serial number and the hardware and firmware version.

To read out the I&M0 data, use the "Get_IM_Data" instruction. You read the I&M0 data of all modules in the user program of the CPU with "Get_IM_Data" instructions and store the I&M0 data in a data block.

Conditions and parameters

To read out the I&M data of the CPU, use the following block parameters of the "Get_IM_Data" instruction:

- LADDR: Enter the HW ID of the module at the block parameter "LADDR".
- IM_TYPE: Enter the I&M data number (for example "0" for I&M0 data) at the "IM_TYPE" block parameter.
- DATA: Area for storing the read I&M data (for example. in a global data block). Store I&M0 data in an area of the data type "IM0_Data".

This example shows how to read out the I&M0 data of a CPU 1516pro-2 PN (6ES7516-2PN00-0AB0). To read out the I&M0 data of a different module, simply use the HW ID of the module at the parameter LADDR.

Solution

To read out the I&M0 data of the CPU, proceed as follows:

1. Create a global data block to store the I&M0 data.
2. Create a structure of the data type "IM0_Data" in the global data block. You can assign any name to the structure ("imData") in this case.

SLI_gDB_Get_IM_Data

	Name	Data type	Start value
1	Static		
2	imData	IM0_Data	
3	done	Bool	false
4	busy	Bool	false
5	error	Bool	false
6	status	Word	16#0

Figure 8-6 Example: Data block for I&M data

3. Create the Insert the "Get_IM_Data" instruction in the user program, e.g. in OB 1.

4. Connect the "Get_IM_Data" instruction as follows:

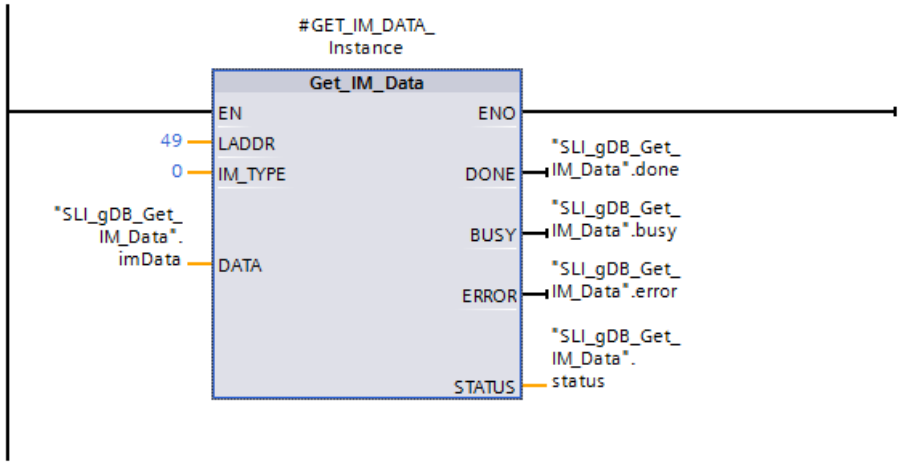


Figure 8-7 Example: Calling the "Get_IM_Data" instruction

5. Call the "Get_IM_Data" instruction in the user program.

Result

The "Get_IM_Data" instruction has stored the I&M 0 data in the data block.

You can view the I&M0 data online in STEP 7, for example with the "Monitor all" button in the data block. The CPU in the example is a CPU 1516pro-2 PN (6ES7516-2PN00-0AB0) with the firmware version V2.8.

SLI_gDB_Get_IM_Data

	Name	Data type	Start value	Monitor value
1	Static			
2	imData	IM0_Data		
3	Manufacturer_ID	UInt	0	42
4	Order_ID	String[20]	''	'6ES7 511-1AK00-0...
5	Serial_Number	String[16]	''	'S C-DOS710132013'
6	Hardware_Revision	UInt	0	3
7	Software_Revision	IM0_Version		
8	Type	Char	' '	'V'
9	Functional	USInt	0	1
10	Bugfix	USInt	0	5
11	Internal	USInt	0	0
12	Revision_Counter	UInt	0	0
13	Profile_ID	UInt	0	0
14	Profile_Specific_Ty...	UInt	0	0
15	IM_Version	Word	16#0	16#0101
16	IM_Supported	Word	16#0	16#001E
17	done	Bool	false	TRUE
18	busy	Bool	false	FALSE
19	error	Bool	false	FALSE
20	status	Word	16#0	16#0000

Figure 8-8 Example: I&M0 data of a CPU 1516pro-2 PN

8.8 Shared commissioning of projects

Team Engineering

Within the framework of Team Engineering, several users work in parallel on a project and access the CPU from different engineering systems.

The users can work on individual parts of a master project independently of one another at the same time. The CPU show the changes of the other editors in a synchronization dialog during the loading of the configuration into the CPU and synchronizes the changes automatically, if possible.

Certain online functions can also be executed in parallel 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 additional information on Team Engineering in the STEP 7 online help.

Maintenance

9

9.1 Firmware update

Introduction

You update the firmware of the CPU/modules with the help of firmware files. The retentive data of the CPU is retained after performing the firmware update.

Requirement

You have downloaded the file(s) for the firmware update from Siemens Industry Online Support Product Support (https://support.industry.siemens.com/cs/ww/en/ps).

- Select the ET 200pro category from the product tree for this:
  Automation Technology > Automation Systems > Industrial Automation Systems SIMATIC > SIMATIC ET 200 I/O systems > ET 200 systems without cabinet > ET 200pro.

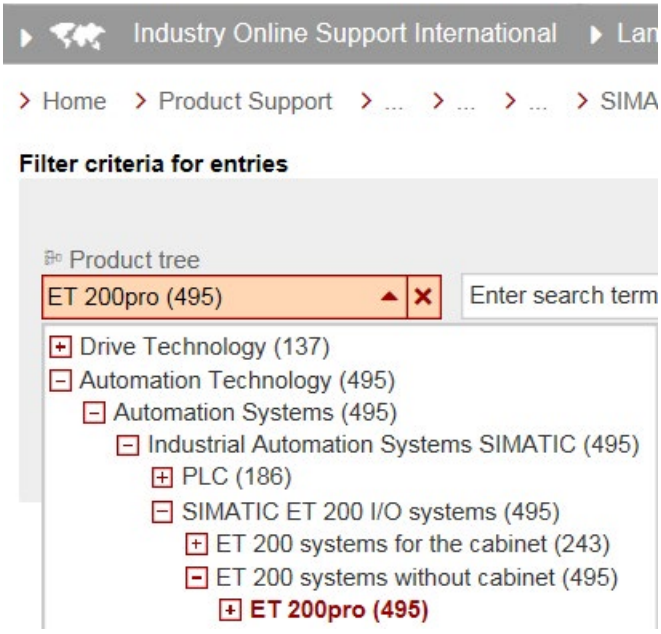


Figure 9-1 ET 200pro in the product tree

From this position, 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.

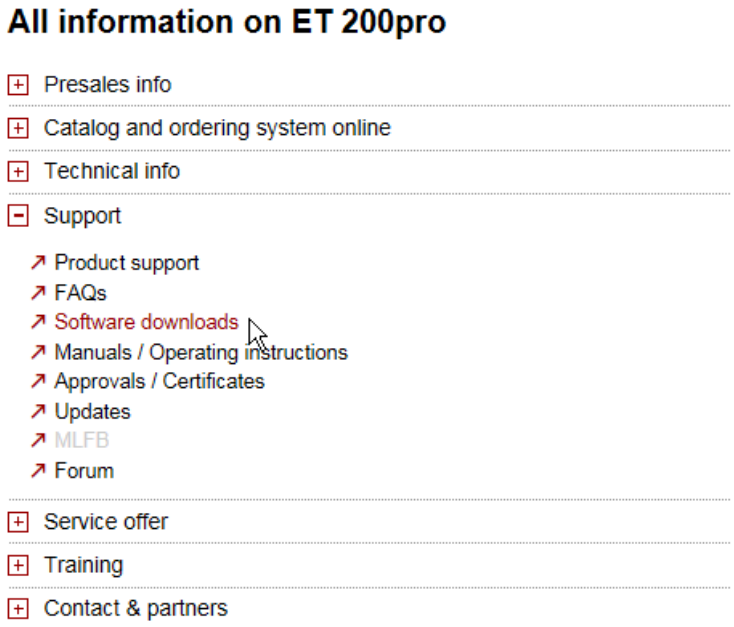


Figure 9-2 Selecting the software downloads

- Before installing the firmware update, ensure that the modules are not being used.

Options for the firmware update

There are the following options for performing a firmware update:

- Online in STEP 7 via Online & Diagnostics
- Via the SIMATIC memory card
- Via the integrated Web server
- Online in STEP 7 via accessible devices
- Online via the SIMATIC Automation Tool

The table below gives an overview of the various options for a firmware update.

Table 9- 1 Overview of firmware update options

Firmware update	CPU	Electronic modules, central *	Electronic modules, distributed *
STEP 7	✓	✓	✓
Accessible devices	✓	--	--
SIMATIC memory card	✓	--	--
Web server of the CPU	✓	--	--
SIMATIC Automation Tool	✓	✓	✓

* Only the RFID-RF170C electronic modules support firmware update via STEP 7.

Installation of the firmware update

⚠ WARNING

Impermissible plant states possible

Installation of the firmware update causes the CPU to switch to STOP mode. STOP may affect 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 controlling any active process.

Procedure: online in STEP 7 via Online & diagnostics

Requirements: There is an online connection between the CPU/module and PG/PC.

To perform a firmware update online via STEP 7, follow these steps:

1. Select the module in the device view.
2. Select the "Online & diagnostics" menu command from the shortcut menu.
3. Select the "Firmware update" group in the "Functions" folder.
4. To select the path to the firmware update files, click the "Browse" button in the "Firmware update" area.
5. Select the matching firmware file. The table in the "firmware loader" 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 operation, the module receives the firmware and then operates with this new firmware.

Note

If a firmware update is interrupted, you must switch off the supply voltage of the CPU and then switch it on again before repeating the firmware update.

Procedure: online in STEP 7 via accessible devices

To perform a firmware update online via accessible devices, follow these steps:

1. From the "Online" menu, select the "Accessible devices" menu item.
2. In the Accessible devices dialog, search for the accessible devices for the selected PROFINET interface.
3. To go to a device in the project tree, select the desired device from the list of accessible devices and click the "Show" button.
4. In the project tree, select the "Online & diagnostics" option of the desired device and perform the firmware update under the category Functions/Firmware update.

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 the SD card reader of your PG/PC.
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 a further step you can decide whether you are deleting the content of the SIMATIC memory card or adding the firmware update files to the SIMATIC memory card.
5. Switch off the supply voltages 1L+ and 2L+ of the CPU, and loosen and remove the connection module from the CPU.
6. Insert the SIMATIC memory card with the firmware update files into the CPU.
7. Insert the connection module onto the CPU again and screw it into place.
8. Switch on the supply voltages 1L+ and 2L+ of the CPU.

   The firmware update begins shortly after the supply voltage is switched on.

   After completion of the firmware update, the RUN LED lights up yellow and the MAINT LED flashes yellow.
9. Switch off the supply voltages 1L+ and 2L+ of the CPU, and loosen and remove the connection module from the CPU.
10. Remove the SIMATIC memory card.

    If you use the SIMATIC memory card subsequently as a program card, delete the firmware update files (including JobFile "S7_JOB.S7S") manually.

Procedure: via the integrated Web server

The procedure is described in the Web server (https://support.industry.siemens.com/cs/ww/en/view/59193560) Function Manual.

Procedure online via the SIMATIC Automation Tool

The procedure is described in the SIMATIC Automation Tool (https://support.industry.siemens.com/cs/de/en/view/98161300) manual (included in the SIMATIC Automation Tool).

Reference

You can find additional information on the procedure in the STEP 7 online help.

9.2 Resetting the CPU to factory settings

Introduction

"Reset to factory settings" restores the CPU to its delivery state. The function deletes all information that was stored internally on the CPU.

Recommendation:

Switch the CPU to its as-delivered condition if

- You want to remove a CPU and use it elsewhere with a different program.
- You want to store the CPU.

When resetting to factory settings, remember that the IP address parameters are also deleted.

Options for resetting a CPU to factory settings

You can reset the CPU to its as-delivered condition by:

- Using the mode selector
- Using STEP 7
- Using the SIMATIC Automation Tool

Required tool (only for procedure using the mode switch)

Cross-tip screwdriver, size 2

Procedure using the mode selector

Make sure that the CPU is in STOP mode: The display of the CPU shows the STOP mode. The 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

Restore the factory settings of the CPU as follows:

1. Switch off the supply voltages 1L+ and 2L+ of the CPU.
2. Using the cross-tip screwdriver, loosen the 4 screws on the front of the connection module CM CPU 2PN M12, 7/8".
3. Remove the connection module from the CPU.
4. Remove the SIMATIC memory card from the card slot (see section Inserting/replacing SIMATIC memory card (Page 76)).
5. Insert the connection module onto the CPU again and screw it into place.
6. Switch on the supply voltages 1L+ and 2L+ of the CPU again.
7. Unscrew the screw cap from the CPU.
8. Set the mode selector to the STOP position.

   Result: The RUN/STOP LED lights up yellow.
9. Set the mode selector to the MRES position. Hold the mode switch 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 switch.
10. 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 STEP 7

To reset a CPU to factory settings using 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.

Procedure using the SIMATIC Automation Tool

The procedure is described in the SIMATIC Automation Tool (https://support.industry.siemens.com/cs/de/en/view/98161300) manual (included in the SIMATIC Automation Tool).

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 9- 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
Retentive tags of technology objects (e.g. adjustment values of absolute encoders)	Initialized
Diagnostics buffer entries	Initialized
IP address	Depends on the procedure: • Using mode switch: is deleted • Using STEP 7: Depending on the setting of the "Keep IP address"/"Delete IP address" option buttons
Device name	Set to "CPU"
Counter readings of the runtime meters	Initialized
Time of day	Is set to "00:00:00, 01.01.2012"

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 Structure and Use of the CPU Memory (https://support.industry.siemens.com/cs/ww/en/view/59193101) Function Manual in the section on memory areas and retentivity, and in the STEP 7 online help. For information on the memory reset of the CPU, refer to the section CPU memory reset (Page 84).

Test and service functions 10

10.1 Test functions

Introduction

You have the option of testing the operation of your user program on the CPU. You monitor signal states and values of tags, and preassign tags with values so that you can simulate specific situations for program execution.

Note

Using test functions

Using test functions affects 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 breakpoints
- Testing with a watch table
- Testing with a force table
- Testing with a PLC tag table
- Testing with a data block editor
- 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 hereby display the values of operands and the results of logic operations (RLO). This allows you to detect and fix logical errors in your program.

Note

Restrictions with the "Program status" function

Monitoring loops can significantly increase the cycle time. The increase in cycle time depends on the following factors:

- The number of tags to be monitored
- The actual numbers of loops run through.

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 you take appropriate measures to exclude the risk of dangerous states occurring before running a test with the "Program status" function.

Testing with breakpoints

With this test option, you set breakpoints in the program code, establish an online connection and enable the breakpoints on the CPU. When testing with breakpoints, you run a program from breakpoint to breakpoint.

Requirements:

- You can set breakpoints in the programming languages SCL or STL

Testing with breakpoints offers the following advantages:

- Narrowing down logic errors step-by-step
- Simple and rapid analysis of complex programs before actual commissioning
- Acquisition of actual values within individual loop passes
- Utilization of breakpoints for program validation also possible in SCL networks with LAD / FBD possible

Note

Restrictions when testing with breakpoints

- If you test with breakpoints, it is possible that the cycle time of the CPU is exceeded.
- If you are using technology objects and test them with breakpoints, the CPU switches to STOP mode.

Note

F-System SIMATIC Safety

Setting breakpoints in the standard user program results in errors in the

safety program:

- Expiration of the fail-safe cycle time monitoring
- Error in communication with the fail-safe I/O devices
- Errors during safety-related CPU-CPU communication
- Internal CPU error

If you nevertheless want to use breakpoints for testing, you must

deactivate safety mode beforehand. This results in the following errors:

- Error in communication with the fail-safe I/O devices
- Errors during safety-related CPU-CPU communication

Testing with watch tables

The following functions are available in the watch table:

- Monitoring of tags

  With watch tables, you monitor the current values of individual tags of a user program or a CPU on the PG/PC and Web server. Note the following requirement to have the Web server display the tag values: You must specify a symbolic name for the tag in the "Name" column of the watch table.

  You 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

  With this function, you assign fixed values to the individual tags of a user program or a 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 force tables to have the current values of the individual tags of a user program or CPU displayed on the programming device or PC and on the Web server. You can monitor the table with or without trigger condition.

  You monitor the following tags:

  – Bit memory
  – Contents of data blocks
  – Peripheral inputs

- 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 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.

The advantage of the force table is that you can simulate different test environments and overwrite tags in the CPU with a fixed 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. You can only end the forcing of peripheral inputs and peripheral outputs in the force table.

Testing with a PLC tag table

You can monitor the current data values of tags in the CPU directly in the PLC tag table. To do so, open the PLC tag table and start the monitoring.

You can also copy PLC tags to a watch or force table and monitor, modify or force the PLC tags there.

Testing with a data block editor

The data block editor offers different options for monitoring and modifying tags. These functions directly access the actual values of the tags in the online program. Actual values are the current values of tags in the CPU work memory at any moment during program execution. The following functions for monitoring and modifying are available in the database editor.

- Monitor tags online
- Modify individual actual values
- Create a snapshot of the actual values
- Overwrite actual values with a snapshot

Note

Setting data values during commissioning

During plant commissioning, you often need to adjust data values to adapt the program to local conditions. The declaration table for data blocks offers some functions for this purpose.

Testing with the LED flash test

In many online dialogs, you can perform an LED flash test. This feature is useful if you are not sure which device in the hardware configuration corresponds to the device currently selected in the software.

If you click on the "Flash LED" button in STEP 7 under Online & diagnostics (online access), an LED flashes on the device currently selected. The RUN/STOP, ERROR, and MAINT LEDs flash on the CPU. The LEDs flash until you cancel 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. If necessary, you can display the recordings with STEP 7 and evaluate them.

Procedure:

- The trace function can be called from the CPU's folder in the project tree, under the name "Traces".

For the testing with the trace functions, please also see the FAQs on the Internet (https://support.industry.siemens.com/cs/ww/en) .

Project trace

A project trace contains trace configurations of multiple devices and records the signals across devices.

A global trigger, which can be activated by each device, is used for the synchronization. After receiving the global trigger, the devices with a valid project trace configuration start recording.

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

You can find additional information on the test functions in the STEP 7 online help.

Additional information about testing with trace functions is available in the Function Manual Using the trace and logic analyzer function (https://support.industry.siemens.com/cs/ww/en/view/64897128).

10.2 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 you cannot resolve with other methods, send the service data to our Service & Support. The service data allow Service & Support to analyze problems that have occurred rapidly.

Note

While reading out the service data of the CPU, you cannot simultaneously execute a download to the device.

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.

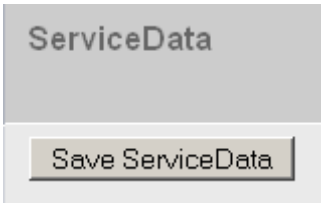


Figure 10-1 Reading out service data via the web server

4. Save the service data locally on your PC/programming device, by clicking "Save ServiceData".

Result: The data is saved in a .dmp file with the following naming convention: <Article number> <Serial number> <Time stamp>.dmp". You can change the file name.

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 (https://support.industry.siemens.com/cs/ww/en/view/64897128) function manual.

Procedure using STEP 7

You can find more information on saving service data with the keyword "Saving service data" in the STEP 7 online help.

Procedure via the SIMATIC memory card

If you can no longer communicate with the CPU via Ethernet, use the SIMATIC memory card only for reading the service data. In all other cases it is preferable to read out the service data via the Web server or STEP 7.

The procedure using the SIMATIC memory card is more time-consuming than the other options for reading out the service data. You must also ensure before reading out that there is sufficient memory space on the SIMATIC memory card.

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. Ensure that the SIMATIC memory card is not write protected and insert it in the card slot of the CPU. Follow the procedure in section Inserting/replacing SIMATIC memory card (Page 76).

Result: The CPU writes the service data file DUMP.S7S to the SIMATIC memory card and remains in STOP mode.

Service data transfer is complete when the STOP LED stops flashing and is lit continuously. If the transfer has been successful, only the STOP LED lights up.

In the event of errors in transfer, the STOP LED is lit continuously and the ERROR LED flashes. The CPU also stores a text file with a note on the error that occurred in the DUMP.S7S folder.

Interrupts, diagnostics, error messages and system events

11

The following section describes the status and fault displays of the CPU 1516pro-2 PN.

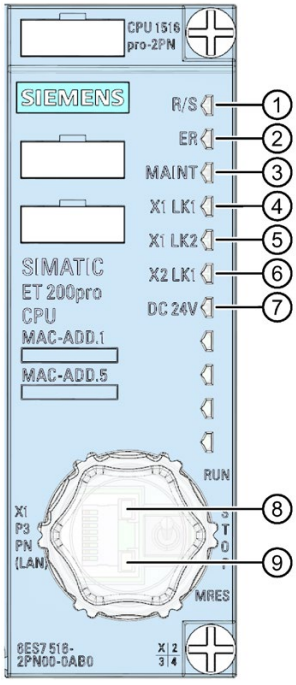
You can find more detailed information on "Interrupts" in the STEP 7 online help.

You can find additional information on the topics of "Diagnostics" and "System alarms" in the Diagnostics (https://support.industry.siemens.com/cs/ww/en/view/59192926) function manual.

11.1 Status and error display of the CPU

LED display

The figure below shows the LED displays of the CPU 1516pro-2 PN.



① RUN/STOP LED (yellow/green LED)
② ERROR LED (red LED)
③ MAINTENANCE LED (yellow LED)
④ LINK RX/TX LED for port X1 P1 (yellow/green LED)
⑤ LINK RX/TX LED for port X1 P2 (yellow/green LED)
⑥ LINK RX/TX LED for port X2 P1 (yellow/green LED)
⑦ DC 24V (green LED)
⑧ LINK LEDs for port X1 P3 (green LED, directly on the RJ45 socket, not labeled)
⑨ RX/TX LEDs for port X1 P3 (yellow LED, directly on the RJ45 socket, not labeled)

Figure 11-1 LED display of the CPU 1516pro-2 PN

Meaning of the RUN/STOP, ERROR and MAINTENANCE LEDs

The CPU 1516pro-2 PN has three LEDs for displaying the current operating state and diagnostic status. The following table shows the meaning of the various combinations of colors of the RUN/STOP, ERROR and MAINTENANCE LEDs.

Table 11- 1 Meaning of the LEDs

RUN/STOP LED	ERROR LED	MAINTENANCE LED	Meaning
LED off	LED off	LED off	Missing or insufficient power supply on the CPU.
LED off	LED flashes red	LED off	An error has occurred.
LED lit green	LED off	LED off	CPU is in RUN mode.
LED lit green	LED flashes red	LED off	A diagnostics event is pending.
LED lit green	LED off	LED lit yellow	Maintenance demanded for the plant. The affected hardware must be checked/exchanged within a short period.
			Active Force job
LED lit green	LED off	LED flashes yellow	Bad configuration
LED lit green	LED flashes red	LED off	An error has occurred.
LED lit yellow	LED flashes red	LED off	
LED lit yellow	LED off	LED flashes yellow	Firmware update successfully completed.
LED lit yellow	LED off	LED off	CPU is in STOP mode.
LED lit yellow	LED flashes red	LED flashes yellow	The program on the SIMATIC memory card is causing an error.
			CPU defective
LED flashes yellow	LED off	LED off	CPU is performing internal activities during STOP, e.g. startup after STOP.
			Download of the user program from the SIMATIC memory card
LED flashes yellow/green	LED off	LED off	Startup (transition from RUN → STOP)
LED flashes yellow/green	LED flashes red	LED flashes yellow	Startup (CPU booting)
			Test of LEDs during startup, inserting a module.
			LED flashing test

Meaning of LINK RX/TX LED

X1 P1, X1 P2 and X2 P1 each have a LINK RX/TX LED (yellow/green LED). Port X1 P3 has a LINK LED (green) and an RX/TX LED (yellow).

The table below shows the various "LED scenarios" of ports X1 P1, X1 P2 and X2 P1.

LINK RX/TX LED *	Meaning
LED off	There is no Ethernet connection between the PROFINET interface of the PROFINET device and the communications partner. No data is currently being sent/received via the PROFINET interface. There is no LINK connection.
LED flashes green	The "LED flashing test" is being performed.
LED lit green	There is an Ethernet connection between the PROFINET interface of your PROFINET device and a communication partner.
LED flickers yellow	Data is currently being received from or sent to a communications partner on Ethernet via the PROFINET interface of the PROFINET device.

* At startup, the CPU does not perform an LED flash test. This means that the LEDs do not light up immediately.

The table below shows the various "LED scenarios" of port X1 P3.

LINK RX/TX LED *	Meaning
Green LED and yellow LED off	There is no Ethernet connection between the PROFINET interface of the PROFINET device and the communications partner. No data is currently being sent/received via the PROFINET interface. There is no LINK connection.
Green LED flashes green	The "LED flashing test" is being performed.
Green LED lit green	There is an Ethernet connection between the PROFINET interface of your PROFINET device and a communication partner.
Yellow LED flickers yellow	Data is currently being received from or sent to a communications partner on Ethernet via the PROFINET interface of the PROFINET device.

* At startup, the CPU does not perform an LED flash test. This means that the LEDs do not light up immediately.

Note

"LED" instruction

You can read the status (e.g. "On" or "Off") of LEDs of a CPU or a module using the "LED" instruction. Note, however, that is not possible to read out the LED status of the LINK RX/TX LEDs on the CPU 1516pro-2 PN.

You can find additional information on the "LED" instruction in the STEP 7 online help.

Status display 24 V DC

The 24 V DC LED lights up green when you have connected the load voltage supply 2L+. If the LED does not light up, check whether the power supply is switched on and the fuse is okay.

In the case of the 24 V DC LED, the CPU does not perform an "LED flash test". This means that the LED does not light up immediately when the load voltage supply 2L+ is switched on.

Identification of the PROFINET device in the control cabinet

During initial commissioning, you must assign a device name to PROFINET IO devices. You can have the LINK LED of a PROFINET IO device flash in STEP 7. This enables you to clearly identify a PROFINET IO device to be addressed from several identical devices, for example in a control cabinet.

MAINTENANCE LED

This LED indicates that a maintenance demand exists, e.g. loss of synchronization of station,

Technical specifications

12

General technical specifications

The CPU 1516pro-2 PN also complies with the standards and test values applicable to the ET 200pro distributed I/O system. You can find detailed information on the general technical specifications in the ET 200pro Distributed I/O System (https://support.industry.siemens.com/cs/ww/en/view/21210852) operating instructions.

Technical specifications of the CPU 1516pro-2 PN

The following table shows the technical specifications as of 11/2019. You will find a data sheet including daily updated technical specifications on the Internet (https://support.industry.siemens.com/cs/ww/en/pv/6ES7516-2PN00-0AB0/td?dl=en).

Article number	6ES7516-2PN00-0AB0
General information	
Product type designation	CPU 1516pro-2 PN
HW functional status	FS02
Firmware version	V2.8
Product function	
• I&M data	Yes; I&M0 to I&M3
• Isochronous mode	Yes; Via X1, with minimum OB 6x cycle of 500 µs
Engineering with	
• STEP 7 TIA Portal configurable/integrated as of version	V16 (FW V2.8) / V14 (FW V2.0) or higher
Configuration control	
via dataset	No
Control elements	
Mode selector switch	1
Supply voltage	
Type of supply voltage	24 V DC
permissible range, lower limit (DC)	20.4 V
permissible range, upper limit (DC)	28.8 V
Reverse polarity protection	Yes
Mains buffering	
• Mains/voltage failure stored energy time	5 ms
Input current	
Current consumption (rated value)	0.31 A
Inrush current, max.	0.4 A; Rated value
I^2t	0.001 $A^2 \cdot s$

Article number	6ES7516-2PN00-0AB0
Power	
Infeed power to the backplane bus	2.275 W
Power loss	
Power loss, typ.	5.3 W
Memory	
Number of slots for SIMATIC memory card	1
SIMATIC memory card required	Yes
Work memory	
• integrated (for program)	1 Mbyte
• integrated (for data)	5 Mbyte
Load memory	
• Plug-in (SIMATIC Memory Card), max.	32 Gbyte
Backup	
• maintenance-free	Yes
CPU processing times	
for bit operations, typ.	10 ns
for word operations, typ.	12 ns
for fixed point arithmetic, typ.	16 ns
for floating point arithmetic, typ.	64 ns
CPU-blocks	
Number of elements (total)	8 000; Blocks (OB, FB, FC, DB) and UDTs
DB	
• Number range	1 ... 60 999; subdivided into: number range that can be used by the user: 1 ... 59 999, and number range of DBs created via SFC 86: 60 000 ... 60 999
• Size, max.	5 Mbyte; For DBs with absolute addressing, the max. size is 64 KB
FB	
• Number range	0 ... 65 535
• Size, max.	1 Mbyte
FC	
• Number range	0 ... 65 535
• Size, max.	1 Mbyte

Article number	6ES7516-2PN00-0AB0
OB	
• Size, max.	1 Mbyte
• Number of free cycle OBs	100
• Number of time alarm OBs	20
• Number of delay alarm OBs	20
• Number of cyclic interrupt OBs	20; With minimum OB 3x cycle of 500 µs
• Number of process alarm OBs	50
• Number of DPV1 alarm OBs	3
• Number of isochronous mode OBs	1
• Number of technology synchronous alarm OBs	2
• Number of startup OBs	100
• Number of asynchronous error OBs	4
• Number of synchronous error OBs	2
• Number of diagnostic alarm OBs	1
Nesting depth	
• per priority class	24
Counters, timers and their retentivity	
S7 counter	
• Number	2 048
Retentivity	
– adjustable	Yes
IEC counter	
• Number	Any (only limited by the main memory)
Retentivity	
– adjustable	Yes
S7 times	
• Number	2 048
Retentivity	
– adjustable	Yes
IEC timer	
• Number	Any (only limited by the main memory)
Retentivity	
– adjustable	Yes

Article number	6ES7516-2PN00-0AB0
Data areas and their retentivity	
Retentive data area (incl. timers, counters, flags), max.	512 kbyte; In total; available retentive memory for bit memories, timers, counters, DBs, and technology data (axes): 472 KB
Flag	
• Number, max.	16 kbyte
• Number of clock memories	8; 8 clock memory bit, grouped into one clock memory byte
Data blocks	
• Retentivity adjustable	Yes
• Retentivity preset	No
Local data	
• per priority class, max.	64 kbyte; max. 16 KB per block
Address area	
Number of IO modules	8 192; max. number of modules / submodules
I/O address area	
• Inputs	32 kbyte; All inputs are in the process image
• Outputs	32 kbyte; All outputs are in the process image
per integrated IO subsystem	
– Inputs (volume)	8 kbyte
– Outputs (volume)	8 kbyte
Hardware configuration	
Number of distributed IO systems	64; A distributed I/O system is characterized not only by the integration of distributed I/O via PROFINET or PROFIBUS communication modules, but also by the connection of I/O via AS-i master modules or links (e.g. IE/PB-Link)
Number of IO Controllers	
• integrated	2
• Via CM	0
Rack	
• Modules per rack, max.	16; Expansion width max. 1.2 m
• Number of lines, max.	1
Time of day	
Clock	
• Type	Hardware clock
• Backup time	6 wk; At 40 °C ambient temperature, typically
• Deviation per day, max.	10 s; Typ.: 2 s
Operating hours counter	
• Number	16

Article number	6ES7516-2PN00-0AB0
Clock synchronization	
• supported	Yes
• in AS, master	Yes
• in AS, slave	Yes
• on Ethernet via NTP	Yes
Interfaces	
Number of PROFINET interfaces	2
Number of PROFIBUS interfaces	0
1. Interface	
Interface types	
• Number of ports	3; 2x M12 + 1x RJ45
• integrated switch	Yes
• RJ 45 (Ethernet)	Yes; X1 P3
Protocols	
• IP protocol	Yes; IPv4
• PROFINET IO Controller	Yes
• PROFINET IO Device	Yes
• SIMATIC communication	Yes
• Open IE communication	Yes
• Web server	Yes
• Media redundancy	Yes; MRP Automanager according to IEC 62439-2 Edition 2.0

Article number	6ES7516-2PN00-0AB0
PROFINET IO Controller	
Services	
– PG/OP communication	Yes
– S7 routing	Yes
– Isochronous mode	Yes
– Direct data exchange	Yes; Requirement: IRT and isochronous mode (MRPD optional)
– IRT	Yes
– MRP	Yes; as MRP redundancy manager and/or MRP client; max. number of devices in the ring: 50
– MRPD	Yes; Requirement: IRT
– PROFIenergy	Yes
– Prioritized startup	Yes; Max. 32 PROFINET devices
– Number of connectable IO Devices, max.	256; In total, up to 1 000 distributed I/O devices can be connected via AS-i, PROFIBUS or PROFINET
– Of which IO devices with IRT, max.	64
– Number of connectable IO Devices for RT, max.	256
– of which in line, max.	256
– Number of IO Devices that can be simultaneously activated/deactivated, max.	8; in total across all interfaces
– Number of IO Devices per tool, max.	8
– Updating times	The minimum value of the update time also depends on communication share set for PROFINET IO, on the number of IO devices, and on the quantity of configured user data
Update time for IRT	
– for send cycle of 250 µs	250 µs to 4 ms; Note: In the case of IRT with isochronous mode, the minimum update time of 500 µs of the isochronous OB is decisive
– for send cycle of 500 µs	500 µs to 8 ms
– for send cycle of 1 ms	1 ms to 16 ms
– for send cycle of 2 ms	2 ms to 32 ms
– for send cycle of 4 ms	4 ms to 64 ms
– With IRT and parameterization of "odd" send cycles	Update time = set "odd" send clock (any multiple of 125 µs: 375 µs, 625 µs ... 3 875 µs)
Update time for RT	
– for send cycle of 250 µs	250 µs to 128 ms
– for send cycle of 500 µs	500 µs to 256 ms
– for send cycle of 1 ms	1 ms to 512 ms
– for send cycle of 2 ms	2 ms to 512 ms
– for send cycle of 4 ms	4 ms to 512 ms

Article number	6ES7516-2PN00-0AB0
PROFINET IO Device	
Services	
– PG/OP communication	Yes
– S7 routing	Yes
– Isochronous mode	No
– IRT	Yes
– MRP	Yes; as MRP redundancy manager and/or MRP client; max. number of devices in the ring: 50
– MRPD	Yes; Requirement: IRT
– PROFIenergy	Yes; per user program
– Prioritized startup	No
– Shared device	Yes
– Number of IO Controllers with shared device, max.	4
– Asset management record	Yes; per user program
2. Interface	
Interface types	
• Number of ports	1; 1x M12
• integrated switch	No
• RJ 45 (Ethernet)	No
Protocols	
• IP protocol	Yes; IPv4
• PROFINET IO Controller	Yes
• PROFINET IO Device	Yes
• SIMATIC communication	Yes
• Open IE communication	Yes
• Web server	Yes
• Media redundancy	No

Article number	6ES7516-2PN00-0AB0
PROFINET IO Controller	
Services	
– PG/OP communication	Yes
– S7 routing	Yes
– Isochronous mode	No
– Direct data exchange	No
– IRT	No
– MRP	No
– MRPD	No
– PROFIenergy	Yes
– Prioritized startup	No
– Number of connectable IO Devices, max.	32; In total, up to 1 000 distributed I/O devices can be connected via AS-i, PROFIBUS or PROFINET
– Number of connectable IO Devices for RT, max.	32
– of which in line, max.	32
– Number of IO Devices that can be simultaneously activated/deactivated, max.	8; in total across all interfaces
– Number of IO Devices per tool, max.	8
– Updating times	The minimum value of the update time also depends on communication share set for PROFINET IO, on the number of IO devices, and on the quantity of configured user data
Update time for RT	
– for send cycle of 1 ms	1 ms to 512 ms
PROFINET IO Device	
Services	
– PG/OP communication	Yes
– S7 routing	Yes
– Isochronous mode	No
– IRT	No
– MRP	No
– MRPD	No
– PROFIenergy	Yes; per user program
– Prioritized startup	No
– Shared device	Yes
– Number of IO Controllers with shared device, max.	4
– Asset management record	Yes; per user program

Article number	6ES7516-2PN00-0AB0
Interface types	
RJ 45 (Ethernet)	
• 100 Mbps	Yes
• Autonegotiation	Yes
• Autocrossing	Yes
• Industrial Ethernet status LED	Yes
Protocols	
Number of connections	
• Number of connections, max.	128; Via integrated interfaces of the CPU
• Number of connections reserved for ES/HMI/web	10
• Number of connections via integrated interfaces	128
• Number of S7 routing paths	16
Redundancy mode	
• H-Sync forwarding	Yes
SIMATIC communication	
• S7 communication, as server	Yes
• S7 communication, as client	Yes
• User data per job, max.	See online help (S7 communication, user data size)
Open IE communication	
• TCP/IP	Yes
– Data length, max.	64 kbyte
– several passive connections per port, supported	Yes
• ISO-on-TCP (RFC1006)	Yes
– Data length, max.	64 kbyte
• UDP	Yes
– Data length, max.	2 kbyte; 1 472 bytes for UDP broadcast
– UDP multicast	Yes; Max. 5 multicast circuits
• DHCP	No
• SNMP	Yes
• DCP	Yes
• LLDP	Yes

Article number	6ES7516-2PN00-0AB0
Web server	
• HTTP	Yes; Standard and user pages
• HTTPS	Yes; Standard and user pages
OPC UA	
• Runtime license required	Yes
• OPC UA client	Yes; Data access (read, write), method call, custom address space
– Application authentication	Yes
– Security policies	Available security policies: None, Basic128Rsa15, Basic256Rsa15, Basic256Sha256
– User authentication	"anonymous" or by user name & password
– Number of connections, max.	10
– Number of nodes of the client interfaces, max.	2 000
– Number of elements for one call of OPC_UA_NodeGetHandleList/OPC_UA_ReadList/OPC_UA_WriteList, max.	300
– Number of elements for one call of OPC_UA_NameSpaceGetIndexList, max.	20
– Number of elements for one call of OPC_UA_MethodGetHandleList, max.	100
– Number of simultaneous calls of the client instructions per connection (except OPC_UA_ReadList,OPC_UA_WriteList, OPC_UA_MethodCall), max.	1
– Number of simultaneous calls of the client instructions OPC_UA_ReadList,OPC_UA_WriteList and OPC_UA_MethodCall, max.	5
– Number of registerable nodes, max.	5 000
– Number of registerable method calls of OPC_UA_MethodCall, max.	100
– Number of inputs/outputs when calling OPC_UA_MethodCall, max.	20
• OPC UA server	Yes; Data access (read, write, subscribe), method call, custom address space; embedded 2017 UA server profile V1.02
– Application authentication	Yes
– Security policies	Available security policies: None, Basic128Rsa15, Basic256Rsa15, Basic256Sha256
– User authentication	"anonymous" or by user name & password

Article number	6ES7516-2PN00-0AB0
– Number of sessions, max.	48
– Number of accessible variables, max.	100 000
– Number of registerable nodes, max.	20 000
– Number of subscriptions per session, max.	20
– Sampling interval, min.	100 ms
– Publishing interval, min.	200 ms
– Number of server methods, max.	50
– Number of inputs/outputs per server method, max.	20
– Number of monitored items, max.	2 000; for 1 s sampling interval and 1 s send interval
– Number of server interfaces, max.	10
– Number of nodes for user-defined server interfaces, max.	5 000
Further protocols	
• MODBUS	Yes; MODBUS TCP
Media redundancy	
• Switchover time on line break, typ.	200 ms; For MRP, bumpless for MRPD
• Number of stations in the ring, max.	50
Isochronous mode	
Isochronous operation (application synchronized up to terminal)	Yes; Via X1, with minimum OB 6x cycle of 500 µs
S7 message functions	
Number of login stations for message functions, max.	32
Program alarms	Yes
Number of configurable program messages, max.	10 000; Program messages are generated by the "Program_Alarm" block, ProDiag or GRAPH
Number of loadable program messages in RUN, max.	5 000
Number of simultaneously active program alarms	
• Number of program alarms	600
• Number of alarms for system diagnostics	200
• Number of alarms for motion technology objects	160

Article number	6ES7516-2PN00-0AB0
Test commissioning functions	
Joint commission (Team Engineering)	Yes; Parallel online access possible for up to 8 engineering systems
Status block	Yes; Up to 8 simultaneously (in total across all ES clients)
Single step	No
Number of breakpoints	8
Status/control	
• Status/control variable	Yes
• Variables	Inputs/outputs, memory bits, DBs, distributed I/Os, timers, counters
• Number of variables, max.	
– of which status variables, max.	200; per job
– of which control variables, max.	200; per job
Forcing	
• Forcing	Yes
• Forcing, variables	Peripheral inputs/outputs
• Number of variables, max.	200
Diagnostic buffer	
• present	Yes
• Number of entries, max.	3 200
– of which powerfail-proof	500
Traces	
• Number of configurable Traces	4; Up to 512 KB of data per trace are possible
Interrupts/diagnostics/status information	
Diagnostics indication LED	
• RUN/STOP LED	Yes
• ERROR LED	Yes
• MAINT LED	Yes
• Monitoring of the supply voltage (PWR-LED)	Yes; Green "24 V DC" LED
• Connection display LINK TX/RX	Yes

Article number	6ES7516-2PN00-0AB0
Supported technology objects	
Motion Control	Yes; Note: The number of axes affects the cycle time of the PLC program; selection guide via the TIA Selection Tool or SIZER
• Number of available Motion Control resources for technology objects (except cam disks)	2 400
• Required Motion Control resources	
– per speed-controlled axis	40
– per positioning axis	80
– per synchronous axis	160
– per external encoder	80
– per output cam	20
– per cam track	160
– per probe	40
• Positioning axis	
– Number of positioning axes at motion control cycle of 4 ms (typical value)	7
– Number of positioning axes at motion control cycle of 8 ms (typical value)	14
Controller	
• PID_Compact	Yes; Universal PID controller with integrated optimization
• PID_3Step	Yes; PID controller with integrated optimization for valves
• PID-Temp	Yes; PID controller with integrated optimization for temperature
Counting and measuring	
• High-speed counter	Yes
Ambient conditions	
Ambient temperature during operation	
• horizontal installation, min.	-25 °C
• horizontal installation, max.	55 °C
• vertical installation, min.	-25 °C
• vertical installation, max.	55 °C
Ambient temperature during storage/transportation	
• min.	-40 °C
• max.	70 °C

Article number	6ES7516-2PN00-0AB0
Altitude during operation relating to sea level	
• Installation altitude above sea level, max.	5 000 m; Restrictions for installation altitudes > 2 000 m, see manual
Configuration	
Programming	
Programming language	
– LAD	Yes
– FBD	Yes
– STL	Yes
– SCL	Yes
– GRAPH	Yes
Know-how protection	
• User program protection/password protection	Yes
• Copy protection	Yes
• Block protection	Yes
Access protection	
• Protection level: Write protection	Yes
• Protection level: Read/write protection	Yes
• Protection level: Complete protection	Yes
Cycle time monitoring	
• lower limit	adjustable minimum cycle time
• upper limit	adjustable maximum cycle time
Dimensions	
Width	135 mm
Height	130 mm
Depth	65 mm
Weights	
Weight, approx.	614 g

Technical specifications of the connection module M12 7/8"

Article number	6ES7194-4AP00-0AA0
Accessories	
Function description	Terminal module M12 7/8": 2x PROFINET and 24 V power; 3x M12 and 2x 7/8" power supply from 1L+ and 2L+ max. 8 A each, internal transfer 2L+ max. 8 A, 1L+ max. 5 A

Article number	6ES7194-4AP00-0AA0
Dimensions	
Width	90 mm
Height	130 mm
Depth	51 mm
Weights	
Weight, approx.	560 g

Dimension diagram

A

CPU 1516pro-2 PN with connection module CM CPU 2PN M12, 7/8"

This section contains dimension drawings of the module mounted on various module racks. You must observe the dimensions when mounting in cabinets, control rooms, etc.

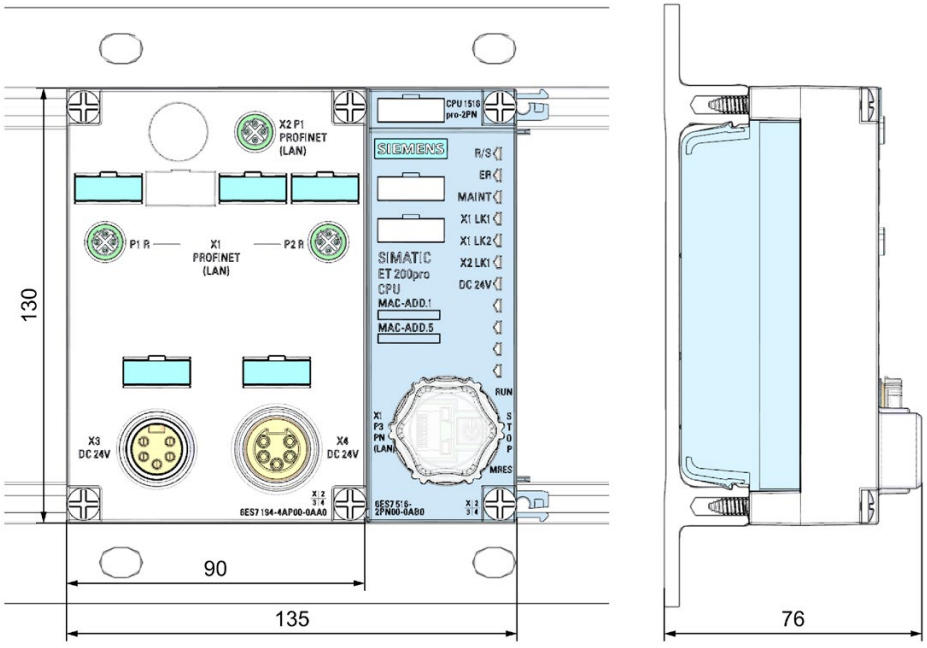


Figure A-1 Dimension diagram - Rack, narrow

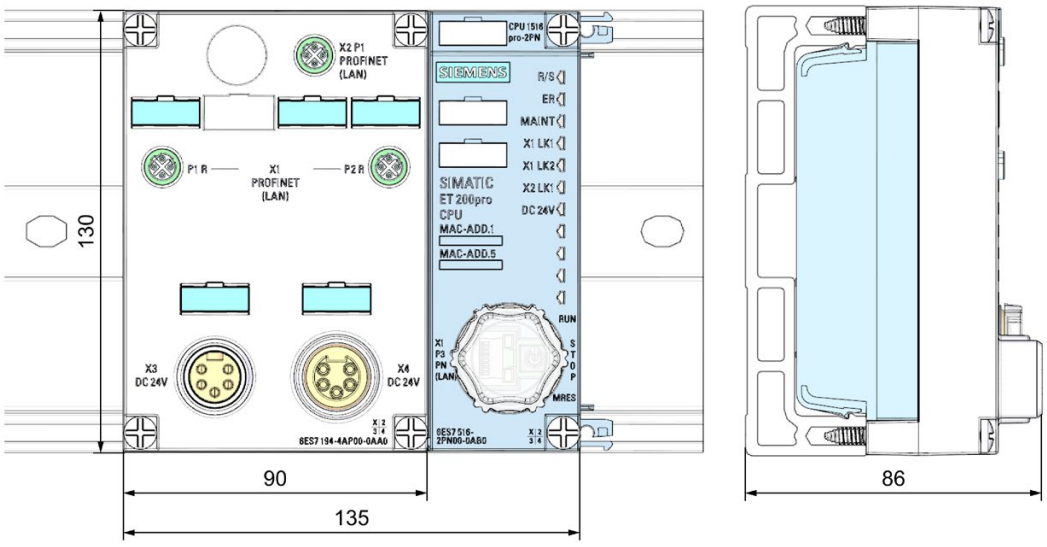


Figure A-2 Dimension diagram - Rack, compact

Accessories/spare parts

B

Order number of CPU and connection module

Designation	Article number
CPU 1516pro-2 PN	6ES7516-2PN00-0AB0
Connection module CM CPU 2PN M12 7/8“	6ES7194-4AP00-0AA0

Order numbers of accessories

Designation		Article number
Preassembled cables and connectors:		
IE M12 connecting cable Trailable cable • Preassembled with M12 connectors 180° at both ends, fixed lengths, 1 unit:	0.3 m	6XV1870-8AE30
	0.5 m	6XV1870-8AE50
	1.0 m	6XV1870-8AH10
	1.5 m	6XV1870-8AH15
	2.0 m	6XV1870-8AH20
	3.0 m	6XV1870-8AH30
	5.0 m	6XV1870-8AH50
	10.0 m	6XV1870-8AN10
	15.0 m	6XV1870-8AN15
IE M12 connecting cable Trailable cable • Preassembled with angled M12 connectors 180° at both ends, fixed lengths, 1 unit:	3.0 m	3RK1902-2NB30
	5.0 m	3RK1902-2NB50
	10.0 m	3RK1902-2NC10
IE M12 connecting cable Trailable cable • Preassembled with angled M12 connector 180° at one end (one end male, one end open), fixed lengths, 1 unit:	3.0 m	3RK1902-2HB30
	5.0 m	3RK1902-2HB50
	10.0 m	3RK1902-2HC10
IE M12 connecting cable Trailable cable • Preassembled with M12 connector 180° (male) at one end, other end with RJ45 Plug 145°, fixed lengths, 1 unit:	2.0 m	6XV1871-5TH20
	3.0 m	6XV1871-5TH30
	5.0 m	6XV1871-5TH50
	10.0 m	6XV1871-5TN10
	15.0 m	6XV1871-5TN15

Designation		Article number
7/8" connecting cable for power supply Trailable power cable, 5 x 1.5 mm² • Preassembled with 7/8" 180 ° connectors at both ends, fixed lengths, 1 unit:	0.3 m	6XV1822-5BH30
	0.5 m	6XV1822-5BH50
	1.0 m	6XV1822-5BH10
	1.5 m	6XV1822-5BH15
	2.0 m	6XV1822-5BH20
	3.0 m	6XV1822-5BH30
	5.0 m	6XV1822-5BH50
	10.0 m	6XV1822-5BN10
	15.0 m	6XV1822-5BN15
7/8" connecting cable for power supply Trailable power cable, 5 x 1.5 mm² • Preassembled cable with 7/8" angled connectors at both ends, fixed lengths, 1 unit	1.5 m	(on request)
	2.0 m	(on request)
	3.0 m	3RK1902-3NB30
	5.0 m	3RK1902-3NB50
	10.0 m	3RK1902-3NC10
	15.0 m	(on request)
7/8" connecting cable for power supply Trailable power cable, 5 x 1.5 mm² • Preassembled with 7/8" angled connector at one end (one end female, one end open), fixed lengths, 1 unit	3.0 m	3RK1902-3GB30
	5.0 m	3RK1902-3GB50
	10.0 m	3RK1902-3GC10
Non-assembled cables and connectors:		
7/8" plug connector (screw mechanism), male contact insert 5 units per package		6GK1905-0FA00
7/8" plug connector (screw mechanism), female contact insert 5 units per package		6GK1905-0FB00
7/8" connector (screw mechanism), angled, male contact insert 5 units per package		3RK1902-3BA00
7/8" plug connector (screw mechanism), angled, female contact insert 5 units per package		3RK1902-3DA00
PROFINET M12 plug connector d-coded with FastConnect connection system, 180°	1 unit per package	6GK1901-0DB10-6AA0
	8 units per package	6GK1901-0DB10-6AA8
PROFINET M12 plug connector d-coded with FastConnect connection system, 180°	1 unit per package	6GK1901-0DB20-6AA0
	8 units per package	6GK1901-0DB20-6AA8
PROFINET M12 plug connector d-coded, angled		3RK1902-2DA00

Designation	Article number
PROFINET FC cable	
• FC TP Standard Cable	6XV1840-2AH10
• FC TP Trailing Cable	6XV1840-3AH10
• FC TP Trailing Cable GP	6XV1870-2D
• FC TP Marine Cable	6XV1840-4AH10
• FC TP Torsion Cable	6XV1870-2F
Energy Cable Trailable power cable, 5 x 1.5 mm^2 Sold by the meter, min. order quantity 20 m Delivery unit max. 1000 m, 1 m	6XV1830-8AH10
M12 cover caps 10 units per package, 10 units	3RX9 802-0AA00
7/8" cover caps 10 units per package, 1 unit	6ES7194-3JA00-0AA0

SIMATIC memory cards

Article number	Capacity
6ES7954-8LCxx-0AA0	4 MB
6ES7954-8LExx-0AA0	12 MB
6ES7954-8LFxx-0AA0	24 MB
6ES7954-8LLxx-0AA0	256 MB
6ES7954-8LPxx-0AA0	2 GB
6ES7954-8LTxx-0AA0	32 GB

Safety-relevant symbols

C

C.1 Safety-related symbols for devices without Ex protection

The following table contains an explanation of the symbols located in your SIMATIC device, its packaging or the accompanying documentation.

Symbol	Meaning
	General warning sign **Caution/Notice** You must read the product documentation. The product documentation contains information about the potential risks and enable you to recognize risks and implement countermeasures.
	Read the information provided by the product documentation. ISO 7010 M002
	Ensure the device is only installed by electrically skilled person. IEC 60417 No. 6182
 CABLE SPEC.	Note that connected mains lines must be designed according to the expected minimum and maximum ambient temperature.
 EMC	Note that the device must be constructed and connected in accordance with EMC regulations.
 230V MODULES	Note that a 230 V device can be exposed to electrical voltages which can be dangerous. ANSI Z535.2
 24V MODULES	Note that a device of Protection Class III may only be supplied with a protective low voltage according to the standard SELV/PELV. IEC 60417-1-5180 "Class III equipment"
 INDOOR USE ONLY INDUSTRIAL USE ONLY	Be aware that the device is only approved for the industrial field and only for indoor use.
	Note that an enclosure is required for installing the device. Enclosures are considered: • Standing control cabinet • Serial control cabinet • Terminal boxes • Wall enclosure

C.2 Safety-related symbols for devices with Ex protection

The following table contains an explanation of the symbols located in your SIMATIC device, its packaging or the accompanying documentation.

Symbol	Meaning
	The assigned safety symbols apply to devices **with Ex approval**. You must read the product documentation. The product documentation contains information about the potential risks and enable you to recognize risks and implement countermeasures.
	Read the information provided by the product documentation. ISO 7010 M002
	Ensure the device is only installed by electrically skilled person. IEC 60417 No. 6182
	Observe the mechanical rating of the device.
	Note that connected mains lines must be designed according to the expected minimum and maximum ambient temperature.
	Note that the device must be constructed and connected in accordance with EMC regulations.
	When the device is under voltage, note that it may not be installed or removed, or plugged or pulled.
	Note that a 230 V device can be exposed to electrical voltages which can be dangerous. ANSI Z535.2
	Note that a device of Protection Class III may only be supplied with a protective low voltage according to the standard SELV/PELV. IEC 60417-1-5180 "Class III equipment"
	Be aware that the device is only approved for the industrial field and only for indoor use.

Symbol	Meaning
	For Zone 2 potentially explosive atmospheres, be aware that the device may only be used when it is installed in an enclosure with a degree of protection ≥ IP54.
	For Zone 22 potentially explosive atmospheres, be aware that the device may only be used when it is installed in an enclosure with a degree of protection ≥ IP6x.

Glossary

Actuator

Actuators are, for example, power relays or contactors for switching on load devices or load devices themselves (e.g. directly controlled solenoid valves).

Automation system

Programmable logic controller for closed-loop and open-loop control of process chains in industrial processes and manufacturing technology. The automation system consists of different components and integrated system functions according to the automation task.

Bit memory

Bit memory is a component of the system memory of the CPU for saving intermediate results. It can be accessed in bit, byte, word or double word mode.

Bus

Shared transmission path to which all devices in a fieldbus system are connected.

Code block

In SIMATIC S7, a code block is a block that contains a section of the STEP 7 user program. In contrast to a code block, a data block only contains data.

Configuration

Assignment of modules to slots and addresses.

Connection plug

Physical connection between device and cable.

Consistent data

Data whose content belongs together and must not be separated is known as consistent data.

Counter

Counters are components of the system memory of the CPU. You can modify the content of the "counter cells" using STEP 7 instructions (e.g. count up/down).

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 runs 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.

Cycle time

The cycle time represents the time a CPU requires to execute the user program once.

Cyclic interrupt

See "Interrupt, cyclic"

Data block

Data blocks (DBs) are data areas in the user program that contain user data. There are global data blocks, which can be accessed from all code blocks, and instance data blocks, which are assigned to a specific FB call.

Device

A device can send, receive or amplify data via the bus, e.g. IO device via PROFINET IO.

Device names

Before an IO device can be addressed by an IO controller, the IO device requires a device name. PROFINET uses this approach because names are easier to handle than complex IP addresses.

In its delivery state, an IO device has no device name. 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.

Diagnostic buffer

The diagnostic buffer is a battery-backed memory area in the CPU where diagnostic events are stored in their order of occurrence.

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. Plant availability is increased because these functions reduce commissioning times and downtimes.

Diagnostics interrupt

See "Interrupt, diagnostic"

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

Electronic modules

Electronic modules form the interface between the process and the automation system. There are digital input and output modules as well as analog input and output modules.

Ethernet

See "Industrial Ethernet"

F-CPU

An F-CPU is a central processor with fail-safe capability that is approved for use in SIMATIC Safety. A standard user program can also run on the F-CPU.

Firmware update

Upgrade of the firmware of modules, e.g. after function extensions, to the newest firmware version (update).

Function

A function (FC) is a code block with no static data. A function allows you to pass parameters in the user program. Functions are thus suited for programming frequently recurring complex functions, such as calculations.

Function block

A function block (FB) is a code block with static data. An FB allows you to pass parameters in the user program. Function blocks are thus suited for programming frequently recurring complex functions, such as closed-loop controls or operating mode selection.

Functional ground

The functional ground is a low-impedance current path between electric circuits and ground. It is not intended as a protective measure but rather, for example, for improvement of interference immunity.

Ground

Chassis ground refers to all interconnected inactive parts of equipment that are unable to carry hazardous voltage even in the event of a fault.

GSD file

The Generic Station Description file contains all properties of a PROFINET or PROFIBUS device that are necessary for its configuration.

Hardware interrupt

See "Interrupt, hardware"

I/O modules

See Electronic modules

Identification data

Information that is saved in modules, and that supports the user in reviewing the system configuration and locating hardware changes.

I-device

The "I-device" functionality (intelligent IO device) of a CPU allows data to be exchanged with an IO controller and subsequent use of the CPU, for example, as an intelligent preprocessing unit of subprocesses. In its role as an IO device, the I-device is connected to a "higher-level" IO controller.

The user program in the CPU with I-device functionality ensures the preprocessing. The process values acquired centrally or decentrally (PROFINET IO or PROFIBUS DP) are preprocessed by the user program and made available to the CPU of a higher-level station via a PROFINET IO device interface.

Instance data block

Each call of a function block in the STEP 7 user program is assigned a data block, which is automatically generated. Values of the input, output and in/out parameters, as well as local block data, are stored in the instance data block.

Interrupt

The operating system of the CPU distinguishes between various priority classes that control the execution of the user program. These priority classes include interrupts, such as hardware interrupts. When an interrupt occurs, the operating system automatically calls an assigned organization block. The user can program the desired reaction in the organization block (e.g. in a FB).

Interrupt, cyclic

The CPU generates a cyclic interrupt periodically within a parameterizable time grid and then processes the corresponding organization block.

Interrupt, diagnostic

Diagnostics-capable modules signal detected system errors to the CPU using diagnostic interrupts.

Interrupt, hardware

As a result of a specific event in the process, interrupt-triggering modules trigger a process interrupt and signal it to the CPU. The CPU then processes the assigned organization block according to the priority of this interrupt.

Interrupt, time-delay

The time-delay interrupt is one of the program execution priority classes of SIMATIC S7. It is generated after expiration of a timer started in the user program. The CPU then processes the corresponding organization block.

Interrupt, time-of-day

The time-of-day interrupt is one of the program execution priority classes of SIMATIC S7.. It is generated based on a defined date (or daily) and time (e.g. 9:50 or every hour, every minute). The CPU then processes the corresponding organization block.

Interrupt, update

If the operating system has received an update interrupt, it calls the update interrupt OB. This may happen if you changed a parameter on a slot of a device.

IP address

The IP address is made up of four decimal numbers with a range of values from 0 through 255. The decimal numbers are separated by periods (for example, 192.162.0.0).

The IP address consists of the following:

- Address of the network
- Address of the device (PROFINET interface of the IO controller/IO device)

Isochronous mode

Process data, transmission cycle via PROFINET IO and user program are synchronized to achieve maximum deterministic behavior. The input and output data of distributed I/O modules in the system is simultaneously acquired and simultaneously output.

Isochronous real-time communication

Synchronized transmission method for cyclic exchange of IRT IO data between PROFINET devices.

A reserved bandwidth within the send clock is available for IRT IO data. The reserved bandwidth guarantees that the IRT IO data can be transmitted in reserved, time-synchronized intervals and not be influenced by high network load arising from other communication (e.g. TCP/IP communication or additional real-time communication).

Load current supply

Supply of the module's input and output electric circuits.

MAC address

Every PROFINET device is assigned a worldwide unique device identification before it leaves the factory. This 6-byte long device identification is the MAC address.

The MAC address is divided into:

- 3-byte manufacturer identification
- 3-byte device identification (consecutive number)

The MAC address is generally shown on the front of the device.
Example: 08-00-06-6B-80-C0

Media redundancy

Function for ensuring the network and system availability. Redundant transmission paths (ring topology) ensure that an alternative communication path is made available if one transmission path fails.

NTP

The Network Time Protocol (NTP) is a standard for synchronizing clocks in automation systems via Industrial Ethernet. NTP uses the UDP connectionless network protocol.

OPC UA

OPC UA (OPC Unified Architecture) is a collection of standards for industrial communications. These standards describe a service-oriented architecture:

- Transport of data between machines
- Interfaces and semantics of data, for example, information about the data such as data type and object type.

OPC UA is particularly suitable for cross-level data exchange:

- Operating system independence
- Manufacturer-independent
- Integrated security

Operating states

Operating states describe the behavior of a single CPU at a specific time.

Organization block

Organization blocks (OBs) form the interface between the operating system of the CPU and the user program. The organization blocks determine the order in which the user program is executed.

Parameter

- Tag of a STEP 7 code block:
- Tag for setting the behavior of a module (one or more per module). In as-delivered state, every module has an appropriate basic setting, which you can change by configuring in STEP 7. There are static and dynamic parameters

Parameter assignment

Parameter assignment is the transfer of parameters from the IO controller to the IO device.

Parameters, dynamic

In contrast to static parameters, you can change dynamic parameters of modules during operation by calling an SFC in the user program, e.g. limit values of an analog input module.

Parameters, static

In contrast to dynamic parameters, you cannot change static parameters of modules with the user program but only by configuring in STEP 7, e.g. input delay of a digital input module.

PELV

Protective **E**xtra **L**ow **V**oltage = grounded extra low voltage with safe isolation

Power module

The power module (PM) opens a new potential group for the load voltage supply 2L+.

Process image (I/O)

The CPU transfers the values from the input and output modules to this memory area. At the start of the cyclic program, the CPU transfers the signal states of the input modules to the process image input. At the end of the cyclic program, the CPU transfers the process image output as a 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.

PROFINET

PROcess FIeld NETwork, open Industrial Ethernet standard that continues PROFIBUS and Industrial Ethernet. A vendor-neutral communication, automation and engineering model, defined as an automation standard by PROFIBUS International e.V.

PROFINET component

A PROFINET component includes the entire data of the hardware configuration, the parameters of the modules and the corresponding user program. The PROFINET component is composed of:

- Technological function

  The (optional) technological (software) function includes the interface to other PROFINET components in the form of interconnectable inputs and outputs.

- Device

  The device is the representation of the physical automation device or field device including the I/O, sensors and actuators, mechanics and device firmware.

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).

PROFINET IO

Communication concept for the realization of modular, distributed applications in the framework 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. Often, the IO controller is the CPU on which the automation program runs.

Real-time

Real-time means that a system processes external events within a defined time.

Determinism means that a system responds in a predictable (deterministic) manner.

Both requirements are important for industrial networks. PROFINET satisfies these requirements. PROFINET is a deterministic real-time network by virtue of the following:

- Transmission of time-critical data between different stations over a network in a defined time interval is guaranteed. For this, PROFINET provides an optimized communication channel for real-time communication: Real-time (RT)
- An exact determination (forecast) of the transmission time instant is possible.
- It is ensured that smooth communication can take place in the same network using other standard protocols, e.g. industrial communication for PG/PC.

Restart

During a 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.

Retentivity

A memory area whose content is retained after power failure and after a STOP to RUN transition is retentive. The non-retentive area of the bit memory, timers and counters is reset after power failure and after a STOP to RUN transition.

Runtime error

Error that occurs during execution of the user program in the automation system (thus not in the process).

SELV

Safety **E**xtra **L**ow **V**oltage = Safety extra-low voltage

Sensors

Encoders are used for exact acquisition of digital and analog signals and for measurement of distances, positions, velocities, rotational speeds, masses, etc.

Shared device

IO device that makes its data available to multiple IO controllers.

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 a wide range of vendors on the Ethernet support SNMP.

SNMP-based applications can be operated in parallel with PROFINET applications on the same network.

The scope of supported functions varies depending on the device type.

Substitute value

Substitute values are parameterizable values that output modules output to the process when the CPU is in STOP mode.

Switch

PROFIBUS is based on a line topology. 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 directly connected to exactly one communication node.

If you want to link a communication node to several communication nodes, you connect this communication node to the port of an active network component - the switch. You can now connect other communication devices (including switches) to the other ports. 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 of other switches, and forwards only the signals intended for the connected PROFINET device or switch.

A switch has a specific number of connections (ports). Connect a maximum of one PROFINET device or other switch to any port.

Technological functions

See "PROFINET component"

Technology object

A technology object supports you in the configuration and commissioning of a technological function.

The properties of real objects are represented by technology objects in the controller. Real objects can be, for example, controlled systems or drives.

The technology object contains all data of the real object required for its open-loop or closed-loop control, and it signals back status information.

Termination module

The termination module terminates the ET 200pro distributed I/O system. The ET 200pro is not ready for operation without an inserted termination module.

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.

Time-delay interrupt

See "Interrupt, time-delay"

Time-of-day interrupt

See "Interrupt, time-of-day"

Timer

Timers are components of the system memory of the CPU. The operating system automatically updates the content of the "timer cells" asynchronously to the user program. STEP 7 instructions define the precise function of the timer cell (e.g. on-delay) and trigger its execution (e.g. start).

Update interrupt

See "Interrupt, update"

User program

SIMATIC differentiates between the operating system of the CPU and user program. The user program contains all instructions and declarations as well as data for the signal processing that enable a plant or process to be controlled. The user program is assigned to a programmable module (a CPU, for example). You can structure the user program into smaller units.

Warm restart

See "Restart"

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