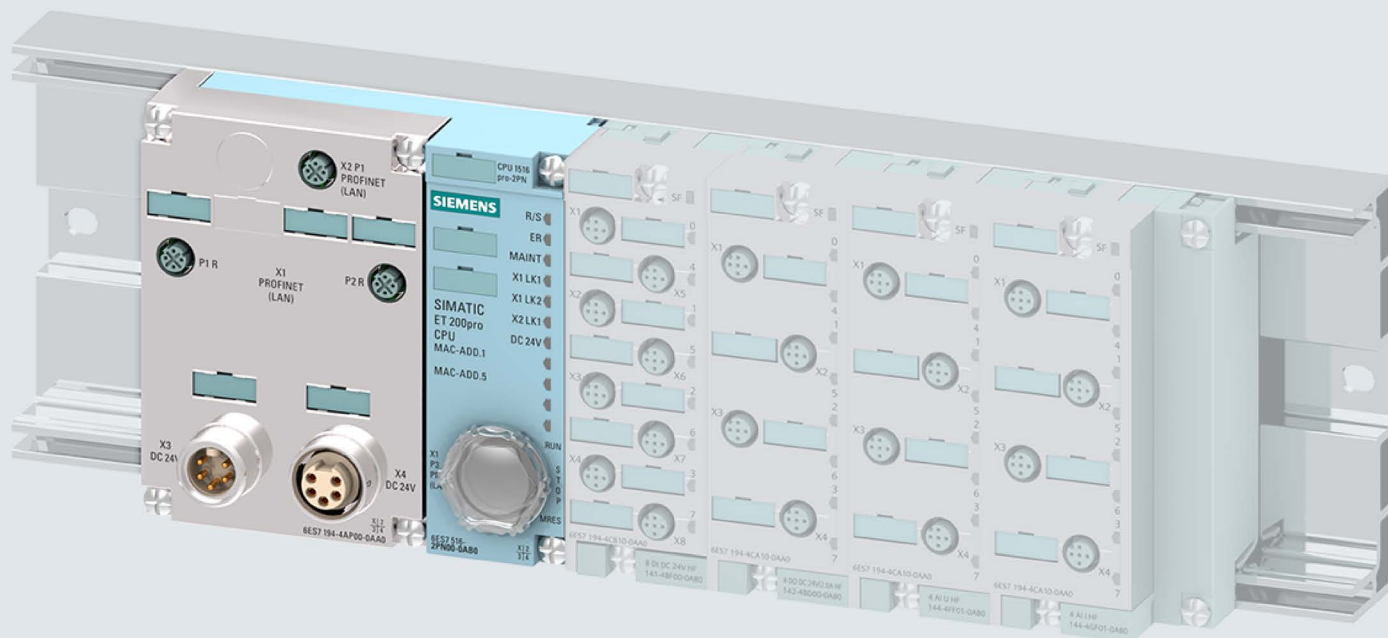


SIEMENS



Operating instructions

SIMATIC

ET 200pro

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

Edition

12/2017

support.industry.siemens.com

SIMATIC

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

Operating Instructions

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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.

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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.

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-CPU's in safety mode, note the description of the fail-safe system SIMATIC Safety Programming and Operating Manual SIMATIC Safety - Configuring and Programming (<http://support.automation.siemens.com/WW/view/en/54110126>).

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 under (<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 (<http://www.siemens.com/automation/service&support>).

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).

Catalogs for all the products in automation and drives are available on the Internet (<https://mall.industry.siemens.com>).

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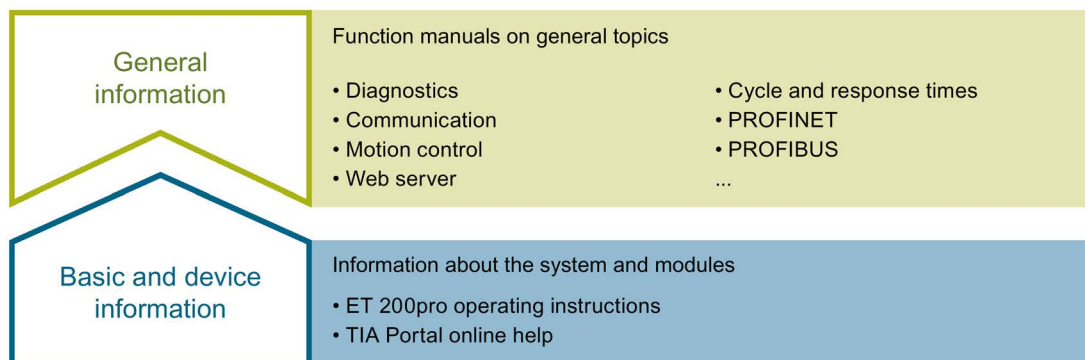
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Documentation guide

The documentation for the distributed I/O system ET 200pro and for the S7-1500 based CPU 1516pro-2 PN 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 (<http://w3.siemens.com/mcims/industrial-automation-systems-simatic/en/manual-overview/Pages/Default.aspx>).

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

"mySupport"

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>).

"mySupport" - Documentation

In the Documentation area in "mySupport" you can combine entire manuals or only parts of these to your own manual.

You can export the manual as PDF file or in a format that can be edited later.

You can find "mySupport" - Documentation on the Internet
(<http://support.industry.siemens.com/My/ww/en/documentation>).

"mySupport" - CAx data

In the CAx data area in "mySupport", you can access the current product data for your CAx or CAe system.

You configure your own download package with a few clicks.

In doing so you can select:

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

You can find "mySupport" - CAx data on the Internet
(<http://support.industry.siemens.com/my/ww/en/CAxOnline>).

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>).

TIA Selection Tool

With the TIA Selection Tool, you can select, configure and order devices for Totally Integrated Automation (TIA).

This tool is the successor of the SIMATIC Selection Tool and combines the known configurators for automation technology into one tool.

With the TIA Selection Tool, you can generate a complete order list from your product selection or product configuration.

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

SIMATIC Automation Tool

You can use the SIMATIC Automation Tool to perform commissioning and maintenance activities simultaneously on various SIMATIC S7 stations as a bulk operation independent of the TIA Portal.

General function overview:

- Network browsing and creation of a table showing the accessible devices in the network.
- Flashing of device LEDs or HMI display to locate a device
- Downloading of addresses (IP, subnet, gateway) to a device
- Downloading the PROFINET name (station name) to a device
- Placing a CPU in RUN or STOP mode
- Setting the time in a CPU to the current time of your PG/PC
- Downloading a new program to a CPU or an HMI device
- Downloading from CPU, downloading to CPU or deleting recipe data from a CPU
- Downloading from CPU or deleting data log data from a CPU
- Backup/restore of data from/to a backup file for CPUs and HMI devices
- Downloading service data from a CPU
- Reading the diagnostics buffer of a CPU
- Performing a CPU memory reset
- Resetting devices to factory settings
- Downloading a firmware update to a device

You can find the SIMATIC Automation Tool on the Internet (<https://support.industry.siemens.com/cs/ww/en/view/98161300>).

PRONETA

With SIEMENS PRONETA (PROFINET network analysis), you analyze the PROFINET network during commissioning. PRONETA features two core functions:

- The topology overview independently scans PROFINET network and all connected components.
- The IO check is a fast test of the wiring and the module configuration of a system.

You can find SIEMENS PRONETA on the Internet (<https://support.industry.siemens.com/cs/ww/en/view/67460624>).

New properties / functions

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 con- tents	Importing the configuration	When there is a connection to a physically present 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 physical configuration, you do not need to manually configure the CPU. This saves you time and avoids input errors.	Section Importing the configuration (Page 33)
	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 66)
	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 (Page 98)
	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 113)

What's new?		What are the customer benefits?	Where can I find information?
Changed contents	UDP	The maximum data length of the connection-less 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 126)
	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 plant configurations • Respond to hardware modifications. • Respond to hardware faults in the user program Finding and elimination of hardware errors is made easier.	Section Fetching and entering I&M data (Page 93)

See also

Product overview (Page 15)

Product overview

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

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 13849-1:2006 or according to EN ISO 13849-1:2008

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. Instead having to invest work in programming the diagnostic types, you can configure these on the user interface of STEP 7. The CPU shows system diagnostic information with a uniform design and in plain text in STEP 7, on the HMI and on the Web server, even alarms of the drives. This information is available in RUN mode, but also 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.

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 control systems and further systems

The CPU 1516pro-2 PN supports 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.

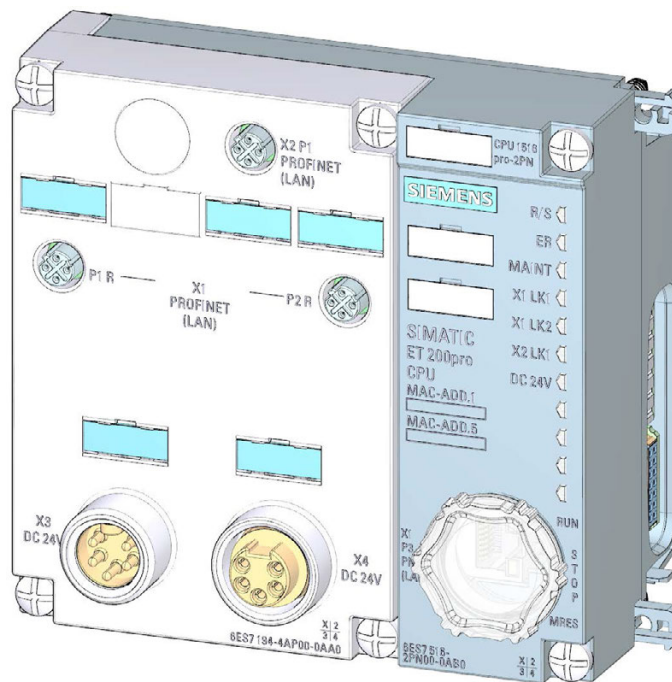


Figure 3-1 CPU 1516pro-2 PN

Properties

CPU 1516pro-2 PN has the following properties:

Property	Description	Additional 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)
PROFINET IO		
PROFINET interface X1	The first PROFINET interface (X1) has three ports (P1 R, P2 R and P3). In addition to PROFINET basic functionality, it also supports PROFINET IO RT (real-time) and IRT (isochronous real-time). P1R and P2R 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.	
Operation of the CPU as - IO controller - I-device	IO controller: As an IO controller, the CPU addresses the connected IO devices I-device As an I-device, the CPU is assigned to a high-level IO controller and is used as an intelligent pre-processing unit of sub-processes	

See also

FHB_Cycle_Reaction_Times

(<https://support.industry.siemens.com/cs/de/de/view/59193558/en>)

Trace (<https://support.industry.siemens.com/cs/ww/en/view/64897128>)

Motion control (<https://support.industry.siemens.com/cs/ww/en/view/59381279>)

Internet (<http://www.profibus.com>)

Sizer (<http://w3.siemens.com/mcsmc-solutions/en/engineering-software/drive-design-tool-sizer/Pages/drive-design-tool-sizer.aspx>)

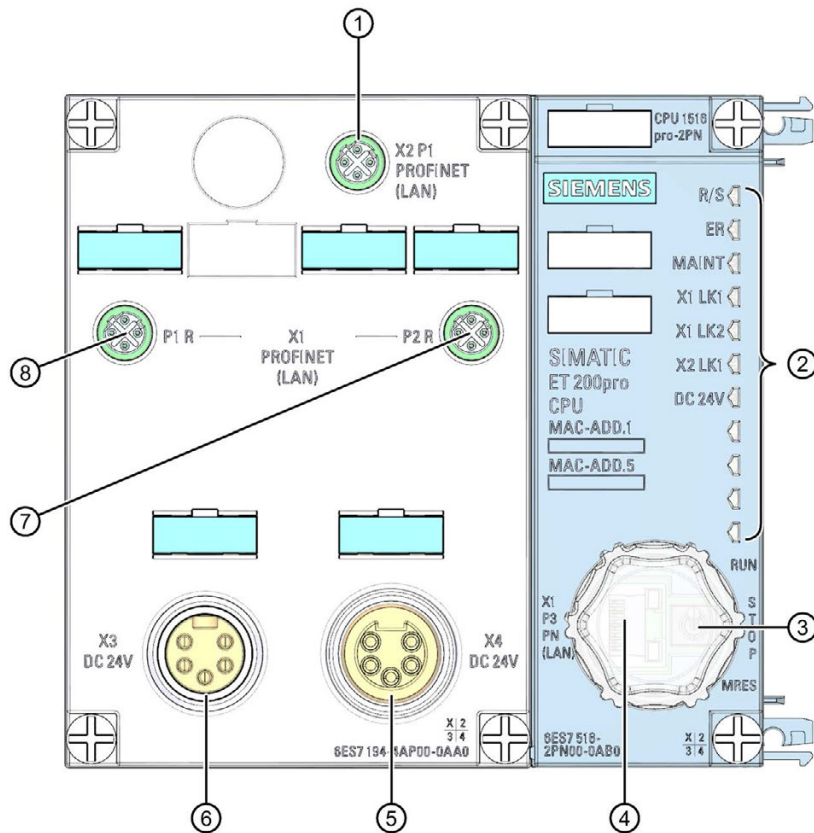
TIA Selection Tool (<http://w3.siemens.com/mcsm/topics/en/simatic/tia-selection-tool>)

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 M12 circular socket with female contact insert for connection to PROFINET (Port 1 of PROFINET interface X2)
- ② Status and error displays
- ③ Mode switch
- ④ 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.
- ⑤ 7/8" circular socket with female contact insert (X4) for loop-through of electronics/encoder supply 1L+ and load voltage supply 2L+
- ⑥ 7/8" circular socket with male contact insert (X3) for infeed of electronics/encoder supply 1L+ and load voltage supply 2L+
- ⑦ M12 circular socket with female contact insert for connection to PROFINET (Port 2 of PROFINET interface X1)
R: Ring port for configuration of a ring topology with media redundancy*
- ⑧ M12 circular socket with female contact insert for connection to PROFINET (Port 1 of PROFINET interface X1)
R: Ring port for configuration of a ring topology with media redundancy*

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

Slot for the SIMATIC memory card

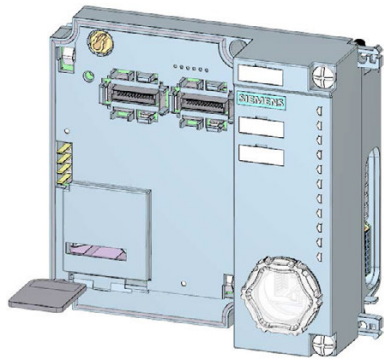


Figure 3-3 Slot for the SIMATIC memory card

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 79).

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 user program is not being executed.
MRES	Memory reset	Position for CPU memory reset.

Mounting and connecting

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 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 N/m
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 79).
4. Insert the connection module CM CPU 2PN M12, 7/8" onto the CPU.
5. Screw the terminal module onto the rack.
4 recessed head screws on the front, 1.5 Nm torque.
6. Mount the electronic modules and any power modules or 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.

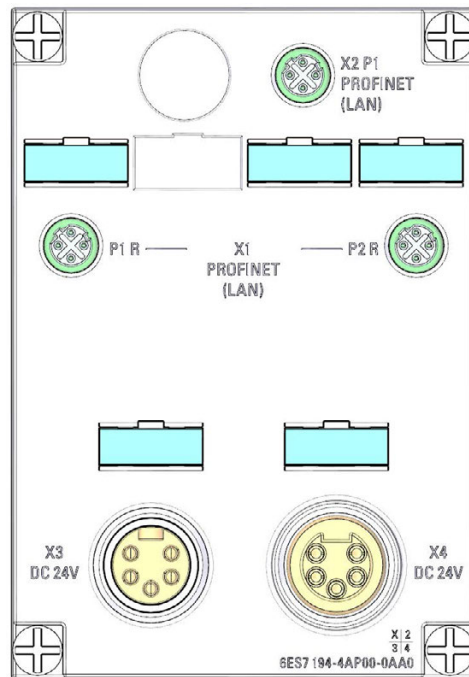


Figure 4-1 View of the connection module CM CPU 2PN M12, 7/8"

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

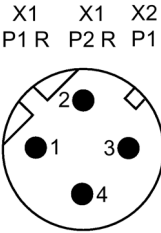
Pin assignment of the M12 connector

M12 circular socket X1-P1 R and X1-P2 R:

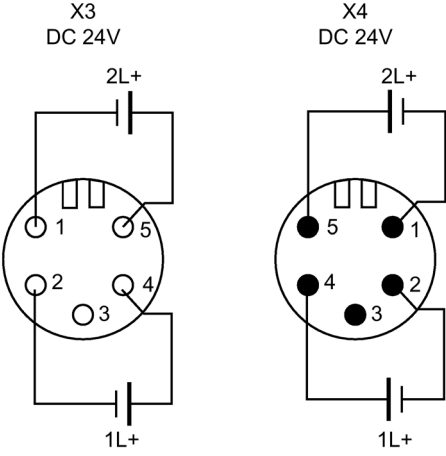
- If autonegotiation is activated, then the M12 circular socket has the switch assignment (MDI-X).
- If autonegotiation is activated, then autocrossing is active and the M12 circular socket has either a device assignment (MDI) or switch assignment (MDI-X).

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 (torque = 1.5 N/m).

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.

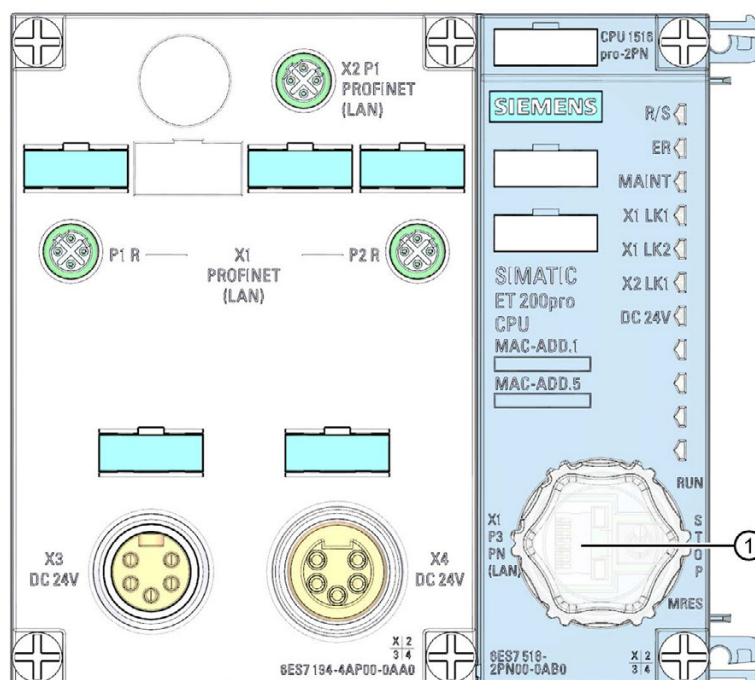
Closing unused sockets

Always close all unused sockets with M12 and 7/8" cover caps (see section Accessories) in order to achieve degree of protection IP65, IP66 or IP67. You can find the order numbers of the cover caps in appendix Accessories/spare parts (Page 140).

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).

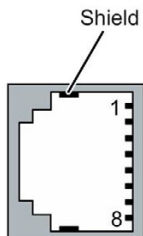


Figure 4-3 View of RJ45 socket

Connect the RJ45 connector

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

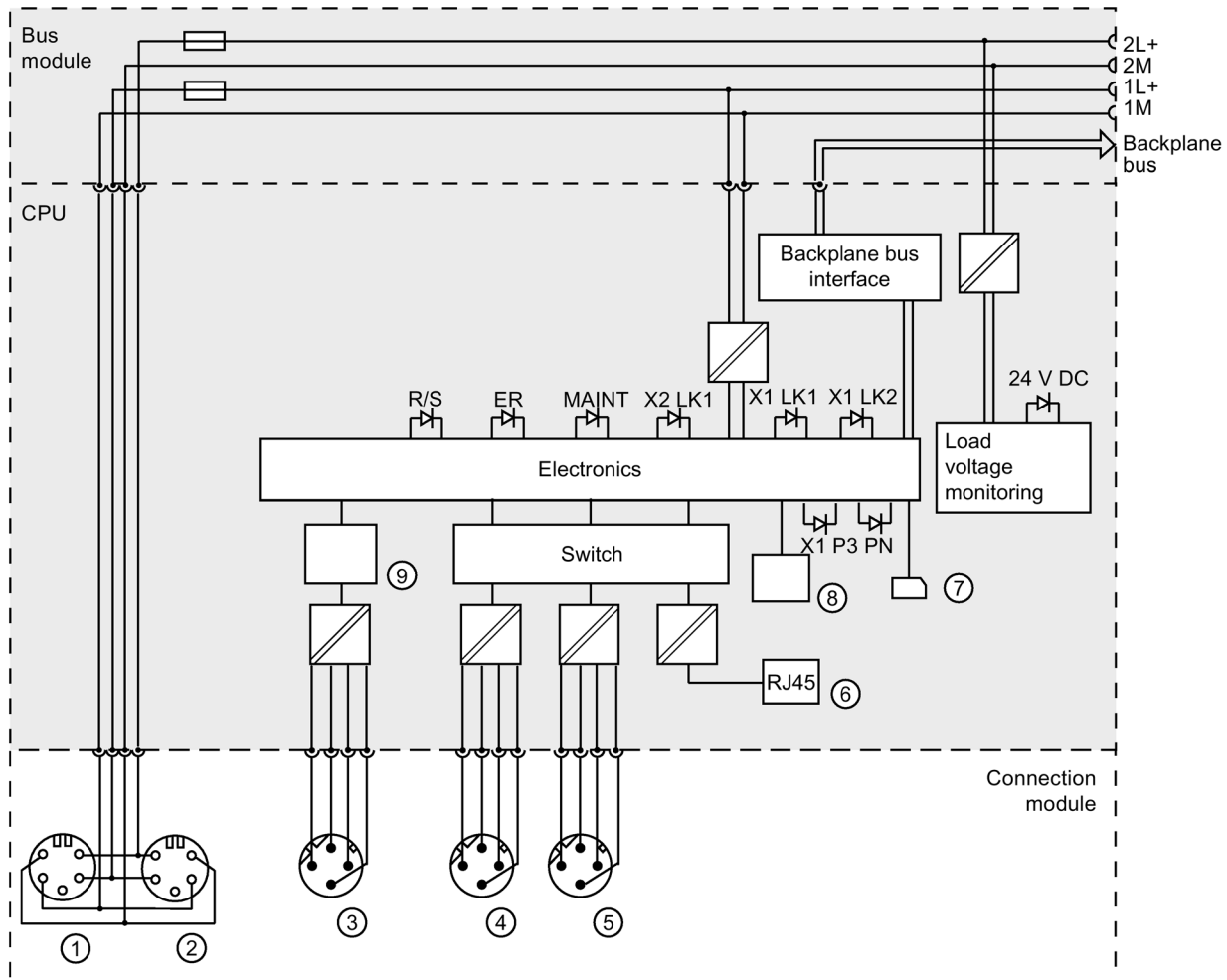
Note

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

Screw the screw cap back onto the CPU in order to achieve degree of protection IP65, IP66 and IP67. 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) | ERROR | LED diagnostic status (red) |
| ④ | PROFINET interface X1 Port 1 (X1 P1 R) | MAINT | LED diagnostic status (yellow) |
| ⑤ | PROFINET interface X1 Port 2 (X1 P2 R) | 24 V DC | LED load voltage supply (green) |
| ⑥ | PROFINET interface X1 Port 3 (X1 P3) | X1 P1 | PROFINET LEDs (green) |
| ⑦ | SIMATIC memory card | X1 P2 | |
| ⑧ | Mode switch | X1 P3 | |
| ⑨ | Ethernet controller | X2 P1 | |
| RUN | LED operating mode (green) | | |

Figure 4-4 Wiring and circuit diagram

Configuring

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 for the TIA Portal 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 a physically present 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 90).

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 CPU".

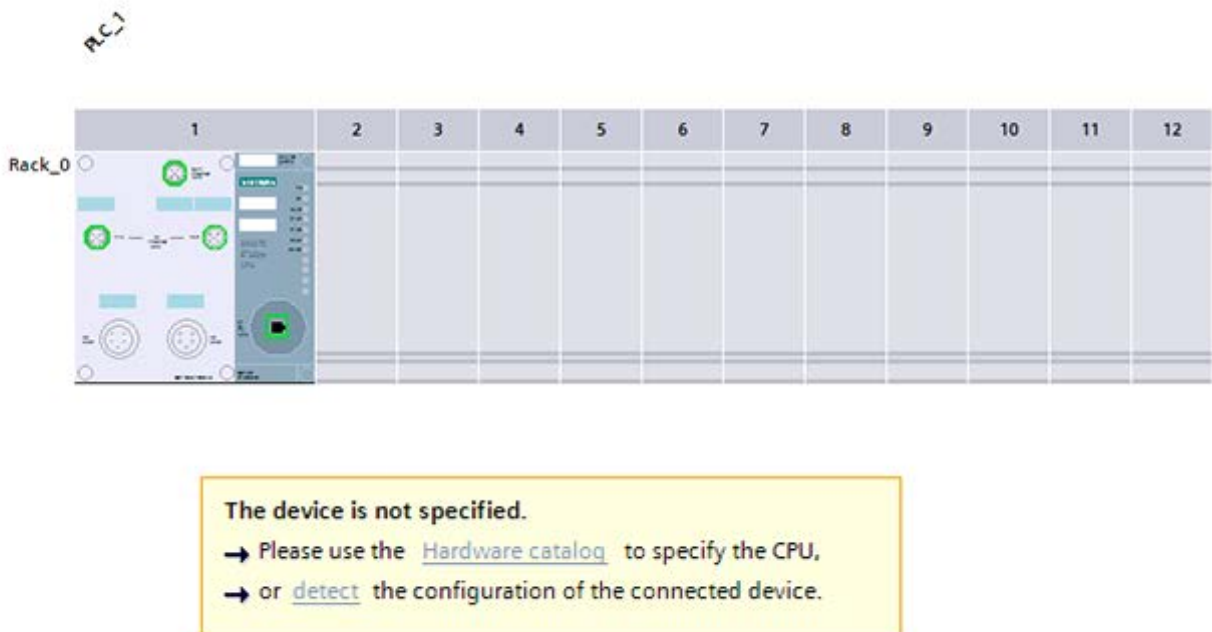


Figure 5-1 Unspecified CPU in the device view

Note

Click the "detect" link to open the "Hardware detection for PLC_x" dialog.

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.

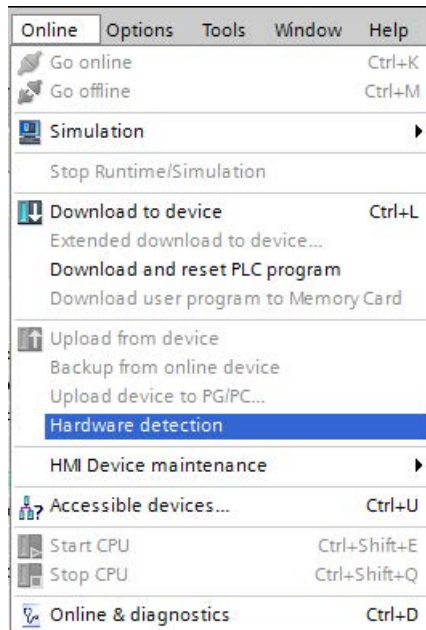


Figure 5-2 Hardware detection in the Online menu

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

- [illegible]

Figure 5-3 Hardware detection dialog box

Result of the hardware detection

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

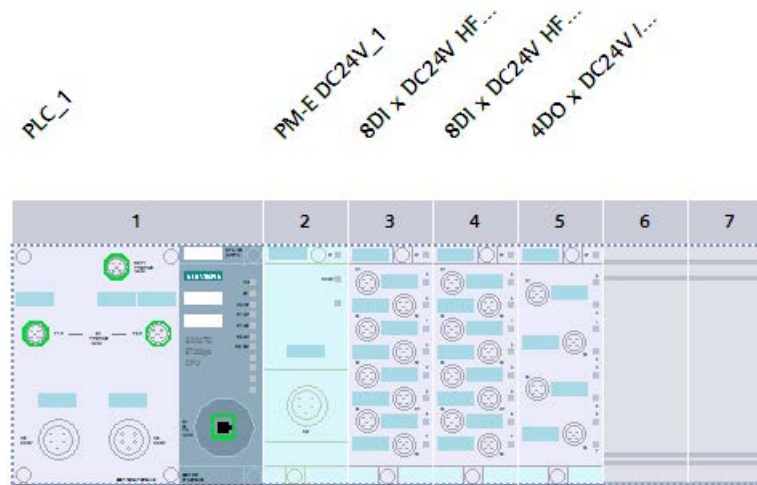


Figure 5-4 Result of the hardware detection in the device view

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 central modules

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

- Startup characteristics
- Parameter assignment of the interface(s), e.g. IP address, subnet mask
- Web server, e.g., activation, user administration, and languages
- OPC UA server
- 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 have to 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.

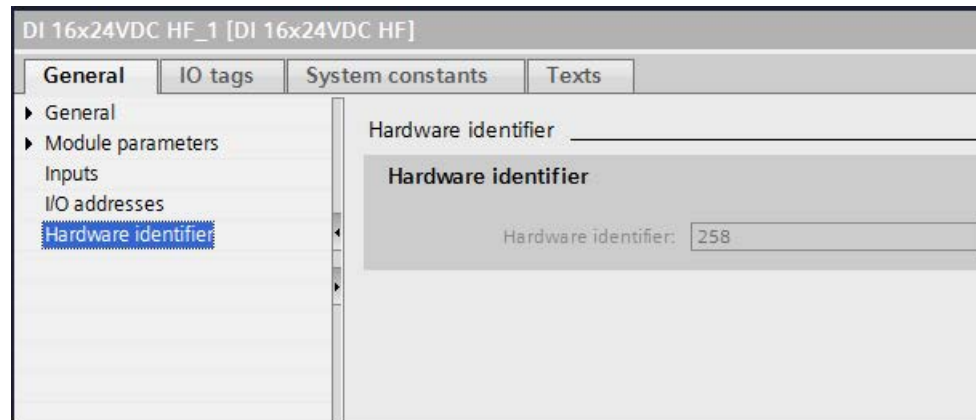


Figure 5-6 Example of a hardware identifier from STEP 7

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.

Tags			
User constants			
System constants			
	Name	Data type	Value
47	DI_16x24VDC_HF_1[DI]	Hw_SubModule	258
48	DQ_32x24VDC_0.5A_ST_1[DO]	Hw_SubModule	259
49	AI_8xU_I_HS_1[AI]	Hw_SubModule	260
50	AQ_8xU_I_HS_1[AO]	Hw_SubModule	261

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

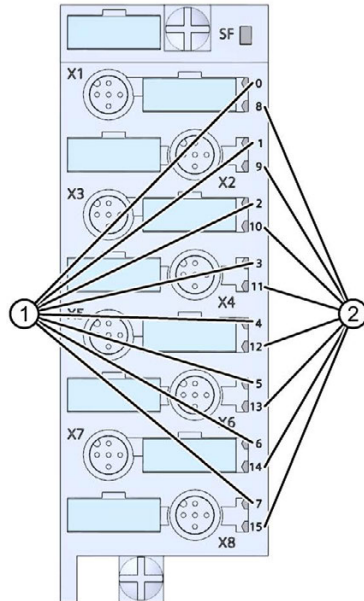
The example consists of:

- 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 arise using the digital electronic module 16 DI DC 24 V as an example.



- 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

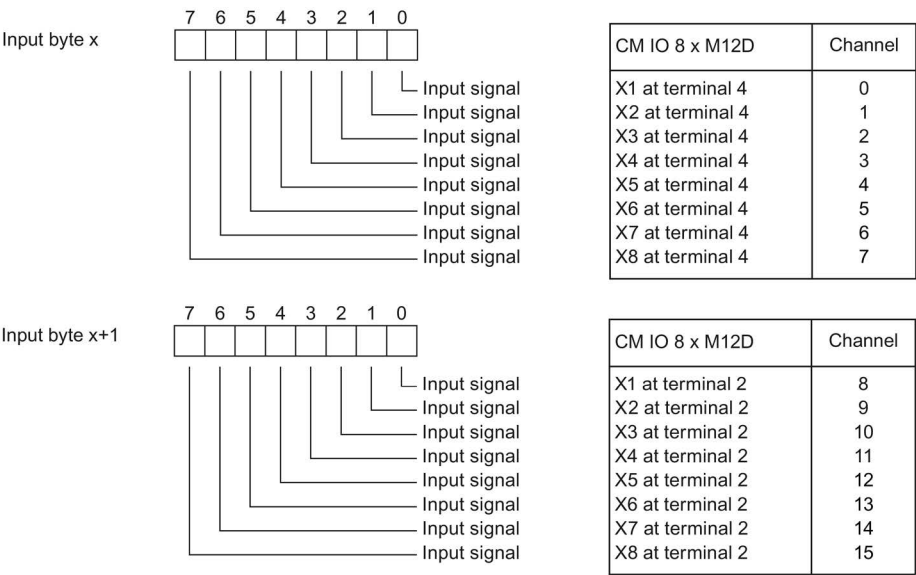


Figure 5-9 Address space 16 DI DC 24 V

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 (in the following figure, the module start address is 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 arise using the analog electronic module 4 AI RTD High Feature as an example.

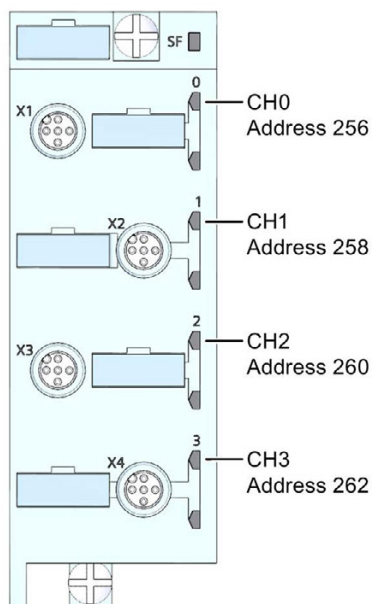


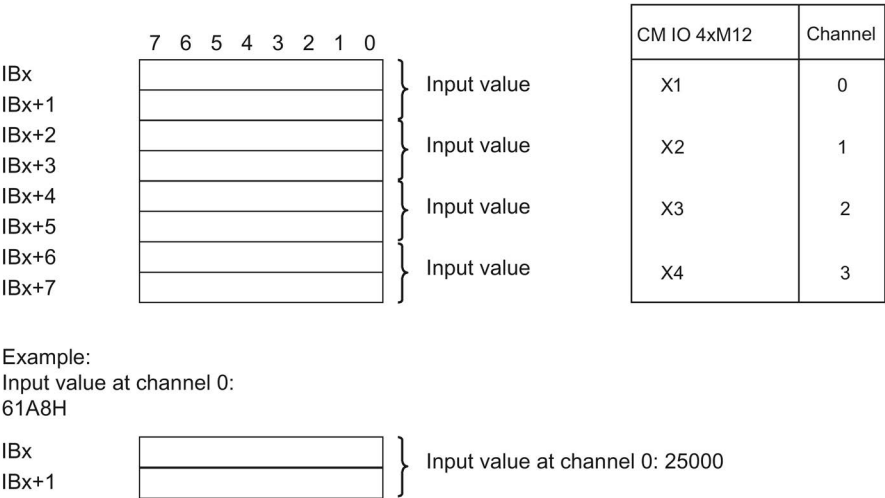
Figure 5-10 Example of the assignment of addresses to channels (analog electronic module)

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



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.

After the OB has been started, the CPU updates the assigned process image partition for inputs and reads in the process signals. At the end of the OB the CPU writes the outputs of the assigned process image partition directly to the peripheral outputs without having to wait for the completion of the cyclic program processing.

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 of the associated OB and always outputs the process image partition of the outputs (PIPO) at the end of the OB.

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

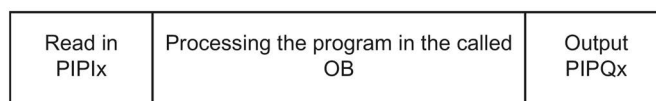


Figure 5-12 Update process image partitions

5.2.3.3 Update process image partitions in the user program

Requirements

As an alternative to the methods described above, you can use the "UPDAT_PI" or "UPDAT_PO" instruction at the start or end of the respectively assigned OB to update the process image. These instructions are available in STEP 7 on the "Instructions" task card under "Extended instructions" and may be called from any point in the program.

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

- The process image partitions cannot be assigned to any OB, i.e. they cannot be 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 the situation where a subsequent output of the process image overwrites the value written via direct access again.

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

6.1 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 provides an overview of:

- Possible event sources
- Possible values for the OB priority
- Possible OB numbers
- Default system reaction
- Number of 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 (18)	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

Types of event sources	Possible priorities (default priority)	Possible OB numbers	Default system reaction ¹⁾	Number of OBs
Isochronous mode interrupt	16 to 26 (21)	61 to 64, ≥ 123	Ignore	0 to 2
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
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, where applicable after you have configured the event source.

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

The CPU ignores hardware interrupts to which you did not assign an OB in your configuration or which occur after the DETACH instruction. The 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 prevent extending the program runtime unnecessarily in time-critical applications, these OBs should not be 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 CPU overload behavior

Requirements

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

Principle of CPU overload behavior

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

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

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

More detailed information is provided in the following sections.

Discarding similar events or fetching them later

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

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

Note

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

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

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

Threshold mechanism for time error OB request

The OB parameter "Enable time error" is used to specify whether the time error OB is to be called at a defined overload for similar events. You can find the OB parameter "Enable time error" in the properties of the OB in the "Attributes" category.

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

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

The following value range applies to the "Event threshold for time error" parameter: $1 \leq \text{"Event threshold for time error"} \leq \text{"Events to be queued"}$.

6.3 Asynchronous instructions

Difference between synchronous and asynchronous instructions

Program processing differentiates between instructions operating synchronously and asynchronously.

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 (data records for modules, communication data, diagnostic data, etc.).

Processing of 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 five times before its execution is complete, e.g. a data record has been completely transferred.

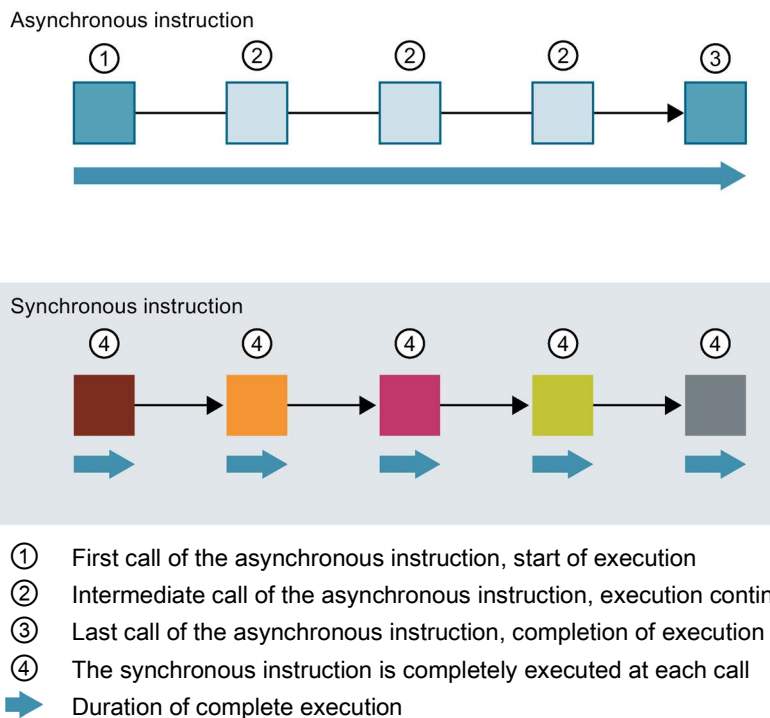


Figure 6-1 Difference between asynchronous and synchronous instructions

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:

- Several asynchronous instruction jobs are called at the same time.
- 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.

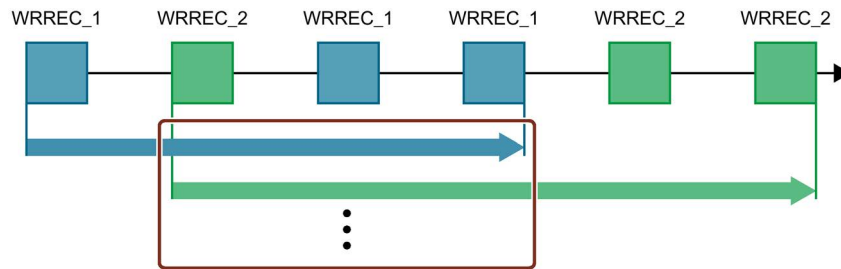


Figure 6-2 Parallel processing of the asynchronous instruction WRREC

Assignment of call to job of the instruction

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.

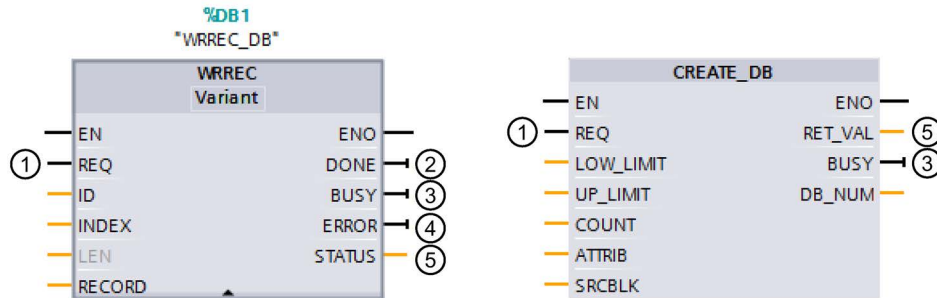
The following table shows which input parameters you use to identify which instruction.

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

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
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 simultaneous jobs for an instruction is exceeded, 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 with multiple lower-level instructions, only one lower-level resource is typically allocated at a time.

Extended instructions: maximum number of simultaneously running jobs

The following table shows the maximum number of simultaneously running jobs for asynchronous extended instructions.

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
PROFenergy	
PE_START_END	uses RDREC, WRREC
PE_CMD	uses RDREC, WRREC
PE_DS3_Write_ET200 S	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

The following table shows the maximum number of simultaneously running jobs 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

The following table shows the maximum number of simultaneously running jobs for asynchronous instructions (Open User Communication) for the CPU.

Open User Communication	CPU 1516pro-2 PN
TSEND TUSEND	256
TRCV TURCV	256
TCON	256
TDISCON	256
T_RESET	256
T_DIAG	256
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

The following table shows the maximum number of simultaneously running jobs for asynchronous instructions (MODBUS TCP) for the CPU.

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

The table below shows the maximum number of simultaneously running jobs for asynchronous instructions (S7 communication) for the CPU. The S7 communication instructions use a common pool of resources.

S7 communication	CPU 1516pro-2 PN
PUT GET USEND URCV BSEND BRCV	768

The table below shows the maximum number of simultaneously running jobs for asynchronous instructions (communications processors) for the CPU.

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

The following table shows the maximum number of simultaneously running jobs for asynchronous instructions (OPC UA) for the CPU.

OPC_UA	CPU 1516pro-2 PN
OPC_UA_Connect	10
OPC_UA_Disconnect	10
OPC_UA_Namespace GetIndexList	10
OPC_UA_NodeGetHandleList	10
OPC_UA_NodeReleaseHandleList	10
OPC_UA_TranslatePathList	10
OPC_UA_Browse	10
OPC_UA_ReadList	10
OPC_UA_WriteList	10
OPC_UA_MethodGetHandleList	10
OPC_UA_MethodReleaseHandleList	10
OPC_UA_MethodCall	10
OPC_UA_ServerMethodPre	10
OPC_UA_ServerMethodPost	10
OPC_UA_ConnectionGetStatus	10

Technology: maximum number of simultaneously running jobs

The following table shows the maximum number of simultaneously running jobs for asynchronous instructions (technology).

Technology	CPU 1516pro-2 PN
Motion control	
MC_Power	1500
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	

Reference

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

Protection

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 access levels to limit access to specific functions.

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

Access levels of the CPU

Table 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. Without entering the password, you cannot load any blocks or hardware configuration into the CPU. Additionally, the following are not possible without the password: Writing test functions and firmware update (online).
HMI access	With this access level only HMI access and access to diagnostics data is possible without entering the password. Without entering the password, you can neither load blocks and hardware configuration into the CPU, nor load blocks and hardware configuration from the CPU into the programming device. Additionally, the following are not possible without the password: Test functions, 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.

You can find a list of which functions are possible in the various protection levels in the STEP 7 online help under the entry "Setting options for the protection".

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

The configuration of access levels offers a high degree of protection against unauthorized changes on the CPU. The access levels 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

You can find a tabular list of which online functions are possible in the various access levels in the STEP 7 online help.

Parameterizing the procedure at 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. Open the "Protection" entry in the area navigation.

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

Access level	Access			Access permission
	HMI	Read	Write	Password
☐ Full access (no protection)	✓	✓	✓	
☒ Read access	✓	✓		
☐ HMI access	✓			
☐ No access (complete protection)				

Enter password:
 Confirm password:

☐ ☐

Read access:
TIA Portal users will have read access to all functions.
HMI applications can access all functions.

Mandatory password:
For additional write access, TIA Portal users need to enter the "full access" password.

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 (see above), read access and HMI access is 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.

Ensure that the password is sufficiently secure, in other words, that it does not follow a pattern that can be recognized by a machine!

5. Assign additional passwords to other access levels as needed, if the selected access level calls for this.
6. Download the hardware configuration for the access level to take effect.

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

Behavior of a password-protected CPU during operation

The CPU protection takes effect after 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".

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 (<http://support.automation.siemens.com/WW/view/en/54110126>).

7.3 Using the user program to set additional access protection

Access protection by means of the user program

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

7.4 Know-how protection

Application

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

Password provider

As an alternative to manual password entry, you can link 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. A password is, for example, identified with the symbolic name "Machine_1" in the password provider. The actual password behind "Machine_1" remains hidden to you.
This means that a password provider offers you optimal block protection because operators do not know the actual password.
- 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 can provide global data blocks (global DBs) with know-how protection. Users who do not possess the valid password can read the global data block but not change it.

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

Setting up block know-how protection

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

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

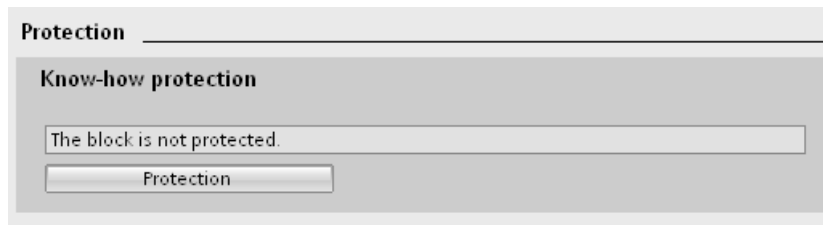


Figure 7-2 Setting up block know-how protection (1)

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



Figure 7-3 Setting up block know-how protection (2)

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



Figure 7-4 Setting up block know-how protection (3)

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

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

Note

Password provider

Alternatively, you can configure 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 and you will not be able to edit the block.

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

Removing block know-how protection

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

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



Figure 7-5 Removing block know-how protection (1)

4. Enter the password.



Figure 7-6 Removing block know-how protection (2)

5. Click "OK" to confirm your entry.

Result: Know-how protection is removed for the selected block.

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".

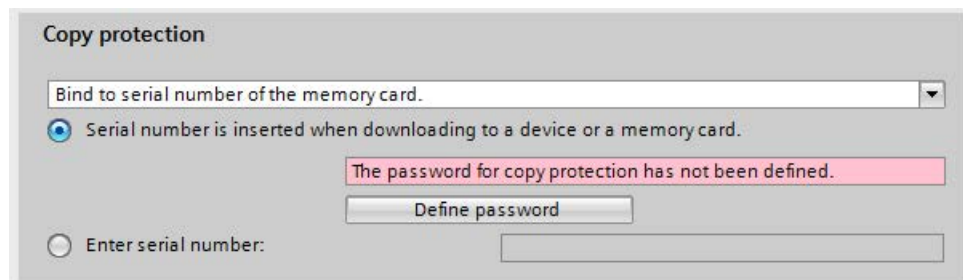


Figure 7-7 Setting up copy protection (1)

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

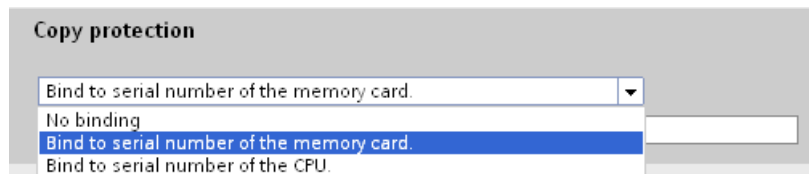


Figure 7-8 Setting up copy protection (2)

4. Activate the option "Serial number is inserted when downloading to a device or a memory card" if STEP 7 is to automatically insert the serial number during the upload process (dynamic binding). Assign a password using the "Define password" to link the use of a block/program additionally to the input of a password.
If you want to manually bind the serial number of the CPU or the SIMATIC memory card to a block activate the option "Enter serial number" (static binding).
5. You can now set up the know-how protection for the block in the "Know-how protection" area.

Note

If you download a copy-protected block to a device that does not match the specified serial number, the entire download operation 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 66).
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.

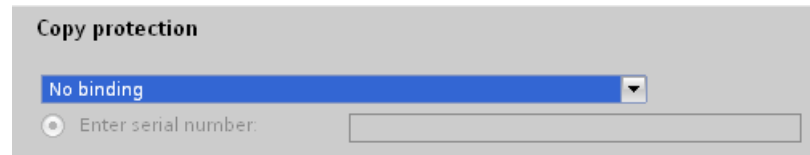


Figure 7-9 Removing copy protection

Commissioning

8.1 Overview

Introduction

This section includes information on the following topics:

- Commissioning the CPU 1516pro-2 PN on PROFINET IO
- Removing/inserting the SIMATIC memory card
- Operating modes of the CPU
- CPU memory reset
- Identification and maintenance data

Commissioning requirements

Note

Performing tests

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

Also allow for any possible foreseeable errors in the tests. This avoids endangering persons or equipment during operation.

PRONETA

With SIEMENS PRONETA (PROFINET network analysis), you analyze the system network during commissioning. PRONETA features two core functions:

- The topology overview independently scans PROFINET and all connected components.
- The IO check is a fast test of the wiring and the module configuration of a plant.

You can find SIEMENS PRONETA on the Internet

(<https://support.industry.siemens.com/cs/ww/en/view/67460624>).

SIMATIC Automation Tool

You can use the SIMATIC Automation Tool to perform commissioning and maintenance activities simultaneously on various SIMATIC S7 stations as a bulk operation independent of the TIA Portal.

General function overview:

- Network browsing and creation of a table showing the accessible devices in the network.
- Flashing of device LEDs or HMI display to locate a device
- Downloading of addresses (IP, subnet, gateway) to a device
- Downloading the PROFINET name (station name) to a device
- Placing a CPU in RUN or STOP mode
- Setting the time in a CPU to the current time of your programming device/PC
- Downloading a new program to a CPU or an HMI device
- Downloading from CPU, downloading to CPU or deleting recipe data from a CPU
- Downloading from CPU or deleting data log data from a CPU
- Backup/restore of data from/to a backup file for CPUs and HMI devices
- Downloading service data from a CPU
- Reading the diagnostics buffer of a CPU
- Performing a CPU memory reset
- Resetting devices to factory settings
- Downloading a firmware update to a device

You can find the SIMATIC Automation Tool on the Internet (<https://support.industry.siemens.com/cs/de/en/view/98161300>).

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 110)).
- 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, i.e. all bus, electronic, and 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.

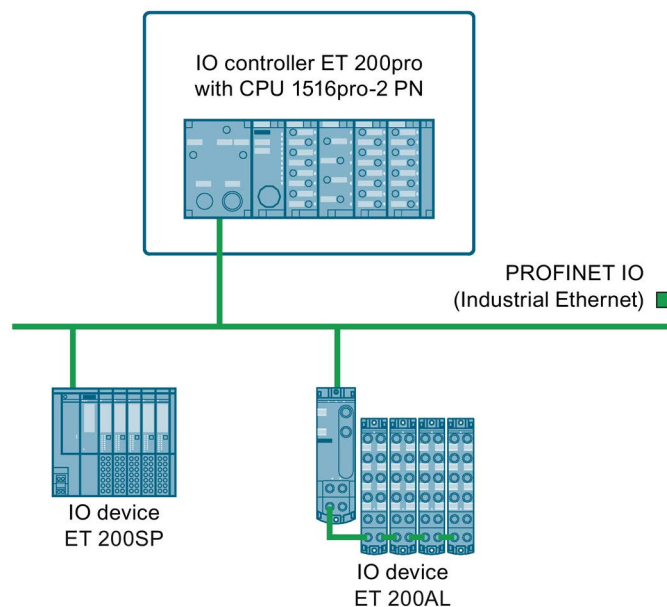


Figure 8-1 CPU 1516pro-2 PN as IO controller

Commissioning procedure

To commission the ET 200pro distributed I/O system as an IO controller on PROFINET IO, we recommend the following procedure:

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 79)
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 33)

Step	Procedure	See ...
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 84)
9	Check LEDs	Section Interrupts, diagnostics, error messages and system events (Page 121)
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 functions and fault resolution (Page 113)

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.

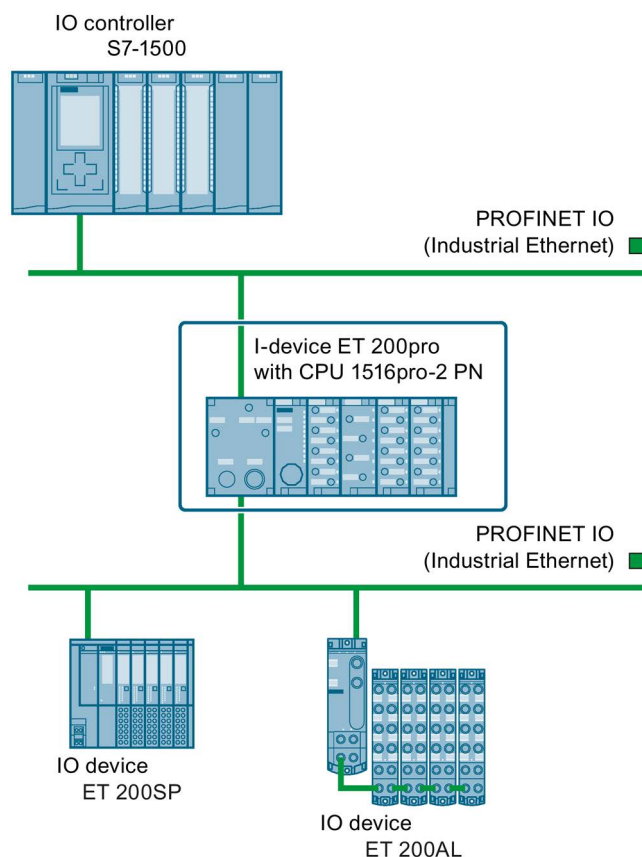


Figure 8-2 CPU 1516pro-2 PN as I-device

Commissioning procedure

To commission the ET 200pro distributed I/O system as an I-device on PROFINET IO, we recommend the following procedure:

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 79)

Step	Procedure	See ...
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 33)
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 84)
9	Check LEDs	Section Interrupts, diagnostics, error messages and system events (Page 121)
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 functions and fault resolution (Page 113)

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

Ensure that the SIMATIC memory card to be inserted contains the correct user program for the CPU (for 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.
2. Loosen the 4 screws of the connection module CM CPU 2PN M12, 7/8" and remove it from the CPU.

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.

3. Is a SIMATIC memory card already inserted?
If so, gently push the SIMATIC memory card into the card slot to release the locking mechanism. You can then 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 screw it into place.
6. Perform a memory reset (see section "CPU memory reset (Page 87)").

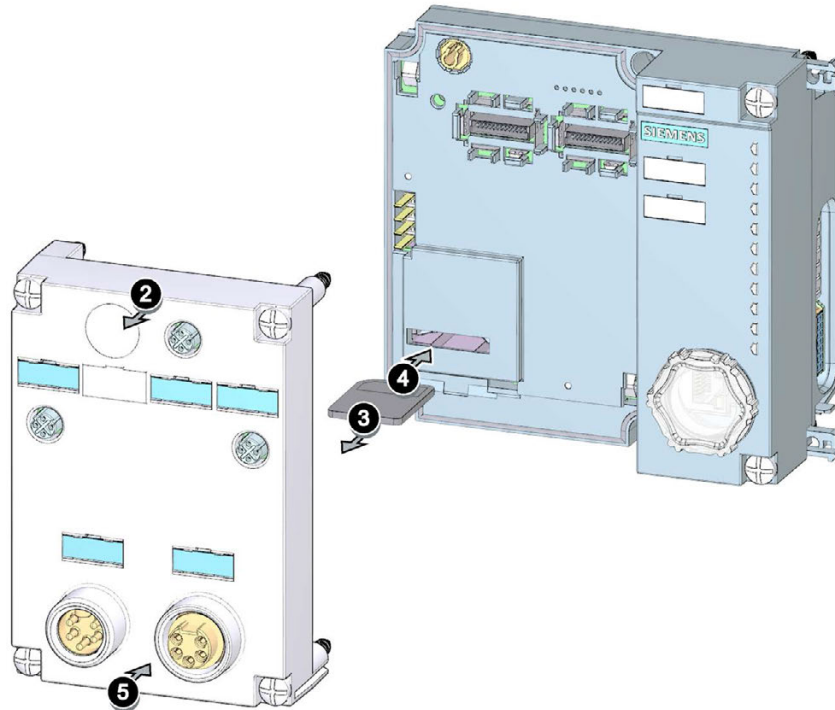


Figure 8-3 Inserting/replacing the SIMATIC memory card

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 recognizes

- A physically identical SIMATIC memory card with modified content
- A new SIMATIC memory card with the same content as the old 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 sections SIMATIC memory card (Page 98) and Accessories/spare parts (Page 140).

8.4 Operating modes of the CPU

8.4.1 Operating modes of the CPU

Introduction

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

- STARTUP
- RUN
- STOP

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

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

8.4.2 STARTUP mode

Function

Before the CPU starts to execute the cyclic user program, it executes a startup program.

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

Special features in Startup mode

- All outputs are disabled or react according to the parameter settings for the respective module: They provide a substitute value as set in the parameters or retain the last value output and bring the controlled process to a safe operating mode.
 - The process image is initialized.
 - The process image is not updated.
In order to read the current state of inputs during STARTUP, you can access inputs by direct I/O access.
In order to initialize outputs during STARTUP, you can write the values via the process image or via direct I/O access. The 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 mode.
 - 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 find a description of the use of global and local error handling in the STEP 7 online help.
- The CPU cannot start all other OBs until after the transition to RUN mode.

Response when expected and actual configurations do not match

The configuration downloaded to the CPU represents the expected configuration. The actual configuration is the actual 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 (see section Operating mode transitions).

Canceling a startup

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

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

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

Parameter assignment of startup behavior

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

Setting the startup behavior

To set the startup characteristics, follow these steps:

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

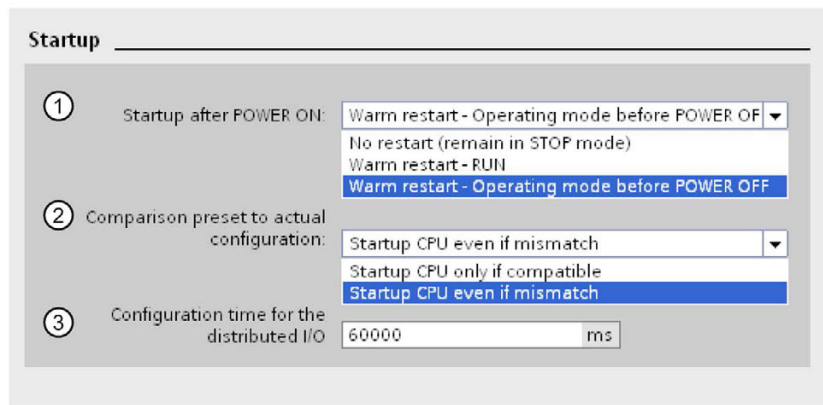


Figure 8-4 Setting the startup characteristics

- 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 number of inputs and output and must match with respect to its electrical and functional properties.
 - Startup CPU even if mismatch: At this setting the CPU starts up irrespective of the type of module plugged.
- 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"

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

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

8.4.3 STOP mode

Function

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

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

8.4.4 RUN mode

Function

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, see also section Process images and process image partitions (Page 44).

Execution of the user program

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

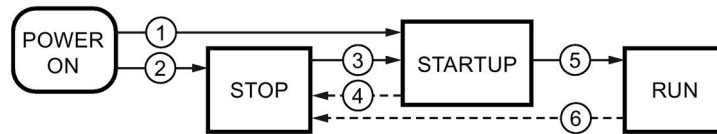


Figure 8-5 Operating modes and operating mode transitions

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	The CPU returns to the "STOP" mode in the following cases of "STARTUP": • 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	The CPU goes to the "RUN" mode in the following cases of "START-UP": • The CPU has initialized the PLC tags. • The CPU has executed the startup blocks successfully.	
⑥	RUN → STOP	The CPU returns to the "STOP" mode in the following cases of "RUN": • 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

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

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

This means that:

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

Result:

- If you set an IP address in the hardware configuration ("Set IP address in the project" option) and a SIMATIC memory card with the project is in the CPU, this IP address is valid after the memory reset.
- Data blocks no longer have current values but rather their configured start values.
- Force jobs remain active.

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

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

Result after memory reset

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

Table 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
Diagnostics buffer entries	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 cause of automatic memory reset

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

Causes for such errors can be:

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

8.5.3 Manual memory reset

Reason for manual memory reset

A memory reset of the CPU is required to reset the CPU to its "initial state".

CPU memory reset

The memory reset of the CPU is possible:

- 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 selector in this position until the RUN/STOP LED lights up for the 2nd time and remains continuously lit (this takes three seconds). After this, release the 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 110).

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

Upload from device (software)

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

Upload device as new station

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

Snapshot of the monitor values

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

Overview of backup types

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

	Backup from online device	Upload from device (software)	Upload device as new station	Snapshot of the monitor values
Actual values of all DBs (global and instance data blocks)*	✓	✓	✓	✓
Blocks of the type OB, FC, FB and DB	✓	✓	✓	--
PLC tags (tag names and constant names)	✓	✓	✓	--
Technology objects	✓	✓	✓	--
Hardware configuration	✓	--	✓	--
Actual values (bit memories, timers, counters)*	✓	--	--	--
Contents of the SIMATIC memory card	✓	--	--	--
Archives, recipes	✓	--	--	--
Entries in the diagnostics buffer	--	--	--	--
Current time	--	--	--	--
Properties of the type of backup				
Backup possible for fail-safe 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, refer to an FAQ on the Internet (<https://support.industry.siemens.com/cs/ww/en/view/97649773>).

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 are made available by the system (e.g. diagnostic buffer texts) or created during the configuration (e.g. alarms).

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 are downloaded in the selected languages with the project data to the CPU and are also used by the Web server/CPU display:

- Diagnostic buffer texts (cannot be changed)
- Status texts for the module status (cannot be changed)
- Alarm texts with associated text lists
- Tag comments and step comments for S7 GRAPH and PLC Code Viewer
- Comments in watch tables

The following texts are also downloaded in the selected languages with the project languages to the CPU but are not used by the Web server/CPU display:

- 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. If the project texts of a particular project language exceed the reserved memory space nevertheless, the project cannot be downloaded to the CPU. The download is aborted with a notice that not enough memory space is available. If this happens, take steps to reduce the required memory space, e.g. shorten 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 (e.g. Russian texts more 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 the memory space needed for downloading projects exceeds the memory space on the utilized SIMATIC memory card, the download to the CPU is aborted with 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

I&M identification data is information which is stored on the module either as read-only data (I-data) or read/write data (M-data).

Identification data (I&M0): Manufacturer information about the module that can only be read and is in part also printed on the housing of the module, for example, article number and serial number.

Maintenance data (I&M1, 2, 3): Plant-dependent information, e.g. installation location. Maintenance data is created during configuration and written to the module.

Note

The CPU supports identification data (I&M0) only for the 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.

STEP 7 allows you to read the identification I&M data (see STEP 7 online help).

Options for reading out I&M data

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

Procedure for reading I&M data by means of the user program

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

The data record structure for distributed modules accessible via PROFINET IO is described in section Data record structure for I&M data (Page 95).

Procedure for reading the 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. Select the CPU 1516pro-2 PN in the project tree and go to "Online & diagnostics".
2. Select the "General" area in the "Diagnostics" folder.

Procedure for entering the 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. In the properties under "General", select the "Identification & Maintenance" area and enter the data.

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

Procedure for reading out the I&M data via the Web server

The procedure is described in detail in the Web server

(<http://support.automation.siemens.com/WW/view/en/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- 5 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- 6 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.

8.8 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 shows 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 detailed information on Team Engineering in the STEP 7 online help.

SIMATIC memory card

9.1 SIMATIC memory card - overview

Introduction

The CPU uses a SIMATIC memory card as a memory module. The SIMATIC memory card is a preformatted memory card compatible with the Windows file system. The memory card is available in different memory sizes and can be used for the following purposes:

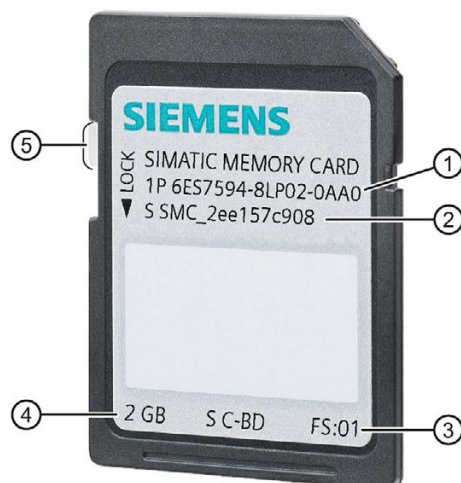
- Transportable data carrier
- Program card
- Firmware update card
- Service data card

If you transfer the user program to the CPU via an online connection, it is written to the SIMATIC memory card, which must be in the card slot of the CPU for this to work.

You can also write the SIMATIC memory card in the PG/PC. A commercially available SD card reader is required to write / read the SIMATIC memory card with the programming device / PC. This is used to copy files directly to the SIMATIC memory card using the Windows Explorer, for example.

A SIMATIC memory card is absolutely required in order to operate the CPU.

Labeling of the SIMATIC memory card



- ① Article number
- ② Serial number
- ③ Production version
- ④ Memory size
- ⑤ Slider for enabling write protection:
 - Slider up: not write-protected
 - Slider down: write-protected

Figure 9-1 Labeling of the SIMATIC memory card

Folders and files on the SIMATIC memory card

The following folders and files can be found on the SIMATIC memory card:

Table 9- 1 Folder structure

Folder	Description
FWUPDATE.S7S	Firmware update files for CPU and modules
SIMATIC.S7S	User program, i.e. all blocks (OBs, FCs, FBs, DBs) and system blocks, project data of the CPU
SIMATIC.HMI	HMI-relevant data
DataLogs	DataLog files
Recipes	Recipe files

Table 9- 2 File structure

File type	Description
S7_JOB.S7S	Job file
SIMATIC.HMI\Backup*.psb	Panel backup files
SIMATIC\HMI_Backups_DMS.bin	Protected file (required to use panel backup files in STEP 7)
__LOG__	Protected system file (required in order to use the card)
crdinfo.bin	Protected system file (required in order to use the card)
DUMP.S7S	Service data file
*.pdf, *.txt, *.csv,	Further files with different formats that you can also store in folders of the SIMATIC memory card

Use the serial number for copy protection

You can set up copy protection for CPUs which binds execution of the block to a specific SIMATIC memory card. Configuration is carried out in STEP 7 in the properties of the block "Bind to serial number of the SIMATIC memory card".

You can only execute the block if it is on the SIMATIC memory card with the specified serial number (see section Copy protection (Page 70)).

Removing 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.

If you remove the SIMATIC memory card during a write process, the following problems can occur:

- The data content of a file is incomplete.
- The file is no longer readable, or no longer exists.
- The entire content of the card is corrupted.

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

Removing the SIMATIC memory card from Windows computers

If you are using the card in a commercially available card reader under Windows, use the "Eject" function before you remove the card from the card reader. If you remove the card without using the "Eject" function, you may lose data.

Deleting the contents of the SIMATIC memory card

You have the following options for deleting the contents of the SIMATIC memory card:

- Delete files using Windows Explorer
- Format with STEP 7

Note

If you format the card with Windows utilities, you will render the SIMATIC memory card unusable as a storage medium for a CPU.

Deletion of files and folders is permitted, with the exception of the "__LOG__" and "crdinfo.bin" system files. The CPU needs these system files. If you delete the files, you will no longer be able to use the SIMATIC memory card with the CPU.

If you have deleted the "__LOG__" and "crdinfo.bin" system files, format the SIMATIC memory card as described in the following section.

Formatting the SIMATIC memory card

Note

You may only format a SIMATIC memory card in the CPU; otherwise, the SIMATIC memory card cannot be used in the CPU.

If you want to format the SIMATIC memory card using STEP 7, an online connection to the relevant CPU must exist. The relevant CPU is in the STOP mode.

Proceed as follows to format a SIMATIC memory card:

1. Open the Online and Diagnostics view of the CPU (either from the project context or via "Accessible devices").
2. In the "Functions" folder, select the "Format memory card" group.
3. Click the "Format" button.
4. Click "Yes" in response to the confirmation prompt.

Result:

- The SIMATIC memory card is formatted for use in the CPU.
- The data on the CPU is deleted with the exception of the IP address.

Service life of a SIMATIC memory card

The service life of a SIMATIC memory card depends essentially on the following factors:

- Number of delete/write operations per memory block
- Number of written bytes
- External influences, such as ambient temperature

Reference

You can find additional information on the service life of the SIMATIC memory card as well as on memory utilization and memory areas to be used in the Structure and Use of the CPU Memory (<https://support.industry.siemens.com/cs/de/de/view/59193101/en>) Function Manual.

Instruction GetSMCInfo

In the TIA Portal, you have the possibility to read out the inserted SIMATIC memory card via the instruction GetSMCInfo. The following information can be read via the instruction:

- Memory size in KB
- Assigned memory space in KB
- Maintenance information: Portion of the service life in % used to date
- Set proportion of the service life as a percentage after which the CPU creates a diagnostics buffer entry and the maintenance LED switches on.

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

9.2 Setting the card type

Introduction

You can use the SIMATIC memory card as a program card or as a firmware update card.

Procedure

1. To set the card type, insert the SIMATIC memory card into the card reader of the programming device.
2. Select the "SIMATIC Card Reader" folder in the project tree.
3. In the properties of the selected SIMATIC memory card, specify the card type:

- **Program card**

You use a program card as an external load memory for the CPU. It contains the entire user program for the CPU. The CPU transfers the user program from the load memory to the work memory. The user program runs in the work memory. If you remove the SIMATIC memory card with the user program, the CPU goes into STOP mode.

The following folder is created on the SIMATIC memory card: SIMATIC.S7

- **Firmware update card**

You can save firmware for the CPU and for the modules on one SIMATIC memory card. You can perform a firmware update with the help of a specially prepared SIMATIC memory card.

The following folder is created on the SIMATIC memory card: FWUPDATE.S7S

Reference

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

9.3 Data transfer with SIMATIC memory cards

Transferring objects from the project to a SIMATIC memory card

When the SIMATIC memory card is inserted in the programming device or external card reader, you can transfer the following objects from the project tree (STEP 7) to the SIMATIC memory card:

- Individual blocks (multiple selection possible)

In this case, the transfer is consistent, i.e. the function takes dependencies between blocks due to block calls into account.

- CPU folder

In this case, all runtime-relevant objects including blocks and the hardware configuration are transferred onto the SIMATIC memory card - just as when downloading.

- Service data

In this case, the service data saved beforehand (see section Reading out/saving service data (Page 119)) is transferred to the memory card.

To perform a transfer, you can transfer the objects by drag-and-drop or use the "Card Reader/USB memory > Write to memory card" command in the "Project" menu.

Firmware update via SIMATIC memory card

You can find information on how to perform a firmware update via SIMATIC memory card in the section Firmware update (Page 105).

Reference

You can find additional information on the SIMATIC memory card in the STEP 7 online help.

Maintenance

10.1 Firmware update

Introduction

During operation, it may be necessary to update the firmware (e.g. due to function extensions).

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 the Product Support (<https://support.industry.siemens.com/cs/ww/en/ps>) web page.

- 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.

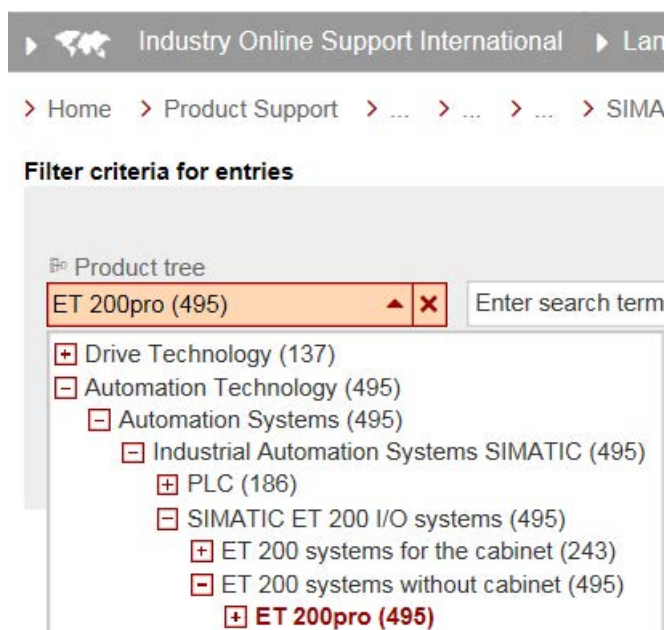


Figure 10-1 ET 200pro in the product tree

Select the specific module type under ET 200pro that you want to update. To continue, click on the "Software downloads" link under "Support". Save the desired firmware update files.

All information on ET 200pro

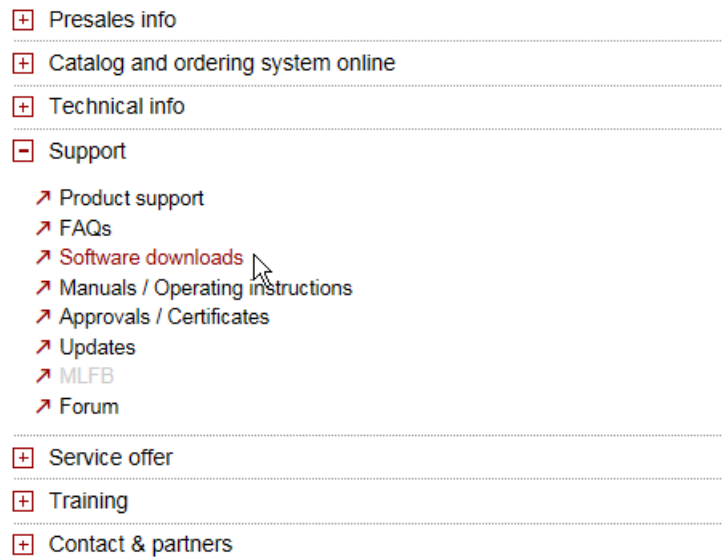


Figure 10-2 Selecting the software downloads

- 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 provides an overview of the media that can be used to update the firmware of a specific module.

Table 10- 1 Overview of firmware update options

Firmware update	CPU	Electronic modules, central *	Electronic modules, distribut- ed *
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 executing any active process.

Procedure: online in STEP 7 via Online & diagnostics

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 programming device/computer.
2. To store the update file on the SIMATIC memory card, select the SIMATIC memory card in the "Card Reader/USB memory" folder in the project tree.
3. Select the "Card Reader/USB memory > Create firmware update memory card" command in the "Project" menu.
4. Use a file selection dialog to navigate to the firmware update file. In 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

(<http://support.automation.siemens.com/WW/view/en/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.

10.2 Resetting the CPU to factory settings

Function

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

Recommendation:

If you want to remove a CPU and use it elsewhere with a different program, or put it into storage, restore the CPU to its delivery state. When restoring the factory settings, remember that you also delete the IP address parameters .

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 (RUN/STOP LED lit yellow).

Note

Reset to factory settings ↔ Memory reset

The procedure described below also corresponds to the procedure for a memory reset:

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

Perform a reset to factory settings as follows:

1. 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 79)).
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 10- 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	Initialized
Counter readings of the runtime meters	Initialized
Time of day	Initialized

If a SIMATIC memory card was inserted prior to the reset to factory settings, the CPU downloads the configuration contained on the SIMATIC memory card (hardware and software). A configured IP address is then valid again.

Reference

Additional information on "Reset to factory settings" can be found in the Structure and Use of the CPU Memory (<http://support.automation.siemens.com/WW/view/en/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 87).

Test functions and fault resolution

11.1 Test functions

Introduction

You have the option of testing the operation of your user program on the CPU. You can then monitor signal states and values of tags and can assign values to tags to simulate specific situations in the running of the program.

Note

Using test functions

The use of test functions can influence the program execution time and thus the cycle and response times of the controller to a slight extent (a few milliseconds).

Requirements

- There is an online connection to the relevant CPU.
- An executable user program is available in the CPU.

Test options

- Testing with program status
- Testing with 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 display the values of operands and the results of logic operations (RLO) allowing you to recognize and fix logical errors in your program.

Note

Restrictions with the "Program status" function

The monitoring of loops can increase the cycle time significantly, depending in each case on the number of tags to be monitored and on the actual number of loops processed.



WARNING

Testing with program status

A test with the "Program status" function can cause serious damage to property or injury to persons if there are functional disturbances or program errors.

Make sure that no dangerous situations can arise before you conduct a test with the "Program status" function.

Testing with 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.

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

You can use watch tables to monitor the current values of the individual tags of a user program or CPU on the programming device or PC and on the Web server. So that the Web server can display the value of the tag, you must specify a symbolic name for the tag in the "Name" column of the watch table.

You can monitor the following operand areas:

- Inputs and outputs (process image) and bit memory
- Contents of data blocks
- Peripheral inputs and peripheral outputs
- Timers and counters

- Modifying tags

Use this function to assign fixed values to the individual tags of a user program or CPU on the PG/PC. Modifying is also possible with Test with program status.

The following operand areas are modifiable:

- Inputs and outputs (process image) and bit memory
- Contents of data blocks
- Peripheral inputs and peripheral outputs (for example, %I0.0:P, %Q0.0:P)
- Timers and counters

- "Enable peripheral outputs" and "Modify now"

These two functions enable you to assign fixed values to individual peripheral outputs of a CPU in the STOP mode. You can also use them to check your wiring.

Testing with a force table

The following functions are available in the force table:

- Monitoring of tags

You can use 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 can 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.

One advantage of the force table is that you can simulate different test environments and overwrite tags in the CPU with a permanent value. This enables you to intervene in the ongoing process for regulating purposes.

Difference between modifying and forcing

The fundamental difference between the modifying and forcing functions consists in the storage behavior:

- Modifying: Modifying of tags is an online function and is not stored in the CPU. You can end modifying of tags in the watch table or force table or by terminating the online connection.
- Forcing: A force job is written to the SIMATIC memory card and is retained after a POWER OFF. 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 also have the option of copying PLC tags to a watch table or force table so that you can monitor, control or force them in the table.

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 commissioning of a plant, data values have to be frequently adjusted in order to optimally adapt the program to the general operating conditions on site. 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 function is useful, for example, when you are not sure which device in the hardware configuration corresponds to the station currently selected in the software.

When you click the "Flash LED" button, an LED flashes at the currently selected station. On the CPU, the following LEDs flash: RUN/STOP LED, ERROR LED and MAINT LED. The LEDs 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. You can display and evaluate the recordings, if necessary, with STEP 7 or via the Web server.

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

In connection with trace functions, please also note the following FAQ on the Internet (<https://support.industry.siemens.com/cs/ww/en>).

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>).

11.2 Reading out/saving service data

Service data

In addition to the contents of the diagnostics buffer, the service data contain numerous additional data points about the internal status of the CPU. If a problem occurs with the CPU that cannot be solved with other methods, send the service data to our Service & Support team. The service data allow Service & Support to analyze problems that have occurred rapidly.

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 11-1 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

A description of how to save service data is available under the keyword "Saving service data" in the STEP 7 online help.

Procedure via the SIMATIC memory card

Use the SIMATIC memory card to read out the service data only if you are no longer able to communicate with the CPU via Ethernet. In all other cases it is preferable to read out the service data via the Web server or STEP 7.

Before reading out the service data, you must ensure 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 79).

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

The transfer of the service data has been completed as soon as the STOP LED stops flashing and lights up continuously. If the transfer was successful, only the STOP LED lights up. If the transfer was not successful, the STOP LED lights up and the ERROR LED flashes. In case of an error, the CPU stores a text file with a note on the error that occurred in the DUMP.S7S folder.

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.

Note**Diagnostic data of the Integrated power module**

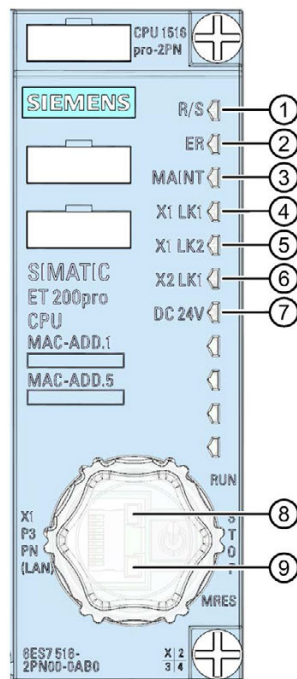
The CPU 1516pro-2 PN is equipped with an integrated power module for the load voltage supply 2L+ of ET 200pro.

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.

12.1 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 12-1 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 12- 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
			PROFenergy pause
 LED lit green	 LED off	 LED flashes yellow	Maintenance required for the plant. The affected hardware must be checked/exchanged within a short period.
			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, i.e. 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, i.e. the LEDs do not light up immediately.

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", i.e. the LED does not light up immediately after switching on the load voltage supply 2L+.

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, for example, to clearly identify a PROFINET IO device to be addressed from several identical devices in a control cabinet.

MAINTENANCE LED

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

Technical specifications

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 (<http://support.automation.siemens.com/WW/view/en/21210852>) operating instructions.

Technical specifications of the CPU 1516pro-2 PN

Article number	6ES7516-2PN00-0AB0
General information	
Product type designation	CPU 1516pro-2 PN
HW functional status	FS02
Firmware version	V2.5
Engineering with	
STEP 7 TIA Portal configurable/integrated as of version	V15 (FW V2.5) / 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 ·s
Power	
Infeed power to the backplane bus	2.275 W
Power loss	
Power loss, typ.	5.3 W

Article number	6ES7516-2PN00-0AB0
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)	6 000; 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 non-optimized block accesses, the max. size of the DB 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	2
• 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 bits, 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
Subprocess images	
• Number of subprocess images, max.	32
Address space per module	
• Address space per module, max.	256 byte; For input and output data respectively
Address space per station	
• Address space per station, max.	4 096 byte; for central inputs and outputs; depending on configuration
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 m
• Number of lines, max.	1

Article number	6ES7516-2PN00-0AB0
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
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
Functionality	
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
– Open IE communication	Yes
– IRT	Yes
– MRP	Yes; As MRP redundancy manager and/or MRP client; max. number of devices in the ring: 50
– MRPD	Yes; Requirement: IRT
– PROFINergy	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)

Article number	6ES7516-2PN00-0AB0
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
PROFINET IO Device	
Services	
– PG/OP communication	Yes
– S7 routing	Yes
– Isochronous mode	No
– Open IE communication	Yes
– IRT	Yes
– MRP	Yes
– MRPD	Yes; Requirement: IRT
– PROFINET energy	Yes
– 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
Functionality	
• 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
– Open IE communication	Yes
– IRT	No
– MRP	No
– PROFINergy	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
– Open IE communication	Yes
– IRT	No
– MRP	No
– MRPD	No
– PROFINergy	Yes
– 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
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
Web server	
• HTTP	Yes; Standard and user pages
• HTTPS	Yes; Standard and user pages

Article number	6ES7516-2PN00-0AB0
OPC UA	
Runtime license required	Yes
- OPC UA Server - Application authentication - Security policies - User authentication	Yes; Data access (read, write, subscribe), method call, custom address space Yes Available security policies: None, Basic128Rsa15, Basic256Rsa15, Basic256Sha256 "anonymous" or by user name & password
Further protocols	
MODBUS	Yes; MODBUS TCP
Media redundancy	
- Switchover time on line break, typ. - Number of stations in the ring, max.	200 ms; For MRP, bumpless for MRPD 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 alarms	10 000
Number of simultaneously active program alarms	
- Number of program alarms - Number of alarms for system diagnostics - Number of alarms for motion technology objects	600 200 160
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 - Variables - Number of variables, max. - of which status variables, max. - of which control variables, max.	Yes Inputs/outputs, memory bits, DBs, distributed I/Os, timers, counters 200; per job 200; per job

Article number	6ES7516-2PN00-0AB0
Forcing	
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
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

Article number	6ES7516-2PN00-0AB0
Controller • PID_Compact • PID_3Step • PID-Temp Counting and measuring • High-speed counter	Yes; Universal PID controller with integrated optimization Yes; PID controller with integrated optimization for valves Yes; PID controller with integrated optimization for temperature Yes
Standards, approvals, certificates	
Suitable for safety functions	No
Ambient conditions	
Ambient temperature during operation	
• horizontal installation, min. • horizontal installation, max. • vertical installation, min. • vertical installation, max.	-25 °C 55 °C -25 °C 55 °C
Ambient temperature during storage/transportation	
• min. • max.	-40 °C 70 °C
Configuration	
Programming	
Programming language	
– LAD – FBD – STL – SCL – GRAPH	Yes Yes Yes Yes Yes
Know-how protection	
• User program protection/password protection • Copy protection • Block protection	Yes Yes Yes
Access protection	
• Protection level: Write protection • Protection level: Read/write protection • Protection level: Complete protection	Yes Yes Yes

Article number	6ES7516-2PN00-0AB0
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
belongs to product	ET 200pro; CPU 1516pro (F)-2 PN
Dimensions	
Width	90 mm
Height	130 mm
Depth	51 mm
Weights	
Weight, approx.	560 g

Dimension diagram

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.

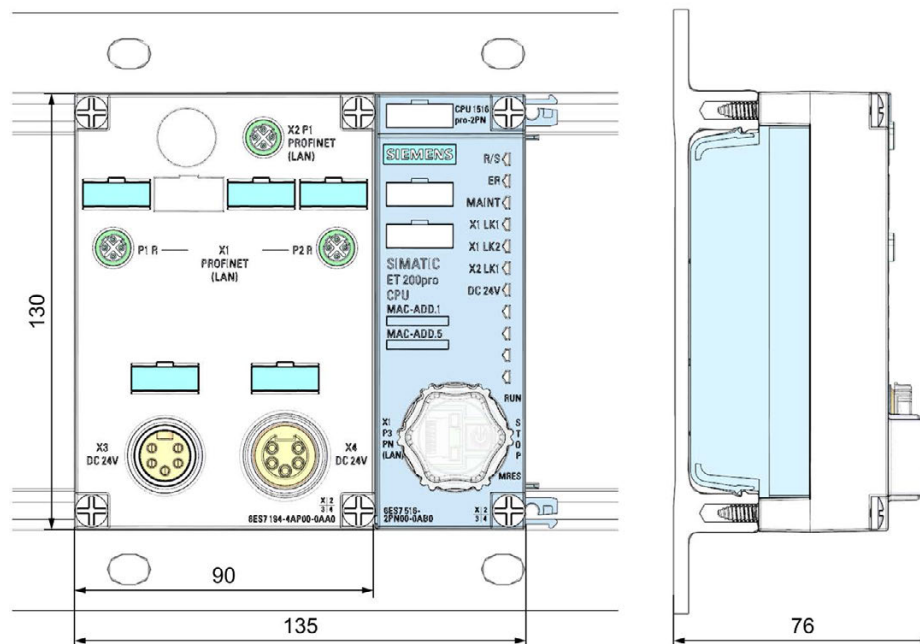


Figure A-1 Dimension diagram - Rack, narrow

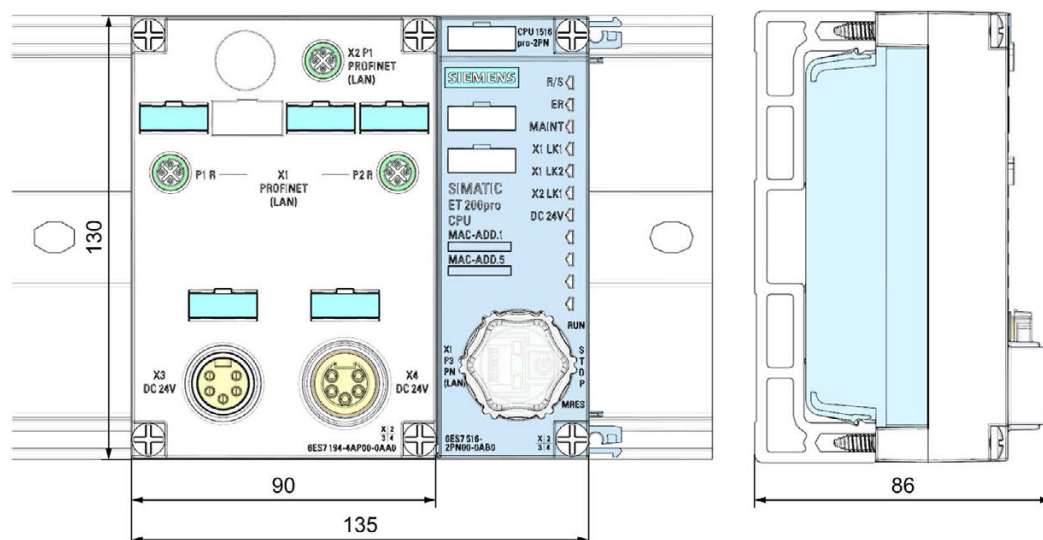


Figure A-2 Dimension diagram - Rack, compact

Accessories/spare parts

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 mm ² Preassembled cable with 7/8" connectors 180 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 mm ² 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 mm ² 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
6ES7954-8LL02-0AA0	256 MB
6ES7954-8LPxx-0AA0	2 GB
6ES7954-8LTxx-0AA0	32 GB

Safety-relevant symbols

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
 F<2N DISPLAY F<4N HOUSING	Observe the mechanical rating of the device.
 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.
 U = 0V	When the device is under voltage, note that it may not be installed or removed, or plugged or pulled.
 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.

Symbol	Meaning
 ZONE 2 INSIDE CABINET IP54 EN60079-15	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 $\geq$ IP54.
 ZONE 22 INSIDE CABINET IP6x EN60079-31	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 $\geq$ 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.

Baud rate

Data transmission rate indicates the number of bits transmitted per second (baud rate = bit rate).

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

Joint transmission path to which all nodes of a fieldbus system are connected; has two defined ends.

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 systems

Input/output units that are used in a distributed configuration at a greater distance from the CPU.

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.

Industrial Ethernet

Industrial Ethernet is a technical setup that allows data to be transferred in an industrial environment in an interference-proof manner.

Due to the openness of PROFINET, you can use standard Ethernet components. However, we recommend setting up PROFINET as Industrial Ethernet.

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 a dot (e.g. 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.

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 Extra Low Voltage = 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 Extra Low Voltage = 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 interconnected directly with precisely one other 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 communications devices (including switches) to the other ports of the switch. The connection between a communication node and the switch remains a point-to-point connection.

A switch thus has the task of regenerating and distributing received signals. The switch "learns" the Ethernet address(es) of a connected PROFINET device or 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 and 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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