SIEMENS

SIMATIC

S7-400
S7-400 Automation System, CPU Specifications

Equipment Manual

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03/2023
A5E00850746-AN

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A5E00850746-AN
Ⓟ 04/2023 Subject to change

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Preface

1

Purpose of the manual

The information provided in this manual can be used as a reference relating to the controls, to the description of functions, and to the technical specifications of the CPUs of the S7-400 product range.

Information on how to install an S7-400 system which contains those and additional modules is provided in the *S7-400 Automation System; Hardware and Installation* manual.

Changes compared to the previous version

The following are the changes as compared to the predecessor version of this manual Automation system S7-400; CPU data, Edition 03/2016 (A5E00850745-12):

- Security information was updated
- Links were updated
- The technical specifications were updated

Basic knowledge required

Comprehension of this manual requires general knowledge in the field of automation technology.

You also need to know how to use computers or PC-like equipment (such as programming devices) under Windows operating systems. As the S7-400 is configured using the STEP 7 basic software, you should also have sufficient knowledge of handling the basic software. This knowledge is provided in the *Programming with STEP 7* manual.

Particularly when using an S7-400 in safety-relevant areas, you should observe the information with regard to the safety of electronic controllers in the appendix of the *S7-400 Automation system; Hardware and Installation* manual.

Scope of the manual

The manual applies to the CPUs listed below:

With PN:

- CPU 412-2 PN V7.0.3; 6ES7 412-2EK07-0AB0
- CPU 414-3 PN/DP, V7.0.3; 6ES7 414-3EM07-0AB0
- CPU 414F-3 PN/DP, V7.0.3; 6ES7 414-3FM07-0AB0
- CPU 416-3 PN/DP, V7.0.3; 6ES7 416-3ES07-0AB0
- CPU 416F-3 PN/DP, V7.0.3; 6ES7 416-3FS07-0AB0

Without PN:

- CPU 412-1, V7.0; 6ES7 412-1XJ07-0AB0
- CPU 412-2, V7.0; 6ES7 412-2XK07-0AB0
- CPU 414-2, V7.0; 6ES7 414-2XL07-0AB0
- CPU 414-3, V7.0; 6ES7 414-3XM07-0AB0
- CPU 416-2, V7.0; 6ES7 416-2XP07-0AB0
- CPU 416F-2, V7.0; 6ES7 416-2FP07-0AB0
- CPU 416-3, V7.0; 6ES7 416-3XS07-0AB0
- CPU 417-4, V7.0; 6ES7 417-4XT07-0AB0

General technical specifications

Information pertaining to approvals and standards is available in the *S7-400 Automation System; Module Data* manual.

Scope of information

This manual is part of the S7-400 documentation package.

System	Documentation package
S7-400	• S7-400 Automation System; Hardware and Installation • S7-400 Automation Systems; Module Data • S7-400 Instruction List • S7-400 Automation System; CPU Specifications

Additional information

The following manuals provide more information relating to the topics in this manual:

Programming with STEP 7 (https://support.industry.siemens.com/cs/ww/en/view/109751825)

Configuring Hardware and Communication Connections with STEP 7 (https://support.industry.siemens.com/cs/ww/en/view/109751824)

System and Standard Functions (https://support.industry.siemens.com/cs/ww/en/view/44240604)

Recycling and disposal

The S7-400 system can be recycled due to its low-üollutant equipment. For ecologically compatible recycling and disposal of your old device, contact a certified disposal service for electronic scrap.

Additional support

Contact your Siemens partner at your local office or agencies if you have any questions relating to the product and do not find the right answers in this manual.

You will find your contact partner at:

Contact person (https://www.siemens.com/automation/partner)

A guide to the technical documentation for the various SIMATIC products and systems is available at:

Documentation (https://new.siemens.com/global/en/products/automation/process-control/simatic-pcs-7/technical-documentation.html)

The online catalog and online ordering system are available at:

Catalog (https://mall.industry.siemens.com/)

Training Centers

Siemens offers corresponding courses to get you started with the SIMATIC S7 automation system. Contact your regional Training Center, or the central Training Center in D-90327 Nuremberg, Germany:

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

Technical Support

You can contact Technical Support for all Industry Automation products using the Web form for Support Request
Support Request (https://support.industry.siemens.com/cs/ww/en/my)

Service & Support on the Internet

In addition to the documentation, Siemens offers a comprehensive online knowledge base on the Internet at:

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

There you will find:

- The newsletter that provides the laterst information about your products.
- The current documentation using the Search function on the Service & Support pages.
- An international forum where users and specialists can exchange their experience.
- Your local contact partner for automation and drive technology in our contacts database.
- Information about on-site services, repairs and spare parts. Lots more is available on the "Services" pages.
- Applications and tools for optimizing operations with SIMATIC S7. The forum is also used to publish items such as the results of DP and PN performance measurements.

1.1 Security information

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

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

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

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

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

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

Structure of a CPU 41x

2

2.1 Control and display elements of the CPUs

Control and display elements of CPU 412-1

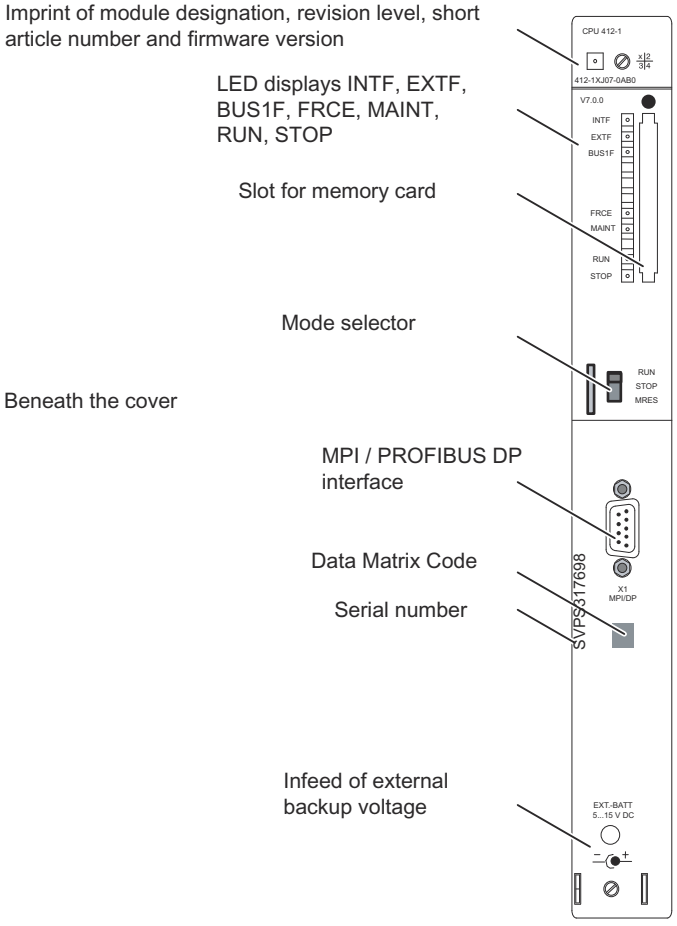


Figure 2-1 Arrangement of the control and display elements on CPU 412-1

Control and display elements of CPU 412-2 PN

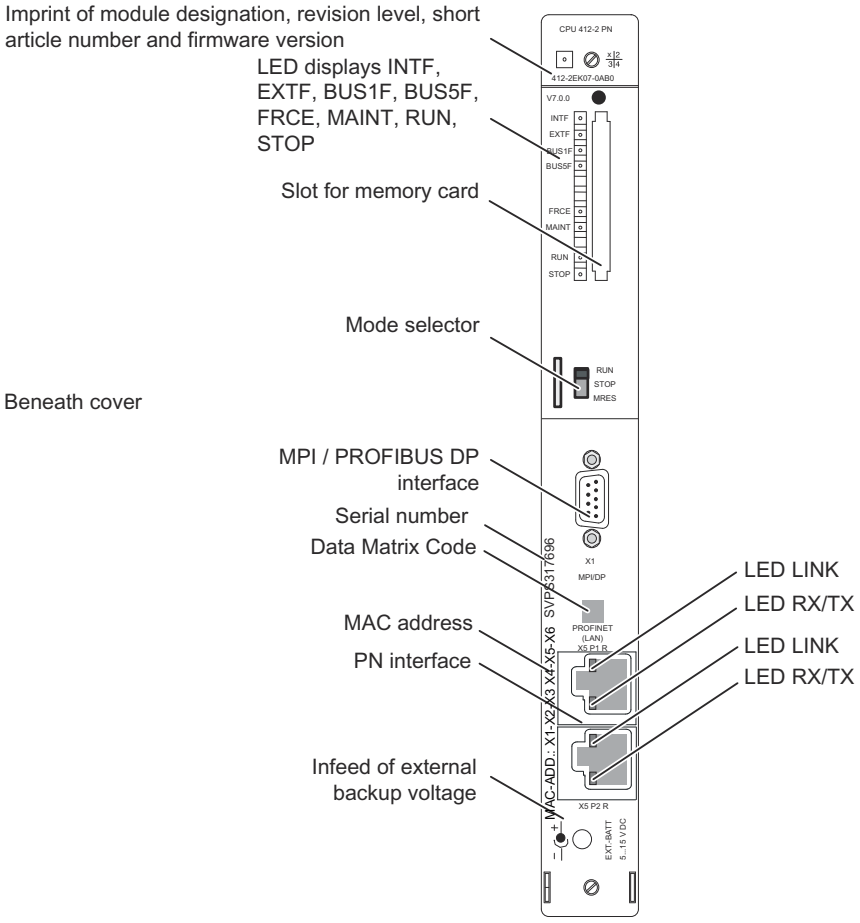


Figure 2-2 Arrangement of the control and display elements on CPU 412-2 PN

Control and display elements of CPU 41x-2

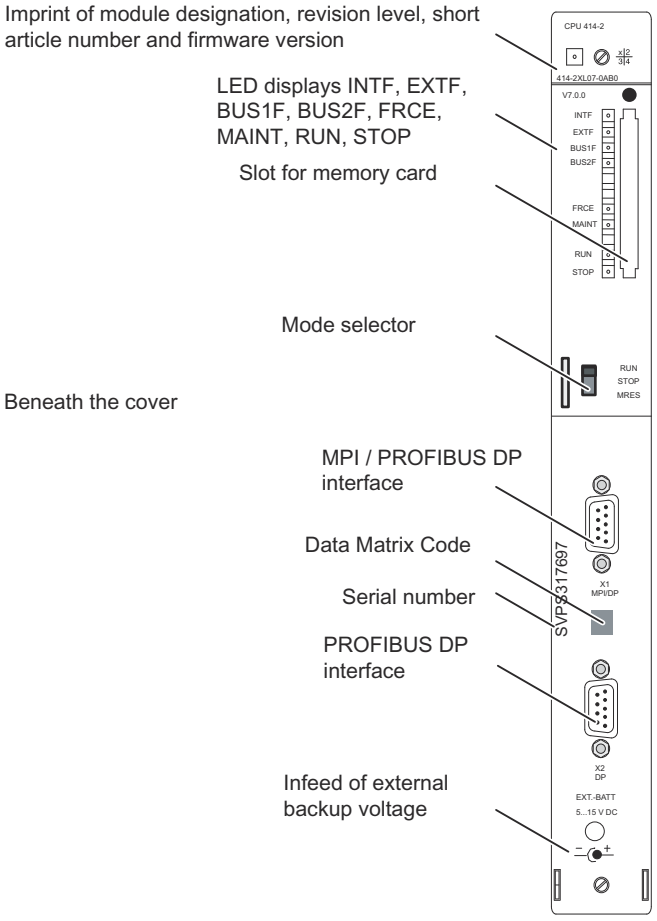


Figure 2-3 Arrangement of the control and display elements on CPU 41x-2

Control and display elements of CPU 41x-3

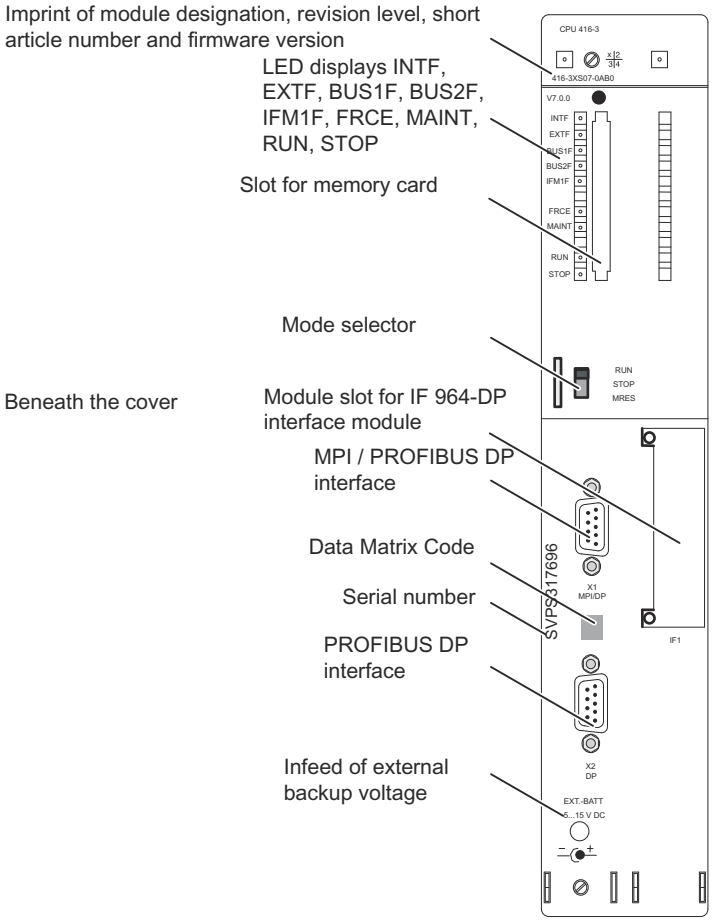


Figure 2-4 Arrangement of the control and display elements on CPU 41x-3

Control and display elements of CPU 41x-3 PN/DP

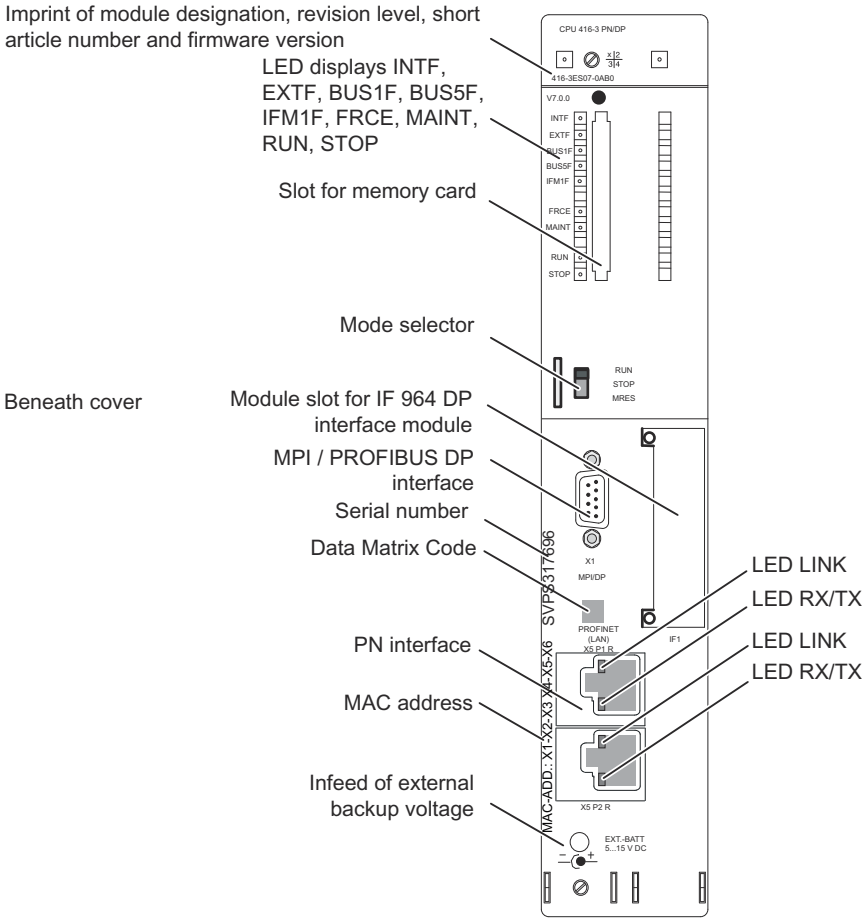


Figure 2-5 Arrangement of the control and display elements on CPU 41x-3 PN/DP

Control and display elements of CPU 417-4

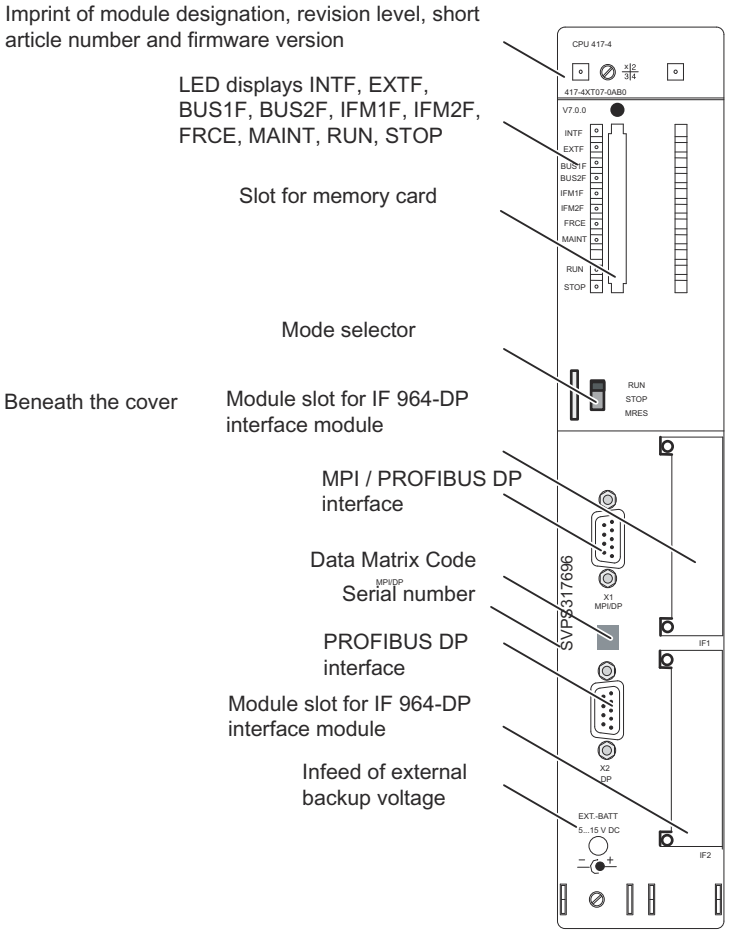


Figure 2-6 Arrangement of the control and display elements on CPU 417-4

LEDs

The table below provides an overview of the LEDs on the specific CPUs.

Table 2-1 LEDs on the CPUs

LED	Color	Description	Installed on CPU				
			412-1	412-2 414-2 416-2 416F-2	414-3 416-3	412-2 PN 414-3 PN/DP 414F-3 PN/DP 416-3 PN/DP 416F-3 PN/DP	417-4
INTF	red	Internal fault	X	X	X	X	X
EXTF	red	External fault	X	X	X	X	X
FRCE	yellow	Force command active	X	X	X	X	X
MAINT	yellow	Maintenance request pending	X	X	X	X	X
RUN	green	RUN mode	X	X	X	X	X

LED	Color	Description	Installed on CPU				
			412-1	412-2 414-2 416-2 416F-2	414-3 416-3	412-2 PN 414-3 PN/DP 414F-3 PN/DP 416-3 PN/DP 416F-3 PN/DP	417-4
STOP	yellow	STOP mode	X	X	X	X	X
BUS1F	red	Bus fault at MPI/PROFIBUS DP interface 1	X	X	X	X	X
BUS2F	red	Bus fault at PROFIBUS DP interface 2	-	X	X	-	X
BUS5F	red	Bus fault at the PROFINET interface	-	-	-	X	-
IFM1F	red	Fault at interface module 1	-	-	X	X	X
IFM2F	red	Fault at interface module 2	-	-	-	-	X

CAUTION

BUS5F LED

For CPUs with PROFINET interface, the BUS5F LED is designated in the module status and module properties as BUS2F LED in the STEP 7 diagnostics.

Mode selector

You can use the mode switch to set the current operating mode of the CPU. The mode switch is a toggle switch with three positions.

Memory card slot

You can insert a memory card into this slot.

There are two types of memory card:

- RAM cards
  You can expand CPU load memory using the RAM card.
- Flash cards
  The FLASH card can be used as non-volatile medium for storing the user program and data (no backup battery necessary). The FLASH card can be programmed either on the programming device, or on the CPU. The FLASH card also expands load memory of the CPU.

Slot for interface modules

On CPUs 41x-3, 41x-3 PN/DP and 417-4, this slot can host one PROFIBUS DP module IF 964-DP, article number 6ES7964-2AA04-0AB0.

MPI/DP interface

The following devices can be connected to the MPI interface of the CPU, for example:

- Programming devices
- Operator control and monitoring devices
- Other S7-400 or S7-300 controllers

Use the bus connector with angled cable outlet; see the *S7-400 Automation System, Hardware and Installation* manual.

You can also configure the MPI interface for operation in DP master mode so that you can use it as PROFIBUS DP interface with up to 32 DP slaves.

PROFIBUS DP interface

You can connect the distributed I/O, programming devices/OPs and other DP master stations to the PROFIBUS DP interface.

PROFINET interface

You can connect PROFINET IO devices to the PROFINET interface. The PROFINET interface features two switched ports with external connectors (RJ 45). The PROFINET interface provides the interconnection with Industrial Ethernet.

Note

Danger of property damage

This interface only allows connection to an Ethernet LAN. You cannot connect it to the public telecommunication network, for example.

You may only connect PROFINET-compliant network components to this interface.

Power input, external backup voltage at the "EXT.-BATT." socket

You can install one or two backup batteries in the S7-400 power supply modules, depending on the module type, to achieve the following result:

- Backup of a user program you saved to RAM.
- You are storing bit memories, timers, counters, system data and data in dynamic DBs.
- You backup the internal clock.

The same backup function can be achieved by applying a voltage of from 5 VDC to 15 VDC to the "EXT.-BATT." jack of the CPU.

The "EXT.-BATT." input has the following features:

- Polarity reversal protection
- Short-circuit current limiting to 20 mA

You need a cable with 2.5 mm Ø jack plug to connect the power supply to the "EXT.-BATT" socket as shown in the following illustration. Make sure the polarity of the jack plug is correct.

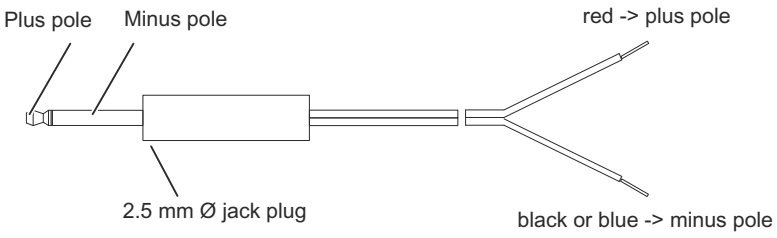


Figure 2-7 Cable with jack plug

You can order a stereo jack with prefabricated cable under the article number A5E00728552A.

Note

If replacing a power supply module you must connect an external power supply to the "EXT.-BATT." jack in order to backup the user program and the data mentioned above stored in RAM.

Do not connect the cables of various CPUs with each other. Connecting the cables of different CPUs with each other can lead to problems with regard to EMC conditions and different voltage potentials.

2.2 Monitoring functions of the CPU

Monitoring functions and error messages

The hardware of the CPU and operating system provide monitoring functions to ensure proper operation and defined reactions to errors. A series of errors may also trigger a reaction in the user program.

The table below provides an overview of possible errors and their causes, and the corresponding responses of the CPU.

Table 2-2 Errors and CPU responses

Type of error	Cause of error	Response of the operating system	Error LED
Loss of clock signal (incoming)	When using isochronous mode: clock pulses were lost either because OB 61...64 was not started due to higher priorities, or because additional asynchronous bus loads have suppressed the bus clock.	Call of OB 80 If the OB is not loaded: CPU goes to STOP. OB 61..64 called in the next clock cycle.	INTF
Time error (incoming)	• The user program execution time (OB 1 and all interrupts and error OBs) exceeds the specified maximum cycle time. • OB request error • Overflow of the start information buffer • Time-of-day error interrupt • Resume RUN after CiR	The "INTF" LED stays lit until the error is acknowledged. Call of OB 80 If the OB is not loaded: CPU goes to STOP.	INTF
Failure of the power supply module(s), no power failure (incoming and outgoing)	In the central controller or expansion unit • At least one backup battery of the power supply module is completely discharged. • The backup battery voltage is missing. • The 24 V DC supply from the power supply module has failed	Call of OB 81 If the OB is not loaded: The CPU remains in RUN.	EXTF
Diagnostic interrupt (incoming and outgoing)	An I/O module with interrupt capability reports a diagnostic interrupt	Call of OB 82 If the OB is not loaded: CPU goes to STOP.	EXTF
Maintenance request (incoming and outgoing)	Maintenance requests initiate a diagnostic interrupt	Call of OB 82 If the OB is not loaded: The CPU goes to STOP	EXTF, MAINT
Insert/remove module interrupt (incoming and outgoing)	Pulling or plugging of an SM, and plugging a wrong module type. The EXTF LED does not light up if only one SM is plugged and then pulled while the CPU is in STOP (default setting). The LED lights up briefly when the SM is plugged back in.	Call of OB 83 If the OB is not loaded: CPU goes to STOP.	EXTF

Type of error	Cause of error	Response of the operating system	Error LED
CPU hardware error (incoming)	• A memory error was detected and eliminated	Call of OB 84 If the OB is not loaded: The CPU remains in RUN.	INTF
Priority class error (incoming only, or incoming and outgoing, depending on OB 85 mode)	• Priority class is called, but the corresponding OB is not available. • For an SFB call: The instance DB is missing or faulty. • Process image update error	Call of OB 85 If the OB is not loaded: CPU goes to STOP.	INTF EXTF
Failure of a rack/station (incoming and outgoing)	• Power failure in an expansion unit • Failure of a PROFIBUS DP segment • Failure of a PROFINET IO subsystem • Failure of a coupling segment: Missing or defective IM, interrupted cable	Call of OB 86 If the OB is not loaded: CPU goes to STOP.	EXTF
Communication error (incoming)	• Status information cannot be written to the DB (global data communication) • Incorrect message frame ID (global data communication) • Incorrect message frame length (global data communication) • Error in structure of global data frame (global data communication) • DB access error	Call of OB 87 If the OB is not loaded: CPU goes to STOP.	INTF
Processing aborted (incoming)	• Nesting depth of synchronization errors too great • Nesting depth of block calls (B stack) too great • Error during allocation of local data	Call of OB 88 If the OB is not loaded: CPU goes to STOP.	INTF
Programming error (incoming)	User program error: • BCD conversion error • Range length error • Range error • Alignment error • Write error • Timer number error • Counter number error • Block number error • Block not loaded	Call of OB 121 If the OB is not loaded: CPU goes to STOP.	INTF

Type of error	Cause of error	Response of the operating system	Error LED
Code error (incoming)	Error in the compiled user program, for example, illegal OP code or a jump beyond block end	CPU goes to STOP. Restart or memory reset required.	INTF
Access error (incoming)	Failure of a module (SM, FM, CP) I/O read access error I/O write access error	The "EXTF" LED stays lit until the error is acknowledged. With SMs: • Call of OB 122 • Entry in the diagnostic buffer • With input modules: Entry of "zero" as a date in the accumulator or the process image With other modules: • Call of OB 122 If the OB is not loaded: CPU goes to STOP.	EXTF

There are additional test and information functions in each CPU which can be initiated in STEP 7.

2.3 Status and error displays

Status LEDs

The RUN and STOP LEDs on the front panel of the CPU indicate the current CPU mode.

Table 2-3 Possible states of the RUN and STOP LEDs

LED		Meaning
RUN	STOP	
Lit	Dark	CPU is in RUN mode.
Dark	Lit	CPU is in STOP mode. The user program is not executed. Cold restart, restart and warm restart/reboot are possible. If STOP was triggered by an error, the error LED (INTF or EXTF) is also set.
Flashes 2 Hz	Flashes 2 Hz	CPU is DEFECTIVE. The INTF, EXTF, FRCE, BUSF1, BUSF5 and IFM1F LEDs also flash.
Flashes 0.5 Hz	Lit	CPU HOLD was triggered by a test function.
Flashes 2 Hz	Lit	A warm restart / cold restart / hot restart was triggered. It can take a minute or more to execute those functions, depending on the length of the OB called. If the CPU still does not go into RUN there might be an error in the system configuration.
Flashes 0.5 Hz	Flashes 0.5 Hz	This signal indicates that internal processes are busy on the CPU and prevent access to the CPU until completed. This status can be triggered by the following routines: • Power up (POWER ON) of a CPU on which a large number of blocks is loaded. If encrypted blocks are loaded, startup can take a longer time, depending on the number of such blocks. • Memory reset after you have inserted a large memory card, or if there are encrypted blocks.
Irrelevant	Flashes 0.5 Hz	The CPU requests a memory reset.
Irrelevant	Flashes 2 Hz	Memory reset in progress, or the CPU is currently being initialized after POWER ON.

Error displays and special features

The three LEDs INTF, EXTF and FRCE on the front panel of the CPU indicate errors and special features in user program runtime.

Table 2-4 Possible states of the INTF, EXTF and FRCE LEDs

LED			Meaning
INTF	EXTF	FRCE	
Lit	Irrelevant	Irrelevant	An internal error was detected (programming or parameterizing error), or the CPU is currently performing a CiR.
Irrelevant	Lit	Irrelevant	An external error was detected, that is, the cause of error is not on the CPU module.

LED			Meaning
INTF	**EXTF**	**FRCE**	
Irrelevant	Irrelevant	Lit	A force command is active.
Irrelevant	Irrelevant	Flashes 2 Hz	Node flash test function.

The LEDs BUS1F, BUS2F and BUS5F indicate errors associated with the MPI/DP, PROFIBUS DP and PROFINET IO interfaces.

Table 2-5 Possible states of the BUS1F, BUS2F und BUS5F LEDs

LED			Meaning	
BUS1F	**BUS2F**	**BUS5F**		
Lit	Irrelevant	Irrelevant	An error was detected at the MPI/DP interface.	
Irrelevant	Lit	Irrelevant	An error was detected on the PROFIBUS DP interface.	
Irrelevant	Irrelevant	Lit	An error was detected at the PROFINET IO interface. A PROFINET IO system is configured but not connected.	
Irrelevant	Irrelevant	Flashes	One or several devices on the PROFINET IO interface are not responding.	
Flashes	Irrelevant	Irrelevant	CPU is DP master:	One or several devices on PROFIBUS DP interface 1 are not responding.
			CPU is DP slave:	CPU is not addressed by the DP master.
Irrelevant	Flashes	Irrelevant	CPU is DP master:	One or several devices on PROFIBUS DP interface 2 are not responding.
			CPU is DP slave:	CPU is not addressed by the DP master.

Error displays and special features, CPU 41x-3, CPU 41x-3 PN/DP und 417-4

The CPUs 41x-3, 41x-3 PN/DP and 417-4 are equipped with the IFM1F LED, or with the IFM1F and IFM2F LEDs. These LEDs indicate problems associated with the module interface.

Table 2-6 Possible states of the IFM1F and IFM2F LEDs

LED		Meaning	
IFM1F	**IFM2F**		
Lit	Irrelevant	An error was detected at module interface 1.	
Irrelevant	Lit	An error was detected at module interface 2.	
Flashes	Irrelevant	CPU is DP master:	One or several slaves connected to PROFIBUS DP interface at module slot 1 are not responding.
		CPU is DP slave:	CPU is not addressed by the DP master.
Irrelevant	Flashes	CPU is DP master:	One or several slaves connected to the PROFIBUS DP interface at module slot 2 are not responding.
		CPU is DP slave:	CPU is not addressed by the DP master.

Error displays and special features of CPU 41x-3 PN/DP and 412-2 PN

The CPUs 41x-3 PN/DP and 412-2 PN are also equipped with a LINK LED and RX/TX LED Those LEDs indicate the current state of the PROFINET interface.

Table 2-7 Possible states of the LINK and RX/TX LEDs

LED		Meaning
LINK	**RX/TX**	
Lit	Irrelevant	Connection at PROFINET interface is active
Irrelevant	Flashes 6 Hz	Receiving or sending data at the PROFINET interface.

Note

The LINK and RX/TX LEDs are located directly next to the jacks of the PROFINET interface. They are not labeled.

LED MAINT

This LED indicates that maintenance is required. For additional information, refer to the STEP 7 Online Help.

Diagnostics buffer

In STEP 7, you can troubleshoot an error by selecting "PLC -> Module status" in order to read the cause of an error from the diagnostics buffer.

2.4 Mode selector switch

2.4.1 Function of the mode selector switch

Overview

The mode selector is used to switch the CPU from RUN to STOP or to reset the CPU memory. STEP 7 offers additional mode selection options.

Positions

The mode selector is designed as a toggle switch. The following figure shows all the positions of the mode selector.

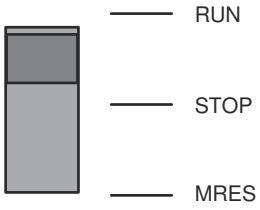


Figure 2-8 Mode switch settings

The following table explains the settings of the mode selector switch. In the event of an error or if there are problems preventing startup, the CPU switches to or remains in STOP mode, regardless of the position of the mode selector.

Table 2-8 Mode switch settings

Position	Notes
RUN	If there is no startup problem or error and the CPU was able to switch to RUN, the CPU either runs the user program or remains idle. The I/O can be accessed. • You can upload programs from the CPU to the programming device (CPU -> Programming device) • You can upload programs from the programming device to the CPU (Programming device -> CPU).
STOP	The CPU does not execute the user program. The digital signal modules are locked. The output modules are disabled in the default parameter settings. • You can upload programs from the CPU to the programming device (CPU -> Programming device) • You can upload programs from the programming device to the CPU (Programming device -> CPU).
MRES (CPU memory reset; master reset)	Toggle switch position for general reset of the CPU memory, see section Running a memory reset (Page 32). Toggle switch position for the "Reset CPU to factory state" function, see section Resetting the CPU to the factory state (Page 58)

Security classes

A security class can be agreed for S7-400 CPUs in order to prevent unauthorized access to CPU programs. You can define a security class which allows users to access PG functions without particular authorization (password) on the CPU concerned. All PG functions can be accessed if a password is entered.

Setting the security classes

You can set the security classes (1 to 3) for a CPU in STEP 7 -> HW Config.

You can delete the the security class set STEP 7 -> HW Config by means of a manual reset using the mode selector switch.

The following table lists the security classes of an S7-400 CPU.

Table 2-9 Security classes of an S7-400 CPU

CPU function	Security class 1	Security class 2	Security class 3
Block list displays	Access allowed	Access allowed	Access allowed
Monitoring Variables	Access allowed	Access allowed	Access allowed
STACKS module status	Access allowed	Access allowed	Access allowed
Operator control and monitoring functions	Access allowed	Access allowed	Access allowed
S7 communication	Access allowed	Access allowed	Access allowed
Read time of day	Access allowed	Access allowed	Access allowed
Set time of day	Access allowed	Access allowed	Access allowed
Monitoring blocks	Access allowed	Access allowed	Password required
Download to programming device	Access allowed	Access allowed	Password required
Download to CPU	Access allowed	Password required	Password required
Delete blocks	Access allowed	Password required	Password required
Compress memory	Access allowed	Password required	Password required
Download user program to memory card	Access allowed	Password required	Password required
Modify selection	Access allowed	Password required	Password required
Modify variable	Access allowed	Password required	Password required
Breakpoint	Access allowed	Password required	Password required
Exit break	Access allowed	Password required	Password required
Memory reset	Access allowed	Password required	Password required
Force	Access allowed	Password required	Password required

Setting the security class with SFC 109 "PROTECT"

SFC 109 "PROTECT" is used to switch between security classes 1 and 2.

2.4.2 Running a memory reset

Operating sequence for memory reset

Case A: You want to download a new user program to the CPU.

1. Set the mode selector to STOP.
   Result: The STOP LED lights up.
2. Set the selector to MRES and hold it there.
   Result: The STOP LED is switched off for one second, on for one second, off for one second and then remains on.
3. Turn the switch back to the STOP setting, then to the MRES setting again within the next 3 seconds, and back to STOP.
   Result: The STOP LED flashes for at least 3 seconds at 2 Hz (memory being reset) and then remains lit.

Performing a memory reset on request

Case B: The CPU requests memory reset, indicated by the flashing STOP LED at 0.5 Hz. The system requests a CPU memory reset, for example, after a memory card was removed or inserted.

1. Set the mode selector to MRES and then back to STOP.
   Result: The STOP LED flashes for at least 3 seconds at 2 Hz (memory being reset) and then remains lit.

For detailed information on CPU memory reset refer to the manual *S7-400 Automation System, Hardware and Installation*.

Memory reset process in the CPU

During a memory reset, the following process occurs on the CPU:

- The CPU deletes the entire user program from main memory and load memory (integrated RAM and, if applicable, RAM card).
- The CPU clears all counters, bit memory, and timers (except for the time of day).
- The CPU tests its hardware.
- The CPU initializes its hardware and system program parameters (internal default settings in the CPU). Some configured default settings will be taken into account.
- If a FLASH card is inserted, the CPU copies the user program and the system parameters stored on the FLASH card into main memory after the memory reset.

Values retained after a memory reset

The following values are retained after a CPU memory reset:

- The content of the diagnostic buffer
  The content can be read out with the programming device using STEP 7.
- Parameters of the MPI (MPI address and highest MPI address). Note the special features shown in the table below.
- The time of day
- The status and value of the operating hours counter

The following values are also retained for CPUs with PN interface:

- The IP address of the CPU
- The subnet mask
- The static SNMP parameters

Feature: MPI parameters and IP address

A special situation is presented for the MPI parameters and IP address when a memory reset is preformed. The following table shows which MPI parameters and IP addresses remain valid after a CPU memory reset.

Table 2-10 MPI parameters and IP address following memory reset

Memory reset ...	MPI parameters and IP address ...
with inserted FLASH card	... that may be stored on the FLASH card are valid
without inserted FLASH card	... in the CPU are retained and valid

See also

You can also reset a CPU completely to the factory state. For more information, refer to sectionResetting the CPU to the factory state (Page 58)

2.4.3 Cold start / Warm restart / Hot restart

Cold restart

- During a cold restart, all data (process image, bit memory, timers, counters and data blocks) is reset to the start values stored in the program (load memory), regardless of whether they were configured as retentive or non-retentive.
- The associated startup OB is OB 102
- Program execution is restarted from the beginning (OB 102 or OB 1).

Restart (warm restart)

- A warm restart resets the process image and the non-retentive bit memories, timers, and counters.
  Retentive bit memories, timers and counters retain their last valid value.
  All data blocks assigned the "Non Retain" attribute are reset to the downloaded values. The other data blocks retain their last valid value.
- The associated startup OB is OB 100
- Program execution is restarted from the beginning (OB 100 or OB 1).
- If the power supply is interrupted, the warm restart function is only available in backup mode.

Restart

- The 41xF CPUs do not support hot restart mode.
- When a hot restart is performed, all data and the process image retain their last valid value.
- Program execution is resumed from the breakpoint.
- The outputs do not change their status until the current cycle is completed.
- The associated startup OB is OB 101
- If the power supply is interrupted, the hot restart function is only available in backup mode.

Operating sequence for reboot (warm restart)

1. Set the mode selector to STOP.
   Result: The STOP LED lights up.
2. Set the selector to RUN.

Operating sequence for hot restart

1. Select the "hot restart" startup type on the PG.
   The button can only be selected if this type of restart is possible on the specific CPU.

Operating sequence for cold restart

A manual cold restart can only be triggered from the programming device.

2.5 Structure and Functions of the Memory Cards

Order numbers

The article numbers of the memory cards are listed in the section Technical specifications of the memory cards (Page 365).

Design

The memory card is slightly larger than a credit card and is protected by a strong metal casing. It is inserted into one of the slots on the front of the CPU. The memory card is designed so that it can only be inserted one way.

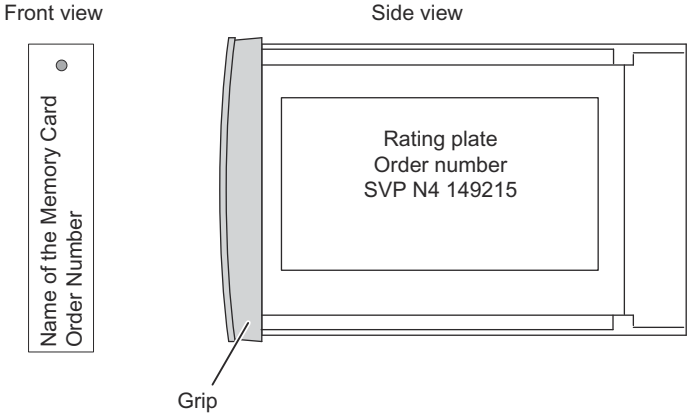


Figure 2-9 Design of the memory card

Function

The memory card and an integrated memory area on the CPU together form the load memory of the CPU. During operation, the load memory contains the complete user program including comments, symbols, and special additional information that enables reverse compilation of the user program, as well as all module parameters.

What is stored on the memory card

The following data can be stored on the memory card:

- User program, i.e. blocks (OBs, FBs, FCs, DBs) and system data
- Parameters that determine the behavior of the CPU
- Parameters that determine the behavior of I/O modules
- The full set of project files on suitable memory cards

Serial number

As of product version 5, all memory cards have a serial number. This serial number is listed in INDEX 8 of the SSL sublist W#16#xy1C. The sublist can be read using SFC 51 "RDSYSST".

You can determine the following when you read the serial number in your user program: The user program can only be executed when a specific memory card is inserted into the CPU. This protects against unauthorized copying of the user program.

See also

Overview of the memory concept of S7-400 CPUs (Page 195)

2.6 Use of the Memory Cards

Types of memory cards for S7-400

Two types of memory card are used in the S7-400:

- RAM cards
- Flash cards (FEPROM cards)

Note

Non-Siemens memory cards cannot be used in the S7-400.

What type of memory card should be used?

Whether you use a RAM card or a flash card depends on how you intend to use the memory card.

Table 2-11 Types of Memory Card

If you ...	Then ...
Want to store the data in RAM and edit your program in RUN,	Use a **RAM card**
Want to store your user program permanently on the memory card, even with power removed (without backup or outside the CPU),	Use a **Flash card**

RAM card

To use a RAM card and load the user program, you must insert it into the CPU slot. The user program is loaded with the help of the programming device (PG).

You can load the entire user program or individual elements such as FBs, FCs, OBs, DBs, or SDBs to the load memory when the CPU is in STOP or RUN mode.

All data on the RAM card is lost when you remove it from the CPU. The RAM card does not have a built-in backup battery.

If the power supply is equipped with an operational backup battery, the RAM card contents are retained after power is switched off, provided you do not remove the RAM card from the CPU, or the CPU from the rack.

If an external backup voltage is applied to the "EXT.-BATT." socket on the CPU, the RAM card contents are retained after power is switched off, provided you do not remove the RAM card from the CPU.

FLASH card

There are two ways to download the user program if you are using a FLASH card:

Option 1:

1. Set the CPU mode to STOP with the mode selector switch.
2. Insert the FLASH card into the CPU.
3. Perform a memory reset.
4. Download the user program with the STEP 7 command "PLC -> Download User Program to Memory Card".

Option 2:

1. Download the user program to the FLASH card when the programming device / programming adapter is offline.
2. Insert the FLASH card into the CPU.

You can only reload the full user program using the FLASH card. You can download smaller program sections to the integrated load memory on the CPU using the programming device. For significant program changes, you must always download the complete user program to the FLASH card.

The FLASH card does not require a backup voltage, that is, the information stored on it is retained even when you remove the Flash card from the CPU or operate your S7-400 system without backup function (without backup battery in the power supply module or "EXT. BATT." socket of the CPU).

Automatic warm restart or cold restart without backup

If you operate your CPU without a backup battery, after startup or when voltage returns following POWER OFF, the CPU automatically undergoes a general reset and then a warm restart or cold restart, depending on the configuration. The user program must be available on the FLASH card and no battery monitoring can be set with the Batt.Indic switch on the power supply module.

After you switch on the CPU, or power has been recovered after POWER OFF, you have to initiate a warm or cold restart by means of mode switch or PG if battery monitoring is enabled. The EXTF LED signals an external error if the backup battery has failed or is missing.

What should be the capacity of the memory card?

The capacity of the required memory card is based on the size of the user program and amount of system data.

To optimize utilization of work memory (code and data) on your CPU, you should expand the load memory of the CPU with a memory card which has at least the same capacity as the work memory.

The configuration data for the Web server is also saved to the memory card.

See also Properties of the web server (Page 92)

Changing the memory card

To change the memory card:

1. Set the CPU to STOP.
2. Remove the memory card.

   Note

   If you remove the memory card, STOP LED flashes at 3-second intervals to indicate that the CPU requires a memory reset. This sequence cannot be influenced by error OBs.

3. Insert the "new" memory card in the CPU.
4. Reset the CPU memory.

2.7 Multipoint Interface (MPI)

Availability

Every S7-400 CPU features an MPI interface.

Connectable devices

The following nodes can be connected to the MPI, for example:

- Programming devices (PG/PC)
- Control and monitoring devices (OPs and TDs)
- Additional SIMATIC S7 PLCs

Certain devices use the 24 VDC power supply of the interface. This voltage provided at the MPI interface is connected to reference potential

PG/OP ->CPU Communication

A CPU is capable of maintaining several simultaneous online connections for PG/OP communication. Only one of those connections is reserved as default connection for a programming device, and a second for the OP/ control and monitoring device.

For CPU-specific information on the number of connection resources or connectable OPs, refer to the technical specifications.

Time synchronization via MPI

You can synchronize the time via the MPI interface of the CPU.The CPU can be master or slave.

Reference

You can find information about planning time synchronization in the Process Control System PCS7; Safety Concept (https://support.industry.siemens.com/cs/ww/en/view/109780811) manual.

CPU to CPU communication

There are three modes of CPU to CPU communication:

- Data exchanger by means of S7 basic communication
- Data exchange by means of S7 communication
- Data exchange by means of global data communication

For addtitional information, refer to the Programming with STEP 7 (https://support.industry.siemens.com/cs/ww/en/view/109751825) manual.

Connectors

Always use bus connectors with angled cable outlet for PROFIBUS DP, or PG cables for connecting devices to the MPI (see the S7-400 Automation System, Hardware and Installation (https://support.industry.siemens.com/cs/ww/en/view/1117849) manual).

MPI interface as PROFIBUS DP interface

You can also configure the MPI for operation as PROFIBUS DP interface. You can edit the MPI parameters accordingly in HW Config of STEP 7. This configuration allows you to set up a DP segment consisting of up to 32 slaves.

2.8 PROFIBUS DP Interface

Availability

The CPUs 41x-2, 41x-3 and 417-4 feature an integrated PROFIBUS DP interface. PROFIBUS DP interfaces are available as plug-in modules for the CPUs 41x-3, 417-4 and for CPUs with the suffix "PN/DP".

To be able to use these interfaces, you must first configure them in HW Config and then download the configuration to the CPU.

Connectable devices

The PROFIBUS DP interface can be used to set up a PROFIBUS master system, or to connect PROFIBUS I/O devices.

You can connect any standard-compliant DP slave to the PROFIBUS DP interface.

The CPU is hereby operated either as DP master or DP slave that is interconnected via PROFIBUS DP fieldbus with the passive slave stations or other DP masters.

Certain devices use the 24 V DC power supply of the interface. This voltage provided at the PROFIBUS DP interface is connected to reference potential.

Connectors

Always use bus connectors for PROFIBUS DP, or PROFIBUS cables, to connect devices to the PROFIBUS DP interface (see the S7-400 Automation System, Hardware and Installation (https://support.industry.siemens.com/cs/ww/en/view/1117849) manual).

Time-of-day synchronization via PROFIBUS

A CPU operating as time master sends synchronization message frames to PROFIBUS to synchronize additional stations.

If operated as time slave, the CPU receives synchronization frames from other time masters. One of the following devices can be the time master:

- A CPU 41x with internal PROFIBUS interface
- A CPU 41x with external PROFIBUS interface, e.g. CP 443-5
- A PC with a SIMATIC NET Profibus CP

Reference

You can find information about planning time synchronization in the following manuals:

- Process Control System PCS 7; Security Concept. (https://support.industry.siemens.com/cs/ww/en/view/28580051)
- Process Control System PCS 7; Time Synchronization (https://support.industry.siemens.com/cs/ww/de/view/28518882)

For more information, refer to the entry list on the topic of time synchronization:

- Time synchronization (https://support.industry.siemens.com/cs/ww/en/view/27236050)

2.9 PROFINET interface

Availability

CPUs with "PN" or "PN/DP" name suffix feature an Ethernet interface with PROFINET functionality.

Assigning an IP address

You have the following options of assigning an IP address to the Ethernet interface:

- By editing the CPU properties in HW Config. Download the modified configuration to the CPU.

You can also set up the IP address parameters and the station name (NameOfStation, NoS) locally without having to modify the configuration data.

- Using the "PLC -> Edit Ethernet Node" command in SIMATIC Manager.
- Using SFB 104 in the user program

These local settings are always possible, regardless of whether the PROFINET IO interface is set up as intelligent device or IO controller in the parameters.

If you want to use the PN interface for communication in plant operation, you must also interconnect it in HW Config or NetPro.

Devices which can be connected via PROFINET (PN)

- Programming device/PC with Ethernet adapter and TCP protocol
- Active network components, for example, a SCALANCE XC-200
- S7-300 / S7-400 with Ethernet CP, e.g. CPU 416-2 with CP 443-1
- PROFINET IO devices of the ET 200 spectrum
- PROFINET CBA components

Connectors

Always use RJ45 connectors to hook up devices to the PROFINET interface.

Time synchronization via PROFINET

Time synchronization uses NTP, whereby the CPU is client, or the SIMATIC procedure.

Reference

- For additional information on PROFINET, refer to PROFINET System Description (https://support.industry.siemens.com/cs/ww/en/view/19292127).
- For detailed information about Ethernet networks, network configuration and network components refer to the manualSIMATIC NET: Twisted-pair and fiber-optic networks (https://support.industry.siemens.com/cs/ww/en/view/8763736) manual.

- Component Based Automation, Commissioning SIMATIC iMap Systems - Tutorial (https://support.industry.siemens.com/cs/ww/en/view/18403908) .
- Additional information on PROFINET (https://www.profibus.com/).

2.10 Overview of the parameters for the S7-400 CPUs

Default values

All parameters are set to factory default values. Those defaults are suitable for a wide range of standard applications and enable the direct operation of an S7-400 system without users having to make any further settings.

You can define the CPU-specific default values using the "HW Config" tool in STEP 7.

Parameter fields

The behavior and properties of the CPU are declared in the parameters that are stored in system data blocks. The CPUs have a defined default setting. You can modify this default setting by editing the parameters in HW Config.

The list below provides an overview of the parameterizable system properties of the CPUs.

- General properties, e.g. the CPU name
- Startup, e.g. enabling hot restarts
- Synchronous cycle interrupts
- Cycle/clock memories (e.g. scan cycle monitoring time)
- Retentivity, i.e., the number of bit memories, timers, and counters that are retained during restart
- Memory, e.g. local data
  Note: After you reconfigured RAM allocation parameters, this RAM is reorganized when system data is downloaded to the CPU. As a consequence, the data blocks generated by means of SFC are deleted and the remaining data blocks are initialized with values from load memory..
  The amount of work memory that is made available for logic or data blocks during the download of system data is adapted if you modify the following parameters:
  - Size of the process image, byte-oriented; in the "Cycle/Clock Memory" tab
  - Communication resources in the "Memory" tab
  - Size of the diagnostics buffer in the "Diagnostics/Clock" tab
  - Number of local data for all priority classes in the "Memory" tab
- Assignment of interrupts, process interrupts, time-delay interrupts and asynchronous error interrupts to the priority classes
- Time-of-day interrupts, e.g., interval duration and priority
- Cyclic interrupts, e.g. priority, interval duration
- Diagnostics/clock, e.g. time synchronization
- Security classes

- Web (on CPUs with PROFINET interface)
- Setting the CPU number (for multicomputing)

Note

16 memory bytes and 8 counters are set by default in non-volatile memory, i.e., they are not cleared at a restart of the CPU.

Programming tool

You can set up CPU parameters using the "Hardware Configuration" dialog in STEP 7.

Note

After you made changes to the existing settings of the following parameters, the operating system performs an initialization similar to the cold restart.

- Size of the process image of inputs
- Size of the process image of outputs
- Size of local data
- Number of diagnostics buffer entries
- Communication resources

This involves the following initializations: procedures

- Data blocks are initialized with the load values.
- Bit memories, timers, counters, inputs and outputs are deleted, regardless of their retentivity setting (0).
- DBs generated by means of SFC are deleted
- Permanently configured, base communication connections are shutdown
- All run levels are initialized.

Special functions of a CPU 41x

3

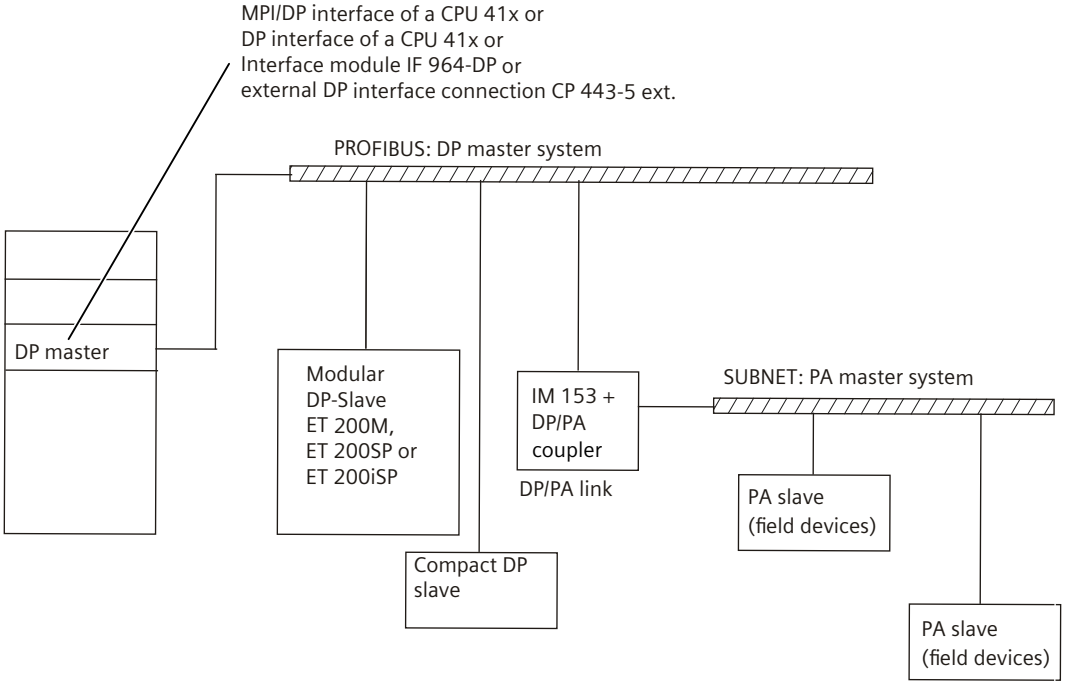
3.1 System modifications during operation

3.1.1 Basics

Overview

With the help of a plant change during operation using CiR (Configuration in RUN), certain configuration changes can be made during RUN mode. In so doing, processing is stopped for a brief time interval. The upper limit of this time interval is set to 1 s by default, but you can change it. During this time, process inputs retain their last value (also see the manual Plant changes during ongoing operation through CiR). (https://support.industry.siemens.com/cs/ww/en/view/45531308)

You can modify a plant during operation using CiR in plant units with distributed I/O. The configuration shown in the following figure is required for this. For the sake of clarity, the configuration considers only one DP master system and only one PA master system. These limitations do not exist in reality.



3.1.2 Hardware requirements

Hardware requirements for system modifications during operation

To be able to make system modifications during operation, the following hardware requirements must be met during commissioning:

- If you want to make system changes to a DP master system with an external DP master (CP 443-5 extended) during operation, this must have at least firmware version V5.0.
- If you want to add modules to an ET 200M: Use of the IM 153-2 as of article number 6ES7153-2BA00-0XB0 or the IM 153-2FO as of article number 6ES7 153-2BB00-0XB0. You must also set up the ET 200M with active bus elements and adequate free space for the planned expansion. The ET 200M must not be linked as a DPV0 slave (using a GSD file).
- If you want to add entire stations: Reserve the necessary bus connectors, repeaters etc.
- If you want to add PA slaves (field devices): Use of the IM 157 as of article number 6ES7157-0AA82-0XA00 in the appropriate DP/PA-Link.
- Use of the CR2 rack is not permitted.
- The use of one or more of the modules listed below within a station in which you want to make plant changes during operation with CiR is not permitted. CP 444, IM 467.
- No multicomputing
- No isochronous operation in the same DP master system
- Plant changes cannot be made on PROFINET IO systems.

Note

You can mix components that are CiR-capable and those that are not as required (with the exception of the modules excluded above). However, you canonly make modifications to CiR-capable components.

3.1.3 Software requirements

Software Requirements for System Modifications during Operation

To be able to make configuration changes in RUN, the user program must meet the following requirement: It must be written so that , for example, station failures, module faults or timeouts do not cause the CPU to change to STOP.

The following OBs must be available on your CPU:

- Hardware interrupt OBs (OB 40 to OB 47)
- Time jump OB (OB80)
- Diagnostic interrupt OB (OB82)
- Remove/insert OB (OB83)
- CPU hardware fault OB (OB84)

- Program execution error OB (OB85)
- Rack failure OB (OB86)
- I/O access error OB (OB122)

3.1.4 Permitted system modifications

Overview

During operation, you can make the following system modifications:

- Add modules to the ET 200M modular DP slave provided that you have not linked it as a DPV0 slave (using a GSD file).
- Change the parameter assignment of ET 200M modules, for example, setting different limits or using previously unused channels.
- Use channels that have been unused thus far in an assembly or in a module for the modular slaves ET 200M, ET 200MP, ET 200S, ET 200iS, ET 200iSP, ET 200SP and ET 200SP HA.
- Add DP slaves to an existing DP master system.
- Add PA slaves (field devices) to an existing PA master system.
- Add DP/PA couplers downstream from an IM157.
- Add PA-Links (including PA master systems) to an existing DP master system.
- Assign added modules to a process image partition.
- Reassign parameters for existing ET 200M stations (standard modules and fail-safe signal modules in standard mode).
- HART tags configured in HW Config as PV, SV, TV, QV, or CiR.
- Reversing changes: Added modules, submodules, DP slaves and PA slaves (field devices) can be removed again.

Note

If you want to add or remove slaves or modules or modify the existing process image partition assignment, this is possible in a maximum of four DP master systems.

All other modifications not specifically permitted above are not permitted during operation and are not further discussed here.

3.2 Encrypting blocks

S7-Block Privacy

The STEP 7 add-on package S7-Block Privacy can be used to encrypt and decrypt functions and function blocks. The S7-Block Privacy add-on package is available in STEP 7 V5.5 or higher.

Observe the following information when using S7-Block Privacy:

- S7-Block Privacy is operated by means of shortcut menus. To view a specific menu help, press the "F1" function key.
- You can no longer edit encrypted blocks in STEP 7. Moreover, testing and commissioning functions such as "Monitor blocks" or breakpoints are no longer available. Only the interfaces of the encrypted block remain visible.
- To decrypt blocks, you always need the correct key and the corresponding decompilation information included in your package. You are strongly advised to keep the key in a secure place and/or generate backup copies of unencrypted versions of the blocks.
- The loading of encrypted blocks is only supported on CPUs V6.0 or higher:
- If your project contains sources, you can use these to restore the encrypted blocks by means of compilation. The S7-Block Privacy sources can be removed from the project.

General procedure

To encrypt the blocks, follow these steps:

1. In STEP 7, right-click the block container and select "Block protection...".
   If you have already selected a specific block, the shortcut menu no longer contains the "Block protection..." command.
2. The S7-Block Privacy application is started.
3. Select the block; multiple selection is supported.
4. Right-click the block to encrypt and select "Encrypt block...". The "Block encryption" dialog opens.
5. Select whether to include decompilation information in the encryption.

   Note

   If you clear the check box it will no longer be possible to decompile the block!

6. Enter a key string consisting of at least 12 characters in both fields. Make sure to keep the key in a secure place. Click "OK" to start encryption.

Result: Your block is now encrypted. The following symbols identify this status:

Encrypted block can be decompiled

Encrypted block cannot be decompiled

Note

Memory requirements

Each encrypted block with decompilation information occupies 232 additional bytes in load memory.

Each encrypted block without decompilation information occupies 160 additional bytes in load memory.

Note

Extended runtimes

The time the CPU requires for startup after power on and loading the blocks can be significantly prolonged.

Operation with FlashCard can significantly prolong the time for memory reset.

To optimize additional time requirements, it is best practice to encrypt one large block instead of many small blocks.

Additional information

For additional information, refer to "S7 block privacy" in the STEP 7 Online Help.

3.3 Multicomputing

3.3.1 Fundamentals

Multicomputing Mode

Multicomputing mode is the simultaneous operation of several (up to 4) CPUs in a central rack of the S7-400.

The CPUs involved automatically change their modes synchronized with each other; the CPUs start up together and change to STOP together. The user program on each CPU runs independently of the user programs on the other CPUs. This allows control tasks to be performed simultaneously.

Racks suitable for Multicomputing

The following racks are suitable for multicomputing:

- UR1 and UR2
- UR2-H, multicomputing with several CPUs is possible only if the CPUs are in the same subdevice.
- CR3, since the CR3 has only 4 slots, multicomputing is possible only with two CPUs.

Difference Compared with Operation in a Segmented Rack

In the CR2 segmented rack (physically segmented, cannot be set using parameters), only one CPU per segment is permitted. This is, however, not multicomputing. The CPUs in the segmented rack each form an independent subsystem and behave like individual processors. There is no common logical address space.

Multicomputing is not possible in the segmented rack (see also *S7-400 Automation System, Hardware and Installation*).

Uses

There are benefits in using multicomputing in the following situations:

- When your user program is too large for one CPU and memory starts running short, distribute your program over several CPUs.
- When a particular part of your plant needs to be processed quickly, separate the relevant program section from the overall program and run this part on a separate "fast" CPU.
- When your plant consists of several parts with a clear demarcation between them so that they can be controlled relatively independently, process plant part 1 on CPU1, plant part 2 on CPU2 etc.

Example

The following figure shows an automation system operating in multicomputing mode. Each CPU can access the modules assigned to it (FM, CP, SM).

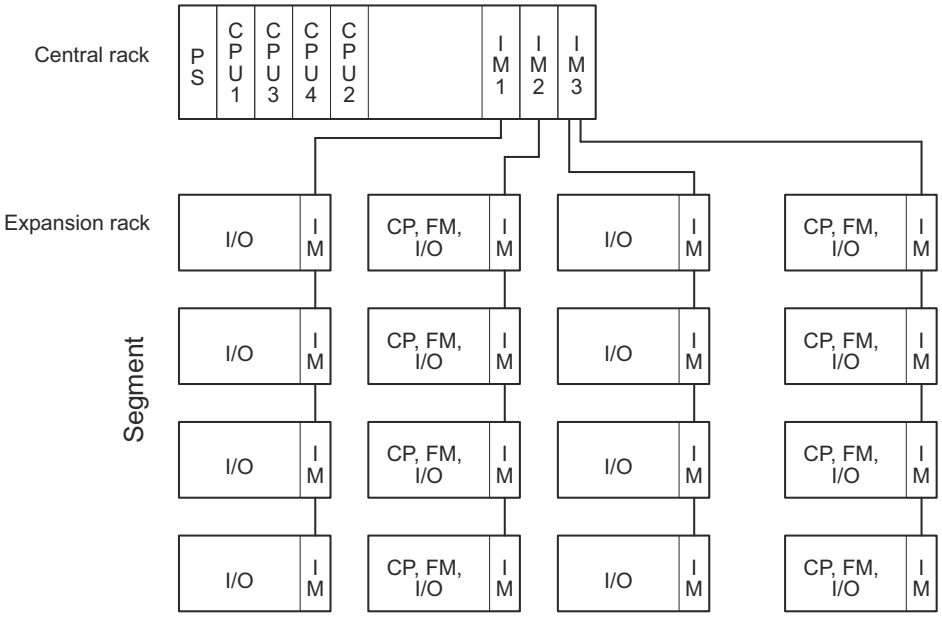


Figure 3-1 Example of multicomputing

3.3.2 Special Features at Multicomputing

Slot rules

In multicomputing mode, up to four CPUs can be inserted in one central controller (CC) in any order.

Accessibility of the CPUs.

All CPUs can be accessed from the programming device if configured accordingly via the MPI interface, PROFIBUS DP interface or PROFINET PN interface **of one** CPU.

Downloading the Configuration in Multicomputing Mode

If you want to use multicomputing, in very rare cases with very large configurations, you may find that the CPUs do not start up after the configuration has been downloaded to the PLC ("PLC > Download to Module" menu command in HW Config).

Remedy: Carry out memory resets for all CPUs with successive power off / power on. Then download your system data (and all blocks) to each CPU in succession in Simatic Manager. Start with the CPU with the highest CPU number, always followed by the CPU with the next lowest number. Then switch the CPUs to RUN in the same order.

Behavior during Startup and Operation

During startup, the CPUs involved in multicomputing automatically check whether they can synchronize themselves. Synchronization is possible only in the following situations:

- When all the configured and only the configured CPUs are inserted and ready to operate.
- If correct configuration data was created with STEP 7 and was downloaded to all plugged-in CPUs.

If one of these conditions is not fulfilled, the event is entered in the diagnostic buffer with ID 0x49A4. You will find explanations of the event IDs in the reference help on standard and system functions.

When STOP mode is left, the types of startup COLD RESTART/WARM RESTART/HOT RESTART are compared. If the types of startup are different, the CPUs do **not** change to RUN.

Address and Interrupt Assignment

In multicomputing, the individual CPUs can access the modules assigned to them during configuration with STEP 7. The address area of a module is always assigned "exclusively" to one CPU.

In particular, this means that every module with interrupt capability is assigned to a CPU. Interrupts triggered by such a module cannot be received by the other CPUs.

Interrupt processing

The following applies to interrupt processing:

- Hardware interrupts and diagnostic interrupts are sent to only one CPU.
- If a module fails or is removed/inserted, the interrupt is processed by the CPU to which the module was assigned during parameter assignment with STEP 7.
  Exception: A remove/insert interrupt triggered by a CP reaches all CPUs even if the CP was assigned to one CPU during configuration with STEP 7.
- If a rack fails, OB86 is called on every CPU; in other words, it is also called on the CPUs to which no module in the failed rack was assigned.

For more detailed information on OB86, refer to the reference help on organization blocks.

Number of I/Os

The number of I/Os of an automation system in multicomputing mode corresponds to the number of I/Os of the CPU with the most resources. The configuration limits for the specific CPU or specific DP master / PROFINET controller must not be exceeded in the individual CPUs.

3.3.3 Multicomputing interrupt

Principle

Using the multicomputing interrupt (OB60), you can synchronize the CPUs involved in multicomputing to an event. In contrast to the hardware interrupts that are triggered by signal modules, the multicomputing interrupt can only be output by CPUs. The multicomputing interrupt is triggered by calling SFC35 "MP_ALM".

For more detailed information, refer to the *System Software for S7-300/400, System and Standard Functions*.

3.3.4 Configuring and programming multicomputing mode

Reference

For information on the procedure for configuring and programming CPUs and modules, refer to the *Configuring Hardware and Connections with STEP 7*.

3.4 Resetting the CPU to the factory state

CPU factory settings

A general memory reset is performed when you reset the CPU to its factory settings and the properties of the CPU are set to the following values:

Table 3-1 CPU properties in the factory settings

Properties	Value
MPI address	2
MPI transmission rate	187.5 Kbps
Contents of the diagnostic buffer	Empty
IP parameters	None
IP parameters	Default values
Operating hours counters	0
Date and time	01.01.94, 00:00:00

Procedure

Proceed as follows to reset a CPU to its factory settings:

1. Switch off the mains voltage.
2. If a memory card is inserted in the CPU, always remove the memory card.
3. Hold the toggle switch in the MRES setting and switch the mains voltage on again.
4. Wait until LED pattern 1 from the following overview is displayed.
5. Release the toggle switch, set it back to MRES within 3 seconds and hold it in this position. After approx. 4 seconds all the LEDs light up.
6. Wait until LED pattern 2 from the following overview is displayed.
   This LED pattern lights up for approximately 5 seconds. During this period you can abort the resetting procedure by releasing the toggle switch.
7. Wait until LED pattern 3 from the following overview is displayed, and release the toggle switch again.

The CPU is now reset to its factory settings. It starts without buffering and goes to STOP mode. The event "Reset to factory setting" is entered in the diagnostic buffer.

LED patterns during CPU reset

While you are resetting the CPU to its factory settings, the LEDs light up consecutively in the following LED patterns:

Table 3-2 LED patterns

LED	LED pattern 1	LED pattern 2	LED pattern 3
INTF	Flashes (0.5 Hz)	Flashes (0.5 Hz)	Lit
EXTF	Dark	Dark	Dark
BUSxF	Dark	Dark	Dark
FORCE	Flashes (0.5 Hz)	Dark	Dark
MAINT	Dark	Dark	Dark
IFMxF	Dark	Dark	Dark
RUN	Flashes (0.5 Hz)	Dark	Dark
STOP	Flashes (0.5 Hz)	Dark	Dark

3.5 Updating the firmware without a memory card

Basic procedure

To update the firmware of a CPU, you will receive several files (*.UPD) containing the current firmware. Download these files to the CPU. You do not need a memory card to perform an online update. However, it is still possible to update the firmware using a memory card.

Requirement

The CPU whose firmware you want to update must be accessible online, for example, via PROFIBUS, MPI or Industrial Ethernet. The files containing the current firmware version must be available in the PG/PC file system. A folder may contain only the files of one firmware version.

Note

You can update the firmware of CPUs with PROFINET interface via Industrial Ethernet at the PROFINET interface. The update via Industrial Ethernet is much faster than via MPI or DP (depending on the configured baud rate).

You can update the firmware of the other CPUs via Industrial Ethernet if the CPU is connected to the Industrial Ethernet via a CP.

Procedure in HW Config

Proceed as follows to update the firmware of a CPU:

1. Open the station containing the CPU you want to update in HW Config.
2. Select the CPU.
3. Select the "PLC > Update Firmware" menu command.
4. In the "Update Firmware" dialog, select the path to the firmware update files (CPU_HD.UPD) using the "Browse" button.
   After you have selected a file, the information in the bottom boxes of the "Update Firmware" dialog box indicate the modules for which the file is suitable and from which firmware version.
5. Click on "Run."

STEP 7 verifies that the selected file can be interpreted by the CPU and then downloads the file to the CPU. If this requires changing the operating state of the CPU, you will be asked to do this in the relevant dialog boxes.

Procedure in SIMATIC Manager

The command procedure is the same as in HW Config, i.e. "PLC > Update firmware". However, STEP 7 waits until the command is executed before it verifies that the module supports this function.

Note

Backup security

For reasons of firmware security, the CPU validates a digital signature before it runs the firmware update. If it detects an error, it retains the current firmware version and rejects the new one.

Values retained after a firmware update

The following values are retained after a CPU memory reset:

- Parameters of the MPI (MPI address and highest MPI address).

The following values are also retained for CPUs with PN interface:

- The IP address of the CPU
- The device name (NameOfStation).
- The subnet mask
- The static SNMP parameters

3.6 Reading out service data

Application case

In a service situation in which you need to call Customer Support, it is possible that the department will need special information about the status of a CPU in your plant for diagnostic purposes. This information is stored in the diagnostic buffer and in the service data.

You can read this information with the menu command "PLC > Save Service Data" and save it in two files. You can then send these to Customer Support.

Note the following:

- Save the service data directly after a CPU changes to STOP mode if possible.

The path and the file name under which the service data is stored are specified when the information is read.

Procedure

1. Select the CPU with the "SIMATIC Manager > Accessible Nodes" menu command.
2. Select the "PLC > Save Service Data" menu command.
   A dialog box opens in which you specify the storage location and name of the two files.
3. Save the file.
4. Forward these files to Customer Support on request.

Communication

4

4.1 interfaces

4.1.1 Multi-Point Interface (MPI)

Availability

In it's factory state, the MPI/DP interface of an S7-400 CPU is programmed as MPI interface and assigned address 2.

Properties

The MPI represents the CPU interface for PG/OP connections or for communication on an MPI subnet.

The default baud rate is 187.5 Kbps for all CPUs. The maximum baud rate is 12 Mbps. Ensure that the cables used are suitable for the baud rate setting.

The CPU automatically broadcasts its configured bus parameters via the MPI interface (the baud rate, for example). A programming device, for example, can supply the correct parameters and automatically connect to a MPI subnet. Nodes with different bus parameters to those set on the CPU cannot be operated on the MPI subnet.

Note

In runtime, you may only connect programming devices to an MPI subnet.
Other stations, such as OP or TP, should not be connected to the MPI subnet in runtime. Otherwise, transferred data might be corrupted due to interference pulses or global data packages may be lost.

Time synchronization

You can synchronize the time via the MPI interface of the CPU. The CPU can be master or slave.

MPI interface as PROFIBUS DP interface

You can also configure the MPI interface as a PROFIBUS DP interface. To do so, you can re-configure the MPI interface under STEP 7 in HW-Config. This configuration allows you to set up a DP segment consisting of up to 32 slaves.

Devices capable of MPI communication

- PG/PC
- OP/TP
- S7-300/S7-400 with MPI/DP interface
- S7-200 only with 19.2 Kbps and 187.5 Kbps

4.1.2 PROFIBUS DP

Availability

The CPUs 41x-2, 41x-3 and 417-4 feature an integrated PROFIBUS-DP interface.

PROFIBUS DP interfaces are available as plug-in modules for the CPUs 41x-3, 417-4 and for CPUs with the suffix "PN/DP". In order for you to be able to use these interfaces, you must first configure them in HW Config. After uploading the configuration, you can use the plugged-in DP modules.

An MPI/DP interface is always configured as an MPI interface in the delivery state of the CPU. If you want to use it as a DP interface, you must re-configure the MPI/DP interface in STEP 7 as a DP interface.

Properties

The PROFIBUS-DP interface is mainly used for connecting distributed I/O devices. You can configure the PROFIBUS DP interface as master or slave. It enables a transmission rate of up to 12 Mbps possible.

The CPU sends its bus parameters, which have been set, to the PROFIBUS DP interface during operation as master, for example, the baud rate. In this manner, for example, a programming device can obtain the correct parameters and connect automatically to a PROFIBUS subnet.

Time-of-day synchronization via the PROFIBUS DP.

A CPU operating as time master sends synchronization message frames to PROFIBUS to synchronize additional stations.

If operated as time slave, the CPU receives synchronization frames from other time masters. One of the following devices can be the Time master:

- a CPU 41x with internal PROFIBUS interface
- A CPU 41x with external PROFIBUS interface, e.g. CP 443-5
- a PC with a Simatic NET module for Profibus

Connectable devices via PROFIBUS DP

The PROFIBUS DP interface can be used to set up a PROFIBUS master system, or to connect PROFIBUS I/O devices.

You can connect the following devices to the PROFIBUS DP interface:

- PG/PC
- OP/TP
- PROFIBUS DP Slaves
- PROFIBUS DP Master

The CPU is hereby operated either as DP master or DP slave that is interconnected via PROFIBUS DP fieldbus with the passive slave stations or other DP masters.

Certain devices use the 24 V power supply of the interface. This voltage provided at the PROFIBUS DP interface is connected to reference potential.

Reference

Further information on PROFIBUS (https://www.profibus.com/)

4.1.3 PROFINET

Availability

CPUs with "PN" or "PN/DP" name suffix feature an Ethernet interface with PROFINET functionality.

Assigning an IP address

You have the following options of assigning an IP address to the Ethernet interface:

1. Using the "PLC -> Edit Ethernet Node" command in SIMATIC Manager.
2. By editing the CPU properties in HW Config. Download the modified configuration to the CPU.
3. Using SFB 104 "IP_CONFIG".

Devices which can be connected via PROFINET (PN)

- Programming device/PC with Ethernet adapter and TCP protocol
- Active network components, for example, a SCALANCE XC-200
- S7-300 / S7-400 with Ethernet CP, e.g. CPU 416-2 with CP 443-1
- PROFINET IO devices of the ET 200 spectrum
- PROFINET CBA components

Connectors

Always use RJ45 connectors to hook up devices to the PROFINET interface.

Properties of the PROFINET interface

Protocol and communication functions	
PROFINET IO PROFINET CBA	
In accordance with IEC61784-2 , Conformance Class A and BC	
Open block communication over • TCP • UDP • ISO on TCP	
S7 communication	
Programming device functions	
Port statistics of PN IO devices (SNMP)	
Detection of the network topology (LLDP)	
Media redundancy (MRP)	
Time synchronization • NTP as client • Master/slave in the SIMATIC procedure	
Connection	
Version	2 x RJ45
	Switch with 2 ports
Media	Twisted pair Cat5
Transmission rate	10/100 Mbps
	Autosensing Autocrossing Autonegotiation

Note

Communication via IP router

In the case of communication via IP router the number of IP hops amounts to 30. If a larger quantity is required, a CP 443-1EX30 can be used. This supports 60 IP hops.

Note

Networking PROFINET components

The PROFINET interfaces of our devices are set to "automatic setting" (autonegotiation) by default. Verify that all devices connected to the PROFINET interface of the CPU are also set to the "Autonegotiation" mode. This is the default setting of standard PROFINET / Ethernet components.

If connecting a device to the on-board PROFINET interface of the CPU that does not support the "automatic setting" (Autonegotiation) operating mode, or selecting a setting other than the "automatic setting" (Autonegotiation), note the following:

- PROFINET IO and PROFINET CBA require operation at 100 Mbps in full-duplex mode, i.e. if the on-board PROFINET interface of the CPU for PROFINET IO/CBA communication and Ethernet communication is used at the same time, the PROFINET interface can only be operated at 100 Mbps in full-duplex mode.
- Operation at 100 Mbps full-duplex or 10 Mbps full-duplex is posible if the on-board PROFINET interface(s) of the CPU is used only for Ethernet communication. Half-duplex mode is not allowed in any situation.

Background: If a switch that is permanently set to 10 Mbps half-duplex is connected to the interface of the CPU, the "Autonegotiation" setting forces the CPU to adapt itself to the settings of the partner device, i.e. the communication operates de facto at "10 Mbps half-duplex". However, this operating mode is not allowed because PROFINET IO and PROFINET CBA must be operated at 100 Mbps in full-duplex mode.

Reference

- For additional information on PROFINET, refer to PROFINET System Description (https://support.industry.siemens.com/cs/ww/en/view/19292127)
- For detailed information about Ethernet networks, network configuration and network components refer to the SIMATIC NET manual: Twisted-pair and fiber-optic networks (https://support.industry.siemens.com/cs/ww/en/view/8763736) manual.
- Component Based Automation, Commissioning SIMATIC iMap Systems - Tutorial (https://support.industry.siemens.com/cs/ww/en/view/22761971) .
- For additional information about PROFINET, refer to: PROFINET (https://www.profibus.com/)

4.2 Communication services

4.2.1 Overview of communication services

Overview

Table 4-1 Communication services of the CPUs

Communication service	Functionality	Allocation of S7 connection resources	via MPI (preset)	via DP	via PN/IE
PG communication	Commissioning, testing, diagnostics	Yes	Yes	Yes	Yes
OP communication	Operator control and monitoring	Yes	Yes	Yes	Yes
S7 basic communication	Data exchange	Yes	Yes	Yes	No
S7 communication	Data exchange via configured connections	Yes	Yes	Yes	Yes
Global data communication	Cyclic data exchange, e.g. bit memories	No	Yes	No	No
Routing of PG functions	For example, testing, diagnostics across network boundaries	Yes	Yes	Yes	Yes
PROFIBUS DP	Data exchange between master and slave	No	No	Yes	No
PROFINET CBA	Data exchange by means of component-based communication	No	No	No	Yes
PROFINET IO	Data exchange between I/O controllers and I/O devices	No	No	No	Yes
Web server	Diagnostics	No	No	No	Yes
SNMP (Simple Network Management Protocol)	Standard protocol for network diagnostics and parameterization	No	No	No	Yes
Open communication over TCP/IP	Data exchange over Industrial Ethernet with TCP/IP protocol (with loadable FBs)	Yes	No	No	Yes
Open communication over ISO on TCP	Data exchange over Industrial Ethernet with ISO on TCP protocol (with loadable FBs)	Yes	No	No	Yes
Open communication over UDP	Data exchange over Industrial Ethernet with UDP protocol (with loadable FBs)	Yes	No	No	Yes
Data record routing	for example, configuration and diagnostics of field devices on PROFIBUS DP via C2 channel	Yes	Yes	Yes	Yes

Connection resources In the S7-400

S7-400 components are equipped with a module-specific number of connection resources.

Availability of connection resources

Table 4-2 Availability of connection resources

CPU	Connection resources				Of those are reserved for	
	Total number	for MPI	for DP	for PN	PG communication	OP communication
412-x	32	32	16	-	1	1
412-2 PN	48	32	16	48	1	1
414-x	32	32	16	-	1	1
414-3 PN/DP 414F-3 PN/DP	64	32	16	64	1	1
416-2 416F-2 416-3	64	44	32	-	1	1
416-3 PN/DP 416F3 PN/DP	96	44	32	96	1	1
417	120	44	32	-	1	1

Free S7 connections can be used for any of the above communication services.

Note

Communication service via the PROFIBUS DP interface

A fixed default timeout of 40 s is specified for communication services using S7 connection resources. Reliable operation of those communication services at a low baud rate via PROFIBUS DP interface can be ensured in configurations with a Ttr (Target Rotation Time) < 20 s.

4.2.2 PG communication

Properties

Programming device communication is used to exchange data between engineering stations (PG, PC, for example) and SIMATIC modules which are capable of communication. This service is available for MPI, PROFIBUS and Industrial Ethernet subnets. Routing between subnets is also supported.

You can use the programming device communication for the following actions:

- Loading programs and configuration data
- Performing tests
- Evaluating diagnostic information

These functions are integrated in the operating system of SIMATIC S7 modules.

A CPU can maintain several simultaneous online connections to one or multiple programming devices.

4.2.3 OP communication

Properties

OP communication is used to exchange data between HMI stations, such as WinCC, OP, TP and SIMATIC modules which are capable of communication. This service is available for MPI, PROFIBUS and Industrial Ethernet subnets.

You can use the OP communication for operator control, monitoring and alarms. These functions are integrated in the operating system of SIMATIC S7 modules. A CPU can maintain several simultaneous connections to one or several OPs.

4.2.4 S7 basic communication

Properties

S7-based communication is used to exchange data between S7 CPUs and the communication-enabled SIMATIC modules within an S7 station (acknowledged data communication). The service is available via the MPI subnet or within the station to function modules (FM).

You do not need to configure connections for basic S7 communication. The integrated communication functions are called via SFCs in the user program.

SFCs for S7 basic communication

The following SFCs are integrated in the operating system of the S7-400 CPUs:

Table 4-3 SFCs for S7 Basic Communication

Block	Block name	Brief description
SFCs for external communication		
SFC 65 SFC 66	X_SEND X_RCV	Transfers a data block to a communication partner.
SFC 67	X_GET	Reads a tag from a communication partner
SFC 68	X_PUT	Writes a tag to a communication partner
SFC 69	X_ABORT	Cancels an established connection without transferring data
SFCs for internal communication		
SFC 72	I_GET	Reads a tag from a communication partner
SFC 73	I_PUT	Writes a tag to a communication partner
SFC 74	I_ABORT	Cancels an established connection without transferring data

Reference

- Refer to the *operation list* to learn which SFCs are included in the operating system of a CPU.
- You can find detailed descriptions of the SFCs in the *STEP 7 Online Help* or *System and Standard Functions* reference manual.

4.2.5 S7 communication

Properties

A CPU can act as a server or client in S7 communication: A connection is configured permanently. The following connections are possible:

- One-sided configured connections (for PUT/GET only)
- Two-side configured connections (for USEND, URCV, BSEND, BRCV, PUT, GET)

You can use S7 communication via integral interfaces (MPI/DP, PROFIBUS-DP, PROFINET) and, if necessary, via additional communication processors (CP443-1 for Industrial Ethernet, CP443-5 for PROFIBUS). Read the Technical Specifications to see which interfaces are integrated into your CPU.

The S7-400 features integrated S7 communication services that allow the user program in the controller to initiate reading and writing of data. The S7 communication functions are called via SFBs in the user program. These functions are independent of the specific network, allowing you to program S7 communication over PROFINET, Industrial Ethernet, PROFIBUS, or MPI.

S7 communication services provide the following functions:

- During system configuration, you configure the connections used by the S7 communication. These connections remain configured until you download a new configuration.
- You can establish several connections to the same partner. The number of communication partners accessible at any time is restricted to the number of connection resources available.

Note

Downloading connection configuration during operation

When you load a modified connection configuration during operation, connections which have been set up which are not affected by changes in the connection configuration may also be aborted.

S7 communication allows you to transfer a block of up to 64 KB per call to the SFB. An S7-400 transfers a maximum of 4 tags per block call.

SFBs for S7 Communication

The following SFBs are integrated in the operating system of the S7-400 CPUs:

Table 4-4 SFBs for S7 Communication

Block	Block name	Brief description
SFB 8 SFB 9	USEND URCV	Send data to a remote partner SFB with the type "URCV" Receive asynchronous data from a remote partner SFB with the type "USEND"
SFB 12 SFB 13	BSEND BRCV	Send data to a remote partner SFB with the type "BRCV" Receive asynchronous data from a remote partner SFB with the type "BSEND" With this data transfer, a larger amount of data can be transported between the communication partners than is possible with all other communications SFBs for the configured S7 connections.

Block	Block name	Brief description
SFB 14	GET	Read data from a remote CPU
SFB 15	PUT	Write data to a remote CPU
SFB 16	PRINT	Send data via a CP 441 to a printer
SFB 19	START	Carry out a reboot (warm restart) or cold restart in a remote station
SFB 20	STOP	Set a remote station to STOP state
SFB 21	RESUME	Carry out a hot restart in a remote station
SFB 22	STATUS	Query the device status of a remote partner
SFB 23	USTATUS	Uncoordinated receiving of a remote device status

Integration into STEP 7

S7 communication offers communication functions through configured S7 connections. You use STEP 7 to configure the connections.

S7 connections with an S7-400 are established when the connection data is downloaded.

4.2.6 Global data communication

Properties

Global data communication is used for cyclic exchange of global data via MPI subnets (for example, I, Q, M) between SIMATIC S7 CPUs. The exchange of data is unacknowledged. One CPU broadcasts its data to all other CPUs on the MPI subnet.

The integrated communication functions are called via SFCs in the user program.

SFCs for Global Data Communication

The following SFCs are integrated in the operating system of the S7-400 CPUs:

Table 4-5 SFCs for Global Data Communication

Block	Block name	Brief description
SFC 60	GD_SEND	Collects and sends data of a GD packet
SFC 61	GD_REC	Fetches data of an arrived GD message frame and enters it in the receive GD packet.

Reduction ratio

The reduction ratio specifies the number of cycles into which the GD communication is broken down. You set the reduction ratio when you configure global data communication in STEP 7. For example, if you set a reduction ratio of 7, global data communication is performed every 7th cycle. This reduces the load on the CPU.

Send and Receive Conditions

Meet the following conditions for communication via GD circuits:

- For the sender of a GD packet:
  Reduction ratio$_{sender}$ x cycle time$_{sender}$ ≥ 60 ms
- For the receiver of a GD packet:
  Reduction ratio$_{receiver}$ x cycle time$_{receiver}$
  < reduction ratio$_{sender}$ x cycle time$_{sender}$

A GD packet may be lost if you do not adhere to these conditions. The reasons being:

- The performance of the "smallest" CPU in the GD circuit
- Transmission and reception of global data is performed asynchronously at the stations.

When setting in STEP 7: “Transmit after each CPU cycle“, and the CPU has a scan cycle time < 60 ms, the operating system might overwrite a GD packet of the CPU before it is transmitted. The loss of global data is indicated in the status box of a GD circuit, if you set this function in your STEP 7 configuration.

4.2.7 S7 routing

Properties

You can access your S7 stations beyond subnet boundaries using the PG/PC. You can use this for the following actions:

- Downloading user programs,
- Downloading a hardware configuration
- Performing test and diagnostic functions

Note

If you are using your CPU as an I-slave, the S7 routing function is only possible with the DP interface set to active mode. In STEP 7, activate the check boxes Test, Commissioning, Routing under the Properties of the DP interface. More information can be found in the *Manual of Programming with STEP 7* or directly in the *online help of STEP 7*

Requirements

- The network configuration does not exceed project limits.
- The modules have loaded the configuration data containing the latest "knowledge" of the entire network configuration of the project.
  Reason: All modules connected to the network gateway must receive routing information which defines the paths to other subnets.
- In your network configuration, the PG/PC you want to use to set up a connection via gateway must be assigned to the network to which it is actually physically connected.

- The CPU must either be configured as the master or
- if the CPU is configured as a slave, then in STEP 7, in the properties of the DP interface for DP slave, the check boxes "Programming, Status/Force or other PG functions" must be checked.

S7 routing gateways: MPI - DP

The gateways from a subnet to another or to several other subnets are routed in a SIMATIC station that is equipped with interfaces to the respective subnets. The following figure shows CPU 1 (DP master) acting as router for subnets 1 and 2.

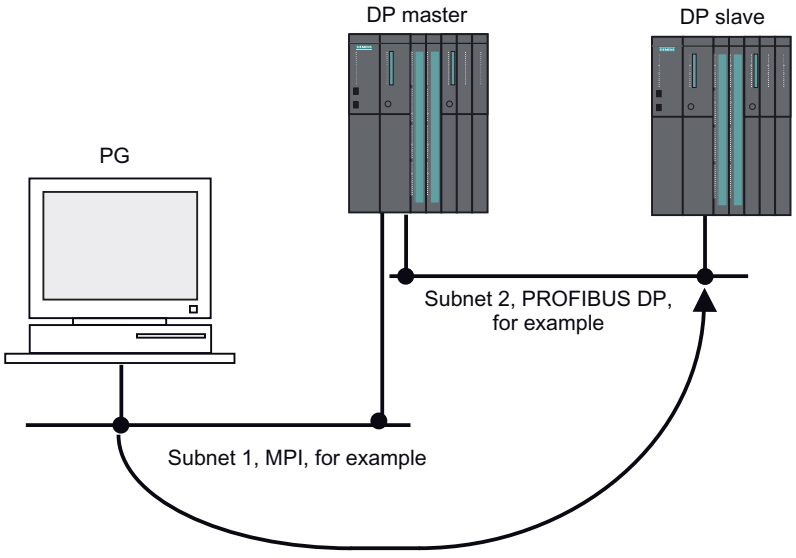


Figure 4-1 S7 routing

S7 routing gateways: MPI-DP-PROFINET

The following figure shows the access from MPI to PROFINET via PROFIBUS. CPU 1, for example, a CPU 416-3, is the router between subnet 1 and subnet 2; CPU 2 is the router between subnet 2 and subnet 3.

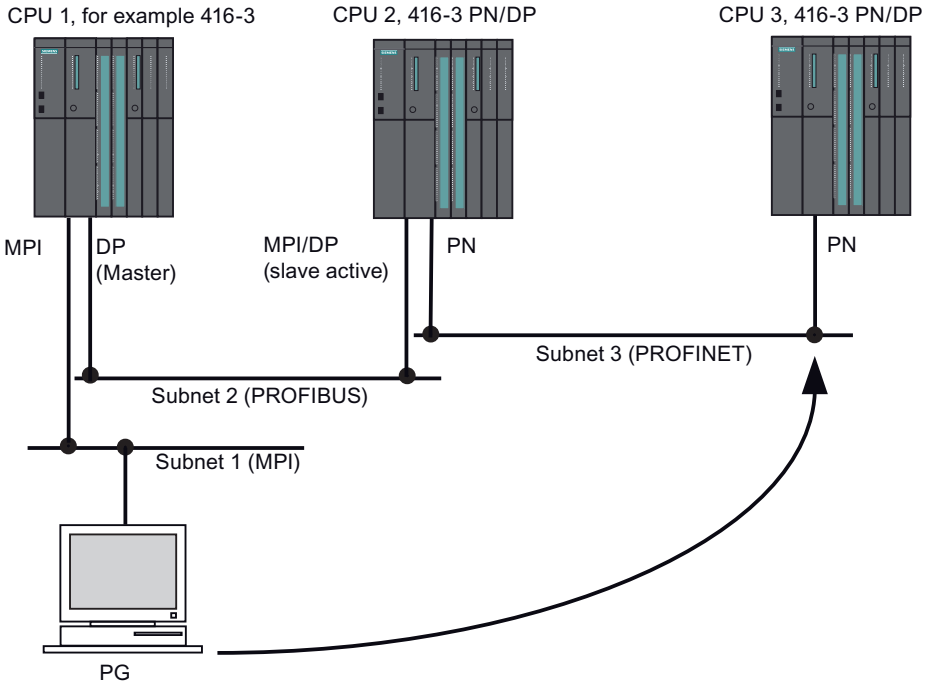


Figure 4-2 S7 routing gateways: MPI-DP-PROFINET

S7 routing: TeleService application example

The following figure shows an application example of the remote maintenance of an S7 station using a PG. The connection is established across subnet boundaries via modem.

The lower part of the figure shows how this can be configured in STEP 7.

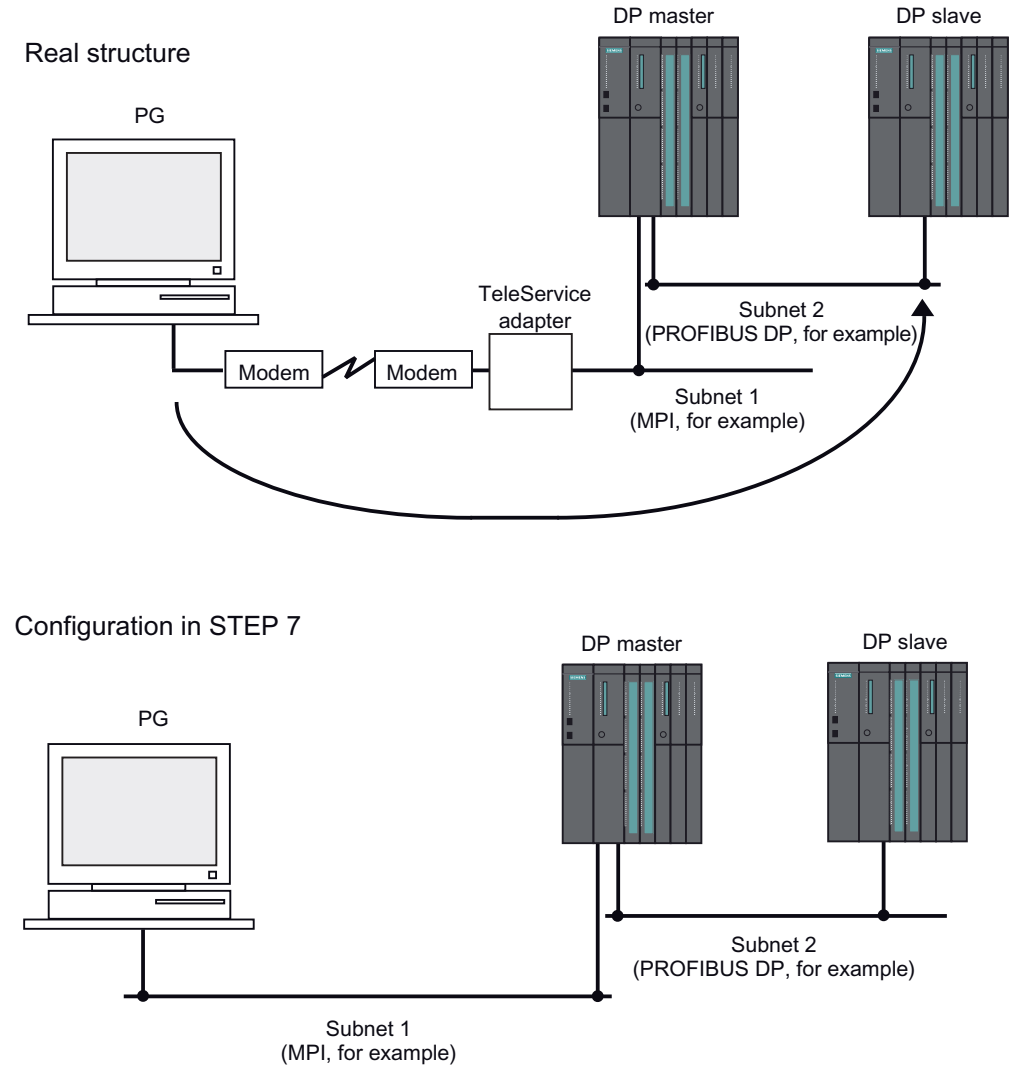


Figure 4-3 S7 routing: TeleService application example

Reference

- More information on configuration with STEP 7 can be found in the manual Configuring hardware and communication connections with STEP 7. (https://support.industry.siemens.com/cs/ww/en/view/18652631)
- More basic information is available in Manual Communication with SIMATIC (https://support.industry.siemens.com/cs/ww/en/view/1254686).
- For more information about the TeleService adapter, refer to the manual TS Adapter (https://support.industry.siemens.com/cs/ww/en/view/20983182)
- For a detailed description, refer to the *STEP 7 online help* or the manual System and Standard Functions (https://support.industry.siemens.com/cs/ww/en/view/44240604).

4.2.8 Time synchronization

Introduction

The S7-400 has a powerful timer system. You can synchronize this timer system using a higher-level time generator, which will allow you to synchronize, complete, document and archive time-critical sequences.

Interfaces

Time synchronization is possible via every interface of the S7-400:

- MPI interface
  You can configure the CPU as a time master or a time slave.
- PROFIBUS DP interface
  You can configure the CPU as a time master or a time slave.
- PROFINET interface via Industrial Ethernet
  Time-of-day synchronization using NTP, the CPU is client, or master/slave in the SIMATIC procedure.
- Via the S7-400 backplane bus
  You can configure the CPU as a time master or a time slave.

CPU as a time master

If you configure the CPU as a time master, you must specify a synchronization interval. You can select any interval between 1 second and 24 hours.

If the CPU time master is on the S7-400 backplane bus, you should select a synchronization interval of 10 seconds.

The time master sends its first message frame once the time has been set for the first time (via SFC 0 "SET_CLK" or PG function). If another interface was configured as a time slave or as an NTP client, the time starts once the first time message frame has been received.

CPU as a time slave

If the CPU is a time slave on the S7-400 backplane bus, then the synchronization is carried out by a central clock connected to the LAN or by another CPU.

You can use a CP to forward the time to the S7-400. To do this, the CP (if it supports direction filtering) must be configured with the "from LAN to station" option in order to forward the time.

Time synchronization via the PROFINET interface

At the PROFINET interface, time synchronization is possible using the NTP method. The PROFINET CPU is client.

You may configure up to four NTP servers. You can set the update interval between 10 seconds and 1 day. If times exceed an interval of 90 minutes, the PROFINET CPU requests an NTP at cyclic intervals of 90 minutes.

If synchronizing the PROFINET CPU based on the NTP method, you should configure the PROFINET CPU as the time master for the synchronization method in the S7-400. Select a synchronization interval of 10 seconds.

Set a time zone in a PROFINET CPU using SFC 100 or with an advanced time setting dialog (similar to the dialog on a Simatic Net CP). Use FB "LT_BT" or FB "BT_LT" from the STEP 7 standard library to make allowances for a time zone or daylight saving/standard time.

Time synchronization is also possible via the SIMATIC procedure (Ethernet MMS) as master or slave. The combination NTP with SIMATIC procedure is allowed in this case.

4.2.9 Data set routing

Availability

S7-400 CPUs as of firmware version 5.1 supports data set routing. The CPUs must also be configured in this or a higher firmware version for this.

Routing and data set routing

Routing is the transfer of data beyond network boundaries. You can send information from a transmitter to a receiver across several networks.
Data record routing is an expansion of the "standard routing" and is used by SIMATIC PDM, for example. The data sent through data record routing include the parameter assignments of the participating communication devices and device-specific information (for example, setpoint values, limit values, etc.). The structure of the destination address for data set routing depends on the data content, in other words, it is determined by the device for which the data is intended. The field device itself does not need to support data set routing, since these devices do not forward the included information.

Data set routing

The following figure shows the engineering station accessing a variety of field devices. The engineering station is connected to the CPU via Industrial Ethernet in this scenario. The CPU communicates with the field devices via the PROFIBUS.

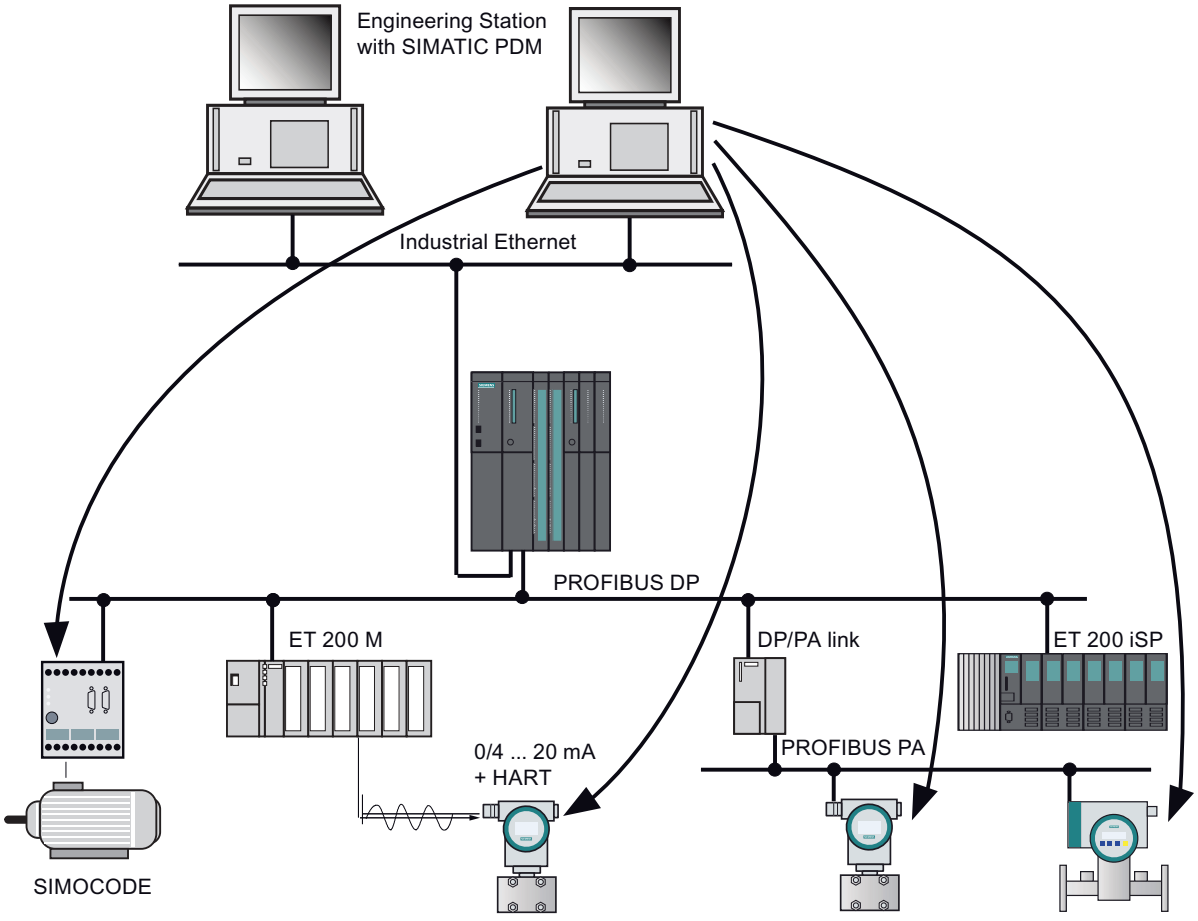


Figure 4-4 Data set routing

See also

You can find additional information on SIMATIC PDM in the *PDM V6.0 The Process Device Manager* manual.

4.3 SNMP network protocol

Availability

CPUs with "PN" or "PN/DP" name suffix support the SNMP network protocol.

Properties

SNMP (Simple Network Management Protocol) is the standardized protocol for diagnostics of the Ethernet network infrastructure. In the office setting and in automation engineering, devices from many different manufacturers support SNMP on the Ethernet. SNMP-based applications can be operated on the same network in parallel to applications with PROFINET.

Configuration of the SNMP OPC server is integrated in the STEP 7 Hardware Configuration application. Already configured S7 modules from the STEP 7 project can be transferred directly. As an alternative to STEP 7, you can also perform the configuration with the NCM PC (included on the SIMATIC NET CD). All Ethernet devices can be detected by means of their IP address and/or the SNMP protocol (SNMP V1) and transferred to the configuration.

Use the profile MIB_II_V10.

Applications based on SNMP can be operated on the same network at the same time as applications with PROFINET.

Note

MAC addresses

During SNMP diagnostics, the following MAC addresses are shown for the ifPhysAddress parameter as of FW V5.1:

Interface 1 (PN interface) = MAC address (specified on the front panel of the CPU)

Interface 2 (port 1) = MAC address + 1

Interface 3 (port 2) = MAC address + 2

Diagnostics with SNMP OPC Server in SIMATIC NET

The SNMP OPC server software provides diagnostics and configuration functions for all SNMP devices. The OPC server uses the SNMP protocol to perform data exchange with SNMP devices.

All information can be integrated in OPC-compatible systems, such as the WinCC HMI system. This enables process and network diagnostics to be combined in the HMI system.

Reference

For further information on the SNMP communication service and diagnostics with SNMP, refer to the *PROFINET System Description*.

Note

The SNMP service is disabled on CPUs from firmware version V7.0.3 by default.

SNMP can be activated or disabled through a user program by writing the data record 0xB071. After a power-off-on, SNMP is disabled again. You can find detailed information on the SNMP function in SIOS (https://support.industry.siemens.com/cs/ww/en/view/109760539).

4.4 Open Communication Via Industrial Ethernet

Availability

CPUs with PROFINET interface support "open communication over Industrial Ethernet" (in short: open IE communication).

Functionality

The following services are available for open IE communication:

- Connection-oriented protocols:
  Prior to data transmission connection-oriented protocols establish a logical connection to the communication partner and close this again, if necessary, after transmission is completed. Connection-oriented protocols are used when security is especially important in data transmission. A physical cable can generally accommodate several logical connections. The maximum job length is 32 KB.
  The following connection-oriented protocols are supported for the FBs for open IE communication:
  - TCP to RFC 793
  - ISO on TCP according to RFC 1006

    Note

    ISOonTCP

    For data communication with third-party systems via RFC1006, the connection partner must adhere to the maximum TPDU size (TPDU = Transfer Protocol Data Unit) negotiated in the ISOonTCP connection establishment.

- Connectionless protocols:
  Connectionless protocols operate without a logical connection. There is also no establishing or terminating a connection to remote partner. Connectionless protocols transfer the data unacknowledged and thus unsecured to the remote partner. The maximum message frame length is 1472 bytes.
  The following connectionless protocols are supported for the FBs for open communication by means of Industrial Ethernet:
  - UDP according to RFC 768
    The single-cast and broadcast modes are supported.

How to use open IE communication

STEP 7 provides the following FBs and UDTs under "Communication Blocks" in the "Standard Library" to allow data to be exchanged with other communication partners:

- Connection-oriented protocols: TCP/ISO-on-TCP
  - FB 63 "TSEND" for sending data
  - FB 64 "TRCV" for receiving data
  - FB 65 "TCON", for connection setup
  - FB 66 "TDISCON", for disconnecting
  - UDT 65 "TCON_PAR" with the data structure for the configuration of the connection
- Connectionless protocol: UDP
  - FB 67 "TUSEND" for sending data
  - FB 68 "TURCV" for receiving data
  - FB 65 "TCON" for setting up the local communication access point
  - FB 66 "TDISCON" for resolving the local communication access point
  - UDT 65 "TCON_PAR" with the data structure for configuring the local communication access point
  - UDT 66 "TCON_ADR" with the data structure of the addressing parameters of the remote partner

Data blocks for parameterization

- Data blocks for parametzerizing TCP and ISO-on-TCP connections
  To be able to parameterize your connection at TCP and ISO-on-TCP, you must create a DB that contains the data structure of UDT 65 "TCON_PAR". This data structure contains all parameters you need to set up the connection. Such a data structure which you can group within a global data range is required for every connection.
  Connection parameter CONNECT of FB 65 "TCON" reports the address of the corresponding connection description to the user program (for example, P#DB100.DBX0.0 byte 64).
- Data blocks for the configuration the local UDP communication access point
  To configure the local communication access point, create a DB containing the data structure from the UDT 65 "TCON_PAR" This data structure contains the required parameters you need to set up the connection between the user program and the communication layer of the operating system
  The CONNECT parameter of the FB 65 "TCON" contains a reference to the address of the corresponding connection description (for example, P#DB100.DBX0.0 Byte 64).

Note

Structure of the connection description (UDT 65)

You must enter the interface to be used for communication in the parameter "local_device_id" in UDT 65 "TCON_PAR".

This is 16#5 for connection types TCP, UDP, ISO on TCP via the PN interface.

It is 16#0 for connection type ISO on TCP via a CP 443-1.

You can also use the default UDT 651 to 661 from "Standard Library" -> "Communication Blocks".

Job lengths and parameters for the different types of connection

Table 4-6 Job lengths and "local_device_id" parameter

Message frame	CPU 412-2 PN CPU 41x-3 PN/DP	CPU 41x with CP 443-1
TCP	32 KB	-
ISO-on-TCP	32 KB	1452 bytes
UDP	1472 bytes	-
"local_device_id" parameter for the connection description		
Dev. ID	16#5	16#0

Establishing a communication connection

- Use with TCP and ISO-on-TCP
  Both communication partners call FB 65 "TCON" to establish the connection. In the configuration, you specify which communication partner activates the connection, and which one responds to the request with a passive connection. To determine the number of possible connections, refer to your CPU's technical specifications.
  The CPU automatically monitors and holds the active connection.
  If the connection is broken, for example by line interruption or by the remote communication partner, the active partner tries to reestablish the connection. You do not have to call FB 65 "TCON" again.
  FB 66 "TDISCON" disconnects the CPU from a communication partner, as does STOP mode. To reestablish the connection to have to call FB65 "TCON" again.
- Use with UDP
  Both communication partners call FB 65 "TCON" to set up their local communication access point. This establishes a connection between the user program and operating system's communication level No connection is established to the remote partner.
  The local access point is used to send and receive UDP message frames.

Disconnecting a communication connection

- Use with TCP and ISO-on-TCP
  FB 66 "TDISCON" disconnects the communication connection between the CPU and a communication partner.
- Use with UDP
  FB 66 "TDISCON" disconnects the local communication access point, i.e., the interconnection between the user program and the communication layer of the operating system is terminated.

Options for closing the communication connection

The following events cause the communication connection to be closed:

- You program the disconnection with FB 66 "TDISCON."
- The CPU state changes from RUN to STOP.
- At POWER OFF / POWER ON

Connection diagnostics

Step7 V5.4 SP5 or higher supports reading of additional information about the configured connections by selecting "Module state -> Communication -> Open communication over Industrial Ethernet".

The same information is also available via Web server on the "Communication" Web page.

Reference

For detailed information on the blocks described above, refer to the *STEP 7 Online Help*.

4.5 S7 connections

4.5.1 Communication path of an S7 connection

An S7 connection is established as a communication channel when S7 modules communicate with one another.

Note

Global data communication, point-to-point connection via CP 440, PROFIBUS DP, PROFINET CBA, PROFINET IO, Web and SNMP require no S7 connections.

Every communication link requires S7 connection resources on the CPU for the entire duration of this connection.

Thus, every S7 CPU provides a specific number of S7 connection resources. These are used by various communication services (PG/OP communication, S7 communication or S7 basic communication).

Connection points

An S7 connection between modules with communication capability is established between connection points. The S7 connection always has two connection points, one active and one passive:

- The active connection point is assigned to the module that establishes the S7 connection.
- The passive connection point is assigned to the module that accepts the S7 connection.

Any module that is capable of communication can thus act as an S7 connection point. At the connection point, the established communication link always uses one S7 connection of the module concerned.

Transition point

If you use the routing functionality, the S7 connection between two modules capable of communication is established across a number of subnets. These subnets are interconnected via a network transition. The module that implements this network transition is known as a router. The router is thus the point through which an S7 connection passes.

Any CPU with a DP or PN interface can be the router for an S7 connection. The number of S7 connections limits the number of routing connections.

Note

Special features for low baud rates (<187.5 kbps)

A fixed timeout of 40 seconds is set for S7 connections. When operating at low baud rates, the Time Target Rotation (TTR) should be clearly less than 40 seconds. You possible have to set the communication load value to "low" in "Properties - DP Master system/ PROFIBUS properties/ options".

4.5.2 Assignment of S7 connections

The number of available S7 connections corresponds to the number of connections of the configured CPU version.

There are several ways to allocate S7 connections on a communication-capable module:

- Reservation during configuration
- Allocating connections using programming
- Allocating connections for commissioning, testing and diagnostics
- Allocating connections for operator control and monitoring (OCMS) services

Reservation during configuration

One connection resource each is automatically reserved on the CPU for PG and OP communication.

Connections must be configured (using NetPro) for the use of S7 communication. This is why connection resources which are not allocated to PG/OP or other connections have to be available. The required S7 connections are then permanently allocated for S7 communication when the configuration is downloaded to the CPU.

Allocating connections using programming

In S7 basic communication and in open Industrial Ethernet communication, the user program establishes the connections. The CPU operating system initiates connection setup and the corresponding S7 connections are assigned.

Allocating connections for commissioning, testing and diagnostics

An active online function on the engineering station (PG/PC with STEP 7) occupies S7 connections for PG communication:

- The S7 connection reserved in the CPU for PG communication is assigned to the engineering station, that is, it is only allocated.
- The S7 connection is only allocated, however, when the PG is communicating with the CPU.
- If all reserved S7 connection resources for PG communication are allocated, the operating system automatically assigns an available connection. If no more connections are available, the engineering station cannot communicate online with the CPU.

Allocating connections for HMI services

S7 connection resources are allocated for the OP communication by an online function on the HMI station (OP/TP/... with *WinCC*) according to the following rules:

- If an S7 connection resource for OP communication has been reserved in your CPU hardware configuration, it is assigned to this HMI station, that is, it only needs to be allocated.
- The S7 connection is permanently assigned.
- If all reserved S7 connections for OP communication are already allocated, the operating system automatically assigns an available connection. If no more connections are available, the HMI station cannot communicate online with the CPU.

Time sequence for allocation of S7 connections

When you configure your project in STEP 7, parameter assignment blocks are generated which are read during startup of the modules. The module's operating system reserves or allocates the relevant S7 connections in this way. This means, for instance, that operator stations cannot access a reserved S7 connection for PG communication. The CPU's S7 connections which were not reserved can be used as required. These S7 connection resources are allocated in the order they are requested.

At least one connection resource is reserved by default each for PG and OP communication.

Note

If there is only one free S7 connection left on the CPU, you can still connect a PG to the bus. The PG can then communicate with the CPU. The S7 connection is only allocated, however, when the PG is communicating with the CPU. If you connect an OP to the bus while the PG is not communicating, the OP can establish a connection to the CPU. Since an OP maintains its communication link at all times, in contrast to the programming device, you cannot subsequently establish another connection via the programming device.

4.6 Communication performance

Introduction

The aim of this description is to provide criteria which allow you to assess the effects of the various communication mechanisms on communication performance.

Definition of communication load

Communication load is the sum of jobs per second issued to the CPU by the communication mechanisms, plus the jobs and messages issued by the CPU.

Higher communication load increases the response time of the CPU, meaning the CPU takes more time to react to a job (such as a read job) or output jobs and messages.

Operating range

In every automation system there is a linear operating range in which an increase in communication load will also lead to an increase in data throughput. This will then result in reasonable response times which are acceptable for the automation task faced.

A further increase of communication load will push data throughput into the saturation range. At certain conditions the automation system could no longer be capable of processing the requested volume within the response time demanded. Data throughput reaches its maximum, and the response time rises exponentially; see the figures below.

Data throughput could actually be reduced by a certain amount due to additional internal loads inside the device.

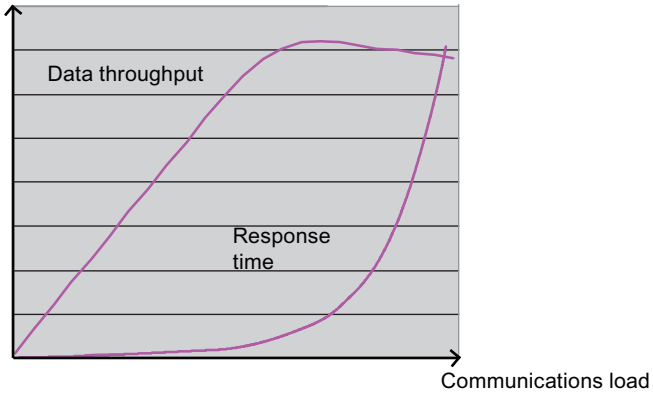


Figure 4-5 Communication load as a function of data throughput and response time (basic profile)

Which variables influence communication load?

The communication load is affected by the following variables:

- Number of connections/connected O&M systems
- Number of tags, or number of tags in images visualized on OPs or using WinCC.
- Communication type (O&M, S7 communication, S7 message functions, S5-compatible communication, ...)

The sections below show the factors having an influence on communication performance.

General issues in communication

Reduce the rate of communication jobs per second as far as possible. Utilize the maximum user data length for communication jobs, for example by grouping several tags or data areas in one read job.

Each job requires a certain processing time, and its status should therefore not be checked before it has been completed.

A freeware tool for the assessment of processing times (https://support.industry.siemens.com/cs/ww/en/view/25209605) is available for download on the Internet.

Your calls of communication jobs should allow the event-driven transfer of data. Check the data transfer event only until the job has been completed.

Call the communication blocks sequentially and stepped down within the cycle, in order to obtain a balanced distribution of communication load.

You can by-pass the block call using a conditional jump if you do not transfer any user data.

A significant increase in communication performance between S7 components is achieved by using S7 communication functions, rather than S5-compatible communication functions.

Use S5-compatible communication (FB "AG_SEND", FB "AG_RECV", AP_RED) only if S7-components should communicate with non-S7-components. This is because S5-compatible communication functions (FB "AG_SEND", FB "AG_RECV", AP_RED) generate a significantly higher communication load. As another alternative to S5-compatible communication, you can use open IE communication as this generates a much lower communication load.

S7 communication (SFB 12 "BSEND" and SFB 13 "BRCV")

Do not call SFB 12 "BSEND" in the user program more often than the corresponding SFB 13 "BRCV" at the communication partner.

S7 communication (SFB 8 "USEND" and SFB 9 "URCV")

SFB 8 "USEND" should always be event-driven because this block may generate a high communication load.

Do not call SFB 8 "USEND" in the user program more often than the corresponding SFB 9 "URCV" at the communication partner.

SIMATIC OPs, SIMATIC MPs

Do not select a screen refresh cycle time of less than 1s, and increase it to 2 s as required.

Verify that all screen tags are requested within the same cycle time, in order to form an optimized group for read jobs.

OPC Server

If OPC is used to connect several HMI devices to an S7-400 for your visualization tasks, you should keep the number of OPC servers accessing the S7-400 as low as possible. OPC clients should always address a shared OPC server, which then fetches the data from the S7-400.

You can fine-tune the data exchange by using WinCC and its client/server concept.

Various HMI devices from third-party vendors support the S7 communication protocol. You should utilize this option.

4.7 Web server

4.7.1 Properties of the web server

Availability

CPUs with PROFINET interface have a Web server.

Activating the Web server

The Web server is activated by default in the factory settings. It is deactivated in HW Config with its basic configuration. To activate the Web server in HW Config, select the "CPU -> Object properties -> Web" command. Refer to section Settings in HW Config, "Web" tab (Page 95)

Benefits of the Web server

The Web server allows you to monitor your CPU on the Internet, or on the Intranet of your company. This allows evaluation and diagnostics to be carried out remotely.

Messages and status information are visualized on HTML pages.

Web browser

You need a Web browser to access the HTML pages of the CPU. A maximum of 5 browser sessions can be active.

Web browsers which are suitable for communication with the CPU:

- Microsoft Edge
- Google Chrome
- Mozilla Firefox
- Opera

If display problems occur, it may be necessary under certain circumstances to switch the page display to compatibility mode.

Note

Note that with the latest browsers, the HTTPs encryption used by the CPU is not supported any more for reasons of security.

Note

Incorrect display

Delete all cookies and temporary Internet files from your PC/programming device if incorrect displays are output while you are working with the Web server.

The cookie used by the CPU on the Web server is valid until 01/01/2050.

Reading information via the Web server

The Web server can be used to read the following information from the CPU:

- Start page with general CPU information
  - Module name
  - Module type
  - State
  - Mode selector switch setting
  - Hardware article number
  - Hardware release version
  - Firmware release version
  - Plant identifier
  - Location ID
  - Serial number
  - Mode
- Content of the diagnostics buffer
- Variable table
  - You can monitor up to 50 variable tables with a of maximum 200 variables. Select the variable tables on the relevant website, see section Variable tables (Page 136)
- Variable status
  - You can monitor up to 50 variables after specifying their address.
- Module status
  To enable the display of the module status, select the "Report system errors" option when configuring the hardware in STEP 7.
  - The status of a station is indicated using symbols and comments.
  - The status of PNIO devices is displayed.
- Messages (message state ALARM_S, ALARM_SQ, ALARM_D, ALARM_DQ) without option of acknowledgement

- Information about Industrial Ethernet
  - Ethernet MAC address
  - IP address
  - IP subnet address
  - Default router
  - Auto negotiation mode ON/OFF
  - Number of packets sent/received
  - Number of faulty packets sent/received
  - Transmission mode (10 Mbps or 100 Mbps)
  - Link status
  - Display of the connection resources for open communication over Industrial Ethernet (OUC)
  - Enhanced connection diagnostics for open communication
- Topology of the PROFINET nodes
  The configured PROFINET nodes of a station are displayed.
  To enable visualization of the topology, select the "Report system errors" option when configuring the hardware in STEP 7. Specify the target topology in the hardware configuration in STEP 7.
- User-defined Web pages
  The size of user pages must not exceed 1 MB. Up to 4 user pages can be active simultaneously.

Web access to the CPU via PG/PC

Proceed as follows to access the Web server:

1. Connect the programming device/PC to the CPU via the Ethernet interface.
2. Open the Web browser (for example, Internet Explorer).
3. Enter the IP address of the CPU in the "Address" field of the Web browser with the following syntax: <http://a.b.c.d/>, e.g. http://192.168.0.1/
   The homepage of the CPU opens.
   Log in with a user name and password specified in the WEB configuration in HW Config. You can now access the websites authorized for this user in accordance with the corresponding access rights. For more information, refer to sectionSettings in HW Config, "Web" tab (Page 95)
   From the start page, you can navigate to addtitional information.

Web access to the CPU via mobile terminal devices

You can also access the Web server using a mobile terminal device. You can select a compact view for this. The procedure is as follows:

1. Connect the device to the CPU via the PROFINET interface.
2. Open the Web browser (for example, Internet Explorer).
   Enter the IP address of the CPU in the "Address" field of the Web browser in the format <http://a.b.c.d/basic> e.g. http://192.168.0.1/basic

The homepage of the CPU opens. From the start page, you can navigate to addtitional information.

HMI devices operating with Windows CE operating system V 5.x or earlier process CPU information in a browser specially developed for Windows CE. The information appears in a simplified format in this browser. The figures in this manual show the more detailed format.

Security

The Web server provides the following security functions:

- Access by means of secure https protocol
- Configurable user authorization by means of user list

See also section Settings in HW Config, "Web" tab (Page 95)

Set up an additional firewall to prevent intrusion on your CPUs that support Web access.

4.7.2 Settings in HW Config, "Web" tab

Requirements

You have opened the CPU properties dialog in HW Config.

To utilize the full functionality of the Web server, make the following settings in the "Web" tab:

- Activating the Web server on this module
- Setting the language for the Web
- User list
- Allow access only via HTTPS

- Activate automatic update
- Display classes of the messages

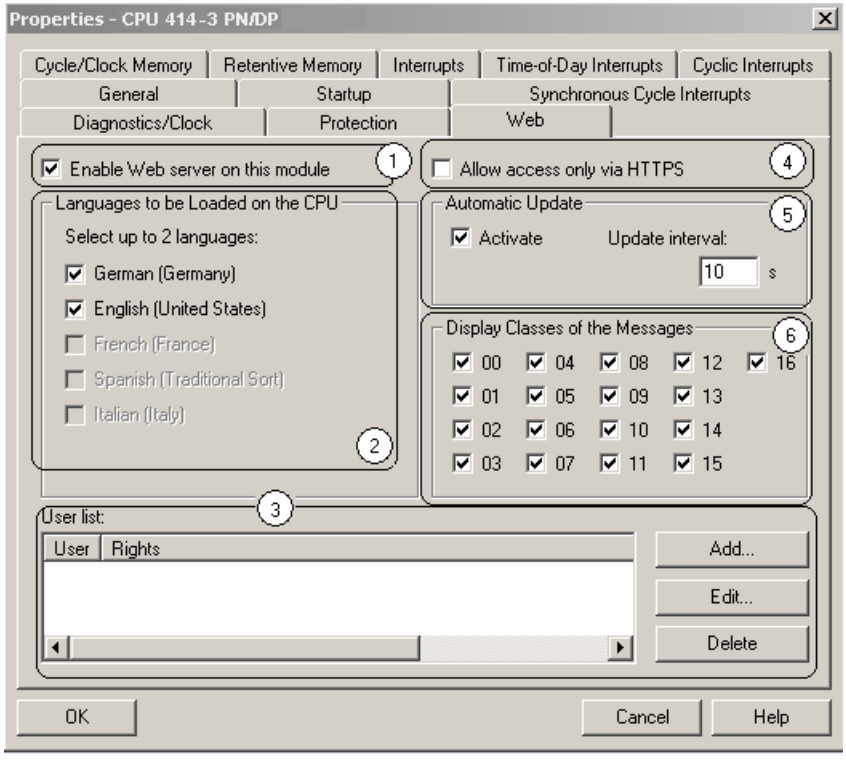


Figure 4-6 Settings in HW Config

① Activate the Web server on this module

The web server is deactivated in the basic configuration in HW Config. Activate the Web server in HW Config.

In the CPU properties dialog:

- Check the "Activate Web server on this module" check box

② Set the language for Web

Select up to two languages for the Web from the languages installed for display devices.

In the CPU properties dialog:

- Check the "Activate Web server on this module" check box
- Select up to two languages for the Web.

Note

If you activate the Web server and do not select a language, messages and diagnostics information will be displayed in hexadecimal code.

③ User list

The user list provides the following options:

- Creating users
- Specifying execution rights
- Assigning passwords

Users can access only options which are assigned permanently to the execution rights.

If you have not entered or logged in a user, read access is granted for all Web pages.

If users are configured, users which are not logged on can only access the Intro and homepage.

User "everybody"

In the user list, you can create a user named "everybody" and assign access rights to this user. The rights of the "everybody" user are specified **without password assignment** .
For example, if "everybody" has the rights to "read variables", the Web page displays the Variable table in the main menu bar by default and **without password input**.
You can create up to 20 users and "everybody" users.

④ Allow access only via HTTPS

HTTPS is used to encrypt communication between the browser and Web server.

To ensure error-free https access to the CPU:

- The current time must be set on the CPU.
- IP address of CPU
- You need a valid installed certificate.

To install a valid certificate (Certification Authority), you can download it from the "Intro" Web page, at "Download certificate". You need to clear the "Allow access only via HTTPS" option for this.

For information about the installation of the certificate, refer to the Online Help of your web browser.

An encrypted connection is identified by the padlock icon in the status bar of the Web page.

Note

Note that with the latest browsers, the HTTPs encryption used by the CPU is not supported any more for reasons of security.

⑤ Activating automatic updates

The following Web pages can be updated automatically:

- Home page
- Diagnostics buffer
- Module status

- Messages
- Information about communication
- Topology
- Variable status
- Variable table

To enable automatic updates, proceed as follows:

- Set the "Activate" check box at "Automatic update" in the properties dialog of the CPU.
- Enter the update interval.

Note

Update time

The activation interval set in HW Config is the shortest update time.

High load on the CPU, e.g. as a result of a high number of PROFINET interrupts, many extensive communication jobs, or several HTTP-/HTTPS connections, can cause noticeable delays during the update of Web pages.

⑥ Display classes of messages

All message display classes are activated in the basic configuration in HW Config. The messages for the selected display classes are displayed at a later time on the "Messages" Web page. Messages which do not belong to the selected display classes are output in hex code instead of plain text.

How to configure the message classes:

- For "Report system error" in HW Config at "Options > Report system error".
- For block-specific messages in STEP 7

Information about configuring message texts and classes can be found in STEP 7.

Note

Reducing memory requirements of the Web SDBs

You can reduce memory requirements of the Web SDBs by selecting only the messages to be filled in the Web SDB.

4.7.3 Language settings

Introduction

The Web server provides information in the following languages:

- German (Germany)
- English (United States)
- French (France)
- Italian (Italy)
- Spanish (traditional sorting)
- Chinese
- Japanese

The two Asian languages can be combined as follows:

- Chinese with English
- Japanese with English

Note

Web server with Chinese/Japanese Windows

When you use the Web server of the CPU together with Chinese/Japanese Windows, you have to manually set the coding of the Internet browser to: View / Coding / Unicode (UTF–8)

Prerequisites for availability of the Asian languages

The following conditions must be fulfilled for the Chinese and Japanese languages:

- An operating system with the corresponding language or a corresponding language package is installed on the display device (e.g. PC).
- STEP 7 for Asian languages (STEP 7 V5.5 or higher) is installed on the programming device used to configure the CPU.

Note

SIMATIC HMI devices with Windows CE operating system do not support Asian languages.

What you need to display texts in different languages

Language settings to be made in STEP 7 in order to ensure proper output of data in the selected language:

- Setting the language for display devices in SIMATIC Manager
- Set the regional Web language in the properties dialog of the CPU

Setting the language for display devices in SIMATIC Manager

Select the languages for display devices in SIMATIC Manager:
"Options > Language for display devices"

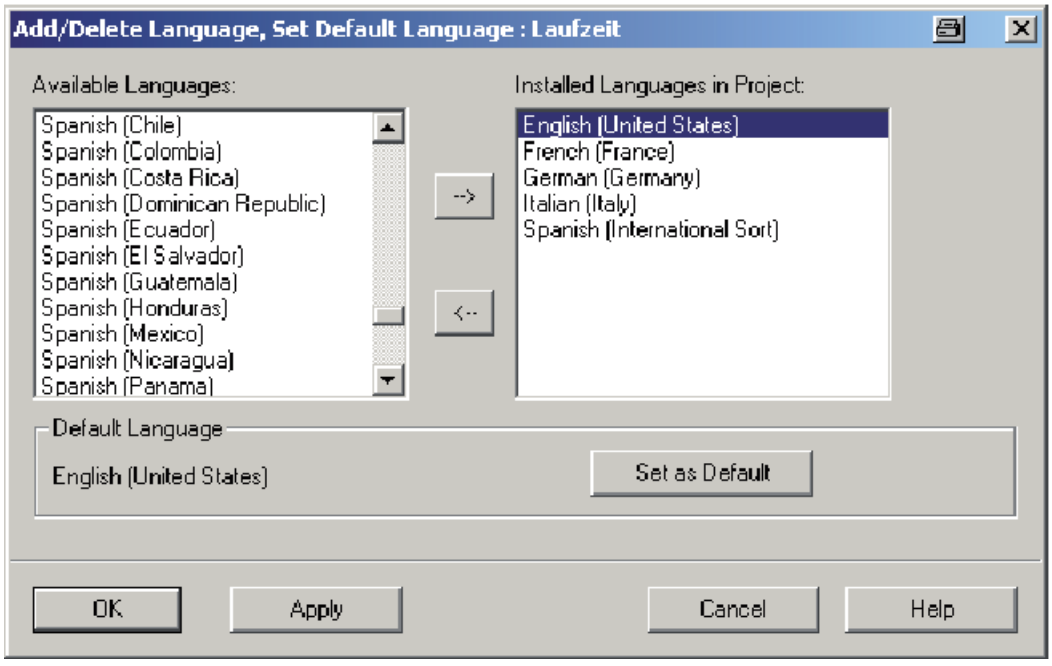


Figure 4-7 Example for selecting the display device language

Setting the language for the Web

Select up to two languages for the Web from the languages installed for display devices.

Open the CPU properties dialog box:

- Select the "Activate Web server on this module" check box
- Select up to two languages for the Web.

Note

If you activate the Web server and do not select a language, messages and diagnostics information will be displayed in hexadecimal code.

4.7.4 Updating and saving information

Screen content refresh status and printing

Screen content

Automatic refresh is deactivated in the basic configuration in HW Config.
This means that the screen of the Web server outputs static information.

Refresh the Web pages manually using the <F5> function key or the following icon:

Printing

Data output to the printer always return the current CPU information. The printed information may therefore be more up to date than the screen contents.

Print Web pages using the following icon:

Filter settings have no effect on the print-out, The print-out always shows the entire contents of the message buffer.

Deactivating automatic refresh for individual Web pages

To deactivate automatic refresh for a Web page for a short time, select the following icon:

Enable automatic refresh again using the <F5> function key or the following icon:

Note

Update time if CPU is heavily loaded

If the CPU is heavily loaded during operation, e.g. by a high number of PROFINET interrupts or by a large number of extensive communication jobs, the update of the Web pages may be delayed considerably for the duration of this high CPU load.

Saving messages and entries of the diagnostics buffer

Messages and diagnostics buffer entries can be saved to a csv file. To save the data, click on the following icon:

A dialog box opens in which you can enter the file name and target directory.

To prevent incorrect display of the data in Excel, do not open the csv file with double-click. Import the file in Excel by selecting the "Data" and "Import external data" menu command.

Select the "Separated" file type and "Unicode UTF-8" as file source. Select the comma separator and the text recognition character " .

4.7.5 Web pages

4.7.5.1 Start page with general CPU information

Going online to the Web server

You log on to the Web server by entering the IP address of the configured CPU in the address bar of the Web browser (example: http: //192.168.1.158). The connection opens with the "Intro" page.

Intro

The screenshot below shows the first page (Intro) called by the Web server.

Figure 4-8 Intro

Click the ENTER link to go to the Web server pages.

Note

Skipping the Intro Web page

Set the "Skip Intro" check box in order to skip the Intro. The Web server will now directly open its start page. You can undo the "Skip intro" setting by clicking the "Intro" link on the start page.

Home page

The start page displays information as shown in the picture below.

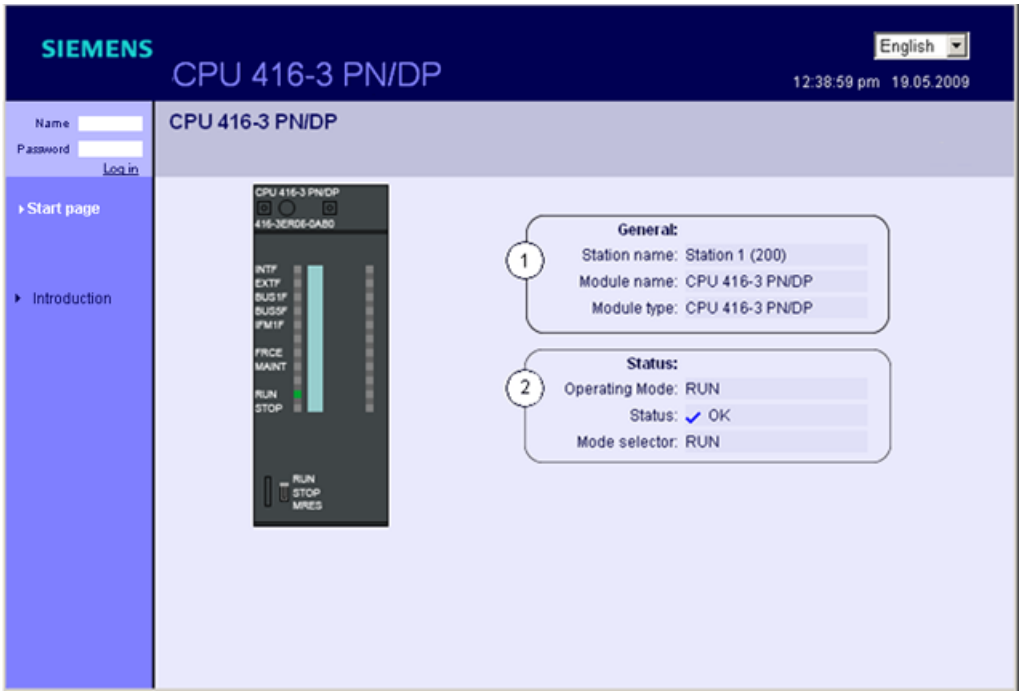


Figure 4-9 General Information

The CPU image with LEDs displays the actual CPU status at the time of data request.

Login

Log in with a user name and password specified in the WEB configuration in HW Config. You can now access the Web pages authorized for this user in accordance with the corresponding access rights. (For more information, refer to chapter: Settings in HW Config, "Web" tab (Page 95)

① "General"

This group displays information about the CPU running the Web server to which you are currently logged on.

② **"Status"**

The "Status" field displays CPU status information which is valid when requested.

4.7.5.2 Identification

Characteristics of the CPU

Characteristics of the CPU are shown on the Identification web page.

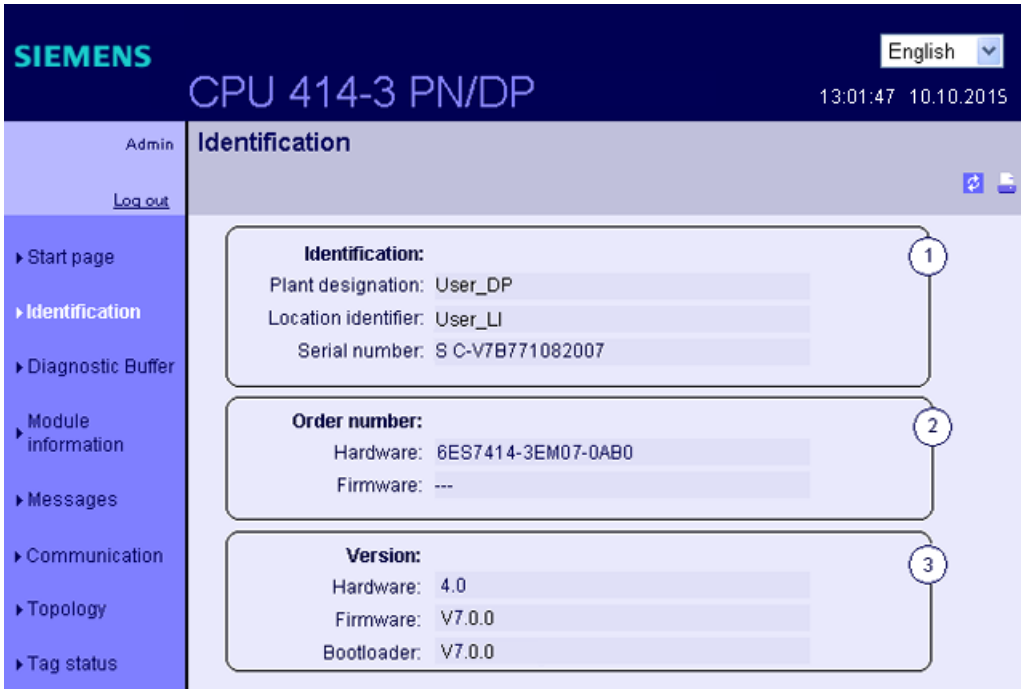


Figure 4-10 Identification

① Identification

The "Identification" field contains the plant and location designation as well as the serial number. Plant and location designations can be configured in HW Config in the Properties dialog of the CPU, "General" tab.

② Order number

You can find the article numbers of the hardware in the "Order number" field.

③ Version

You can find the hardware and firmware versions in the "Version" field.

4.7.5.3 Diagnostics buffer

Diagnostics buffer

The browser displays the content of the diagnostics buffer on the diagnostics buffer Web page.

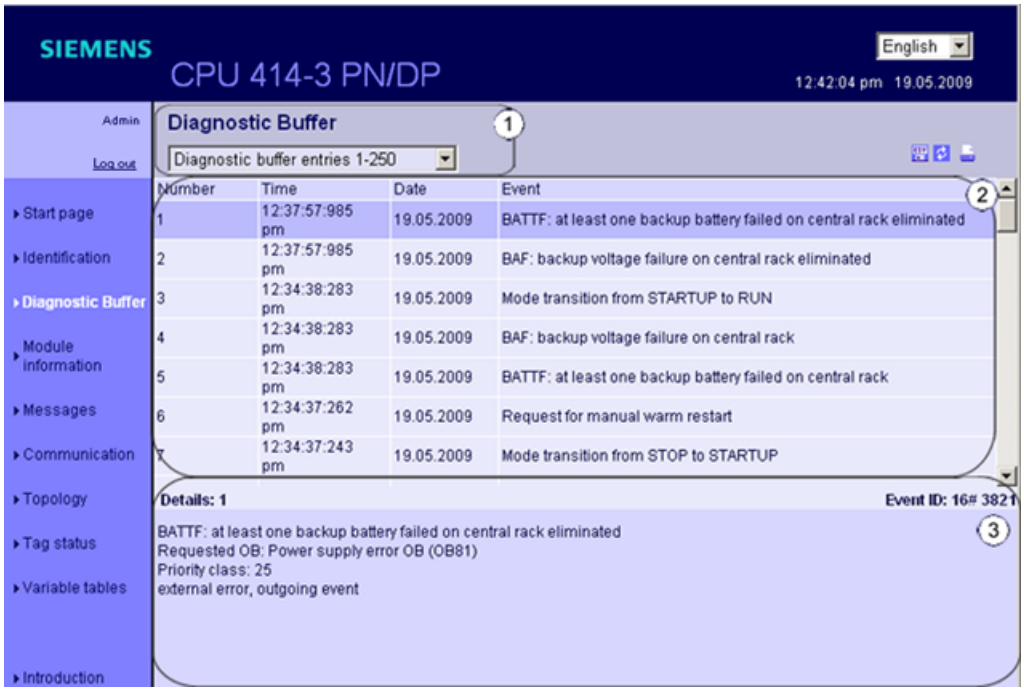


Figure 4-11 Diagnostics buffer

Requirement

The Web server is activated, languages are set, and the project

is compiled and downloaded in STEP 7.

① Diagnostics buffer entries 1-250

The diagnostics buffer can save up to 3200 messages. Select an buffer input interval from the list. Each interval comprises 250 entries. Note that the program does not displays all the buffer entries in RUN for reasons that include performance.

② Events

The "Events" fields displays the diagnostics event and the corresponding date and time stamp.

③ Details

This field outputs detailed information about a selected event.

Select the corresponding event from the "Events" field.

Special features when changing languages

You can click the object in the top right corner to change the language, for example, from German to English.If you select a language you have not configured the program shows a hexadecimal code instead of plain text information.

4.7.5.4 Module state

Requirement

- In HW Config, you made the following settings:
  - You activated the Web server
  - You modified the language settings
  - You generated and enabled the "Report system errors" function
- You compiled the project using STEP 7 HW Config, loaded the SDB container and the user program (particularly the user program blocks generated by "Report system error")
- The CPU is in RUN mode

Note

"Report system error"

- **Duration of display:** Depending on the plant configuration, the display "Report system error" may take some time to create the startup evaluation of the state of all the configured I/O modules and I/O systems. There is no defined display of the status on the "Module status" page during this time. A "?" is displayed in the "Error" column.
- **Dynamic response:** "Report system error" must be called cyclically at least every 100 ms. The call may either take place in OB 1, or if the cycle time is more than 100 ms in the cyclic interrupt OB 3x (≤ 100 ms) and in the restart OB 100.
- **Diagnostics support**: In the "Report system error" dialog box, the "Diagnostics status DB" check box must be selected in the "Diagnostics support" tab and a DB number entered. This check box is normally selected by default for configured Web servers. However, during migration of old projects it may be necessary to select this check box manually.
- **Restart:** The module status is displayed on completion of the CPU restart and expiration of a delay time of some seconds, depending on the station configuration.

Module status

The status of a station is displayed on the "Module status" page using symbols and comments.

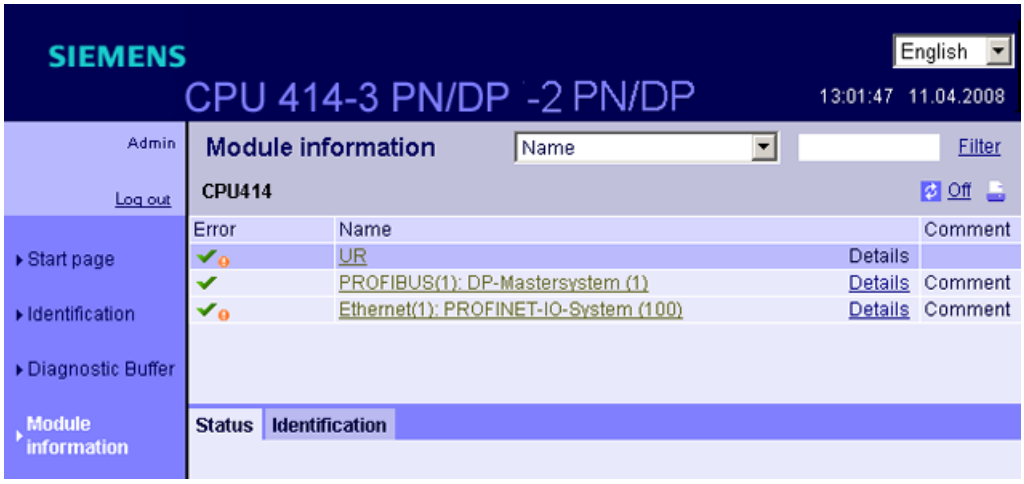


Figure 4-12 Module status

Meaning of the icons

Icon	Color	Meaning
	green	Component OK
	gray	Disabled PROFIBUS slaves, or PROFINET devices
	black	Component unavailable / status cannot be determined "Unable to determine status" is always displayed, for example, when the CPU is in STOP mode, or after a CPU restart during the startup evaluation of "Report system error" for all configured I/O modules and I/O systems. However, this status can also be displayed temporarily at runtime for all modules as a result of a surge of diagnostics interrupts.
	green	Maintenance required
	yellow	Maintenance demanded
	red	Fault - component failure or malfunction
	-	Fault at a lower module level

Navigation to other module levels

The state of individual modules is displayed when you navigate to further module levels:

- Go to the next higher module level using the link in the title line
- Go to the next lower module level using the link in the name

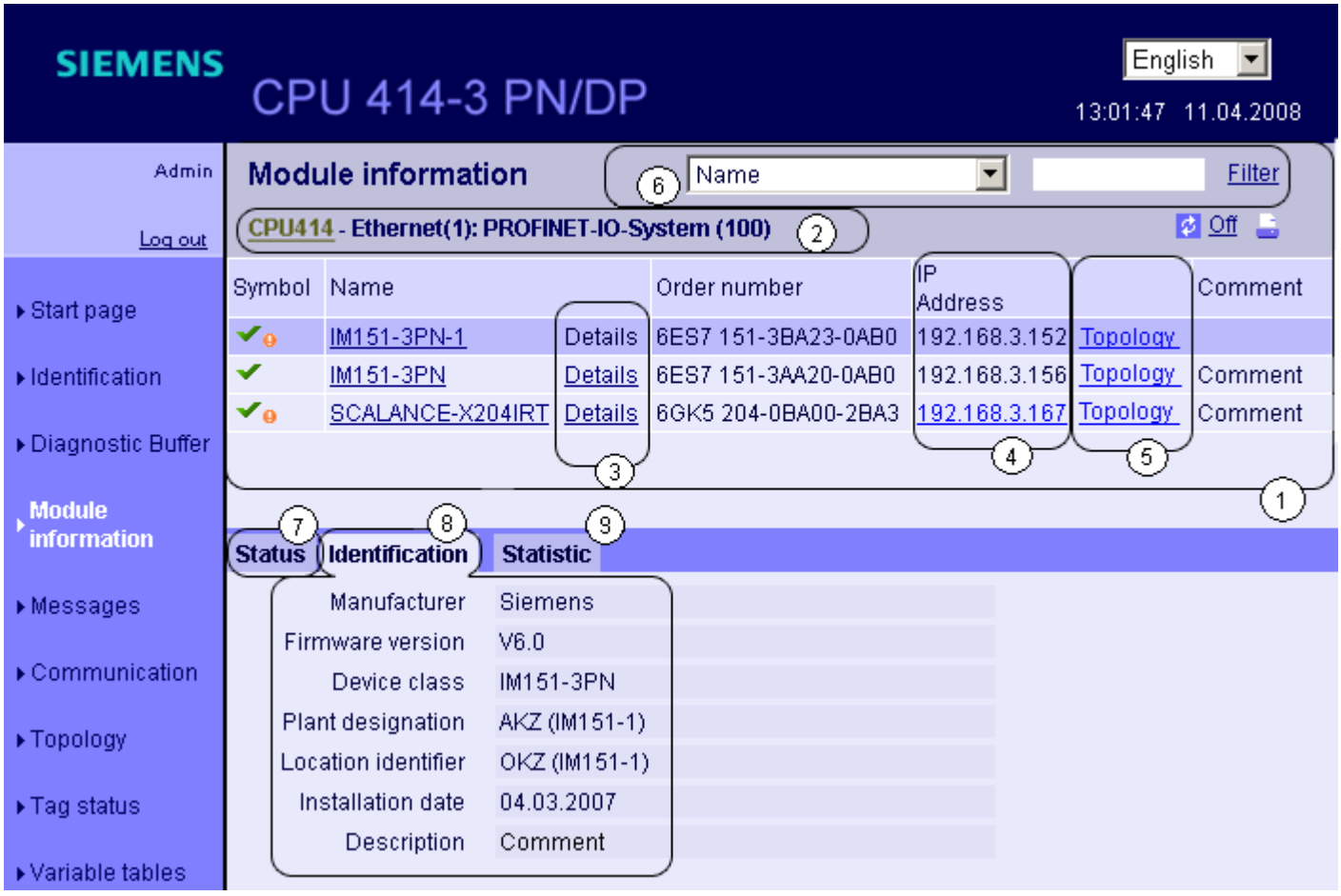


Figure 4-13 Module status

Note

State of the AS-i slaves

The status of AS-i slaves is not displayed on the "Module status" page. Only the state of the AS-i link is displayed.

① "Module status"

The table contains information about the rack, the nodes, the DP master system and the individual modules of the station relating to the selected level.

The requirement for this is that the function "Report system errors" has been configured for the CPU or the station and that the modules generated have been loaded in the CPU.

② "Display of module levels"

The link in the title line takes you to the "module state" of the next higher module level.

③ "Details"

The "Details" link provides you with information on the selected module in the "Status" and "Identification" tabs.

④ "IP address"

You can use the link to access the Web server of the selected, configured devices.

⑤ Topology

The "Topology" and "Module status" Web pages are linked. Click "Topology" of the selected module to automatically jump to this module in the graphic view of the "Topology" web page. The module appears in the visible area of the "Topology" web page and the device head of the selected module flashes for a few seconds.

⑥ "Filter"

You can sort the table by certain criteria.

Use the dropdown list to view only the entries of the selected parameter. Enter the value of the selected parameter in the input box and then click "Filter".

1. Select, for example, the "Name" parameter from the drop-down list box.
2. Click "Filter".

The filter criteria are also retained when you update a page.

⑦ "Status" tab

The tab contains information about the status of the selected module.

⑧ "Identification" tab

The tab contains data on the identification of the selected module.

Note

"Identification" tab

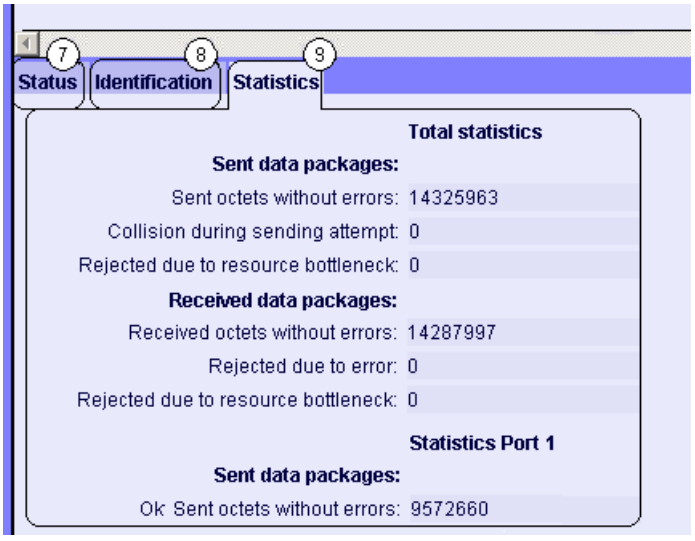
This tab displays only the data configured offline, not the online module data.

⑨ "Statistics" tab

The tab provides the following communication statistics information for the selected IO device: The tab view stays empty if you have not selected a PROFINET module.

This tab contains the following information:

- Overall statistics - Data packets sent"
  The quality of data transmission on the send line can be assessed based on the code numbers output in this info box.
- Overall statistics - Data packets received"
  The quality of data transmission on the receive line can be assessed based on the code numbers output in this info box.
- "Statistics Port 1/Port 2 - Data packets sent"
  The quality of data transmission on the send line can be assessed based on the code numbers output in this info box.
- "Statistics Port 1/Port 2 - Data packets received"
  The quality of data transmission on the receive line can be assessed based on the code numbers output in this info box.



Reference

See also "Statistics" tab in chapter "Communication (Page 115)".

Example: Module status - module

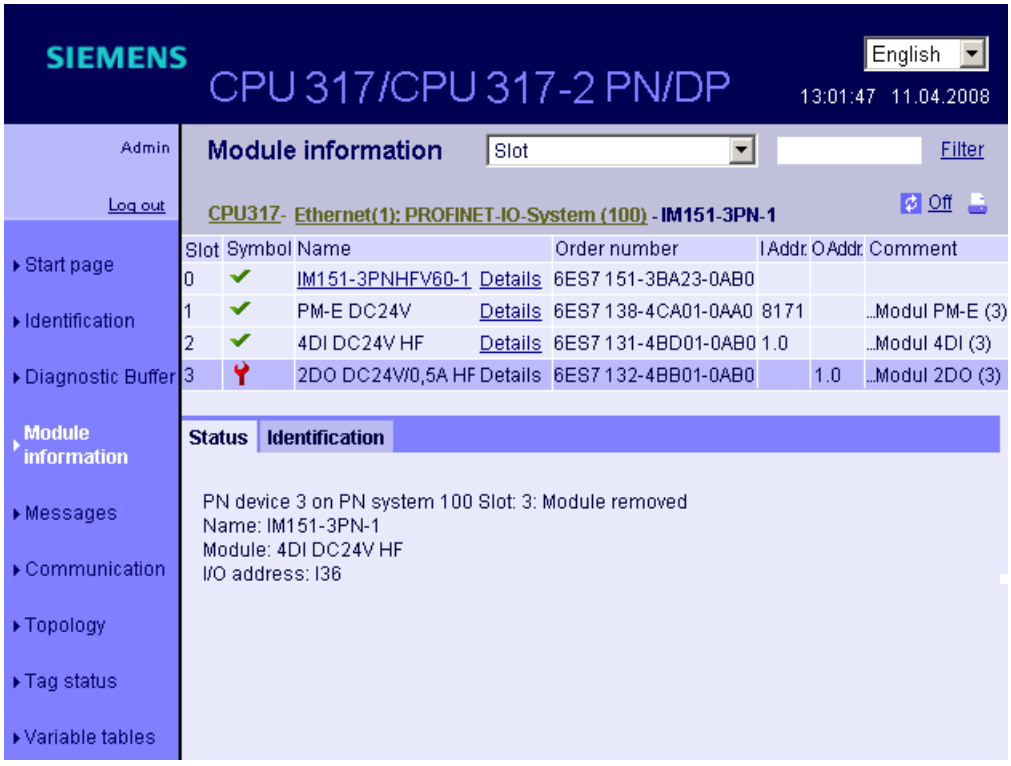


Figure 4-14 Module status - module

Example: Module status - submodule

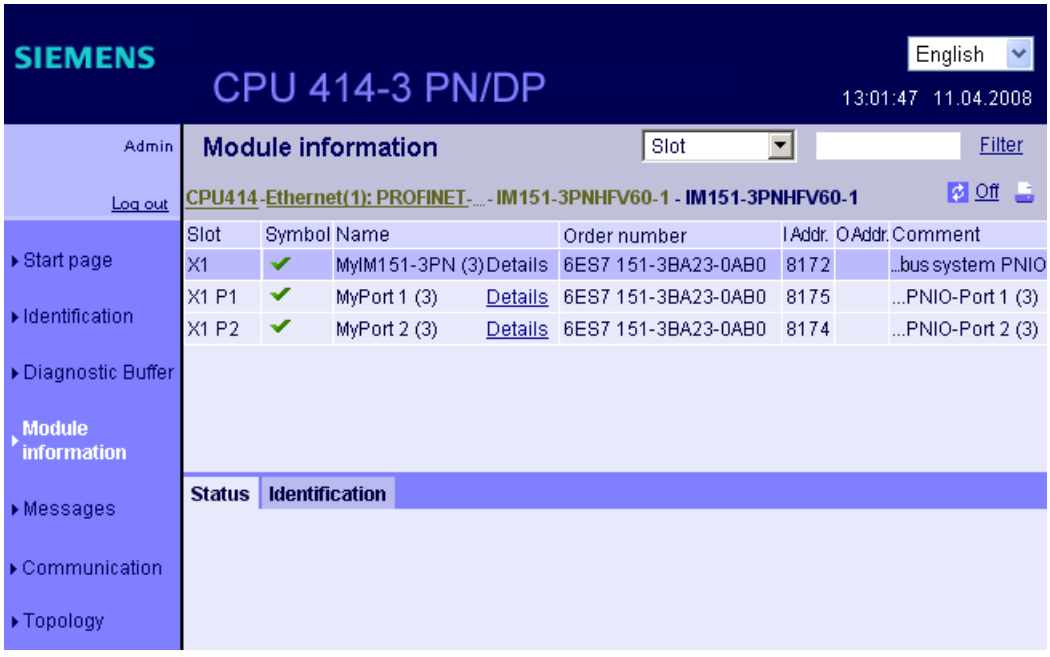


Figure 4-15 Module status - submodule

Reference

For additional information about the "Module status" and "Configuring 'Report system errors'", refer to the STEP 7 Online Help.

4.7.5.5 Alarms

Messages

The browser displays the content of the message buffer on the Messages Web page.
The messages cannot be acknowledged on the web server.

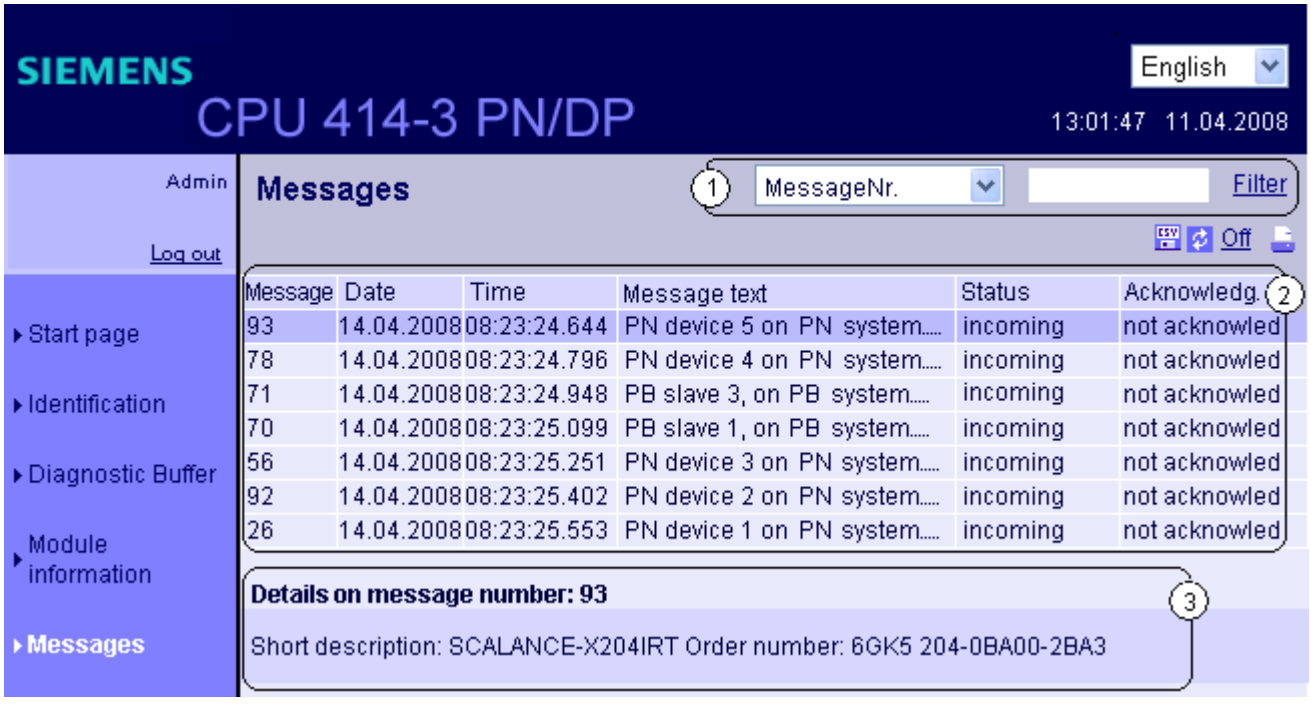


Figure 4-16 Messages

Requirement

The message texts were configured in the user-specific languages. For more information about the configuration of message texts, refer to STEP 7 and to the Internet address: (https://support.industry.siemens.com/cs/ww/en/view/23872245)

① Filter

This functionality allows you to select specific information from this page.

Use the corresponding list to view only the entries of the selected parameter. Enter the value of the selected parameter in the input box and then click "Filter".

To display all messages with "incoming" status, for example, follow these steps:

1. Select the "Status" parameter from the list.
2. Enter the "incoming" text in the input box.
3. Click "Filter".

The filter criteria are also retained when you update a page. Filter settings have no effect on the print-out. The print always displays the entire content of the message buffer.

② Messages

CPU messages are displayed in chronological order, including the **date** and **time**.

The **message text** parameter is an entry which contains the message texts configured for the corresponding fault definitions.

Sorting

You can also view the parameters in ascending or descending order. Click in the column header of one of the parameters.

- Message number
- Date
- Time
- Message Text
- State
- Acknowledgment

The messages are returned in chronological order when you click the "Date" entry. Incoming and outgoing events are output at the **Status** parameter.

③ Message number details

You can view detailed message information in this info field. To do this, select a message the details of which you are interested.

Special features when changing languages

You can click the object in the top right corner to change the language, for example, from German to English. If you select a language you have not configured, or for which no message texts were configured, the information is output in hexadecimal code instead of plain text.

4.7.5.6 Communication

"Parameters" tab

The"Parameters" tab ① of this Web page contains a summary of information about the integrated PROFINET interface of the CPU.

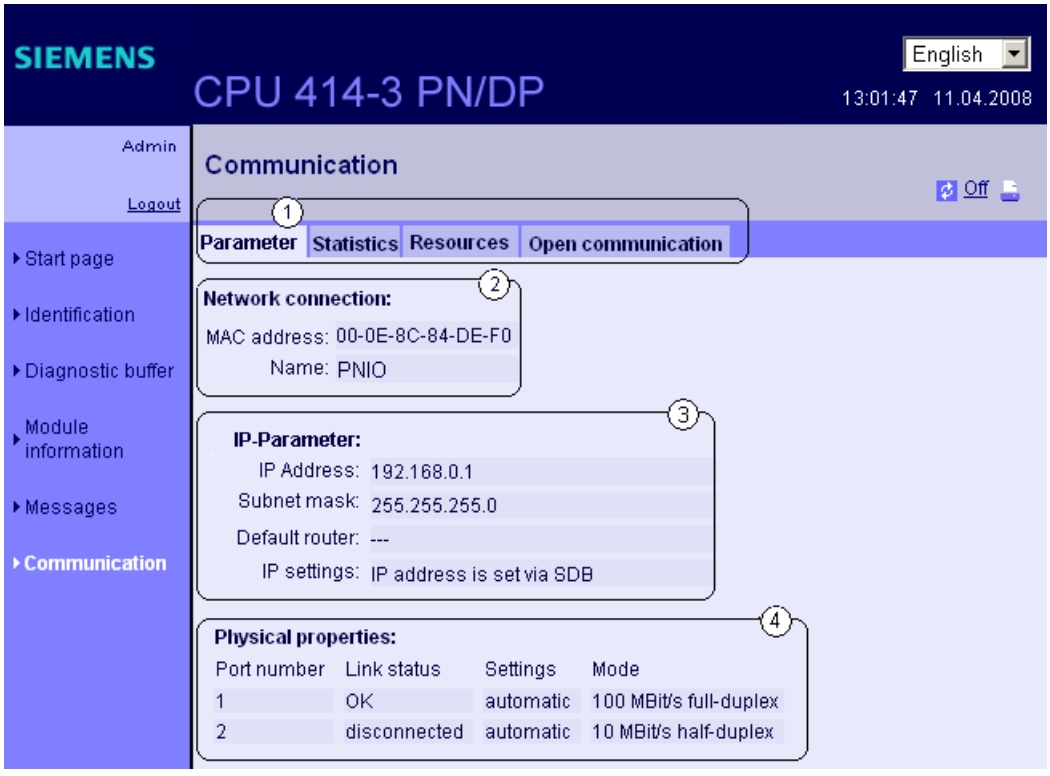


Figure 4-17 Parameters of the integrated PROFINET interface

② Network connection

This page displays information for the identification of the integrated PROFINET interface of the corresponding CPU.

③ IP parameters

Information about the configured IP address and number of the subnet in which the corresponding CPU is networked.

④ Physical properties

You can find the following information in the "Physical properties" field:

- Port number
- Link status

- Settings
- Mode

Note

Updating data

The data you see in the HTML browser are only automatically updated if you activated automatic update in HW Config. Otherwise, you can view the current data by updating the view in the HTML browser at regular intervals (Update button).

"Statistics" tab

Information about the quality of data transfers is available in the ① "Statistics" tab.

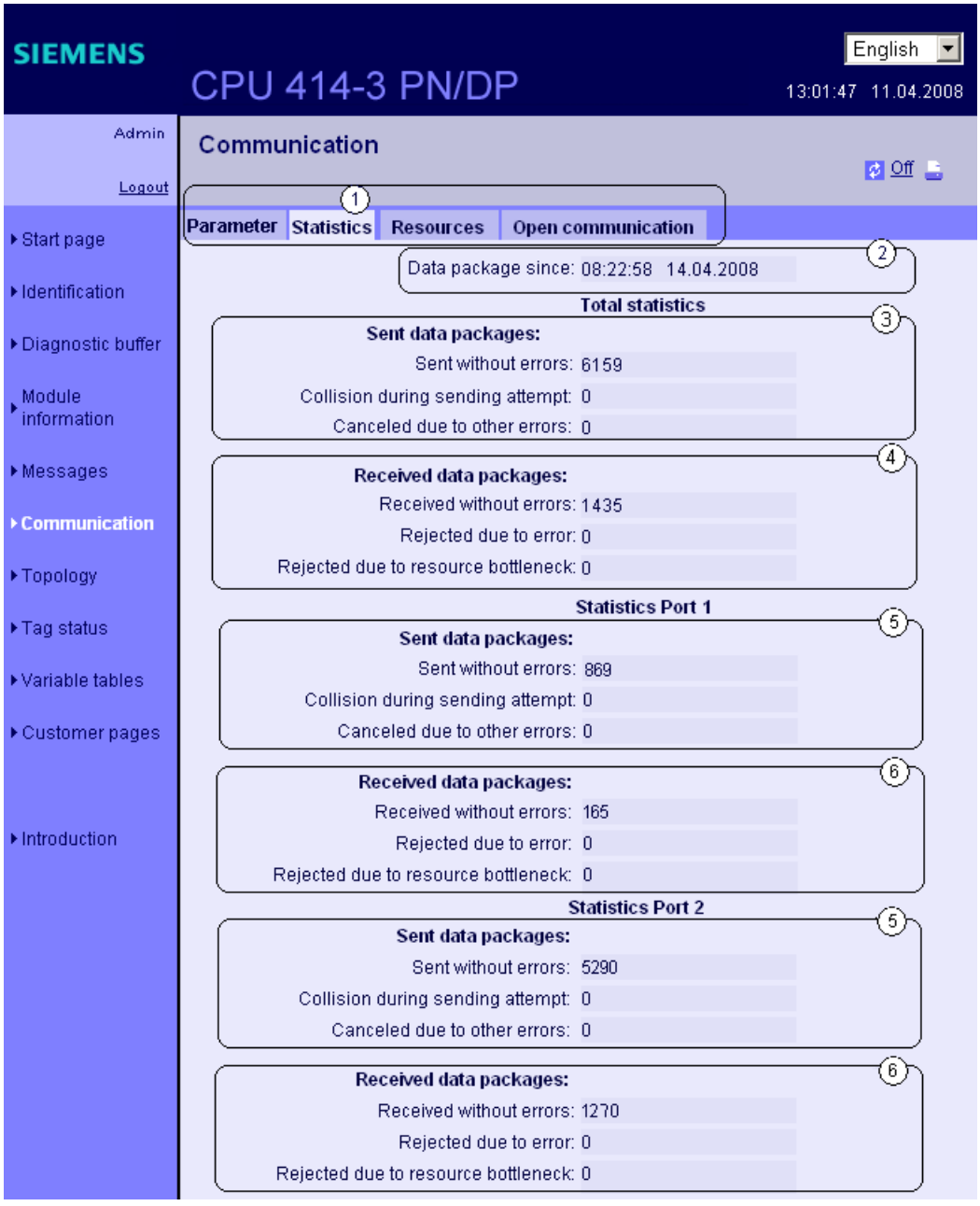


Figure 4-18 Data transfer numbers

② Data packets since

This shows the time at which the first data packet was sent or received after the last POWER ON / memory reset.

③ "Total statistics - Data packets sent"

The quality of data transmission on the send line can be assessed based on the code numbers output in this info box.

④ "Total statistics - Data packets received"

The quality of data transmission on the receive line can be assessed based on the code numbers output in this info box.

"Statistics Port 1/Port 2 - Data packets sent"

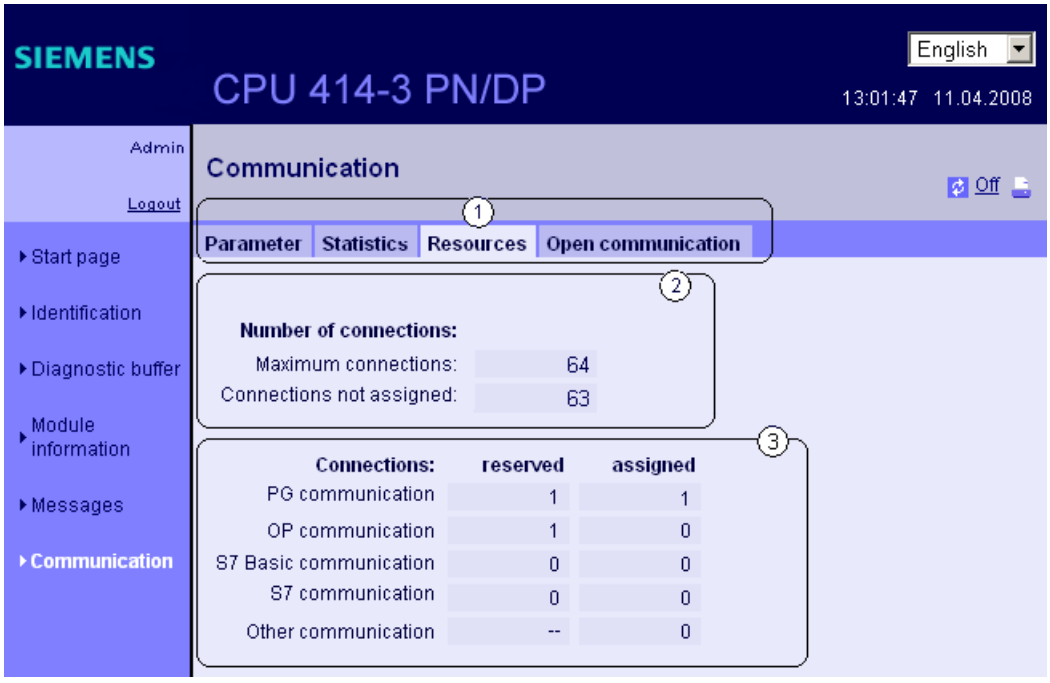
The quality of data transmission on the send line can be assessed based on the code numbers output in this info box.

"Statistics Port 1/Port 2 - Data packets received"

The quality of data transmission on the receive line can be assessed based on the code numbers output in this info box.

"Resources" tab

For information about load on connection resources, refer to the ① "Resources" tab.



② Number of connections

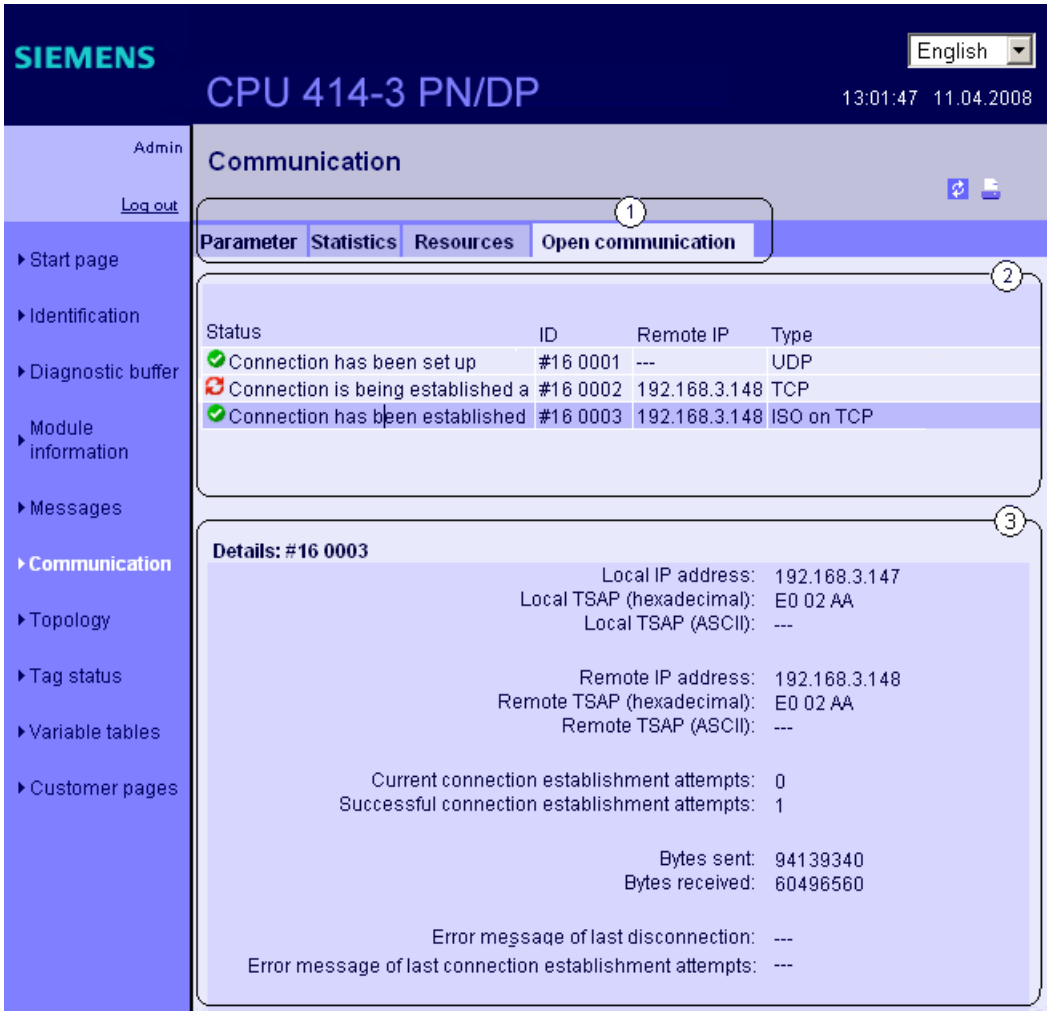
Provides detailed information about the unused and maximum number of connections.

③ Connections

Provides information about the number of connections reserved or used for PG/OP/S7 basic communication and other types of communication.

"Open communication" tab

The ① "Open communication" tab contains information relevant to the status of communication connections.



② Status information

Provides an overview of the connections for open communication over Industrial Ethernet that are currently being set up, including the active or configured connections.

The table contains the following information for those connections:

- "Status" column: Connection status, including the icon
- "ID" column: Connection ID

- "Remote IP" column: Remote IP address
- "Type" column: Connection type

The possible connection states depend on the connection type. This dependency is shown in the following table:

Connection type	Possible connection states
TCP	Active connection setup completed
	Passive connection setup completed
	Active connection initiated
	Passive connection initiated
ISO on TCP	Active connection setup completed
	Passive connection setup completed
	Active connection initiated
	Passive connection initiated
UDP	Connection is configured

The following icons are used to indicate the connection status:

Icon	Color	Meaning
	green	• Connection is configured (for UDP) • Active/passive connection setup completed (with TCP and ISO-on-TCP)
	red	• Active/passive connection initiated (with TCP and ISO-on-TCP)

Meaning of the connection states:

- Active/passive connection initiated:
  You initiated a passive/active connection by calling the TCON block.
- Active/passive connection setup completed.
  The connection initiated with the TCON block is up.

③ Details

Contains detailed information about the selected connection.

Reference

For information about the error messages possibly displayed after a connection was canceled, or an attempt to establish a connection failed, refer to the STEP 7 Online Help.

4.7.5.7 Topology

Requirement

- In HW Config, you made the following settings:
  - You activated the Web server
  - You modified the language settings
  - You generated and enabled the "Report system errors" function

Topology of the PROFINET nodes

The topology is split into two types:

- Target topology
- Actual topology

Target topology

Display of the topological structure you configured in the Topology Editor of STEP 7 for the PROFINET devices of a PROFINET IO system, including the corresponding status view.Adjacent PROFINET devices are also displayed, provided their topological structure has been configured. However, a status view is not available for those devices.

The view also indicates the topological assignment of failed PROFINET devices, differences between the actual and target topology, and incorrect port connections.

Note

The configured target topology is always displayed in the following scenarios:

- When the "Topology" Web page is called via the navigation bar
- When changing from the "Module status" Web page to the "Topology" web page by means of the "Topology" link in the overview of PROFINET IO devices.

If no target topology is configured, the actual topology is called by default.

Actual topology

Displays the current topological structure of the "configured" PROFINET devices of a PROFINET IO system and of directly adjacent PROFINET devices which are not configured (including the display of corresponding relations, if possible. However, the status of these adjacent PROFINET devices is not displayed).

Note

New non-configured directly adjacent PROFINET devices are only shown in the actual topology.

"Topology" Web page

The "Topology" Web page provides information about the topological structure and status of the PROFINET devices in your PROFINET IO system.

Three tabs are available for the following views:

- Graphic view (target and actual topology)
- Tabular view (actual topology only)
- Status overview (target topology without view of the topological relations)

You can print the tabular view and status overview. Use your browser's print preview function before printing and correct the format if necessary.

This status overview is always available. For the graphic view of the target topology, you must configure the structure of the PROFINET devices in your PROFINET I/O system using the Topology Editor.

In the graphic view, you can change between the target and actual topology view. If no target topology is defined, the actual topology is displayed.

The graphic view always outputs the same image of the target topology (line colors and diagnostics states can possibly change), while the view of the actual topology can change completely, depending on the network status.

Topology - Graphical view

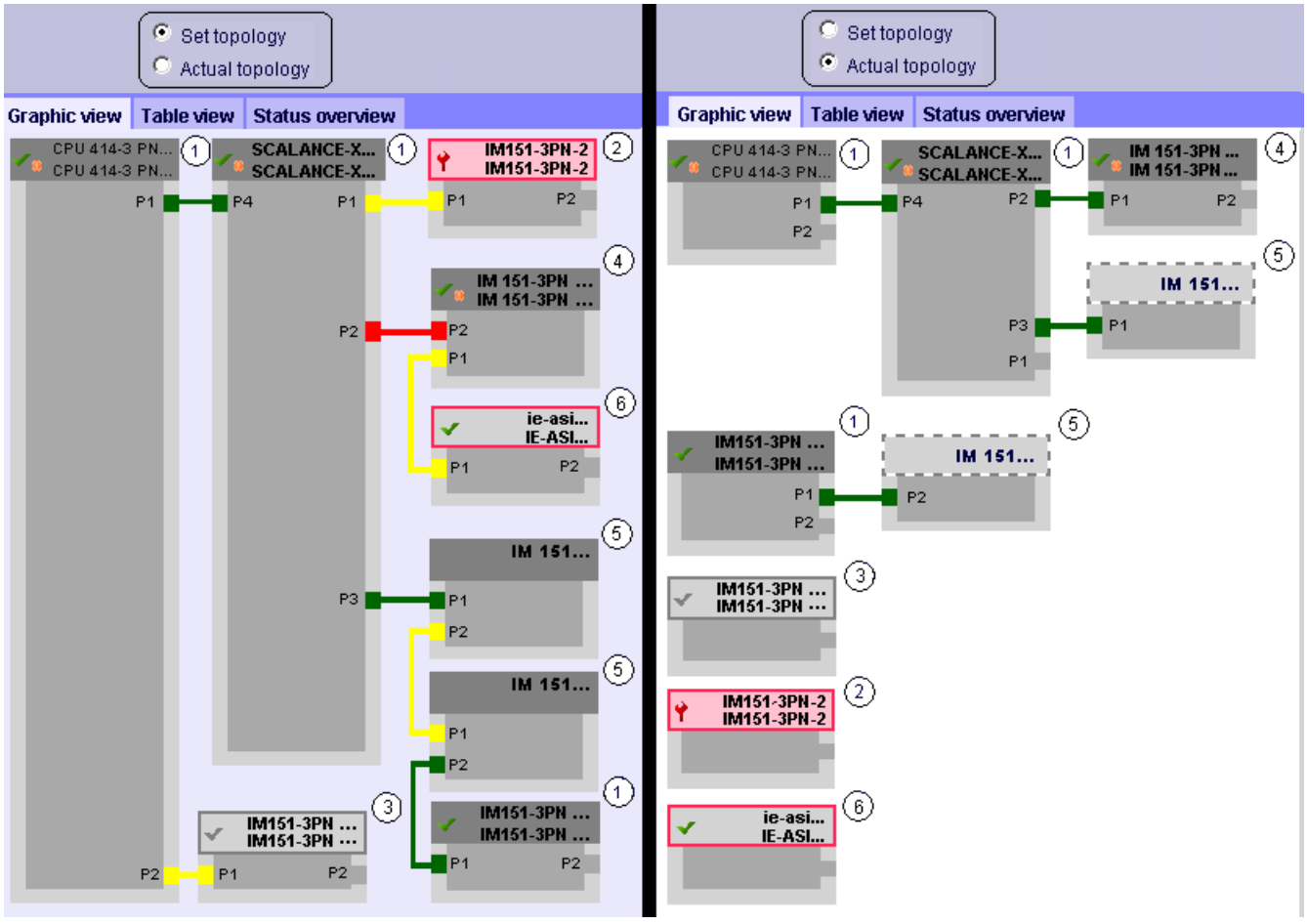


Figure 4-19 Topology - Graphical view

Meaning of the icons

Icon	Color	Meaning
✓	green	Component OK
✓	gray	Disabled PROFIBUS slaves, or PROFINET devices
?	black	Component unavailable / status cannot be determined "Unable to determine status" is always displayed, for example, when the CPU is in STOP mode, or after a CPU restart during the startup evaluation of "Report system error" for all configured I/O modules and I/O systems. However, this status can also be displayed temporarily at runtime for all modules as a result of a surge of diagnostics interrupts.
	green	Maintenance required
	yellow	Maintenance demanded

Icon	Color	Meaning
	red	Fault - component failure or malfunction
	-	Fault at a lower module level

Meaning of the colored connections

Connection	Meaning	
	Target topology	**Actual topology**
green	The current actual connection corresponds to the configured target connection.	Connections detected
red	The current actual connection does not correspond to the configured target connection (e.g. incorrect port).	-
yellow	No connection diagnostics. Causes: • Communication to a device is interrupted (e.g. removed cable). • Connection to a passive component • Connection to devices/ PROFINET devices of a different IO controller / IO subsystem.	-

① Configured and accessible PROFINET nodes

Configured and accessible PROFINET nodes are displayed in dark gray. Green connections show through which ports the PROFINET nodes of a station are connected.

② Configured but inaccessible PROFINET nodes

The configured but inaccessible PROFINET nodes are displayed in the lower section in pink, with a red frame and device number. These PROFINET nodes are only included in the view of the target topology if configured in the Topology Editor.

③ Disabled nodes

Deactivated nodes are shown in light gray.

④ Interchanged ports

Interchanged ports are marked in red in the target topology view. The physically connected ports are displayed in the actual topology, while the configured target connection is displayed in the target topology.

⑤ PROFINET devices of a different PROFINET IO subsystem

- In the target topology:
  A PROFINET device of a different PROFINET IO subsystem is indicated by means of a green interconnection (or red interconnection if ports are interchanged) if accessible and directly adjacent to a configured accessible PROFINET device ①.
  A yellow interconnection is displayed if the PROFINET device of a different PROFINET IO subsystem is not accessible.
  The interconnection between two PROFINET devices that belong to a different PROFINET IO subsystem cannot be determined and is always shown in yellow.
- In the actual topology:
  The PROFINET device of a different PROFINET IO subsystem is only displayed if directly adjacent to a configured PROFINET device. This is displayed in light-gray and dashed line.

The status of PROFINET devices of a different PROFINET IO subsystem is **not** displayed in the device header.

⑥ Display of faulty neighbor relations

Nodes whose neighbor relations cannot be read completely or without errors are displayed in light gray with red frame.

Note

Displaying faulty neighbor relationships

A firmware update of the affected component is required.

Views after changes to the structure

- In the "Target topology" view, a device that has failed is retained at the same position and identified by a device header with red frame and red wrench icon:
- In the "actual topology" view, a device that has failed is displayed separately in the lower section and identified by a device header with red frame and red wrench icon.

Link between the "Topology" and "Module status" Web pages

The "Topology" and "Module status" Web pages are linked. In the topology view, click the head of the select module to jump automatically to this module in the "Module status" Web page.

See also chapter Module state (Page 107).

Topology - Tabular view

The tabular view always shows the actual topology.

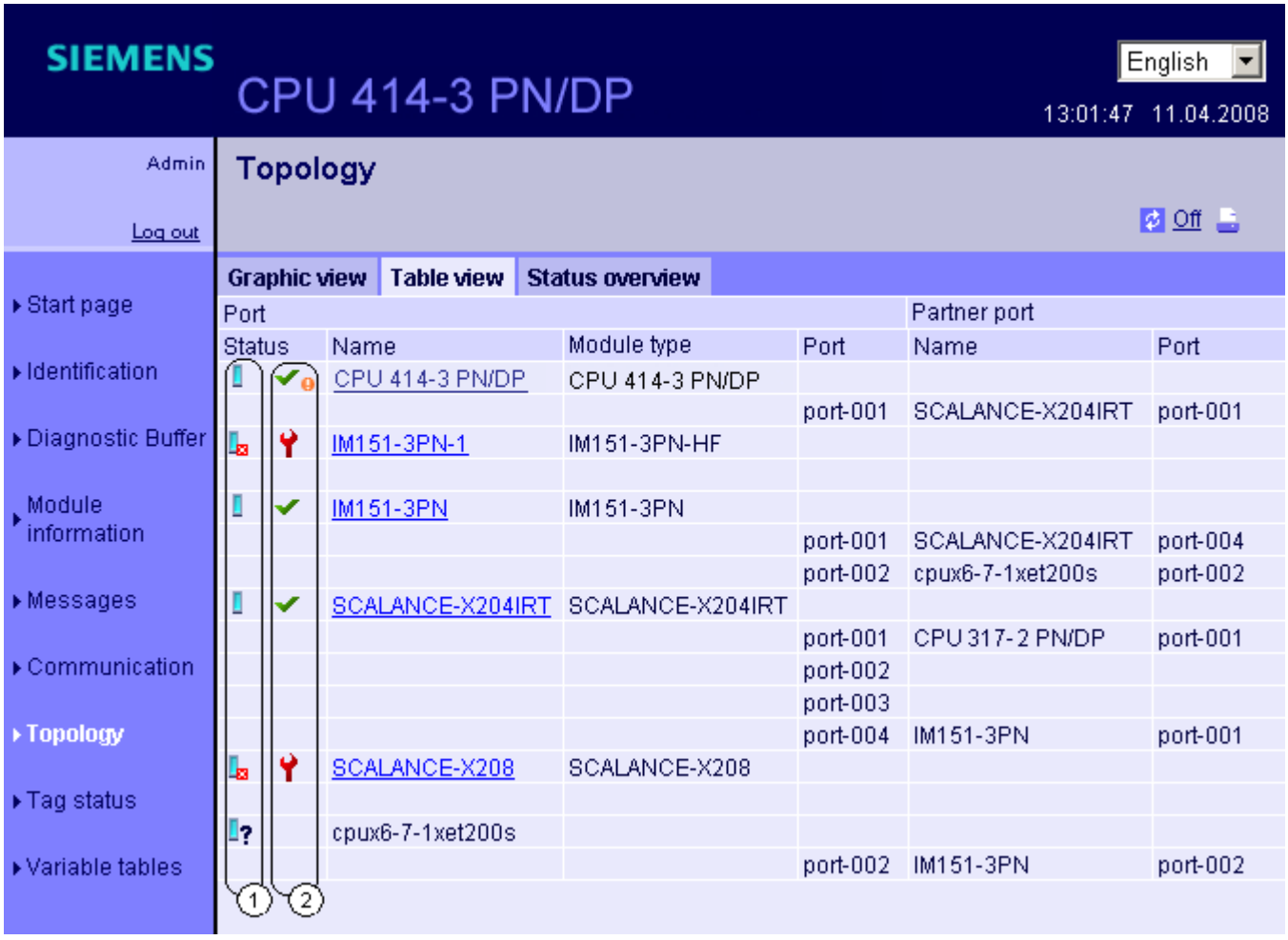


Figure 4-20 Topology - Tabular view

Meaning of the symbols relating to the status of the PROFINET nodes

Icon	Meaning
	Configured and available PROFINET nodes
	Non-configured and available PROFINET nodes
	Configured, but unavailable PROFINET nodes
	Nodes for which neighbor relationships cannot be determined, or for which the neighbor relationship could not be read out completely, or only with errors

Meaning of the icons relating to the module status of the PROFINET nodes

Icon	Color	Meaning
	green	Component OK
	gray	Disabled PROFIBUS slaves, or PROFINET devices Requirement for support: • As of CPU 41x-3 PN/DP, V5.3 and STEP 7 V5.4 + SP5 • Activating/deactivating the PROFIBUS slaves and PROFINET IO devices with SFC12 Mode 3/4
	black	Component unavailable / status cannot be determined "Unable to determine status" is always displayed, for example, when the CPU is in STOP mode, or after a CPU restart during the startup evaluation of "Report system error" for all configured I/O modules and I/O systems. However, this status can also be displayed temporarily at runtime for all modules as a result of a surge of diagnostics interrupts.
	green	Maintenance required
	yellow	Maintenance demanded
	red	Fault - component failure or malfunction
	-	Fault at a lower module level

Topology - Status overview

The "Status overview" shows a clear representation of all PN IO devices / PROFINET devices (without connection relationships) on one page. A quick error diagnostics is possible based on the symbols that show the module states.

Here, too, there is a linking of the modules to the "Module status" Web page.

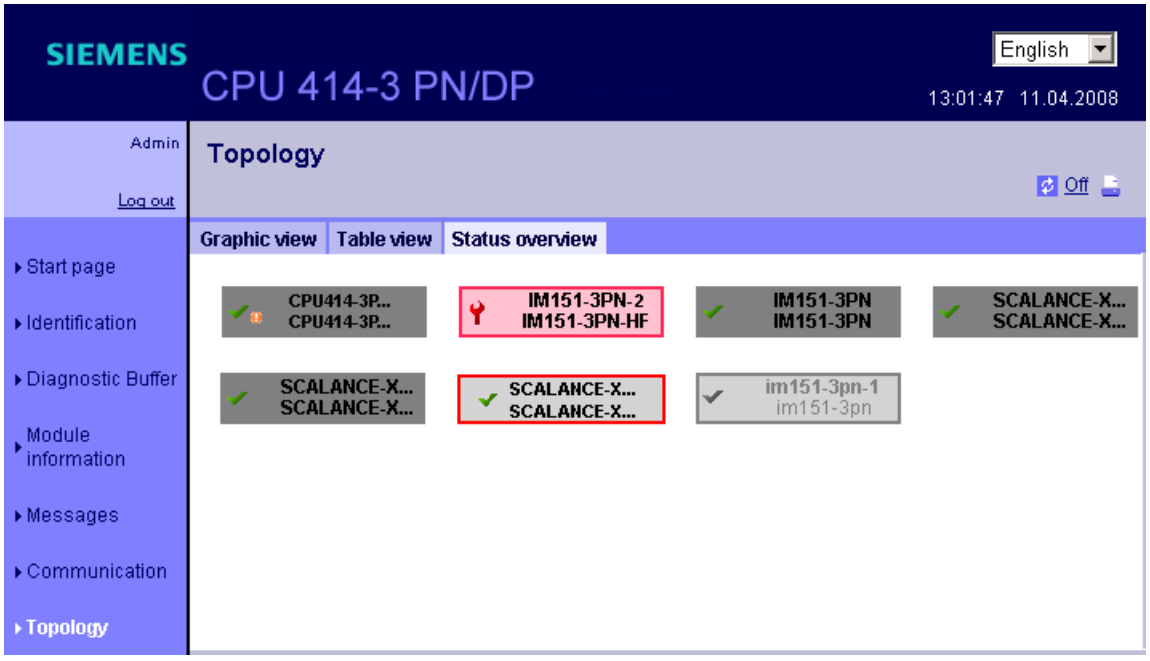


Figure 4-21 Topology - Status overview

4.7.5.8 Examples of individual topology views

The following paragraphs show you some examples of different topology views.

"Actual topology" is OK

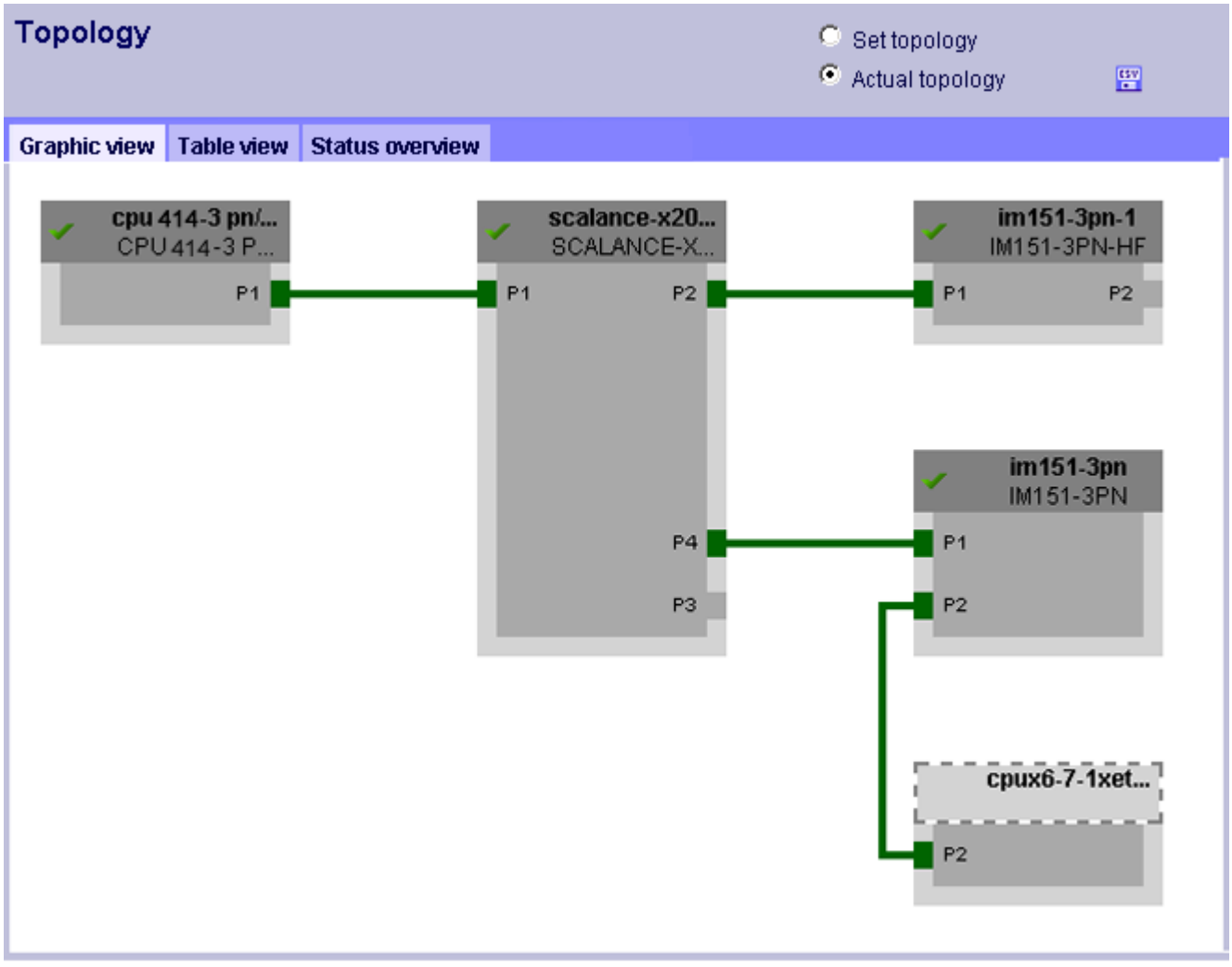


Figure 4-22 "Actual topology" is OK

"Target topology" is OK

This view displays the connections as configured in the Topology Editor of STEP 7. If **no** device has failed in the meantime, the view of the "Target topology" corresponds to that of the "Actual topology".

The button for saving is grayed out in the "Target topology" view.

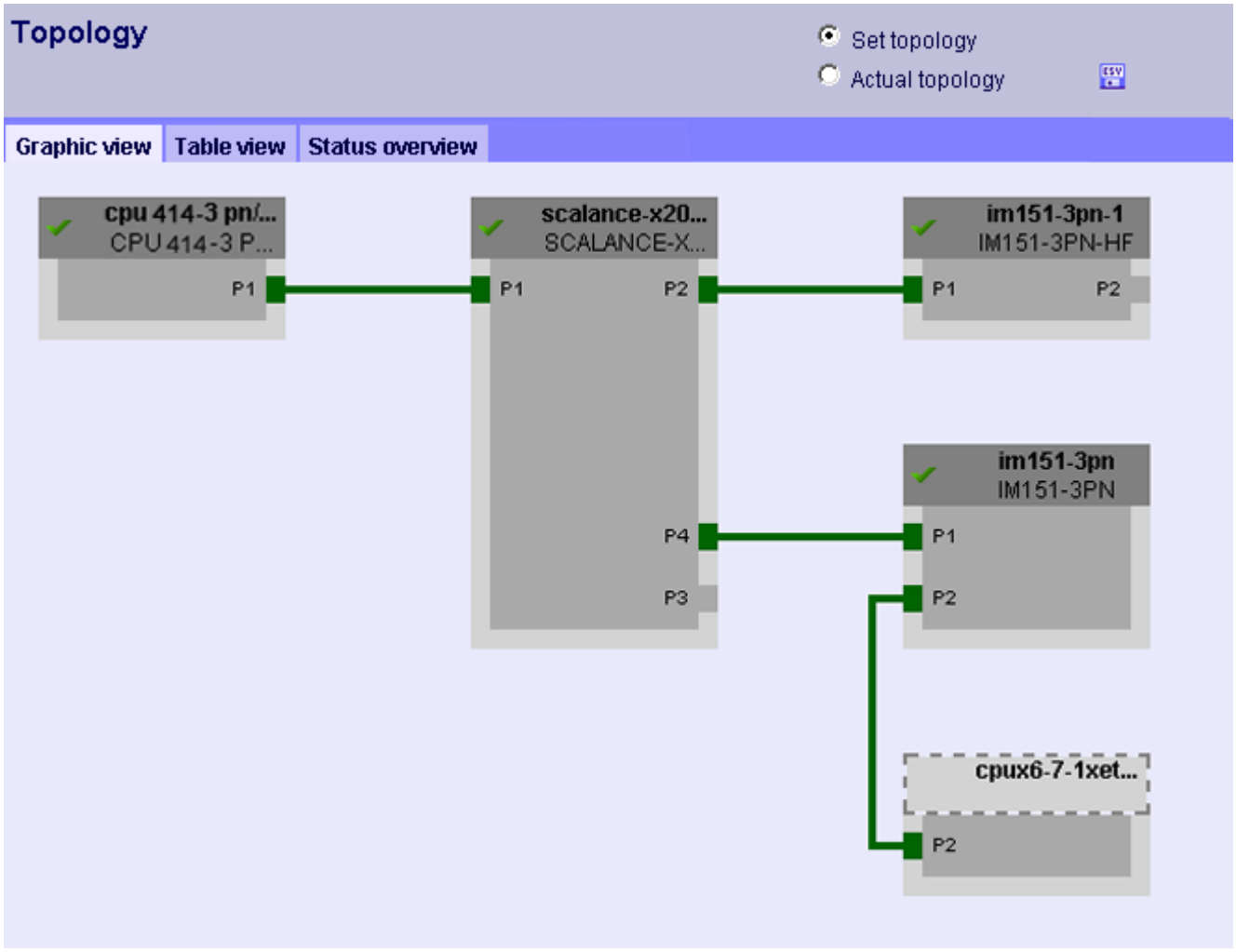


Figure 4-23 "Target topology" is OK

"Target topology" with failed device

A device that has failed in the meantime is retained at the same position in the "Target topology" view. The failed device is displayed with red bordered device head and red wrench .

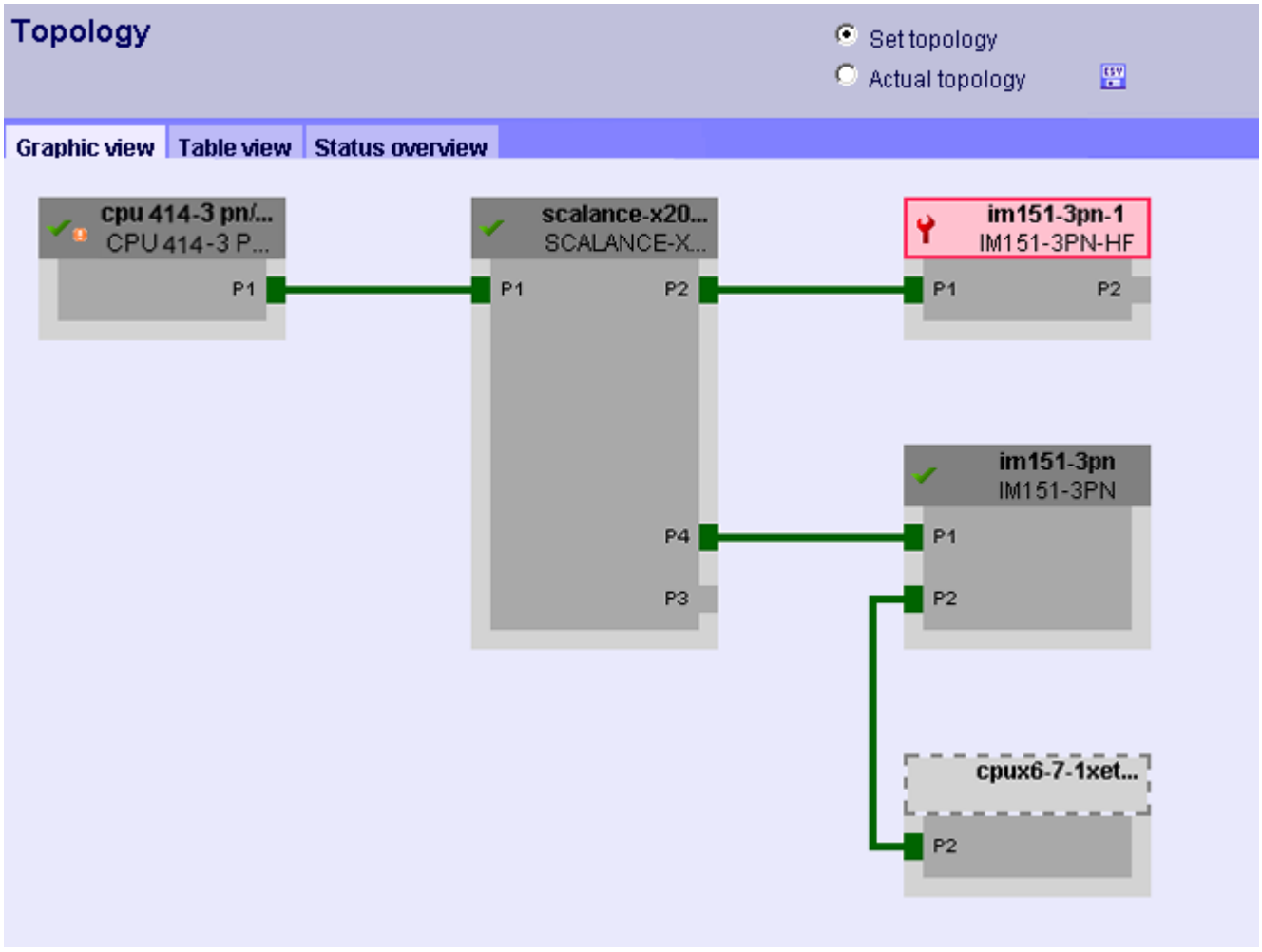


Figure 4-24 "Target topology" with failed device

"Actual topology" with failed device

Now switch to "Actual topology". In this view the device that has since failed is shown separately in the bottom area of the view. The failed device is displayed with red bordered device head and red wrench .

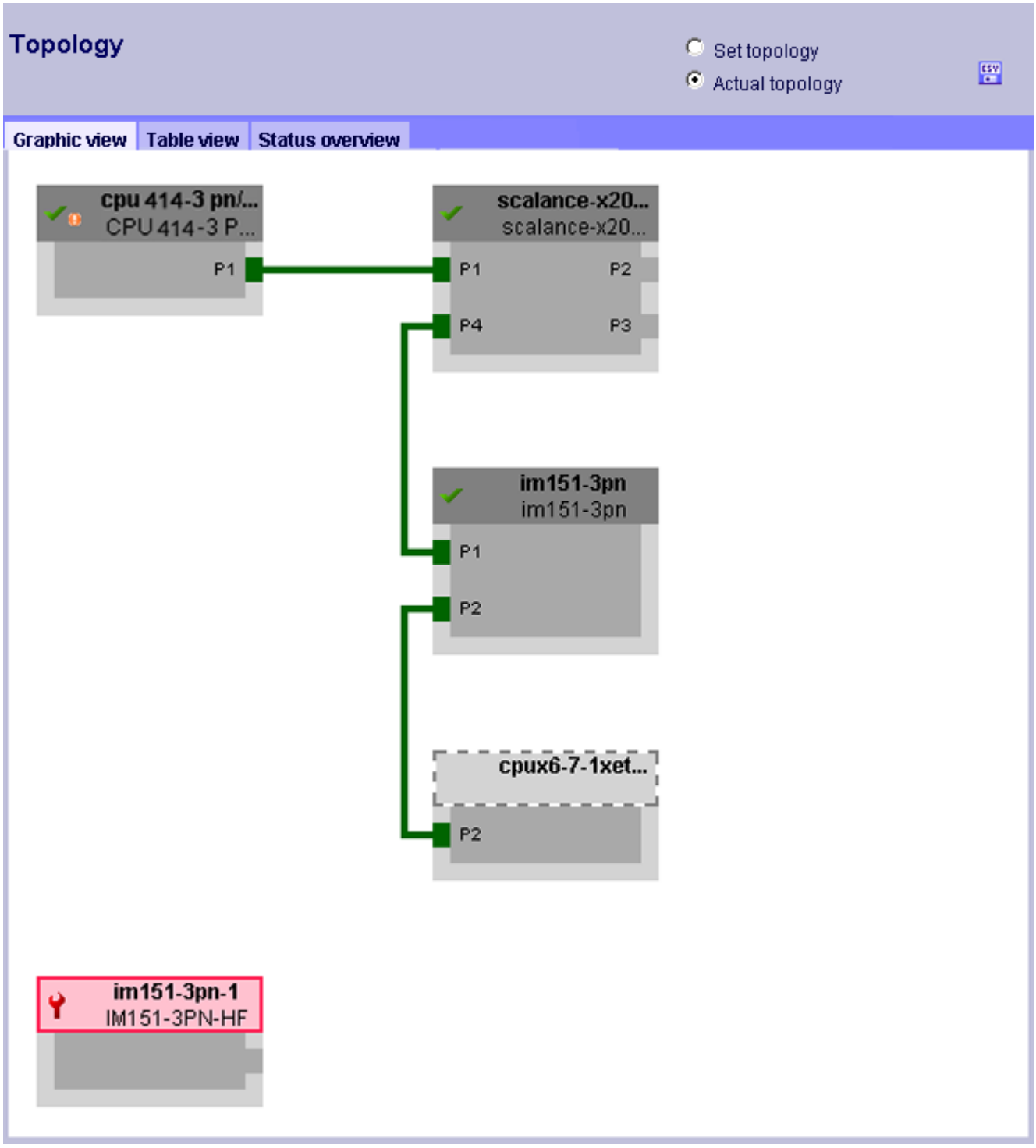


Figure 4-25 "Actual topology" with failed device

"Target topology" with interchanged ports

A configured and directly adjacent PROFINET device at which a port was interchanged by mistake is retained at the same position in the "Target topology" view. The interchanged connection is visualized by a red line.

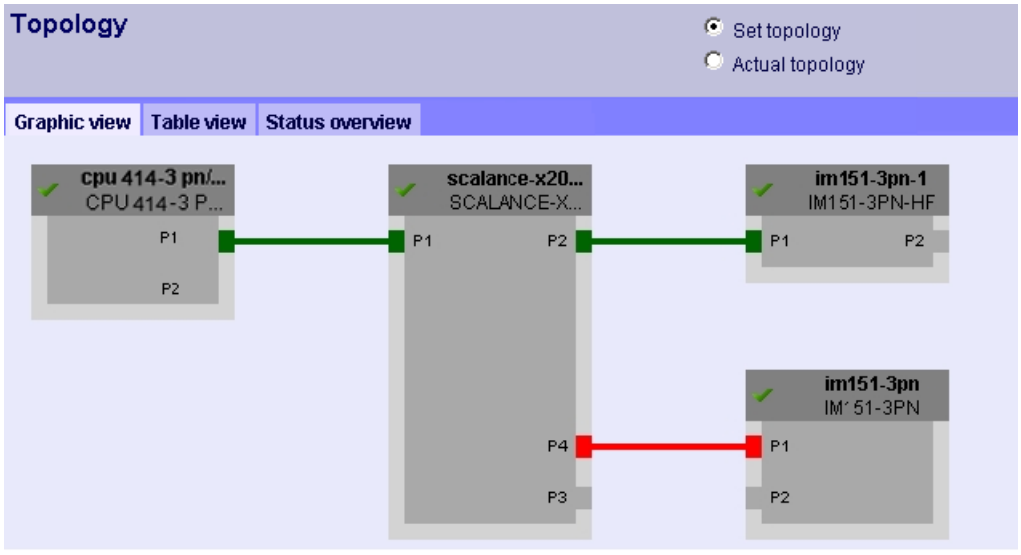


Figure 4-26 "Target topology" with interchanged ports

"Target topology" with tool change

Ports with dynamically changing partners are displayed in italic font (P5 and P6). The interconnection with the IO device currently used is indicated by a green line. Interconnections with IO devices currently not used are indicated by yellow lines.

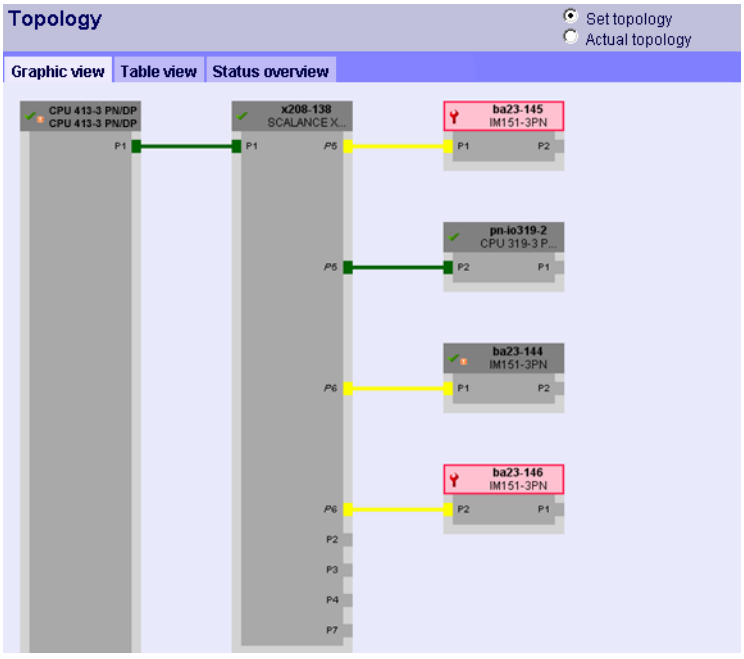


Figure 4-27 "Target topology" with tool change

4.7.5.9 Variable status

Variable status

The browser outputs the variable status on the Web page of the same name. You can monitor the status of up to 50 variables.

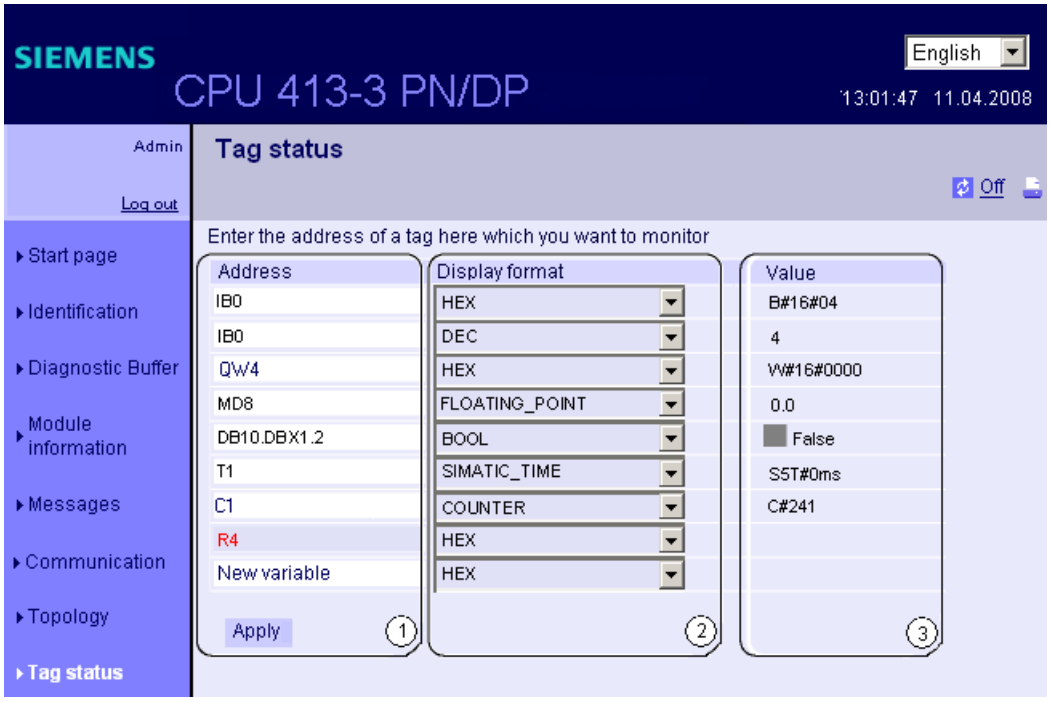


Figure 4-28 Variable status

① Address

Enter the address of the operand of which you want to monitor the response in the "Address" text box. Invalid addresses entered are displayed in red font.

To retain these entries, save the variable status Web page in the Favorites list of your browser.

② Display format

Select the display format of a variable using the drop-down list. The program indicates the variable in hex code if it does not support the selected display format.

③ Value

Outputs the value of the corresponding operand in the selected format.

Special features when changing languages

You can change the language, for example, from German to English, by clicking the object in the upper right corner. The German mnemonics differ compared to other languages. The syntax of operands you enter may be invalid for this reason when you change languages. For example, ABxy instead of QBxy. The browser outputs a faulty syntax in red font.

4.7.5.10 Variable tables

Variable tables

The browser displays the content of the variable tables on the Web page of the same name. You can monitor up to 50 variable tables with a of maximum 200 variables.

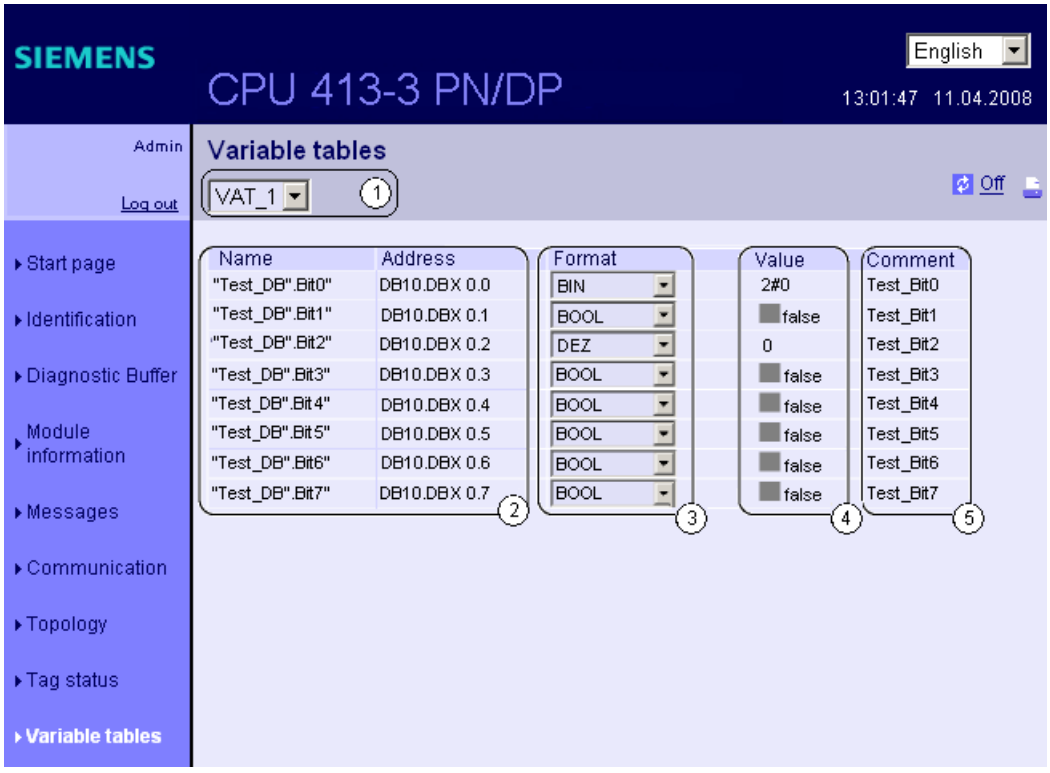


Figure 4-29 Variable tables

① Selection

Select one of the configured variable tables from this drop-down list.

② Name and address

This field displays the operand's name and address.

③ Format

Select the display format of the corresponding operand using the drop-down lists. The drop-down list outputs a selection of all valid display formats.

④ Value

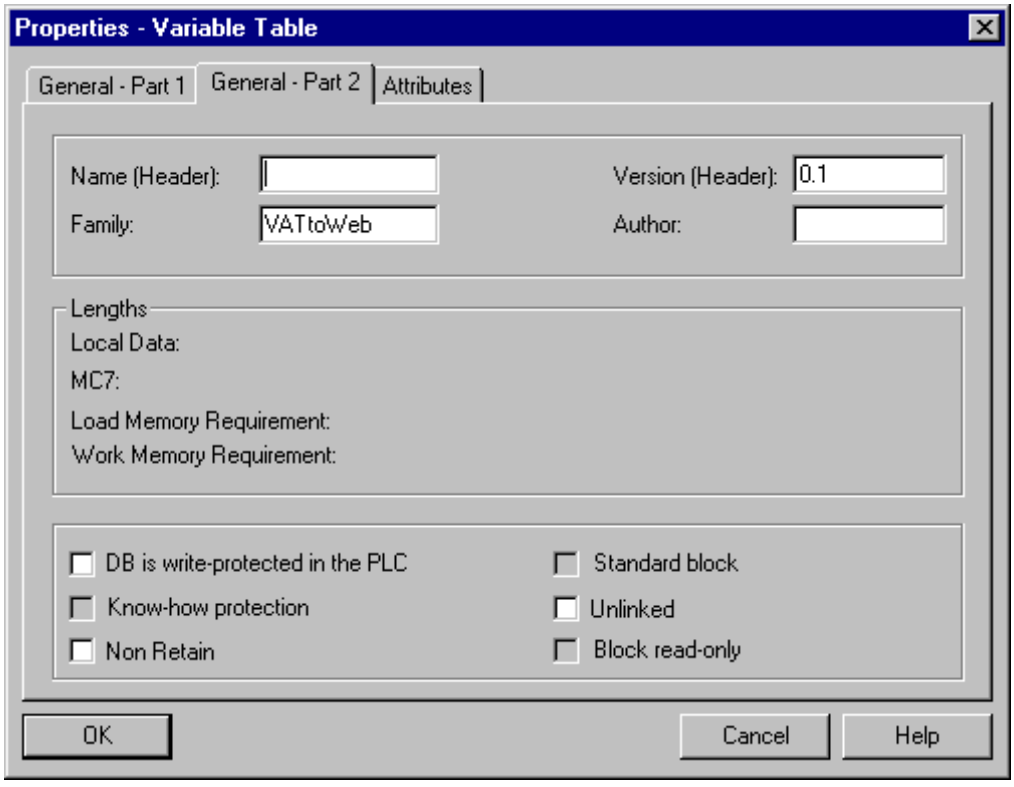
This column shows the values in the corresponding display format.

⑤ Comment

The program outputs the comment you configured in order to highlight the meaning of an operand.

Creating a variable table for the Web server

1. Generate a variable table in STEP 7.
2. Open the properties dialog of the variable table and select the "General - Part 2" tab.
3. Activate the "Web server" check box. As an alternative, you can enter the ID "VATtoWEB" in the "Family" field.

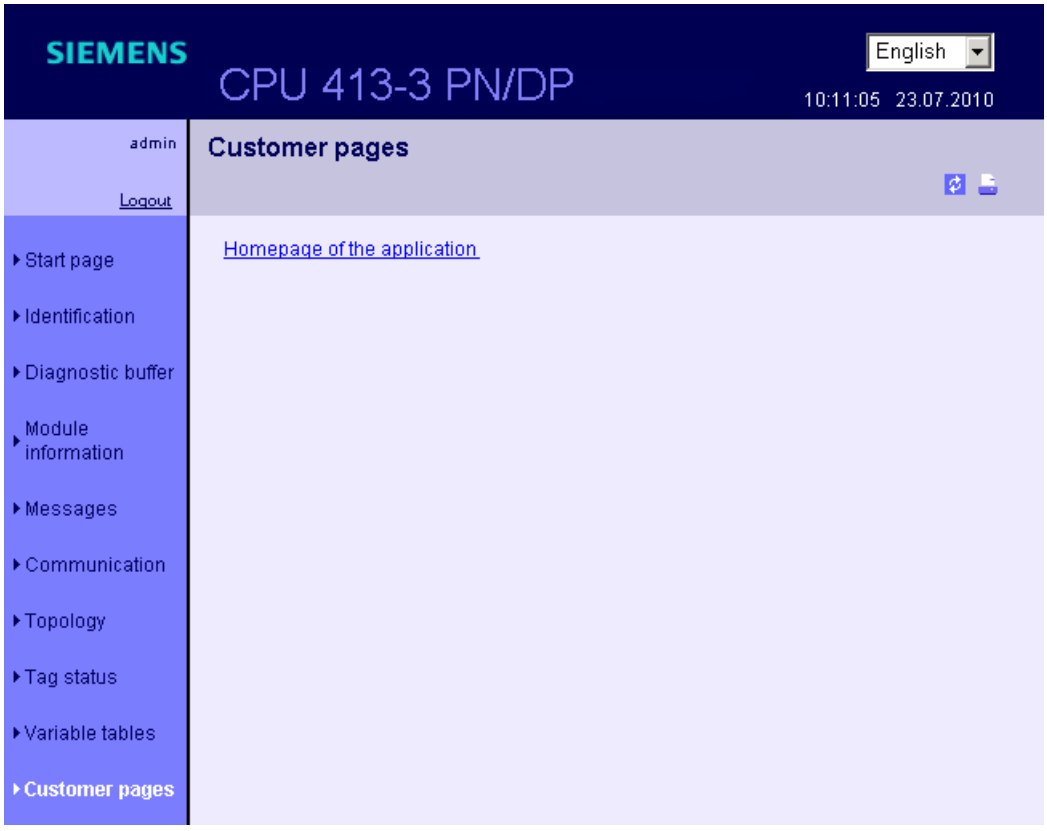


4. Save and compile the project and download the configuration data to the CPU.

4.7.5.11 User pages

User pages

This Web page contains the link to your programmed user page.



You can create the user page in a Web Editor of your choice, using the symbols from the STEP 7 user program. The Web2PLC application included in your STEP 7 package converts this user page into data blocks. The size of user pages must not exceed 1 MB. The DBs generated are downloaded to the CPU and the corresponding link is displayed on the user page. You can click this link to start the user page in a new window.

Up to four configured user pages can be activated simultaneously. The size of each user page must not exceed 1 MB.

Note

Calling SFC99

You call SFC 99 to synchronize the CPU user program with the Web server. This SFC must be called at least once.

In special application cases, the call to the SFC 99 must take place cyclically.

Requirements

- In your STEP 7 project, you created the icons for the I/O tags to be included on your user page.
- In the "Web" tab of the CPU properties dialog, you
  - activated at least the Web server
  - entered a user in the user list
  - assigned read or write access authorizations to this (and other) user(s) (see the chapter Settings in HW Config, "Web" tab (Page 95)
- You completed the necessary communication settings (IP address parameters, subnet mask, ...).
- You saved and downloaded the hardware configuration.
- You created your user page in an HTML Editor of your choice:
  - automatic HTML pages, if you do not want to control page loading by means of the user program (requires one call of SFC 99)
  - manual HTML pages, if you want to control page loading by means of the user program (requires the call of SFC 99 at cyclic intervals)
- You installed the Web2PLC applications included on your STEP 7 CD (installation path: CD2: \Optional Components\S7 Web2PLC\)

Creating a dynamic user page

To create a dynamic user page, you have to use the AWP (Advanced Web Programming) commands in your HTML user page. AWP commands represent a Siemens command set that you can use to access CPU information. For information about the AWP commands, refer to the Web2PLC Online Help.

Procedure

1. In SIMATIC Manager, select the "Blocks" folder in the S7 program of the CPU and then select the "S7 web 2PLC" command from the shortcut menu. The S7-Web2PLC application starts.
2. Select the File > New Project... menu command and enter the project name.
3. Select the File > Edit project settings... menu command.
   The project settings dialog opens.
4. In the "General" tab, specify the path to your HTML folder.
5. Specify the HMTL file to open as user page and the application name.
6. In the "STEP 7" tab, specify the DB numbers (default setting is 333 and 334)
   Confirm your entries with OK. The STEP 7/ Web project dialog opens.
7. Open your user page with the HTML editor and reference the variables that you wish to use in your user page by means of AWP commands and the symbolic names from STEP 7. To that end, use the online help for Web2PLC.

8. After having edited and saved the page, return to your S7-Web2PLC project. Click the following buttons in succession:
   - "Export symbols"
   - "Generate DB source"
   - "Compile DB source"
     The corresponding actions are executed and a control DB ("Web DB") and at least one fragment DB is created in the "Blocks" folder in the S7 program of the CPU.
9. To download the DBs to the CPU, click "Download to CPU".

Note

The CPU should be in STOP for this download. Overloading of the WEB DBs in RUN can lead to synchronization errors when the user program makes an attempt to access the control DB during the download.

Reference

For additional information about the conversion of Web pages into DBs, refer to the Web2PLC Online Help. For more information on SFC 99, refer to the STEP 7 Online Help.

PROFIBUS DP

5

5.1 CPU 41x as DP master / DP slave

5.1.1 Overview

Introduction

This section describes the properties and technical specifications that you will need when you use a CPU 41x as a DP master or DP slave and configure it for direct data exchange.

Declaration: The DP master / DP slave behavior is the same for all CPUs therefore the CPUs described below will be named CPU 41x.

Further Information

For information on the hardware and software configuration of a PROFIBUS subnet and on diagnostic functions within the PROFIBUS subnet, refer to the STEP 7 Online Help.

5.1.2 DP address areas of 41x CPUs

Address Areas of 41x CPUs

Table 5-1 41x CPUs (MPI/DP interface as PROFIBUS-DP and DP interface)

Address area	412-1	412-2	414-2	416-2
MPI/DP interface X1 as PROFIBUS DP, both inputs and outputs (bytes)	2048	2048	2048	2048
DP interface X2 as PROFIBUS DP, both inputs and outputs (bytes)	-	4096	6144	8192

Table 5-2 41x CPUs (MPI/DP interface as PROFIBUS-DP, DP interface and DP module as PROFIBUS-DP)

Address area	414-3	416-3	417-4
MPI/DP interface X1 as PROFIBUS DP, both inputs and outputs (bytes)	2048	2048	2048
DP interface X2 as PROFIBUS DP, both inputs and outputs (bytes)	6144	8192	8192
DP module IF1 as PROFIBUS DP, both inputs and outputs (bytes)	6144	8192	8192

You can add all inputs and outputs to the process image of the CPU.

DP diagnostics addresses

In the input address area, the DP diagnostic addresses occupy at least 1 byte for the DP master and each DP slave. The DP standard diagnostics for each node can be called at these addresses, for example (LADDR parameter of SFC13). You specify the DP diagnostic addresses during project engineering. If you do not specify DP diagnostic addresses, STEP 7 assigns the addresses as DP diagnostic addresses in descending order starting at the highest byte address.

In the DPV1 master mode, the slaves are usually assigned two diagnostic addresses, with the ET200 M for example, one for the station and one for the IM.

5.1.3 CPU 41x as PROFIBUS DP master

Introduction

This section describes the properties and technical specifications of the CPU if you operate it as a PROFIBUS DP master.

Reference

You can find the features and technical specifications of the 41x CPUs as of in this manual in *Technical specifications*.

Requirements

You will need to configure the relevant CPU interface for use as a DP master. This means that you do the following in *STEP 7*:

1. Configure the CPU as a DP master
2. Assign a PROFIBUS address.
3. Select an operating mode (S7-compatible or DPV1).
4. Assign a diagnostics address.
5. Connect DP slaves to the DP master system.

Note

Is one of the PROFIBUS DP slaves a CPU 31x or CPU 41x?

If yes, you will find it in the PROFIBUS DP catalog as a "preconfigured station". Assign this DP slave CPU a slave diagnostics address in the DP master. Interconnect the DP master with the DP slave CPU, and define the address areas for data exchange with the DP slave CPU.

From EN 50170 to DPV1

The standard concerning distributed I/O (EN 50170) has been further developed. The results were incorporated into IEC 61158 / IEC 61784-1:2002 Ed1 CP 3/1. The SIMATIC documentation refers to this as DPV1.

Operating modes for DPV1 components

- S7-compatible mode
  In this mode, the components are compatible with EN 50170. Note that you cannot utilize the full DPV1 functionality in this mode.
- DPV1 mode
  In this mode, you can utilize the full DPV1 functionality. Automation components in the station that do not support DPV1 can be used as before.

DPV1 and EN 50170 compatibility

You can continue to use all existing slaves after the system conversion to DPV1. These do not, however, support the enhanced function of DPV1.

DPV1 slaves can be used in systems that are not converted to DPV1. In this case, their behavior corresponds with that of conventional slaves. SIEMENS DPV1 slaves can be operated in S7-compatible mode. For the DPV1 slaves of other manufacturers, you need a GSD file < Rev. 3 file to EN 50170.

Additional information

A comprehensive description of migration from EN 50170 to DPV1 is provided in the FAQ titled Migration from EN 50170 to DPV1 (https://support.industry.siemens.com/cs/ww/en/view/7027576)

Status/modify, programming via PROFIBUS

As an alternative to the MPI interface, you can use the PROFIBUS DP interface to program the CPU or execute the programming device functions Monitor and Modify.

Note

The execution of programming and status and modify functions via PROFIBUS DP interface prolongs the DP cycle.

Constant bus cycle time

This is a property of PROFIBUS DP that ensures same length bus cycles. The "Constant bus cycle time" function ensures that the DP master always starts the DP bus cycle within a constant interval. From the perspective of the slaves, this means that they receive their data from the master at constant time intervals.

The constant cycle time (isochronous) PROFIBUS is the basis for "isochronous mode".

Isochronous mode

S7-400 CPUs support the mechanism of isochronous reading and outputting of I/O signals. This allows the user program to synchronize with the I/O processing. Input data is then recorded at a set time and output data takes effect at a set time.

Full "terminal-to-terminal" support of isochronous mode is only possible if all components within the sequence support the "isochronous mode" system property.

The *Isochronous mode* manual contains a full overview of this system property.

Isochronous updating of process image partitions

SFC126 "SYNC_PI" is used to isochronously update a process input image partition. A user program which is linked to a DP cycle can use the SFC to update the input data in the process input image partition consistently and synchronously with these intervals. SFC126 accepts interrupt control and can only be called in OBs 61, 62, 63 and 64.

SFC 127 "SYNC_PO" is used to isochronously update the process output image partition. An application program which is linked to a DP cycle can use the SFC to transfer the computed output data from a process output image partition to the I/O consistently and synchronously with these intervals. SFC127 accepts interrupt control and can only be called in OBs 61, 62, 63 and 64.

To allow isochronous updates of process image partitions, all input or output addresses of a slave must be assigned to the same process image partition.

To ensure consistency of data in a process image partition, the following conditions must be satisfied on the various CPUs:

- CPU 412: Number of slaves + number of bytes / 100 < 16
- CPU 414: Number of slaves + number of bytes / 100 < 26
- CPU 416: Number of slaves + number of bytes / 100 < 40
- CPU 417: Number of slaves + number of bytes / 100 < 44

SFCs 126 and 127 are described in the corresponding Online Help and in the *System and Standard Functions* manual.

Consistent user data

Data that belongs together in terms of its content and describes a process state at a specific point in time is known as consistent data. To maintain consistency, the data should not be changed or updated during processing or transmission.

For a description, please refer to the section Consistent Data (Page 189).

Sync/Freeze

The SYNC control command is used to set sync mode on the DP slaves of selected groups. In other words, the DP master transfers current output data and instructs the relevant DP slaves to freeze their outputs. The DP slaves writes the output data of the next output frames to an internal buffer; the state of the outputs remains unchanged.

Following each SYNC control command, the DP slaves of the selected groups transfer the output data stored in the internal buffer to the process outputs.

The outputs are only updated cyclically again after you transfer the UNSYNC control command using SFC11 "DPSYC_FR".

The FREEZE control command is used to set the relevant DP slaves to Freeze mode, in other words, the DP master instructs the DP slaves to freeze the current state of the inputs. It then transfers the frozen data to the input area of the CPU.

Following each FREEZE control command, the DP slaves freeze the state of their inputs again.

The DP master receives the current state of the inputs cyclically, again not until you have sent the UNFREEZE control command with SFC11 "DPSYC_FR".

For information on SFC11, refer to the corresponding online help and to the *System and Standard Functions* manual

Startup of the DP master system

Use the following parameters to set startup monitoring of the DP master:

- Transfer of the parameters to modules
- "Ready" message from the module

That is, the DP slaves must start up within the set time and be configured by the CPU (as DP master).

PROFIBUS address of the DP master

All PROFIBUS addresses are allowed.

See also

System and Standard Functions (https://support.industry.siemens.com/cs/ww/en/view/44240604)

5.1.4 Diagnostics of the CPU 41x as DP master

Diagnostics using LEDs

The following table explains the meaning of the BUSF LED. The BUSF LED assigned to the interface configured as the PROFIBUS DP interface is always lit or flashing on a display.

Table 5-3 Meaning of the "BUSF" LED of the CPU 41x as DP master

BUSF	Description	Remedy
Off	Configuration correct; All configured slaves can be addressed	–
Lit	• Bus fault (hardware fault) • DP interface fault • Different transmission rates in multi-DP master mode	• Check for short-circuit or interruption of the bus cable. • Evaluate the diagnostics. Reconfigure or correct the configuration.

BUSF	Description	Remedy
Flashing	• Station failure • At least one of the assigned slaves cannot be addressed	• Check whether all the configured nodes are correctly connected to the bus. • Wait until the CPU 41x has started up. If the LED does not stop flashing, check the DP slaves or analyze the diagnostics data of the DP slaves.
flashes briefly INTF lights up briefly	CiR synchronization running	–

Triggering Detection of the Bus Topology in a DP Master System with the SFC103 "DP_TOPOL"

The diagnostics repeater is available to improve the ability to locate faulty modules or an interruption on the DP cable when failures occur in ongoing operation. This module operates as a slave and can identify the topology of a DP chain and record any faults originating from it.

You can use SFC103 "DP_TOPOL" to trigger the identification of the bus topology of a DP master system by the diagnostics repeater. For information on SFC 103, refer to the corresponding online help and to the manual *System and Standard Functions*. The diagnostics repeater is described in the manual *Diagnostics repeater für PROFIBUS-DP*, Article No. 6ES7972-0AB01-0XA0.

Reading the diagnostics data with *STEP 7*

Table 5-4 Reading the diagnostics data with STEP 7

DP master	Block or tab in *STEP 7*	Application	Reference
CPU 41x	"DP Slave Diagnostics" tab	Show slave diagnostics in clear text on the *STEP 7* user interface	See the section on hardware diagnostics in the *STEP 7* Online Help and in the *Programming with STEP 7* manual
	SFC 13 "DPNRM_DG"	Read slave diagnostics (save to data area of the user program)	SFC, see *System Software for S7-300/400, System and Standard Functions* reference manual. For the structure of other slaves, refer to their descriptions.
	SFC59 "RD_REC"	Reading the data records of S7 diagnostics (stored in the data area of the user program)	*System Software for S7-300/400, System and Standard Functions* reference manual.
	SFC 51 "RDSYSST"	Reading partial SSL lists. If you call SFC 51 in the diagnostics interrupt OB with SSL-ID W#16#00B3 and access the module that initiated the diagnostics interrupt, the read operation is carried out immediately.	
	SFB 52 "RDREC"	Reading the data records of S7 diagnostics (stored in the data area of the user program)	
	SFB 54 "RALRM"	To read out interrupt information within the associated interrupt OB	
	SFC 103 "DP_TOPOL"	Triggers detection of the bus topology of a DP master system with diagnostics repeaters installed there.	

Analysis of diagnostics data in the user program

The following figure shows you how to evaluate the diagnostics data in the user program.

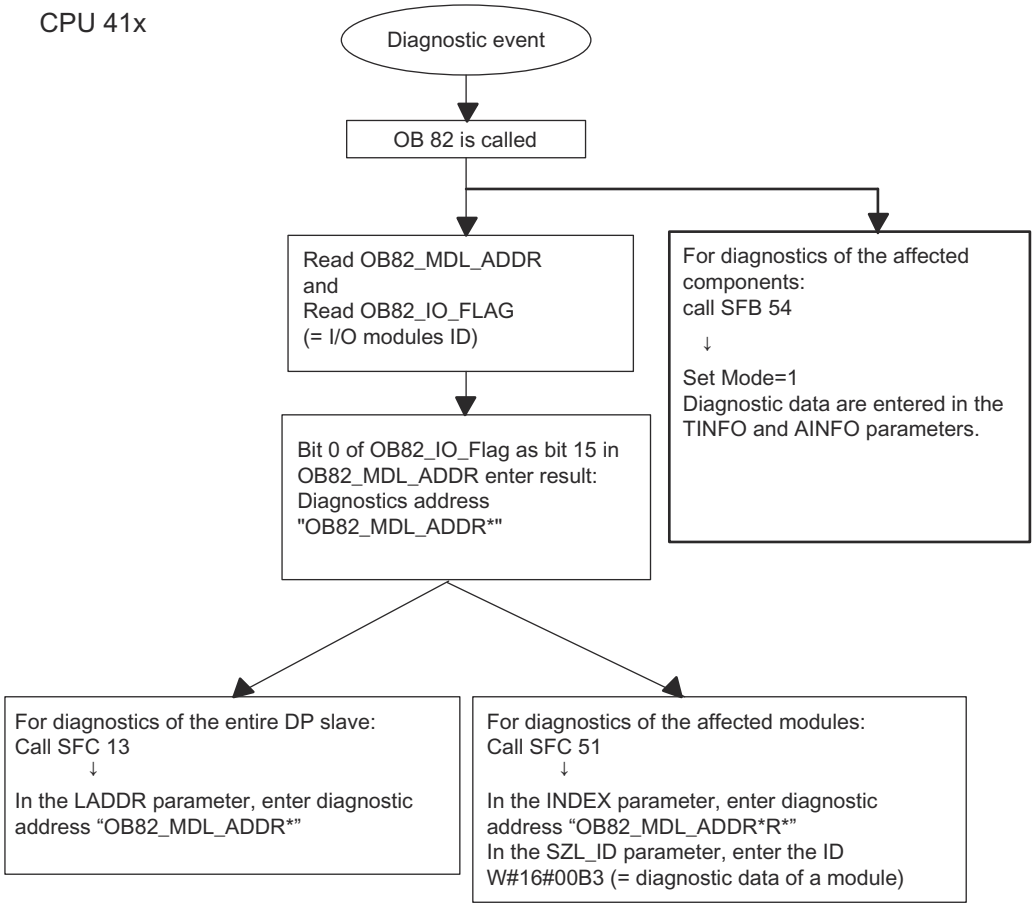
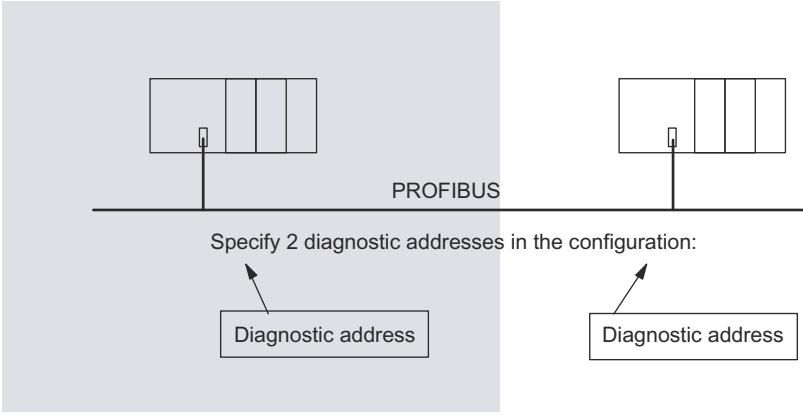


Figure 5-1 Diagnostics with CPU 41x

Diagnostics addresses in conjunction with DP slave functionality

You assign diagnostics addresses for the PROFIBUS DP in the CPU 41x. Verify in your configuration that the DP diagnostics addresses are assigned once to the DP master and once to the DP slave.

Table 5-5 Diagnostics addresses for the DP master and DP slave

S7 CPU as DP master	S7 CPU as DP slave
	
During configuration of the DP master, specify (in the associated project of the DP master) a diagnostics address for the DP slave. This diagnostics address is identified as *assigned to the DP master* below. The DP master uses this diagnostics address to receive information about the status of the DP slave or a bus interruption (see also table "Event detection of the CPUs 41x as DP master").	During configuration of the DP slave, also specify (in the associated project of the DP slave) a diagnostics address that is *assigned to the DP slave*. This diagnostics address is identified as assigned to the DP slave below. The DP master uses this diagnostics address to receive information about the status of the DP master or a bus interruption (see also table "Event detection of the CPUs 41x as DP slave").

Event detection

The following table shows you how the CPU 41x as DP master detects any changes in the operating mode of a CPU as DP slave or interruptions in data transfer.

Table 5-6 Event detection of the CPUs 41x as DP master

Event	What happens in the DP master
Bus interruption (short-circuit, connector removed)	• OB86 called with the message station failure (event entering state; diagnostics address of the DP slave that is assigned to the DP master) • With I/O access: call of OB 122 (I/O access error)
DP slave: RUN → STOP	• OB 82 is called with the message "Faulty module" (incoming event; diagnostics address of the DP slave that is assigned to the DP master; variable OB 82_MDL_STOP=1)
DP slave: STOP → RUN	• OB 82 is called with the message "Module OK" (outgoing event; diagnostics address of the DP slave that is assigned to the DP master; variable OB82_MDL_STOP=0)

Evaluation in the user program

The following table shows you how, for example, you can evaluate RUN-STOP transitions of the DP slave in the DP master (see also table "Event detection of the CPUs 41x as DP master").

Table 5-7 Evaluation of RUN-STOP transitions of the DP slave in the DP master

In the DP master		In the DP slave (CPU 41x)
Diagnostics addresses: (example) Master diagnostics address=**1023** Slave diagnostics address in the master system=**1022**		Diagnostics addresses: (example) Slave diagnostics address=**422** **Master diagnostics address=not relevant**
The CPU calls OB82 with at least the following information: • OB82_MDL_ADDR:=**1022** • OB82_EV_CLASS:=B#16#39 (incoming event) • OB82_MDL_DEFECT:=module fault Tip: The CPU diagnostics buffer also contains this information You should also program SFC "DPNRM_DG" in the user program for reading the diagnostics data of the DP slave. Use SFB54. It outputs the interrupt information in its entirety.	←	CPU: RUN → STOP CPU generates a DP slave diagnostics frame.

5.1.5 CPU 41x as DP slave

Introduction

This section describes the properties and technical specifications of the CPU if you use it as a DP slave.

Reference

You can find the features and technical specifications of the 41x CPUs in the section *Technical Specifications*.

Requirements

- Only one DP interface of a CPU can be configured as a DP slave.
- Will the MPI/DP interface be a DP interface? If so, you must configure the interface as a DP interface.
  Before commissioning you must configure the CPU as a DP slave. In other words, you must do the following in STEP 7
  - Activate the CPU as a DP slave,
  - Assign a PROFIBUS address,
  - Assign a slave diagnostics address
  - Define the address areas for data transfer to the DP master

Configuration and parameterization frame

STEP 7 supports you in configuring and assigning parameters to CPU 41x. A description of the configuration and parameterization frame (https://support.industry.siemens.com/cs/ww/en/view/1452338) you might need, for example, to use a bus monitoring function is available on the Internet.

Monitor/Modify and Programming via PROFIBUS

As an alternative to the MPI interface, you can use the PROFIBUS DP interface to program the CPU or execute the programming device functions Monitor and Modify. To do this, you must enable these functions when you configure the CPU as DP slave in *STEP 7*.

Note

The use of Programming or Monitor and Modify via the PROFIBUS DP interface extends the DP cycle.

Data Transfer Via a Transfer Memory

As a DP slave the CPU 41x makes a transfer memory available to PROFIBUS DP. Data transfer between the CPU as DP slave and the DP master always takes place via this transfer memory. Configure the following address areas: Maximum of 244 bytes per input and 244 bytes per output with a maximum of 32 bytes per module.

This means that the DP master writes its data to these transfer memory address areas, the CPU reads these data in the user program, and vice versa.

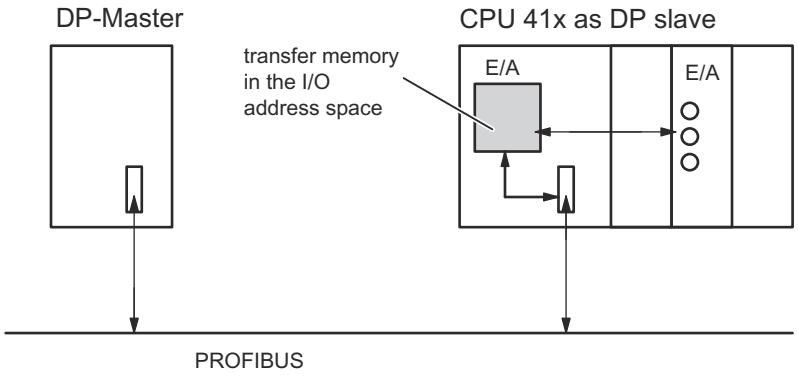


Figure 5-2 Transfer memory in the CPU 41x as DP slave

Address Areas of the Transfer Memory

Configure the input and output address areas in *STEP 7*:

- You can configure up to 32 input and output address areas.
- Each of these address areas can be up to 32 bytes in size.
- You can configure a maximum of 244 bytes of inputs and 244 bytes of outputs in total.

An example for the configuration of the address assignments of the transfer memory is provided in the table below. You will also find this in the online help for STEP 7 configuration.

Table 5-8 Configuration example for the address areas of the transfer memory

	Type	Master address	Type	Slave address	Length	Unit	Consistency
1	I	222	O	310	2	Byte	Unit
2	O	0	I	13	10	Word	Total length
:							
32							
	Address areas in the DP master CPU		Address areas in the DP slave CPU		These parameters of the address areas must be the same for the DP master and DP slave		

Rules

You must adhere to the following rules when working with the transfer memory:

- Assignment of the address areas:
  - Input data for the DP slave is **always** output data from the DP master
  - Output data from the DP slave is **always** input data for the DP master
- You can assign the addresses as you choose. You access the data in the user program with load/transfer commands or with SFCs 14 and 15. You can also specify addresses from the process image input and output table (see also section "DP address areas of the 41x CPUs").

  Note

  You assign addresses for the transfer memory from the DP address area of the CPU 41x.

  You must not reassign the addresses you have already assigned to the transfer memory to the I/O modules on the CPU 41x.

- The lowest address in each address area is the start address of that address area.
- The length, unit and consistency of address areas for the DP master and DP slave that belong together must be the same.

S5 DP Master

If you use an IM 308 C as a DP master and the CPU 41x as a DP slave, the following applies to the exchange of consistent data:

You must program FB192 in the IM 308-C so that consistent data can be transferred between the DP master and DP slave. The data of the CPU 41x is only output or displayed contiguously in a block with FB 192.

AG S5-95 as a DP Master

If you use an AG S5-95 as a DP master, you must also set its bus parameters for the CPU 41x as DP slave.

Sample Program

The small sample program below illustrates data transfer between the DP master and DP slave. This example contains the addresses from the table "Configuration example for the address areas of the transfer memory".

```
In the DP slave CPU                  In the DP master CPU

L      2                Data pre-
T      MB       6       processing
L      IB       0       in the DP
T      MB       7       slave
L      MW       6       Transfer
T      PQW      310     data to the
                        DP master
```

```
L      PIB      222       Process
T      MB       50        received
L      PIB      223       data in the
L      B#16#3               DP master
+      I
T      MB       51

L      10                 Data pre-
+      3                  processing
T      MB       60        in the DP
                          master

CALL   SFC      15        Send data to
 LADDR:= W#16#0            the DP slave
 RECORD:= P#M60.0 Byte20
 RET_VAL:= MW 22
```

```
CALL   SFC      14        Receive
 LADDR:=W#16#D             data from
 RET_VAL:=MW 20            the DP
 RECORD:=P#M30.0 Byte20    master
L      MB       30        Process
L      MB       7         received
+      I                  data
T      MW       100
```

Data Transfer in STOP Mode

The DP slave CPU changes to STOP mode: The output data of the slave in the transfer memory of the CPU is overwritten with "0". In other words, the DP master reads "0". The input data of the slave is retained.

The DP master changes to STOP mode: The current data in the transfer memory of the CPU is retained and can continue to be read by the CPU.

PROFIBUS address

You should not set 0 and 126 as the PROFIBUS address for the CPU 41x as DP slave.

CPUs as DP slave in external systems

In order to operate an S7-400 CPU as DP slave on a system other than SIMATIC, you need to install a GSD file. You can download this at:GSD (https://support.industry.siemens.com/cs/ww/en/view/113652)

5.1.6 Diagnostics of the CPU 41x as DP slave

Diagnostics with LEDs – CPU 41x

The following table explains the meaning of the BUSF LEDs. The BUSF LED assigned to the interface configured as the PROFIBUS DP interface is always lit or flashing.

Table 5-9 Meaning of the "BUSF" LEDs of the CPU 41x as DP slave

BUSF	Description	Remedy
Off	Configuration correct	–
Flashing	The parameter settings of the CPU 41x are incorrect. There is no data exchange between the DP master and the CPU 41x. Causes: • The response monitoring timeout. • Bus communication over PROFIBUS DP was interrupted. • The PROFIBUS address is incorrect.	• Check the CPU 41x. • Check to make sure that the bus connector is properly inserted. • Check whether the bus cable to the DP master has been disconnected. • Check the configuration and parameter settings.
on	• Bus short-circuit	• Check the bus configuration

Determining the bus topology in a DP master system with the SFC 103 "DP_TOPOL"

The diagnostics repeater is available to improve the ability to locate faulty modules or an interruption on the DP cable when failures occur in ongoing operation. This module operates as a slave and can identify the topology of a DP subnet and record any faults originating from it.

You can use SFC 103 "DP_TOPOL" to trigger the identification of the bus topology of a DP master system by the diagnostics repeater. For information on SFC 103, refer to the corresponding online help and to the manual *System and Standard Functions*. The diagnostic repeater is described in the *Diagnostic Repeater for PROFIBUS DP* manual, article number 6ES7972-0AB00-8BA0.

Diagnostics with *STEP 5* or *STEP 7* slave diagnostics

The slave diagnostics complies with the EN 50170, Volume 2, PROFIBUS standard. Depending on the DP master, diagnostics information can be read with *STEP 5* or *STEP 7* for all DP slaves that comply with the standard.

The display and structure of the slave diagnostics is described in the following sections.

S7 diagnostics

S7 diagnostics information can be requested in the user program from all modules with diagnostics functionality of the SIMATIC S7 product range. You can find out which modules support diagnostics in the module information or in the catalog. The structure of the S7 diagnostics data is the same for both central and distributed modules.

The diagnostics data of a module is located in data records 0 and 1 of the system data area of the module. Data record 0 contains 4 bytes of diagnostics data describing the current status of a module. Data record 1 also contains module-specific diagnostics data.

You can find the structure of the diagnostics data in the reference manual System and Standard Functions (https://support.industry.siemens.com/cs/ww/en/view/44240604)

Reading the diagnostics

Table 5-10 Reading the diagnostics data with STEP 5 and STEP 7 in the master system

Automation system with DP master	Block or tab in *STEP 7*	Application	Reference
SIMATIC S7	"DP Slave Diagnostics" tab	Show slave diagnostics in clear text on the *STEP 7* user interface	See the section on hardware diagnostics in the *STEP 7* Online Help and in the *Programming with STEP 7* manual
	SFC 13 "DP NRM_DG"	Read slave diagnostics (save to data area of the user program)	SFC, see *System Software for S7-300/400, System and Standard Functions* reference manual.
	SFC 51 "RDSYSST"	Read partial SSL lists. Call SFC 51 in the diagnostics interrupt using the SSL ID W#16#00B3 and read the SSL of the slave CPU.	*System Software for S7-300/400, System and Standard Functions* reference manual.
	SFB 54 "RDREC"	The following applies to the DPV1 environment: To read out interrupt information within the associated interrupt OB	
	FB125/FC125	Evaluating slave diagnostics data	On the Internet (https://support.industry.siemens.com/cs/ww/en/view/387257)
SIMATIC S5 with IM 308-C as the DP master	FB 192 "IM308C"	Read slave diagnostics (save to data area of the user program)	For structure, see "Diagnostics of the CPU 41x as a DP slave" section; for the FBs see the *Distributed I/O Station ET 200* manual
SIMATIC S5 with the S5-95U programmable controller as the DP master	FB 230 "S_DIAG"		

Example of reading slave diagnostics data, using FB 192 "IM 308C"

Here you will find an example of how to use FB 192 to read the slave diagnostics for a DP slave in the STEP 5 user program.

Assumptions

For this STEP 5 user program, the following is assumed:

- The IM 308-C assigned as the DP master mode uses page frames 0 to 15 (number 0 of IM 308-C).
- The DP slave is assigned PROFIBUS address 3.
- Slave diagnostics data should be stored in DB 20. You can also use any other data block for this.
- The slave diagnostics data has a length of 26 bytes.

STEP 5 user program

```
 STL                                Description
          :A         DB 30          Default address area for the IM 308-C
          :SPA       FB 192         IM no. = 0, PROFIBUS address of the DP slave
                                    = 3
Name      :IM308C                  Function: Read slave diagnostics
DPAD      :          KH F800       is not evaluated
IMST      :          KY 0, 3       S5 data area: DB 20
FCT       :          KC SD         Diagnostics data as of data word 1
GCGR      :          KM 0          Length of diagnostics data = 26 bytes
TYPE                 KY 0, 20      Error code storage in DW 0 of DB 30
STAD                 KF +1
LENG                 KF 26
ERR                  DW 0
```

Diagnostics addresses in connection with DP master functionality

You assign diagnostics addresses for the PROFIBUS DP in the CPU 41x. Verify in your configuration that the DP diagnostics addresses are assigned once to the DP master and once to the DP slave.

Table 5-11 Diagnostics addresses for the DP master and DP slave

S7 CPU as DP master	S7 CPU as DP slave
During configuration of the DP master, specify (in the associated project of the DP master) a diagnostics address for the DP slave. This diagnostics address is identified as assigned to the DP master below. The DP master uses this diagnostics address to receive information about the status of the DP slave or a bus interruption (see also table "Event detection of the CPUs 41x as DP master").	During configuration of the DP slave, also specify (in the associated project of the DP slave) a diagnostics address that is assigned to the DP slave. This diagnostics address is identified as assigned to the DP slave below. The DP master uses this diagnostics address to receive information about the status of the DP master or a bus interruption (see also table "Event detection of the CPUs 41x as DP slave").

Event detection

The following table shows you how the CPU 41x as DP slave detects any operating mode changes or interruptions in data transfer.

Table 5-12 Event detection of the CPUs 41x as DP slave

Event	What happens in the DP slave?
Bus interruption (short-circuit, connector removed)	• Calls OB 86 with the message *Station failure* (incoming event; diagnostics address of the DP slave, assigned to the DP slave) • With I/O access: call of OB 122 (I/O access error)
DP master RUN → STOP	• Call of OB 82 with the message *Module faulty*(incoming event; diagnostics address of the DP slave assigned to the DP slave; tag OB82_MDL_STOP=1)
DP master STOP → RUN	• OB 82 is called with the message *Module OK*(event exiting state; diagnostics address of the DP slave that is assigned to the DP slave; tag OB82_MDL_STOP=0)

Evaluation in the user program

The table below shows an example of you how you can evaluate RUN-STOP transitions of the DP master in the DP slave (see also the previous table).

Table 5-13 Evaluating RUN-STOP transitions in the DP master/DP slave

In the DP master	In the DP slave (CPU 41x)
Diagnostics addresses: (example) Master diagnostics address=**1023** Slave diagnostics address in the master system=**1022**	Diagnostics addresses: (example) Slave diagnostics address=**422** **Master diagnostics address=not relevant**
CPU: RUN → STOP	The CPU calls OB 82 with at least the following information: • OB82_MDL_ADDR:=422 • OB82_EV_CLASS:=B#16#39 (incoming event) • OB82_MDL_DEFECT:=module fault Tip: The CPU diagnostics buffer also contains this information

Example of the structure of slave diagnostics data

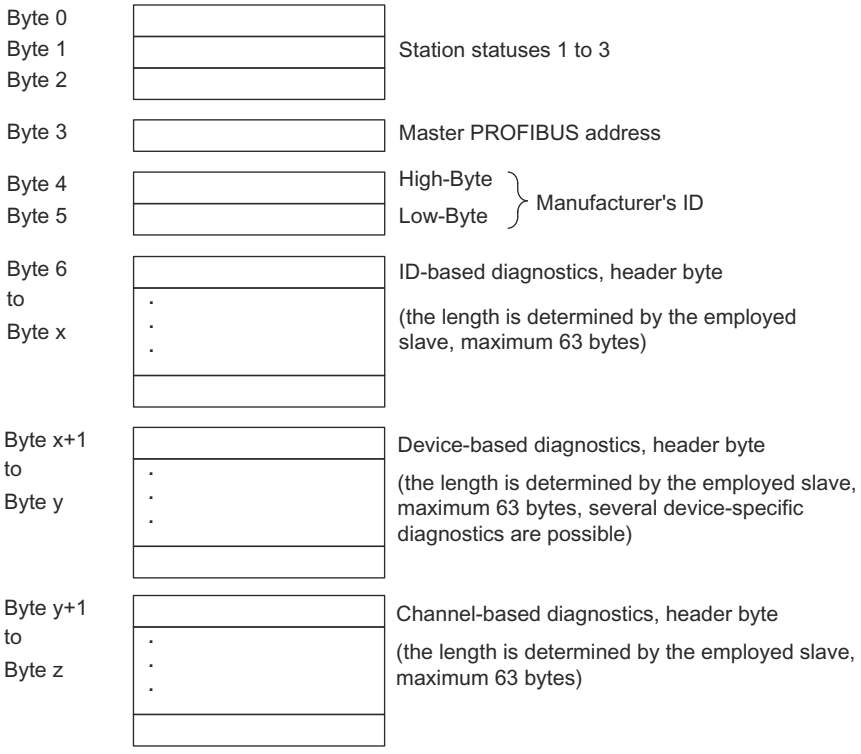


Figure 5-3 Structure of slave diagnostics

ID-based diagnostics, device-based diagnostics and channel-based diagnostics can be performed in any order for slave diagnostics.

5.1.7 CPU 41x as DP slave: Station statuses 1 to 3

Station status 1 to 3

Station status 1 to 3 provides an overview of the status of a DP slave.

Table 5-14 Structure of station status 1 (Byte 0)

Bit	Meaning	Remedy
0	1:The DP slave cannot be addressed by the DP master.	• Correct DP address set on the DP slave? • Bus connector connected? • Voltage at DP slave? • RS-485 repeater set correctly? • Execute reset on the DP slave
1	1:The DP slave is not yet ready for data exchange.	• Wait while the DP slave powers up.
2	1:The configuration data sent by the DP master to the DP slave does not match the configuration of the DP slave.	• Correct station type or correct configuration of the DP slave entered in the software?

Bit	Meaning	Remedy
3	1:Diagnostic interrupt, triggered by RUN-STOP change on the CPU 0:Diagnostic interrupt, triggered by STOP-RUN change on the CPU	• You can read the diagnostic information.
4	1:Function is not supported, e.g. changing the DP address via software	• Check the configuration.
5	0:The bit is always "0".	–
6	1:The DP slave type does not correspond to the software configuration.	• Correct station type entered in the software? (Parameter assignment error)
7	1:Parameters have been assigned to the DP slave by a different DP master to the one that currently has access to the DP slave.	• The bit is always 1, for example, if you access the DP slave with the programming device or another DP master. The DP address of the parameter assignment master is in the "master PROFIBUS address" diagnostic byte.

Table 5-15 Structure of station status 2 (Byte 1)

Bit	Meaning
0	1:The DP slave must be assigned new parameters and reconfigured.
1	1:There is a diagnostic message pending. The DP slave cannot continue until the problem has been eliminated (static diagnostic message).
2	1:The bit is always set to "1" if the DP slave with this DP address is present.
3	1:Watchdog monitoring is enabled for this DP slave.
4	0:The bit is always set to "0".
5	0:The bit is always set to "0".
6	0:The bit is always set to "0".
7	1:The DP slave is disabled; in other words, it has been removed from cyclic processing.

Table 5-16 Structure of station status 3 (Byte 2)

Bit	Meaning	
0 to 6	0:The bits are always set to "0".	
7	1:	• There are more diagnostic messages than the DP slave can store. • The DP master cannot enter all the diagnostic messages sent by the DP slave in its diagnostic buffer.

Master PROFIBUS Address

The master PROFIBUS address diagnostic byte contains the DP address of the DP master that:

- Assigned parameters to the DP slave and
- has read and write access to the DP slave

Table 5-17 Structure of the master PROFIBUS address (byte 3)

Bit	Meaning
0 to 7	DP address of the DP master that configured the DP slave and that has read and write access to the DP slave.
	FF_H: DP slave has not been assigned parameters by any DP master.

Identifier-related diagnostics

The ID-related diagnostic data tells you for which of the configured address areas of the transfer memory an entry has been made.

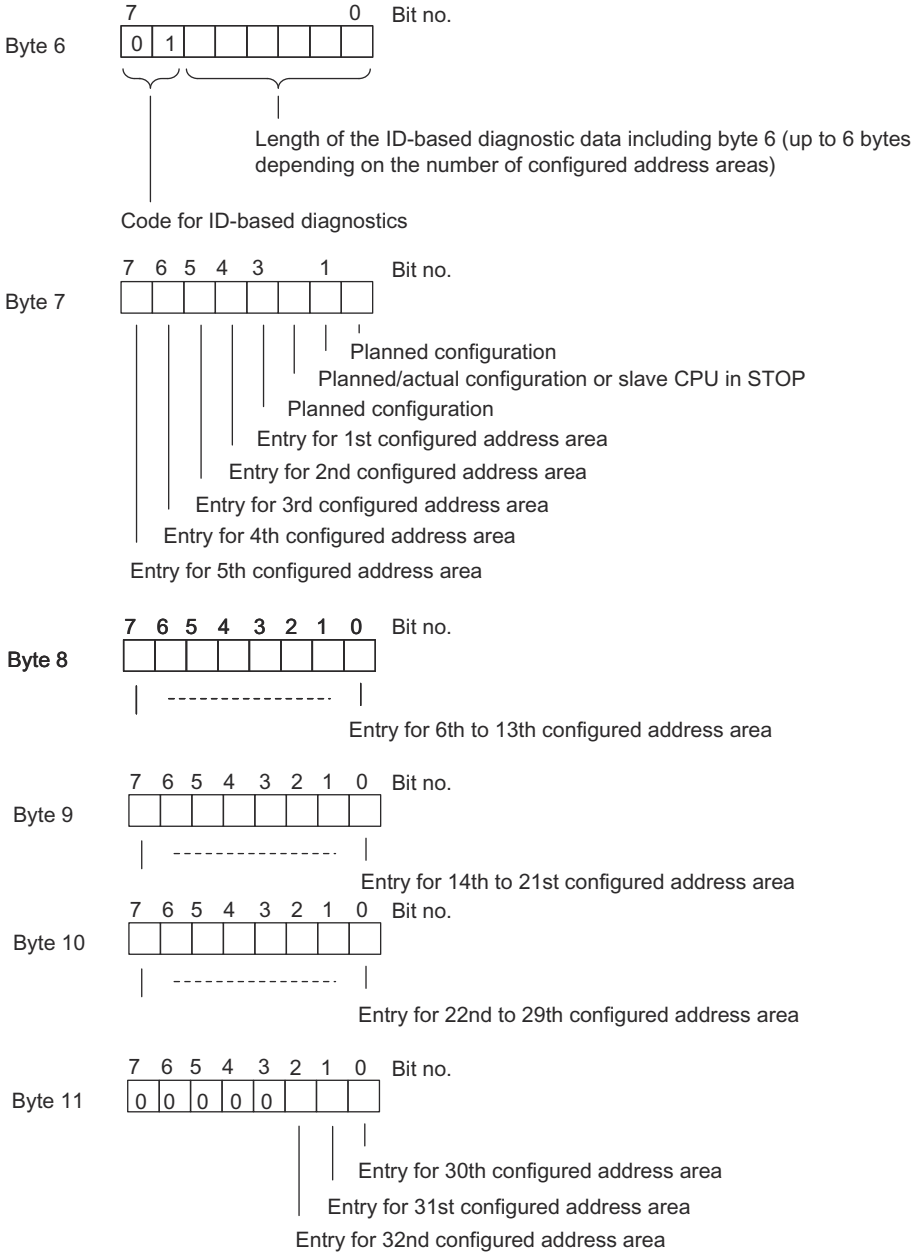


Figure 5-4 Structure of the ID-related diagnostic data of the CPU 41x

Device-Related Diagnostics

Device-related diagnostics provides detailed information about a DP slave. Device-related diagnostics starts at byte x and can include up to 20 bytes.

The figure below illustrates the structure and contents of the bytes for a configured address area of the transfer memory.

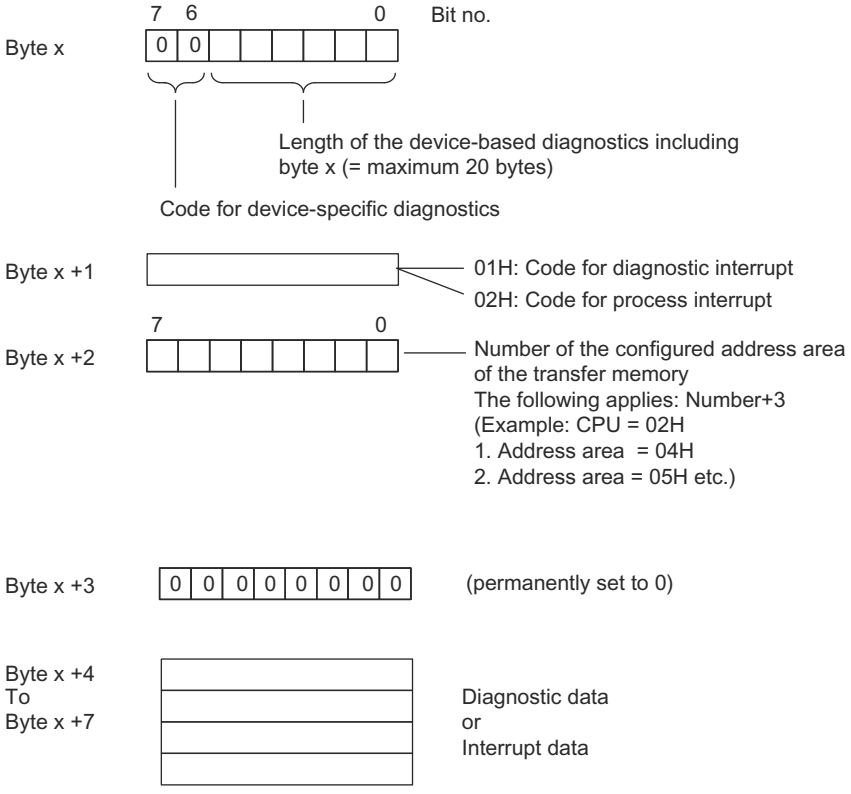


Figure 5-5 Structure of the device-related diagnostics

Starting at byte x +4

The meaning of the bytes starting at byte x+4 depends on byte x +1 (see figure "Structure of device-related diagnostics").

In byte x +1, the code stands for...	
Diagnostic interrupt (01_H)	**Hardware interrupt (02_H)**
The diagnostic data contains the 16 bytes of status information of the CPU. The figure below shows the allocation of the first four bytes of diagnostic data. The following 12 bytes are always 0.	You can program 4 bytes of interrupt information any way you wish for the process interrupt. You transfer these 4 bytes to the DP master in *STEP 7* using SFC7 "DP_PRAL".

Bytes x +4 to x +7 for Diagnostic Interrupts

The following figure illustrates the structure and content of bytes x +4 to x +7 for the diagnostic interrupt. The data in these bytes correspond to the contents of data record 0 of the diagnostic data in STEP 7 (not all bits are used in this case).

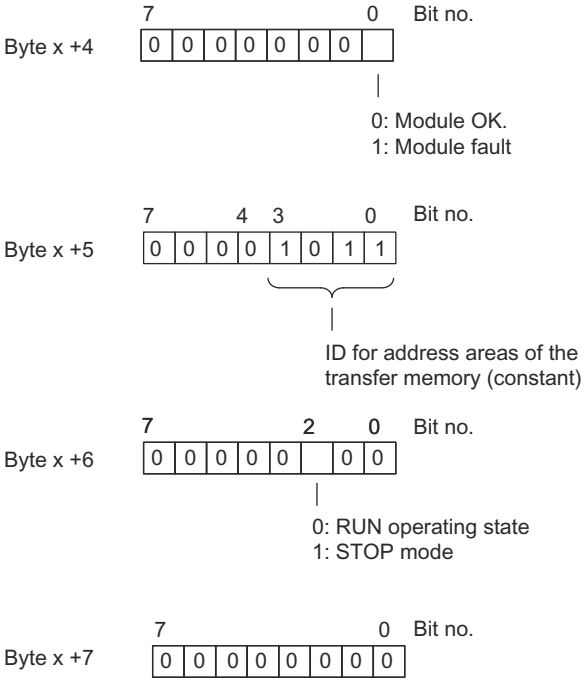


Figure 5-6 Bytes x +4 to x +7 for diagnostic and hardware interrupts

Interrupts with the S7 DP Master

In the CPU 41x as a DP slave you can trigger a process interrupt in the DP master from the user program. You can trigger an OB40 in the user program of the DP master by calling SFC7 "DP_PRAL". Using SFC7, you can forward interrupt information in a double word to the DP master and evaluate it in OB40 in the OB40_POINT_ADDR variable. You can program the interrupt information as required.. You will find a detailed description of SFC7 "DP_PRAL" in the *System Software for S7-300/400, System and Standard Functions* reference manual.

Interrupts with a Different DP Master

If you are using the CPU 41x with a different DP master, these interrupts are simulated in the device-related diagnostic data of the CPU 41x. You will have to process the relevant diagnostic events in the DP master's user program.

Note

Note the following in order to be able to evaluate diagnostic interrupts and hardware interrupts using device-related diagnostics when using a different DP master:

- the DP master should be able to save the diagnostic messages, i.e. the diagnostic messages should be stored within the DP master in a ring buffer. If there are more diagnostic messages than the DP master can store, then, for example, only the last diagnostic message received would be available for evaluation.
- You must scan the relevant bits in the device-related diagnostic data in your user program at regular intervals. You must also take the PROFIBUS DP bus cycle time into consideration so that, for example, you can query the bits at least once synchronized with the bus cycle time.
- With an IM 308-C operating in DP master mode, you cannot utilize process interrupts in device-specific diagnostics, because only incoming events are reported, rather than outgoing events.

5.1.8 Direct Data Exchange

5.1.8.1 Principle of direct data exchange

Overview

Direct data exchange is characterized by PROFIBUS DP nodes which "listen" on the bus and know which data a DP slave returns to its DP master.

This mechanism allows the "listening node" (recipient) direct access to deltas of input data of remote DP slaves.

In your STEP 7 configuration, define the address area of the recipient in which the required data of the publisher will be read, based on the peripheral input addresses.

A CPU 41x can be:

- Sender is a DP slave
- Recipient is a DP slave or DP master or a CPU that is not linked into a master system (see Fig. 3-9).

Example

The following figure uses an example to explain which direct data exchange "relations" you can configure. All the DP masters and DP slaves in the figure are 41x CPUs. Note that other DP slaves (ET 200M, ET 200X, ET 200S) can only be senders.

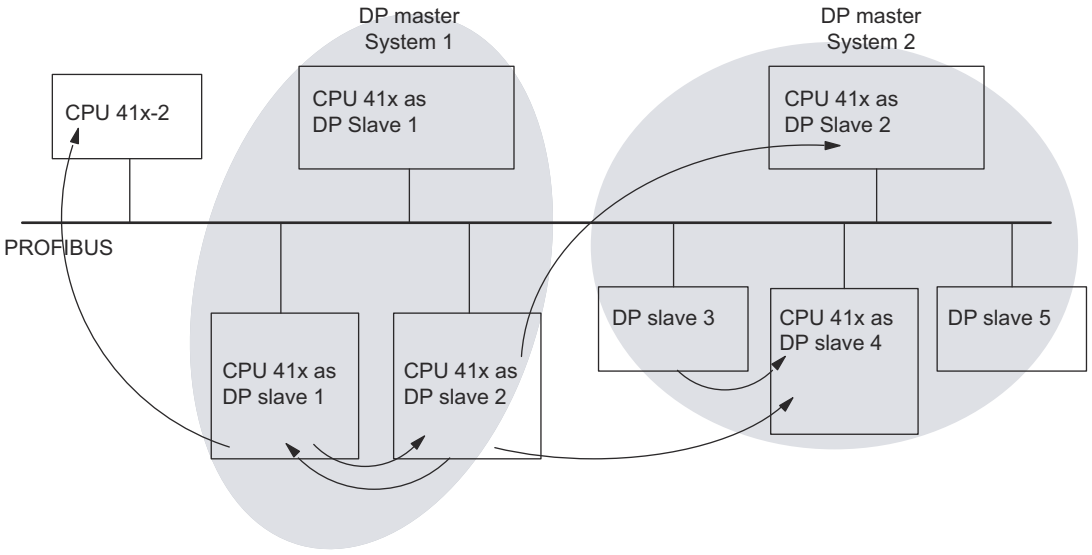


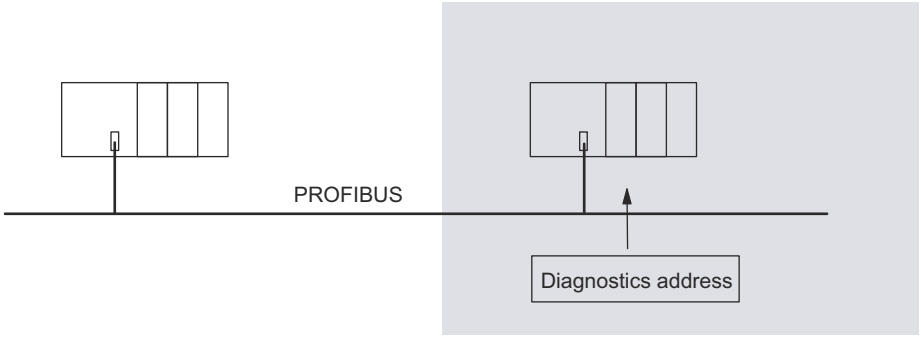
Figure 5-7 Direct data exchange with 41x CPUs

5.1.8.2 Diagnostics in direct data exchange

Diagnostics addresses

In direct data exchange you assign a diagnostics address in the recipient:

Table 5-18 Diagnostics address for the recipient for direct data exchange

S7-CPU as sender	S7-CPU as recipient
	
	In your configuration, specify a diagnostics address in the recipient that is assigned to the sender. The recipient obtains information on the status of the sender or a bus interruption via this diagnostics address (see also following table).

Event detection

The following table shows you how the CPU 41x as recipient detects interruptions in the data transfer.

Table 5-19 Event detection by the 41x CPUs as recipients during direct communication

Event	What happens in the recipient
Bus interruption (short-circuit, connector removed)	• OB 86 is called with the station failure alarm (event entering state; diagnostics address of the recipient assigned to the sender) • With I/O access: call of OB 122 (I/O access error)

Evaluation in the user program

The following table shows you, for example, how you can evaluate a sender station failure in the recipient (see also table above).

Table 5-20 Evaluation of the station failure in the sender during direct data exchange

In the sender		In the recipient
Diagnostics addresses: (example) Master diagnostics address=**1023** Slave diagnostics address in the master system=**1022**		Diagnostics address: (example) Diagnostics address=**444**
Station failure	→	The CPU calls OB 86 with at least the following information: • OB86_MDL_ADDR:=**444** • OB86_EV_CLASS:=B#16#38 (event entering state) • OB86_FLT_ID:=B#16#C4 (failure of a DP station) Tip: The CPU diagnostics buffer also contains this information

5.1.9 Isochrone mode

Equidistant PROFIBUS

Equidistant (isochronous) PROFIBUS forms the basis for synchronized processing cycles. The PROFIBUS system provides a basic clock for this. The "isochrone mode" system property can couple a S7-400-CPU with the equidistant PROFIBUS.

Isochronous data processing

Data is processed isochronously using the following method:

- Reading of the input data is synchronized with the DP cycle; all the input data is read at the same time.
- The user program that processes the data is synchronized with the DP cycle by means of the isochronous interrupt OBs OB61 to OB64.

- Data output is synchronized with the DP cycle; All the output data takes effect at the same time.
- All input and output data is transferred consistently. This means that all the data from the process image belongs together, both logically and with respect to timing.

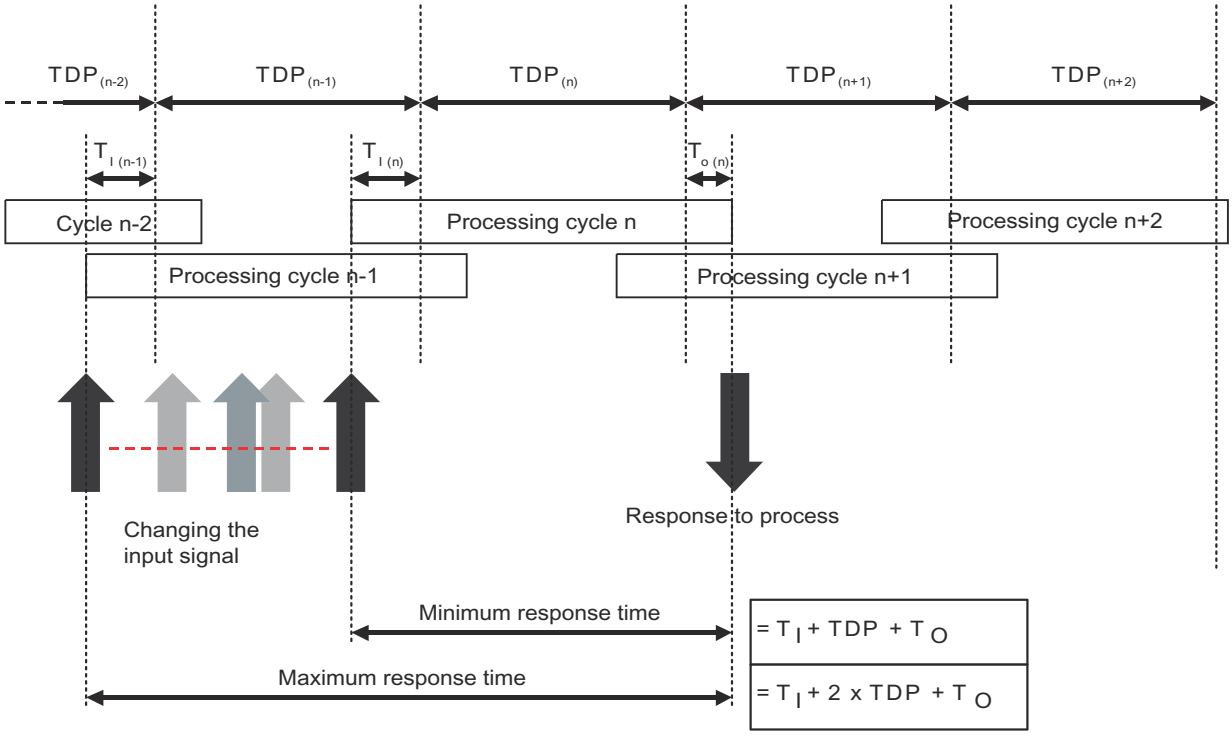


Figure 5-8 Isochronous data processing

TDP	System cycle
Ti	Time at which the input data is read
To	Time at which the output data is output

Synchronization of the cycles allows the input data to be read with a cycle "n-1", the data to be transferred and processed with cycle "n", and the calculated output data to be transferred and switched to the "terminals" at the start of cycle "n+1". This gives a true process response time from "Ti + TDP + To" to "Ti + (2 x TDP) + To".

The "isochrone mode" system property means that cycle times within the S7-400 system are constant; the S7-400 system is strictly deterministic on the bus system.

Just-In-Time

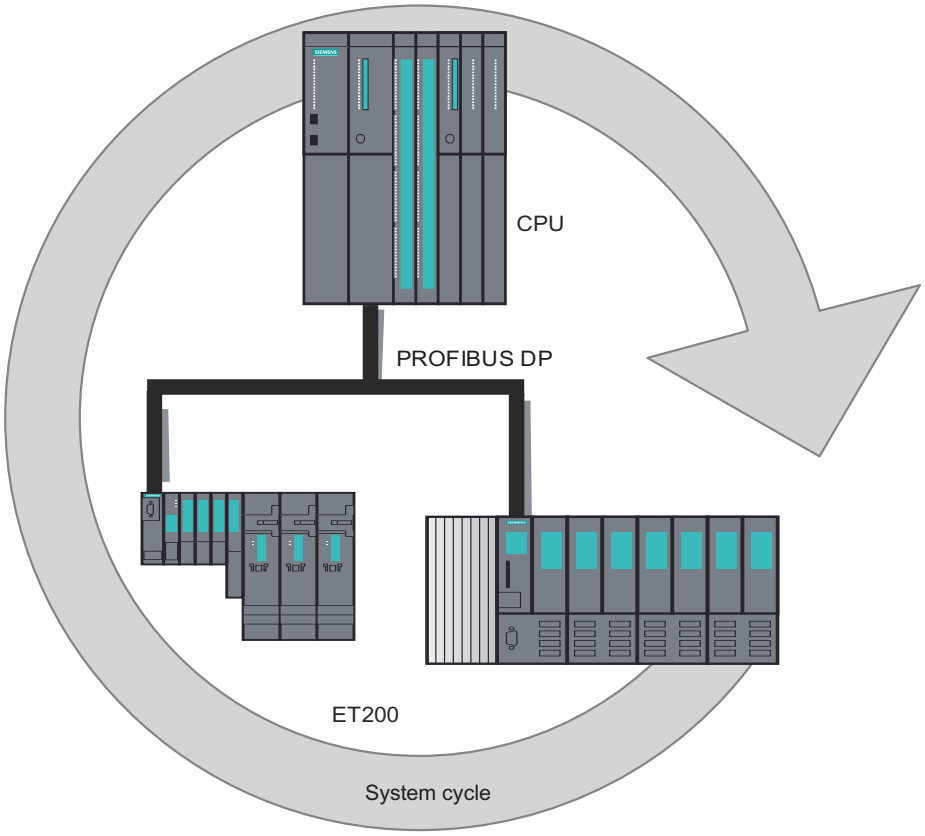


Figure 5-9 Just-In-Time

The fast and reliable response time of a system operating in isochrone mode is based on the fact that all data is provided just-in-time. The equidistant (isochronous) DP cycle forms the master clock for this.

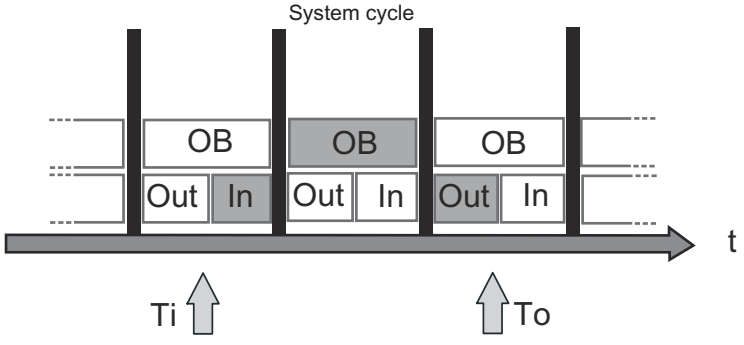


Figure 5-10 System cycle

The start of the I/O read cycle is started one bias time Ti earlier in order to make all input data available for transfer on the DP subnet at the start of the next DP cycle. You can configure this bias time Ti yourself or have it determined automatically by STEP 7.

PROFIBUS transfers the input data to the DP master via the DP subnet. The synchronous cycle interrupt OB (OB61, OB62, OB63 or OB64) is called. The user program in the synchronous

cycle interrupt OB determines the process response and provides the output data in time for the start of the next DP cycle. You can configure the length of the DP cycle yourself or have it determined automatically by STEP 7.

The output data is provided just-in-time for the start of the next DP cycle. The data is transferred on the DP subnet to the DP slaves and passed to the process in an isochronous operation, that is, in synchronism with the time To.

The result is a total reproducible response time of "Ti + (2 x TDP) + To" for the transfer from the input to the output terminal.

Characteristics of isochrone mode

Isochrone mode is characterized by the three following essential features:

- The user program is synchronized with I/O processing, that is, all operations are coordinated on a time basis. All input data is logged at a defined time. The output data also takes effect at a defined time. The I/O data is synchronized with the system clock cycle up to the terminals. The data of one cycle is always processed in the next cycle, and it takes effect at the terminals in the subsequent cycle.
- I/O data is processed in equidistant (isochrone) mode, that is, input data is always read at constant intervals, and always output at the same intervals.
- All I/O data is transferred consistently, that is, all the data of a process image belongs together logically and has the same timing.

Direct access in isochrone mode

NOTICE
Avoid direct access (e.g. T PAB) to I/O areas that you process with SFC 127 "SYNC_PO". Ignoring this rule may mean that the process image partition of the outputs may not be fully updated.

PROFINET

6

6.1 Introduction

What is PROFINET?

PROFINET is the open, cross-vendor Industrial Ethernet standard for automation. It enables continuous communication from the business management level down to the field level.

PROFINET fulfils the strict requirements of the industry, such as:

- Industry-complaint installation technology
- Real-time capability
- Pan-manufacturer engineering

A broad product range of active and passive network components, controllers, distributed field devices as well as components for Industrial Wireless LAN and industrial security is available for PROFINET.

With PROFINET IO, a switching technology is implemented that allows all nodes to access the network at any time. As a result, the network can be utilized more efficiently through simultaneous data transmission of multiple nodes. Simultaneous transmission and receiving is enabled through the full-duplex operation of Switched Ethernet.

PROFINET IO is based on Switched Ethernet with full duplex mode and a bandwidth of 100 Mbps.

Note

Network protocol SNMP

The SNMP network protocol is disabled on CPUs from firmware version V7.0.3 by default. More detailed information on this can be found in the chapter: Network protocol SNMP (Page 80)

Documentation on the Internet

Comprehensive information about PROFINET (https://www.profibus.com/) is available on the Internet.

More information is available at the Internet address (https://new.siemens.com/global/en/products/automation/industrial-communication/profinet.html)

6.2 PROFINET IO and PROFINET CBA

PROFINET variants

PROFINET has the two following characteristics:

- PROFINET IO: With PROFINET IO communication a part of the transfer time is reserved for cyclic, deterministic data traffic. This allows you to split the communication cycle into a deterministic and an open part. Communication takes place in runtime.
  Direct connection of distributed field devices (IO devices such as signal modules) to Industrial Ethernet. PROFINET IO supports a uniform diagnostics concept which permits efficient fault locating and troubleshooting.
- PROFINET CBA: A component-based automation solution in which complete technological modules are used as standardized components in large plants. This approach simplifies intercommunication between the devices. You create the CBA components in SIMATIC with STEP 7 and the SIMATIC iMap add-on package. You interconnect the individual components with SIMATIC iMap.
  CBA interconnections you download to an S7-400 CPU are saved to work memory and are not written to the memory card. The interconnections are lost if there is defective hardware, a memory reset or firmware update. In this case you will have to download the interconnections again using SIMATIC iMap.
  If you use PROFINET CBA, you cannot use isochrone mode or carry out configuration changes at runtime.

PROFINET IO and PROFINET CBA

PROFINET IO and PROFINET CBA are two different views of automation devices on Industrial Ethernet.

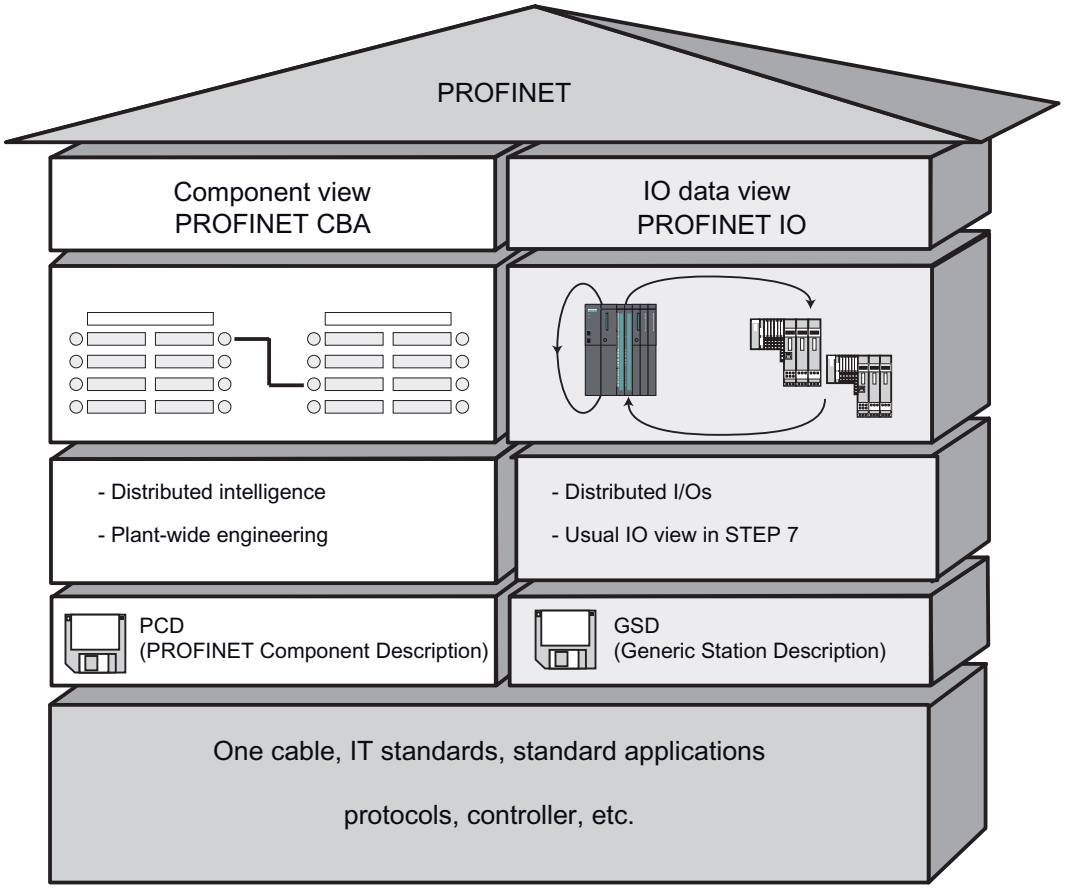


Figure 6-1 PROFINET IO and PROFINET CBA

PROFINET CBA divides an entire plant into various functions. These functions are configured and programmed.

PROFINET IO provides an image of the system that is very similar to the view obtained in PROFIBUS. You continue to configure and program the individual automation devices.

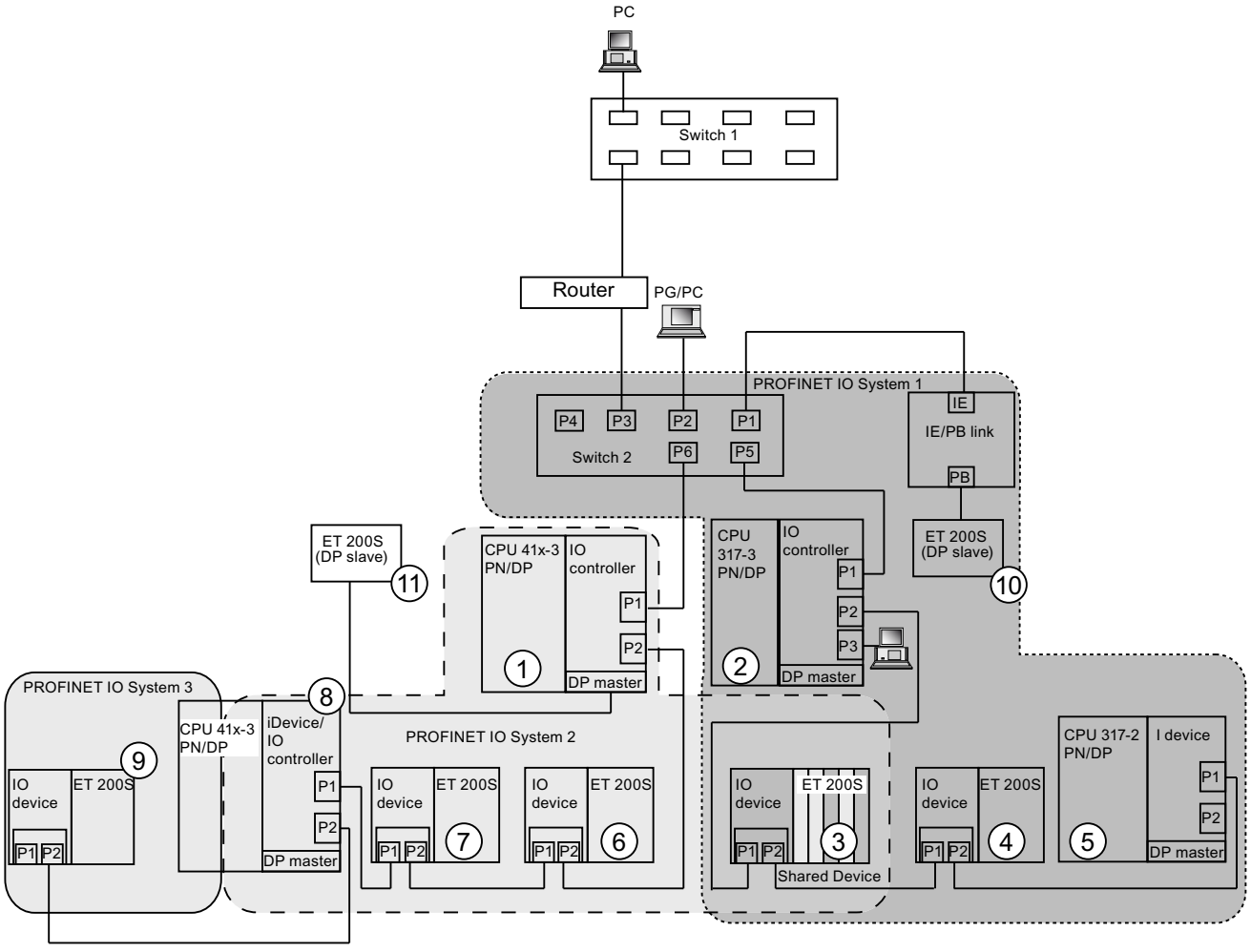
Reference

- For additional information about PROFINET IO and PROFINET CBA, refer to the *PROFINET System Description*.
- Differences between and common properties of the PROFIBUS DP and PROFINET IO are described in the *From PROFIBUS DP to PROFINET IO* Programming Manual.
- For additional information about PROFINET CBA, refer to the documentation on SIMATIC iMap and Component Based Automation.

6.3 PROFINET IO systems

Functions of PROFINET IO

The following graphic shows the new functions in PROFINET IO:



The graphic shows	Examples of connection paths
The connection of company network and field level	You can access devices at the field level from PCs in your company network Example: • PC - Switch 1 - Router - Switch 2 - CPU 41x-3 PN/DP ①.
Connections between the automation system and field level	You can also access other areas on the Industrial Ethernet from a programming device at the field level. Example: • PG - integrated switch CPU 317-3 PN/DP ② - Switch 2 - integrated switch CPU 41x-3 PN/DP ① - integrated switch IO device ET 200S ⑥ - to IO device ET 200S ⑦.

The graphic shows	Examples of connection paths
The IO controller of CPU 317-3 PN/DP ② sets up PROFINET IO system 1 and directly controls devices on the Industrial Ethernet and PROFIBUS.	At this point, you can see the IO feature between the IO controller, intelligent device, and the IO devices on Industrial Ethernet: • CPU 317-3 PN/DP② is operating as IO controller for the IO devices ET 200S ③ and ET 200S ④, Switch 2, and intelligent device CPU 41x-3 PN/DP ⑤. • In this scenario, IO device ET 200S ③ is operated as shared device, which means that CPU 317-3 PN/DP② can access only the IO device (sub)modules it has been assigned in its role as controller. • CPU 317-3 PN/DP② is also operated via the IE/PB Link as the IO controller for ET 200S (DP-Slave) ⑩.
CPU 41x-3 PN/DP ① operates as IO controller for PROFINET system 2 and is also DP master on the PROFIBUS. In addition to other IO devices, this IO controller is used to operate an additional CPU 41x-3 PN/DP ⑧ as intelligent device that controls a PROFINET subsystem as IO controller.	Here you can see that a CPU can be both the IO controller for an IO device and the DP master for a DP slave: • CPU 41x-3 PN/DP ① is the IO controller for the ET 200S ⑥ and ET 200S ⑦ IO devices, and for the intelligent device CPU 41x-3 PN/DP ⑧. • Moreover, CPU 41x-3 PN/DP ① shares the ET 200S ③ IO device with IO controller CPU 317-3 PN/DP ②, which means that the CPU 41x-3 PN/DP ① can access only the IO device (sub)modules it has been assigned in its role as controller . • CPU 41x-3 PN/DP ⑧ operating as intelligent device on CPU 41x-3 PN/DP ① is also IO controller for its own PROFINET system 3 on which the ET 200S ⑨ IO device is operated. • CPU 41x-3 PN/DP ① is DP master for a DP slave ⑪. The DP slave ⑪ is assigned locally to CPU 41x-3 PN/DP ① and not visible on Industrial Ethernet.

Further information

You will find further information about PROFINET in the documents listed below:

- In the PROFINET system description (https://support.industry.siemens.com/cs/ww/en/view/19292127) manual
- In the *From PROFIBUS DP to PROFINET IO programming manual.*
  This manual also provides a clear overview of the new PROFINET blocks and system status lists.

6.4 Blocks in PROFINET IO

Compatibility of the New Blocks

For PROFINET IO, some new blocks were created, among other things, because larger configurations are now possible with PROFINET. You can also use the new blocks with PROFIBUS.

Comparison of the system and standard functions of PROFINET IO and PROFIBUS DP

For CPUs with an integrated PROFINET interface, the table below provides you with an overview of the following functions:

- System and standard functions for SIMATIC that you may need to replace when migrating from PROFIBUS DP to PROFINET IO.
- New system and standard functions

Table 6-1 System and standard functions which are new or have to be replaced

Blocks	PROFINET IO	PROFIBUS DP
SFC 12 "D_ACT_DP" Deactivation and activation of DP slaves/IO devices	Yes S7-400: As of firmware V5.0	Yes
SFC 13"DPNRM_DG" Reading diagnostics data of a DP slave	No Replacement: • Event-related: SFB 54 • Status-related: SFB 52	Yes
SFC 58 "WR_REC" SFC 59 "RD_REC" Write/read record in the I(O devices.	No Replacement: SFB 53/52	Yes, if you will have not already replaced these SFBs under DPV 1 by SFB 53/52.
SFB 52 "RDREC" SFB 53 "WRREC" Read/write record	Yes	Yes
SFB 54 "RALRM" Evaluating alarms	Yes	Yes
SFB 81 "RD_DPAR" Reading predefined parameters	Yes	Yes
SFB 104 "IP_CONF" Program-controlled configuration of the CPU's integrated PROFINET interface.	Yes	No
SFC 5 "GADR_LGC" Determining the start address of a module	No Replacement: SFC 70	Yes
SFC 70 "GEO_LOG" Determining the start address of a module	Yes	Yes

Blocks	PROFINET IO	PROFIBUS DP
SFC 49 "LGC_GADR" Determining the slot that belongs to a logical address	No Replacement: SFC 71	Yes
SFC 71 "LOG_GEO" Determining the slot that belongs to a logical address	Yes	Yes

The following table provides an overview of the system and standard functions for SIMATIC, whose functionality must be implemented by other functions when converting from PROFIBUS DP to PROFINET IO.

Table 6-2 System and standard functions of PROFIBUS DP that can be emulated in PROFINET IO

Blocks	PROFINET IO	PROFIBUS DP
SFC 54 "RD_DPARM" Reading predefined parameters	No Replacement: SFB 81 "RD_DPAR"	Yes
SFC 55 "WR_PARM" Writing dynamic parameters	No Emulation by means of SFB 53	Yes
SFC 56 "WR_DPARM" Writing predefined parameters	No Emulation by means of SFB 81 and SFB 53	Yes
SFC 57 "PARM_MOD" Assigning module parameters	No Emulation by means of SFB 81 and SFB 53	Yes

You cannot use the following SIMATIC system and standard functions for PROFINET IO:

- SFC 7 "DP_PRAL" Trigger hardware interrupt on DP master
- SFC 11 "DPSYC_FR" Synchronize groups of DP slaves
- SFC 72 "I_GET" Read data from a communication partner within local S7 station
- SFC 73 "I_PUT" Write data to a communication partner within local S7 station
- SFC 74 "I_ABORT" Abort an existing connection to a communication partner within local S7 station
- SFC 103 "DP_TOPOL" Determine the bus typology in a DP master

Comparison of the Organization Blocks of PROFINET IO and PROFIBUS DP

The following table lists the changes to OBs 83 und OB 86:

Table 6-3 OBs in PROFINET IO and PROFIBUS DP

Blocks	PROFINET IO	PROFIBUS DP
OB 83 Removing and inserting modules at runtime	New error information	Unchanged
OB 86 Rack failure	New error information	Unchanged

Detailed Information

For more information about the blocks, refer to the manual *System Software for S7-300/400 System and Standard Functions*.

6.5 System status lists for PROFINET IO

Introduction

The CPU makes certain information available and stores this information in the "System status list".

The system status list describes the current status of the automation system. It provides an overview of the configuration, the current parameter assignment, the current statuses and sequences in the CPU, and the assigned modules.

The system status list data can only be read, but not changed. The system status list is a virtual list that is compiled only on request.

A system status list provides you with the following information on the PROFINET IO system:

- System data
- Module status information in the CPU
- Diagnostic data from a module
- Diagnostics buffer

Compatibility of the new system status lists

For PROFINET IO, some new system status lists were created, because larger configurations, among other things, are now possible with PROFINET.

You can also use these new system status lists with PROFIBUS.

You can continue to use a PROFIBUS system status list that is also supported by PROFINET in the usual way. If you nonetheless use a system status list that PROFINET does not support for PROFINET, an error message is returned in the parameter RET_VAL (W#16#8083: Index wrong or not permitted).

Comparison of the system status lists of PROFINET IO and PROFIBUS DP

Table 6-4 Comparison of the system status lists of PROFINET IO and PROFIBUS DP

SSL ID	PROFINET IO	PROFIBUS DP	Scope
W#16#0591	Yes Parameter adr1 changed	Yes	Module status information of the interfaces of a module
W#16#0C91	Yes, internal interface Parameter adr1/adr2 and setpoint/actual type identifier changed No, external interface	Yes, internal interface No, external interface	Module status information of a module in a central configuration or at an integrated DP or PN interface, or an integrated DP interface using the logical address of the module.
W#16#4C91	No, internal interface Yes, external interface Parameter adr1 changed	No, internal interface Yes, external interface	Module status information of a module at an external DP or PN interface using the start address
W#16#0D91	Yes Parameter adr1 changed No, external interface	Yes, internal interface No, external interface	Module status information of all modules in the specified rack/station

SSL ID	PROFINET IO	PROFIBUS DP	Scope
W#16#0696	Yes, internal interface No, external interface	No	Module status information of all submodules on an internal interface of a module using the logical address of the module, not possible for submodule 0 (= module)
W#16#0C96	Yes	Yes, internal interface No, external interface	Module status information of a submodule using the logical address of this submodule
W#16#xy92	No Substitute: SSL ID W#16#0x94	Yes	Rack/station status information Replace this system status list with the system status list with ID W#16#xy94 in PROFIBUS DP, as well.
W#16#0x94	Yes	No	Rack/station status information

Detailed information

For detailed descriptions of the individual system status lists, refer to the manual *System Software for S7-300/400 System and Standard Functions*.

6.6 Isochronous real-time communication

Isochronous real-time communication (IRT) is a synchronized transmission method for the cyclic exchange of IRT data between PROFINET devices. A reserved bandwidth is available within the send cycle for the IRT IO data.

The reserved bandwidth ensures that IRT data can be transmitted at reserved, synchronized intervals whilst remaining insensitive to high network load caused by other applications (e.g. TCP/IP communication, or additional real-time communication).

PROFINET with IRT can be operated with the following two options:

- IRT option "high flexibility":
  Maximum flexibility for system planning and expansions.
  A topological configuration is **not** required.
- IRT option "high performance":
  Topological configuration is necessary.

Note

IO controller as Sync Master for IRT communication with IRT option "high performance"

It is advisable to operate the IO controller also as Sync Master in a configuration for IRT communication with "high performance" option. Otherwise, failure of the Sync Master can lead to failure of the IO devices configured for IRT and RT.

Conditions

- You cannot combine the IRT options "high flexibility" and "high performance".
- You can initiate only one transition from IRT with "high performance" option, i.e. to real-time communication (RT), or to non-real-time communication (NRT).
- The following send cycles are possible:
  - IRT option "high flexibility": 250 µs, 500 µs, 1 ms
  - Mixed mode with RT and IRT option "high performance": 250 µs, 500 µs, 1 ms, 2 ms, and 4 ms
  - IRT option "high performance": 250 µs to 4 ms, at a resolution of 125 µs

Additional information

For more information about the configuration of PROFINET devices, refer to the STEP 7 Online Help and the PROFINET System Description (https://support.industry.siemens.com/cs/ww/en/view/19292127) manual.

6.7 Prioritized startup

Prioritized startup denotes PROFINET functionality for the acceleration of IO devices (distributed I/O) in a PROFINET IO system with RT and IRT communication.

The function reduces the time that correspondingly configured IO devices need in the following scenarios to recover cyclic user data exchange:

- After power recovery
- After station recovery
- After IO devices have been activated

Note

Startup times

The startup time depends on the number and type of modules used.

Note

Prioritized startup and media redundancy

You cannot operate IO devices with prioritized startup on a ring topology with media redundancy.

Additional information

For additional information, refer to the STEP 7 Online Help and to the PROFINET System Description (https://support.industry.siemens.com/cs/ww/en/view/19292127) manual.

6.8 Device replacement without removable medium/programming device

IO devices having this function can be replaced in a simple manner:

- A removable medium (e.g. SIMATIC Micro Memory Card) with stored device name is not required.
- The device name does not have to be assigned with the programming device.
  The replacement IO device is now assigned a device name from the IO controller. It is no longer assigned using a removable medium or programming device. The IO controller uses the configured topology and the relations determined by the IO devices. The configured target topology must match the actual topology.

Before reusing IO devices that you already had in operation, reset these to factory settings.

Additional information

For additional information, refer to the STEP 7 Online Help and to the PROFINET System Description (https://support.industry.siemens.com/cs/ww/en/view/19292127) manual.

6.9 IO devices changing at runtime

Functionality of a PROFINET device. Provided the IO controller and IO devices support this functionality, you can assign "alternating partner ports" of other devices to an IO device port that you can activate at a specific time to communicate with one of these alternating IO devices. However, only the changing device that is currently being communicated with may be physically connected to the alternating port.

Additional information

For additional information, refer to the STEP 7 Online Help and to the PROFINET System Description (https://support.industry.siemens.com/cs/ww/en/view/19292127) manual.

6.10 Isochronous mode

The process data, transmission cycles over PROFINET IO, and the user program are synchronized in order to achieve maximum deterministics. The I/O data of distributed I/O devices in the system are acquired and output simultaneously. The constant PROFINET IO cycle forms the corresponding clock generator.

Note

The following devices cannot be operated in isochronous mode:

- Shared devices
- Intelligent devices on the higher-level IO controller

Additional information

For additional information, refer to the STEP 7 Online Help and to chapter Isochrone mode (Page 167).

6.11 Intelligent IO device

The "I-Device" (intelligent IO device) functionality of a CPU facilitates data exchange with an IO controller and operation of the CPU, for example, as intelligent preprocessing unit of sub processes. In its role as an IO device, the I-Device is integrated accordingly into a "higher-level" IO controller.

The I-Device functionality ensures reliable preprocessing by means of the user program in the CPU. The process data acquired from central or distributed locations (PROFINET IO or PROFIBUS DP) is preprocessed by the user program made available to a higher-level station via
PROFINET IO device interface of the CPU.

Note

Isochronous mode

Intelligent IO devices cannot be operated in isochronous mode on higher-level IO controllers

Combination of functions

A CPU operated as intelligent device on a "higher-level" IO controller is, in turn, capable of operating as sublevel IO controller that controls IO devices on a subnet.

An intelligent IO device can also be operated as shared device.

Application transfer area

The IO controller and intelligent IO device communicate via the configured submodules of this transfer area. With regard to the submodules, transmission of the user data remains consistent.

Additional information

For more information about the configuration of intelligent IO devices, refer to the STEP 7 Online Help and to the PROFINET System Description (https://support.industry.siemens.com/cs/ww/en/view/19292127) manual.

6.12 Shared Device

The "Shared Device" functionality facilitates distribution of the submodules of an IO device to different IO controllers. An intelligent IO device can also be operated as shared device.

Prerequisite for using the "Shared Device" function is that the IO controller and shared device are located on the same Ethernet subnet.

The IO controllers can be located in the same or different STEP 7 projects. If they are located in the same STEP 7 project, a consistency check is initiated automatically.

Note

Shared devices cannot be operated in isochronous mode.

Note

Note that the power modules and electronic modules belonging to the same potential group of a shared IO device (e.g. ET 200S) must be assigned to the same IO controller in order to enable the diagnosis of load voltage failure.

Additional information

For more information about shared devices and their configuration, refer to the STEP 7 Online Help and to the PROFINET System Description (https://support.industry.siemens.com/cs/ww/en/view/19292127) manual.

6.13 Media redundancy

Media redundancy is a function that ensures network and system availability. Redundant transmission links in a ring topology ensure that an alternative communication path is always available if a transmission link fails.

You can enable the media redundancy protocol (MRP) for IO devices, switches, and CPUs with PROFINET interface V6.0 or higher. MRP is a component of PROFINET standardization to IEC 61158.

Installing a ring topology

To set up a ring topology with media redundancy, you must join both free ends of a line network topology in the same device. You join the line topology to form a ring via two ports (ring ports, port ID "R") of a device connected to the ring. Specify the ring ports in the configuration data of the relevant device.

Note

IRT communication / prioritized startup

Media redundancy is not supported for IRT communication or prioritized startup.

Additional information

For additional information, refer to the STEP 7 Online Help and to the PROFINET System Description (https://support.industry.siemens.com/cs/ww/en/view/19292127) manual.

Consistent Data

7

7.1 Basics

Overview

Data that belongs together in terms of its content and describes a process state at a specific point in time is known as consistent data. To maintain consistency, the data should not be changed or updated during processing or transmission.

Example

To ensure that the CPU has a consistent image of the process signals for the duration of cyclic program scanning, the process signals are read from the process image inputs prior to program scanning and written to the process image outputs after the program scanning. Subsequently, during program scanning when the address area "inputs" (I) and "outputs" (O) are addressed, the user program addresses the internal memory area of the CPU on which the image of the inputs and outputs is located instead of directly accessing the signal modules.

SFC 81 "UBLKMOV"

With SFC 81 "UBLKMOV" (uninterruptible block move), you can copy the contents of a memory area (= source area) consistently to a different memory area (= destination area). The copy operation cannot be interrupted by other operating system activities.

SFC 81 "UBLKMOV" enables you to copy the following memory areas:

- Bit memory
- DB contents
- Process Image of Inputs
- Process Image of Outputs

The maximum amount of data you can copy is 512 bytes. Remember the restrictions for the specific CPU as described, for example, in the operations list.

Since copying cannot be interrupted, the interrupt reaction times of your CPU may increase when using SFC 81 "UBLKMOV".

The source and destination areas must not overlap. If the specified destination area is larger than the source area, the function only copies as much data to the destination area as that contained in the source area. If the specified destination area is smaller than the source area, the function only copies as much data as can be written to the destination area.

For information on SFC81, refer to the corresponding online help and to the *System and Standard Functions* manual.

7.2 Consistency for communication blocks and functions

Overview

Using S7-400, the communication jobs are not processed at the scan cycle checkpoint; instead, in fixed time slices during the program cycle.

In the system the byte, word and double word data formats can always be processed consistently, in other words, the transfer or processing of 1 byte, 1 word (= 2 bytes) or 1 double word (= 4 bytes) cannot be interrupted.

If communication blocks (such as SFB^12 "BSEND") are called in the user program, which are only used in pairs (such as SFB 12 "BSEND" and SFB 13 "BRCV") and which share access to data, the access to this data area can be coordinated between themselves, for example, using the "DONE" parameter. Data consistency of the communication areas transmitted locally with a communication block can thus be ensured in the user program.

S7 communication functions such as SFB 14 "GET", SFB 15 "PUT" react differently because no block is needed in the user program of the destination device. In this case the size of data consistency has to be taken into account beforehand during the programming phase.

Access to the Work Memory of the CPU

The communication functions of the operating system access the work memory of the CPU in fixed field lengths. The field size is a variable length up to a maximum of 462 bytes.

7.3 Consistent Reading and Writing of Data from and to DP Standard Slaves/IO Devices

Reading Data Consistently from a DP Standard Slave/IO Device Using SFC 14 "DPRD_DAT"

Using SFC14 "DPRD_DAT" (read consistent data of a DP standard slave) you can consistently read the data of a DP standard slave.

If no error occurred during the data transmission, the read data is entered in the destination area defined by RECORD.

The destination area must be the same length as the one you configured for the selected module with *STEP 7*.

A call of SFC14 lets you access the data of only one module / DP ID at the configured start address.

For information on SFC14, refer to the corresponding online help and to the *System and Standard Functions* manual

Writing Data Consistently to a DP Standard Slave/IO Device Using SFC 15 "DPWR_DAT"

Using SFC 15 "DPWR_DAT" (write consistent data to a DP standard slave) you can consistently write data to the DP standard slave or IO device addressed in the RECORD.

The source area must be the same length as the one you configured for the selected module with *STEP 7*.

Upper Limit for the Transmission of Consistent User Data to a DP Slave

The PROFIBUS DP standard defines the upper limit for the transmission of consistent user data to a DP slave. For this reason a maximum of 64 words = 128 bytes of user data can be consistently transferred in a block to the DP slave.

During the configuration you can determine the size of the consistent area. You can set a maximum length of consistent data at 64 words = 128 bytes in the special identification format (SKF) (128 bytes for inputs and 128 bytes for outputs); the data block size cannot exceed this.

This upper limit only applies to pure user data. Diagnostics and parameter data is regrouped into full records and therefore always transferred consistently.

In the general identification format (AKF) the maximum length of consistent data can be set at 16 words = 32 bytes (32 bytes for inputs and 32 bytes for outputs); the data block size cannot exceed this.

Note in this context that a CPU 41x in a general environment acting as a DP slave on a third-party master (connection defined by GSD) has to be configured with the general identification format. The transfer memory for each virtual slot of a CPU 41x acting as a DP slave to the PROFIBUS DP can therefore be a maximum of 16 words = 32 bytes. Up to 32 such virtual slots can be configured in the i slave; the highest slot number is 35.

For information on SFC 15, refer to the corresponding Online Help and to the *System and Standard Functions* manual

Note

The PROFIBUS DP standard defines the upper limit for the transmission of consistent user data. Typical DP standard slaves adhere to this upper limit. In older CPUs (<1999) there are restrictions in the transmission of consistent user data depending on the CPU. The maximum length of data this CPU can consistently read and write to and from a DP standard slave is specified in your technical specifications, index entry "DP Master – User data per DP slave". With this value, newer CPUs exceed the length of data that a DP standard slave provides or receives.

Upper limits of the length of consistent user data that can be transferred to a IO Device

The length of consistent user data that you can transmit to an IO device is limited to 1025 bytes (= 1024 bytes user data + 1 byte associated value). Irrespective of whether you can transmit more than 1024 bytes to an IO device, the transmission of consistent data is still limited to 1024 bytes.

When operating in PN-IO mode, the length of data transfer via CP 443-1 is limited to 240 bytes.

Consistent data access without using SFC 14 or SFC 15

The CPUs described in this manual support consistent data access of > 4 bytes without using SFC 14 or SFC 15. The data area of a DP slave or IO devices to be transferred consistently is transferred to a process image partition. The information in this area is therefore always consistent. You can then use load/transfer commands (such as L IW 1) to access the process image. This is an especially convenient and efficient (low runtime load) way to access consistent data. This allows efficient integration and configuration of drives or other DP slaves, for example.

An I/O access error does **not** occur with direct access (e.g. L PIW or T PQW).

The following is important for converting from the SFC14/15 method to the process image method:

- SFC 50 "RD_LGADR" outputs another address area with the SFC 14/15 method as with the process image method.
- PROFIBUS DP via Interface interface:
  When converting from the SFC14/15 method to the process image method, it is not recommended to use the system functions and the process image at the same time. Although the process image is updated when writing with the system function SFC15, this is not the case when reading. In other words, the consistency between the process image values and the values of the system function SFC14 is not ensured.
- PROFIBUS-DP via CP 443-5 Extended:
  Simultaneous operation of an CP 443-5 ext by means of SFC14/15 call and process image will prevent consistent read/write access to the process image, or consistent read/write operations with SFC 14/15.

Note

Forcing variables

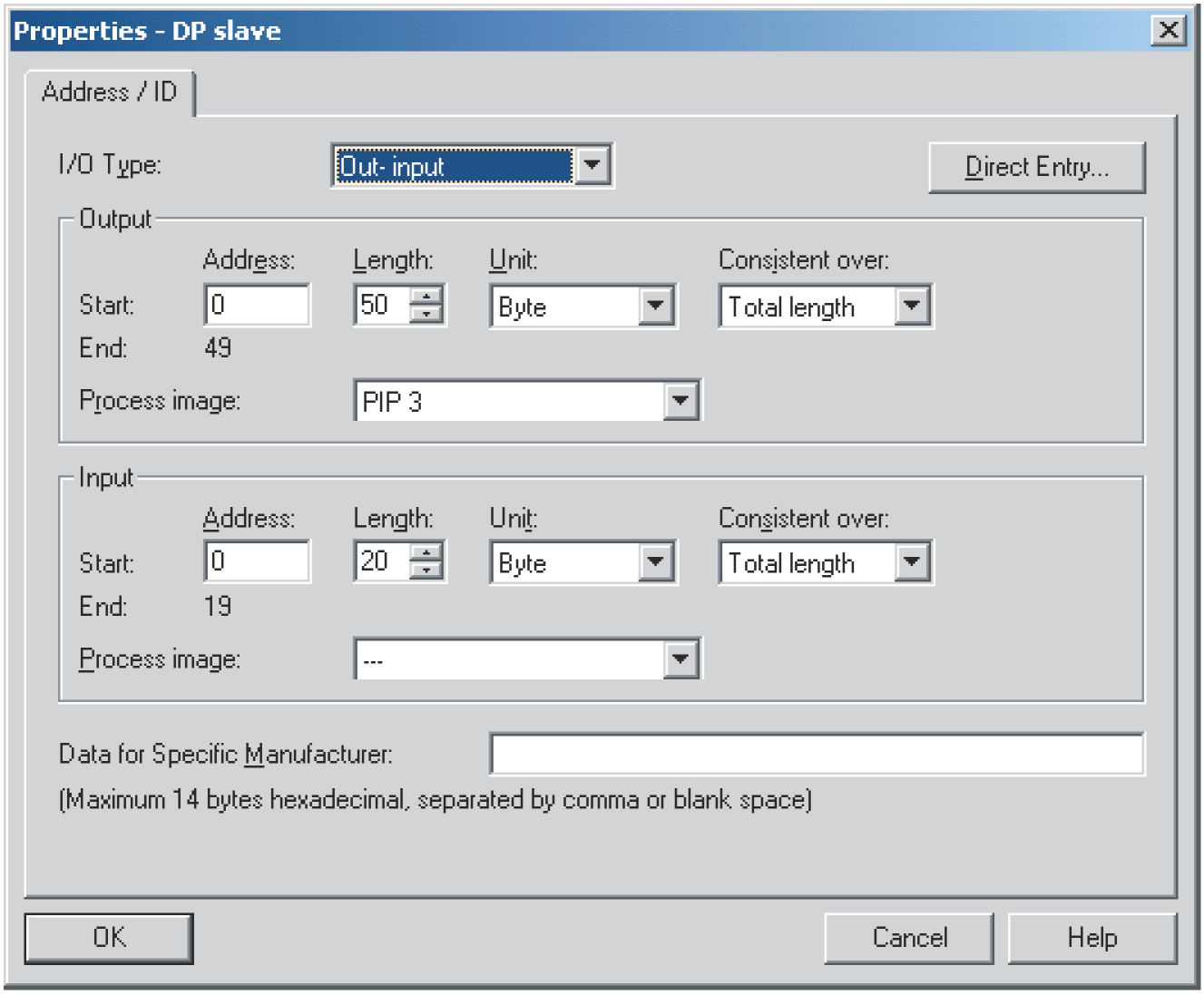
Forcing variables which lie in the I/O or process image range of a DP slave or IO device and which belong to a consistency range is not permitted. The user program may overwrite these variables in spite of the force job.

Example:

The following example (of the process image partition 3 "TPA 3") shows such a configuration in HW Config.

Requirements: The process image was previously updated via SFC 26/27 or updating of the process image was linked to an OB.

- TPA 3 at output: These 50 bytes are stored consistent in the process image partition 3 (pull-down list "Consistent over -> entire length") and can therefore be read through the normal "load input xy" commands.
- Selecting "Process Image Partition -> ---" under input in the pull-down menu means: do not store in a process image. Then the handling can only be performed using the system functions SFC14/15.



Memory concept

8

8.1 Overview of the memory concept of S7-400 CPUs

Organization of Memory Areas

The memory of the S7 CPUs can be divided into the following areas:

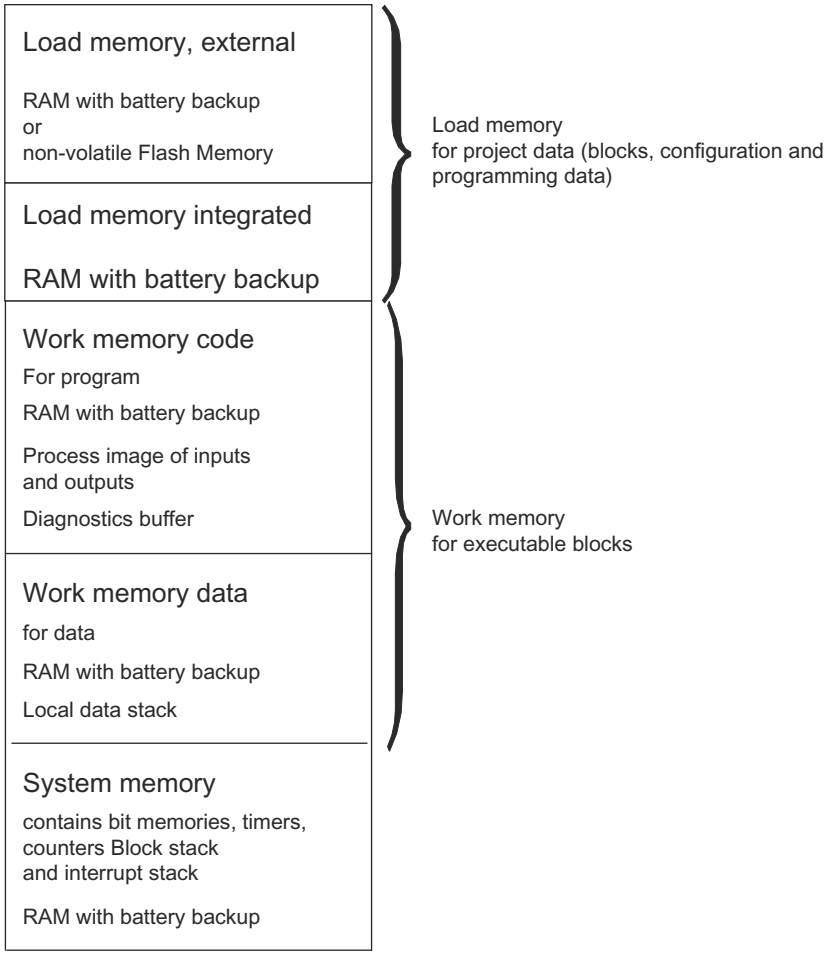


Figure 8-1 Memory areas of S7-400 CPUs

Memory Types in S7-400 CPUs

- Load memory for the project data, e.g. blocks, configuration, and parameter settings.
- Work memory for the runtime-relevant blocks (logic blocks and data blocks).

- System memory (RAM) contains the memory elements that each CPU makes available to the user program, such as bit memories, timers and counters. System memory also contains the block stack and interrupt stack
- System memory of the CPU also provides a temporary memory area (local data stack, diagnostics buffer, and communication resources) that is assigned to the program for the temporary data of a called block. This data is only valid while the block is active.
  By changing the default values for the process image, local data, diagnostics buffer, and communication resources (see object properties of the CPU in HW Config), you can influence the work memory available to the runtime-relevant blocks.

Note

Please note the following if you expand the process image of a CPU. Reconfigure the modules whose addresses have to be above the highest address of the process image so that the new addresses are still above the highest address of the expanded process image. This rule applies in particular to IP and WF modules that you operate in the S5 adapter bay on an S7-400.

Important note for CPUs after the parameter settings for the allocation of RAM have been changed

If you change the work memory allocation by modifying parameters, this work memory is reorganized when you load system data into the CPU. As a consequence, the data blocks generated by means of SFC are deleted and the remaining data blocks are initialized with values from load memory..

The amount of work memory that is made available for logic or data blocks during the download of system data is adapted if you modify the following parameters:

- Size of the process image (byte-oriented; in the "Cycle/Clock Memory" tab)
- Communication resources (S7-400 only; "Memory" tab)
- Size of the diagnostics buffer ("Diagnostics/Clock" tab)
- Number of local data for all priority classes ("Memory" tab)

Basis for Calculating the Required Working Memory

To ensure that you do not exceed the available amount of working memory on the CPU, you must take into consideration the following memory requirements when assigning parameters:

Table 8-1 Memory requirements

Parameters	Required working memory	In code/data memory
Size of the process image (inputs)	12 bytes per byte in the process image of inputs As of V6.0: 20 bytes per byte in the process image of inputs	Code memory
Size of the process image (outputs)	12 bytes per byte in the process image of outputs As of V6.0: 20 bytes per byte in the process image of inputs	Code memory
Communication resources (communication jobs)	72 bytes per communication job	Code memory

Parameters	Required working memory	In code/data memory
Size of the diagnostics buffer	32 bytes per entry in the diagnostics buffer	Code memory
Quantity of local data	1 byte per byte of local data	Data memory

Flexible memory space

- Work memory:
  The capacity of the work memory is determined by selecting the appropriate CPU from the graded range of CPUs.
- Load memory:
  The integrated load memory is sufficient for small and medium-sized programs.
  The load memory can be increased for larger programs by inserting the RAM memory card. Flash memory cards are also available to ensure that programs are retained in the event of a power failure even without a backup battery. Flash memory cards (8 MB or more) are also suitable for sending and carrying out operating system updates.

Battery backup

- The backup battery provides backup power for the integrated and external part of the load memory, the data section of the working memory and the code section.

Cycle and Response Times of the S7-400

9

9.1 Cycle time

Definition of the Cycle Time

The cycle time represents the time that an operating system needs to execute a program, that is, one OB 1 cycle, including all program sections and system activities interrupting this cycle.

This time is monitored.

Time-Sharing Model

Cyclic program scanning, and thus also processing of the user program, is performed in time slices. So that you can better appreciate these processes, we will assume in the following that each time slice is exactly 1 ms long.

Process Image

The process signals are read or written prior to program scanning so that a consistent image of the process signals is available to the CPU for the duration of cyclic program scanning. Then the CPU does not directly access the signal modules during program scanning when the address area "inputs" (I) and "outputs" (O) are addressed, but addresses instead the internal memory area of the CPU on which the image of the inputs and outputs is located.

The Cyclic Program Scanning Process

The following table and figure illustrate the phases of cyclic program scanning.

Table 9-1 Cyclic program processing

Step	Process
1	The operating system starts the scan cycle monitoring time.
2	The CPU writes the values from the process-image output table in the output modules.
3	The CPU reads out the status of the inputs at the input modules and updates the process-image input table.
4	The CPU processes the user program in time slices and performs the operations specified in the program.
5	At the end of a cycle, the operating system executes pending tasks, such as the loading and clearing of blocks.
6	The CPU then goes back to the beginning of the cycle after the configured minimum cycle time, as necessary, and starts cycle time monitoring again.

Parts of the Cycle Time

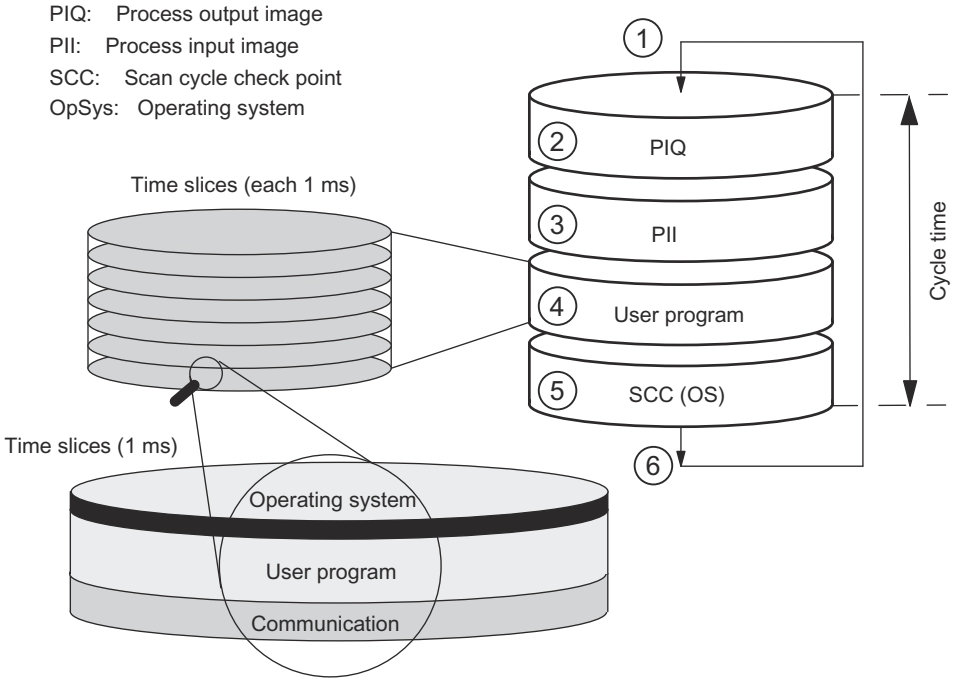


Figure 9-1 Parts and Composition of the Cycle Time

9.2 Cycle Time Calculation

Increasing the Cycle Time

Basically, you should note that the cycle time of a user program is increased by the following:

- Time-driven interrupt processing
- Hardware interrupt processing
- Diagnostics and error handling
- Communication via MPI, PROFIBUS-DP interface, PROFINET interface and CPs connected internally to the automation system
  (for example, Ethernet, PROFIBUS DP); included in the communication load
- Special functions such as control and monitoring of variables or the block status
- Transfer and deletion of blocks, compression of user program memory
- Internal memory test

Influencing factors

The following table indicates the factors that influence the cycle time.

Table 9-2 Factors that influence the cycle time

Factors	Remarks
Time slice for the transfer of the process image of outputs (PIQ) and inputs (PII)	... see table 9.3 "Portions of the process image transfer time"
User program execution time	... is calculated based on the execution times of the different instructions, see *S7-400 Instruction List*.
Operating system execution time at the scan cycle checkpoint	... see table 9.4 "Operating system execution time at the scan cycle checkpoint"
Increase in the cycle time through communications	Configure the parameters that specify the maximum communication load on the cycle as a percentage in *STEP 7*, see the *Programming with* STEP 7 Manual
Impact of interrupts on the cycle time	Interrupts can always interrupt the user program. See table 9.5 "Cycle time extension due to nested alarms"

Process image update

The table below shows the CPU times for process image updating (process image transfer time). The times listed in the table are "ideal values" that may be increased by the occurrence of interrupts and by CPU communications.

The transfer time for process image updating is calculated as follows

C + portion in the central rack (from row A in the following table)
+ portion in the expansion rack with local connection (from row B)
+ portion in the expansion rack with remote connection (from row C)
+ portion via integrated DP interface (from row D)
+ portion via external DP interface (from row D2)
+ portion of consistent data via integrated DP interface (from row E1)
+ portion of consistent data via external DP interface (from row E2)
+ portion via integrated PN/IO interface (from row F1)
+ portion via external PN/IO interface (from row F2)
+ portion of consistent data via integrated PN-IO interface (from row G1)
+ portion of consistent data via external PN-IO interface (from row G2)

= Transfer time for the process image update

The tables below show the individual portions of the transfer time process image updating (process image transfer time). The times listed in the table are "ideal values" that may be increased by the occurrence of interrupts and by CPU communications.

Table 9-3 Portions of the process image transfer time

	Time slices for CPUs	CPU 412	CPU 414	CPU 416	CPU 417
C	Basic load	7 µs	5 µs	1 µs	1 µs
A	Per byte in the central rack	1.9 µs	1.8 µs	1.75 µs	1.7 µs
B	Per byte in the expansion rack with local connection	5.6 µs	5.5 µs	5.4 µs	5.3 µs
C	Per byte in the expansion rack with remote connection *)	11 µs	11 µs	11 µs	11 µs
D1	Per byte, word or double word in the DP area for the integrated DP interface	0.3 µs	0.2 µs	0.15 µs	0.1 µs
D2	Per word in the DP area for the external DP interface (CP 443-5) **)	5.1 µs	4.8 µs	4.5 µs	4.4 µs
E1	Per module with 32 bytes of consistent data for the integrated DP interface	25.6 µs	14.4 µs	9.6 µs	6.4 µs
E2	Per module with 32 bytes of consistent data for the external DP interface (CP 443-5)	122 µs	108 µs	96 µs	90 µs
F1	Per byte, word or double word in the PN-IO area for the integrated DP interface	3.7 µs	2.6 µs	2.4 µs	-
F2	Per word in the PN/IO area for the external interface (CP 443-1) **)	5.1 µs	4.8 µs	4.5 µs	4.4 µs
G1	Per sub-module with 32 bytes of consistent data for the integrated PN-IO interface	22 µs	16 µs	13 µs	-
G2	Per sub-module with 32 bytes of consistent data for the external PN-IO interface (CP 443-1)	122 µs	108 µs	96 µs	90 µs

* Measured with IM 460-3 and IM 461-3 and a connection length of 100 m

** Measured with modules with 1 word of user data, e.g. DI 16.

Note

Note on I/O

For I/O devices inserted into the central rack or an expansion rack, the specified value contains the runtime for the I/O module. If the I/O is connected via fieldbus (DP or PN-IO) only the runtime for the DP master and/or IO controller is included.

Note

Note on DP

Rows D1 and D2 apply to modules whose user data are consistently in bytes, words or double words, e.g. AI 8 with 8 channels of 16 Bit. The transfer always has the largest possible access width.

Note

Note on PN-IO

Rows F1 and F2 apply to sub-modules whose user data are up to one byte, one word or one double word in size.

Example 1

The following modules are connected to the internal DP interface on a CPU 414:

- 1 * Digital module DI 4 (4 bit) -> Row D1, 1* Byte 0.2 µs

The result of this: 1 * 0.2 µs + 5µs (basic load). Therefore 5.2 µs is required.

Example 2

The following modules are connected to the internal PN-IO interface on a CPU 414:

- 1 * Digital module DI 4 (4 Bit) -> Row F1, 1* Byte 2.6 µs

The result of this: 1 * 2.6 µs + 5 µs (basic load). Therefore 7.6 µs is required.

Example 3

The following modules are connected to the internal DP interface on a CPU 416:

- 1 * Analog modules AI 8 (16 byte) -> Row D1, 4* double words 0.15 µs

The result of this: 4 * 0.15 µs + 1 µs (basic load). Therefore 1.6 µs is required.

Example 4

The following modules are connected to the internal PN-IO interface on a CPU 416:

- 1 * Analog modules AI 8 (16 byte) -> Row F1, 4* double words 2.4 µs

The result of this: 4 * 2.4 µs + 1 µs (basic load). Therefore 10.6 µs is required.

Example 5

The following modules are connected to CPU 412 via a CP 443-5 (external DP interface):

- 1 * Digital module DI 16 (2 byte) -> Row D2, 1* Word 5.1 µs
- 1 * Digital module DO 16 (2 byte) -> Row D2, 1* Word 5.1 µs
- 3* analog modules AI 8 HARD (per module (with 1 HARD variable) 21 byte of consistent user data) -> Row E2, 3*122 µs

The result of this: 2 * 5.1 µs + 3 * 122 µs + 7 µs (basic load). Therefore 383.2 µs is required.

Example 6

The following modules are connected to CPU 416 via a CP 443-1 (external PN-IO interface):

- 3 * I-Device each with 32 byte of consistent user data -> Row G2, 3*module 96 µs

The result of this: 3 * 96 µs + 1 µs (basic load). Therefore 289 µs is required.

Example 7

The following modules are connected to the internal PN-IO interface on a CPU 416:

- 3 * I-Device each with 32 byte of consistent user data -> Row G1, 3*module 13 µs

The result of this: 3 * 13 µs + 1 µs (basic load). Therefore 40 µs is required.

Operating system execution time at the scan cycle checkpoint

The table below lists the operating system execution times at the scan cycle checkpoint of the CPUs.

Table 9-4 Operating system execution time at the scan cycle checkpoint

Process	CPU 412	CPU 414	CPU 416	CPU 417
Scan cycle control at the SCC	108 µs to 183 µs Ø 117 µs	64 µs to 108 µs Ø 71 µs	45 µs to 80 µs 48 µs	27 µs to 54 µs Ø 28 µs

Increase in cycle time by nesting interrupts

Table 9-5 Increase in cycle time by nesting interrupts

CPU	Hardware interrupt	Diagnostic interrupt	Time-of-day Interrupt	Time-delay interrupt	Cyclic interrupt	Programming / PI/O access error	Asynchronous error*
CPU 412-1/-2	245 µs	243 µs	231 µs	122 µs	122 µs	59 µs / 61 µs	154
CPU 414-2/-3	148 µs	145 µs	117 µs	70 µs	70 µs	35 µs / 35 µs	92
CPU 416-2/-3	138 µs	136 µs	98 µs	48 µs	48 µs	23 µs / 24 µs	63
CPU 417-4	122 µs	124 µs	76 µs	31 µs	30 µs	13 µs / 14 µs	57

* OB 85 in process image update

You will have to add the program execution time at the interrupt level to this increase.

If several interrupts are nested, their times must be added together.

9.3 Different cycle times

Fundamentals

The length of the cycle time (T_{cyc}) is not identical in each cycle. The following figure shows different cycle times, T_{cyc1} and T_{cyc2}. T_{cyc2} is longer than T_{cyc1}, because the cyclically scanned OB 1 is interrupted by a time-of-day interrupt OB (here, OB10).

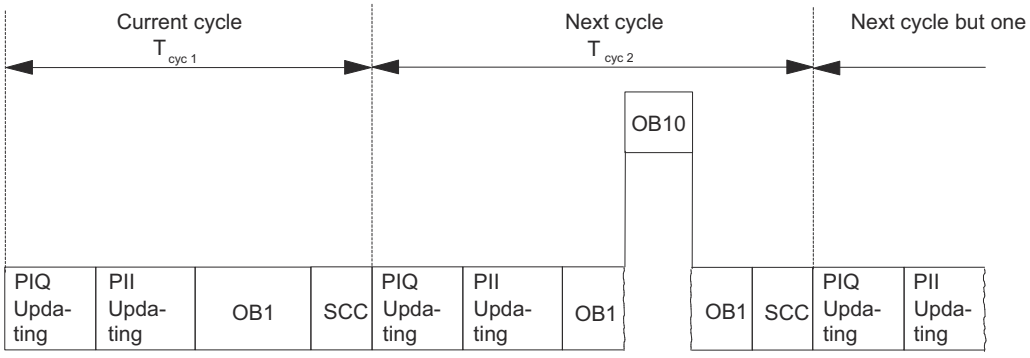


Figure 9-2 Different cycle times

Fluctuation of the block processing time (e.g. OB 1) may also be a factor causing cycle time fluctuation, due to:

- Conditional commands
- Conditional block calls
- Different program paths,
- Loops, etc.

Maximum Cycle Time

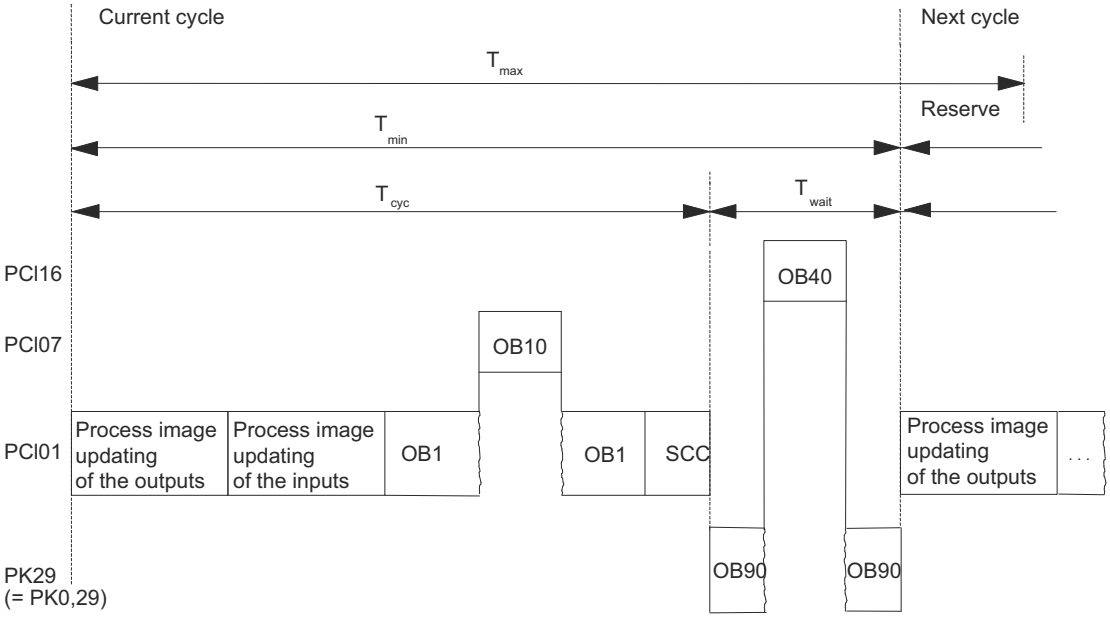
You can modify the default maximum cycle time in STEP 7 (cycle monitoring time). When this time has expired, OB 80 is called. In OB 80 you can specify how the CPU is to react to time errors. If you do not retrigger the cycle time with SFC43, OB 80 doubles the cycle time at the first call. In this case, the CPU goes to STOP at the second call of OB 80.

If there is no OB 80 in the CPU memory, the CPU goes to STOP.

Minimum Cycle Time

You can set a minimum cycle time for a CPU in STEP 7. This is appropriate in the following cases:

- you want the intervals of time between the start of program scanning of OB1 (free cycle) to be roughly of the same length.
- updating of the process images would be performed unnecessarily often with too short a cycle time.
- You want to process a program with the OB 90 in the background.



Tmin = the adjustable minimum cycle time
Tmax = the adjustable maximum cycle time
Tcyc = the cycle time
Twait = the difference between Tmin and the actual cycle time; in this time, any interrupts that occur, the background OB and the SCC tasks can be processed.
PCI = priority class

Figure 9-3 Minimum cycle time

The actual cycle time is the sum of T_{cyc} and T_{wait}. It is always greater than or equal to T_{min}.

9.4 Communication Load

Overview

The CPU operating system continually makes available to communications the percentage you configured for the overall CPU processing performance (time sharing). Processing performance not required for communication is made available to other processes.

In the hardware configuration, you can set communication load to a percentage from 5% and 50%. Th default value is 20%.

This percentage should be regarded as an average value, in other words, the communication load can be considerably greater than 20% in a time slice. On the other hand, communication load in the next time slice is clearly less than that, or zero percent.

This fact is also expressed by the following equation:

$$\text{Actual cycle time} = \text{Cycle time} \times \frac{100}{100 - \text{"configured communication load in \%"}}$$

Round up the result to the next whole number !

Figure 9-4 Equation: Influence of communication load

Note

Real and configured communication load

The configured communication load by itself has no effect on the cycle time. The cycle time is only influenced by the actual communication load imposed. In other words, when a communication load of 50% is configured and a communication load of 10% occurs in a cycle, the cycle time is not doubled, it only increases by a factor of 1.1.

Data consistency

The user program is interrupted for communications processing. The interrupt can be executed after any instruction. These communication jobs can modify the program data. This means that the data consistency cannot be guaranteed for the duration of several accesses.

The section *Consistent Data* provides more information about how to ensure consistency when there is more than one command.

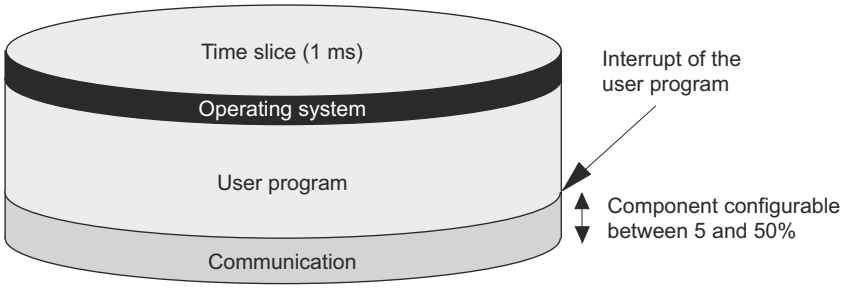


Figure 9-5 Breakdown of a time slice

Of the part remaining, the operating system of the S7-400 requires only a negligibly small amount for internal tasks.

Example: 20 % communication load

You configured a communication load of 20% in the hardware configuration.

The calculated cycle time is 10 ms.

A 20 % communication load means that, on average, 200 µs and 800 µs of the time slice remain for communications and the user program. The CPU therefore requires 10 ms / 800 µs = 13 time slices to process one cycle. This means that the actual cycle time is 13 times one 1 ms time slice = 13 ms, if the CPU fully utilizes the configured communication load.

This means that 20% communications do not increase the cycle linearly by 2 ms but by 3 ms.

Example: 50 % communication load

You have configured a communication load of 50% in the hardware configuration.

The calculated cycle time is 10 ms.

This means that 500 µs of each time slice remain for the cycle. The CPU therefore requires 10 ms / 500 µs = 20 time slices to process one cycle. This means that the actual cycle time is 20 ms if the CPU fully utilizes the configured communication load.

A 50% communication load means that 500 µs of the time slice remain for communication and 500 µs for the user program. The CPU therefore requires 10 ms / 500 µs = 20 time slices to process one cycle. This means that the actual cycle time is 20 times a 1 ms time slice = 20 ms, if the CPU fully utilizes the configured communication load.

This means that 50% communications do not increase the cycle linearly by 5 ms but by 10 ms.

Dependency of the Actual Cycle Time on the Communication load

The following figure describes the non-linear dependency of the actual cycle time on the communication load. This example uses a cycle time of 10 ms.

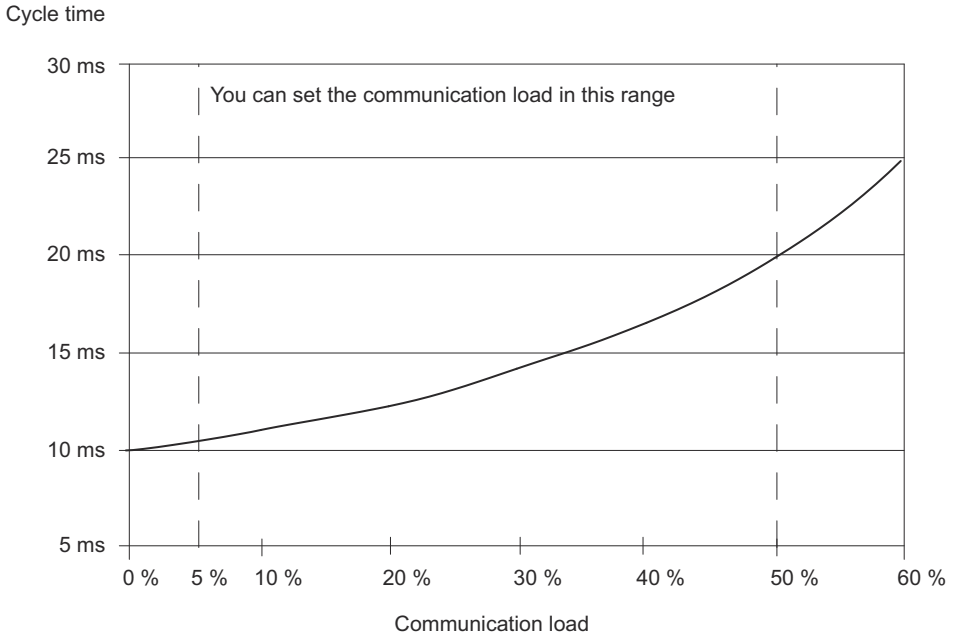


Figure 9-6 Dependency of the Cycle Time on the Communication load

Further Effect on the Actual Cycle Time

Due to the increase in the cycle time as a result of the communications component, even more asynchronous events occur, from a statistical point of view, within an OB 1 cycle than, say, interrupts. This also increases the OB 1 cycle. This extension depends on the number of events that occur per OB 1 cycle and the time required to process these events.

Notes

- Check the effects of a change of the value for the parameter "Cycle load due to communications" in system operation.
- The communication load must be taken into account when you set the maximum cycle time, since time errors will occur if it is not.

Recommendations

- If possible, apply the default value.
- Use a larger value only if the CPU is being used primarily for communication purposes and the user program is non-time-critical. In all other cases select a smaller value.

9.5 Reaction Time

Definition of the response time

The response time is the time from an input signal being detected to changing an output signal linked to it.

Variation

The actual response time is somewhere between a shortest and a longest response time. For configuring your system, you must always reckon with the longest response time.

The shortest and longest response times are analyzed below so that you can gain an impression of the variation of the response time.

Factors

The response time depends on the cycle time and on the following factors:

- Delay in the inputs and outputs
- Additional DP cycle times on the PROFIBUS DP network
- Execution of the user program

Delay in the inputs and outputs

Depending on the module, you must heed the following time delays:

• For digital inputs:	The input delay time
• For digital inputs with interrupt capability:	The input delay time + module-internal preparation time
• For digital outputs	Negligible delay times
• For relay outputs:	Typical delay times of 10 ms to 20 ms. The delay of the relay outputs depends, among other things, on the temperature and the voltage.
• For analog inputs:	Analog input cycle time
• For analog outputs:	Response time of analog outputs

The time delays can be found in the technical specifications of the signal modules.

DP cycle times on the PROFIBUS DP network

If you will have configured your PROFIBUS DP network with **STEP 7**, then **STEP 7** will calculate the typical DP cycle time that must be expected. You can then have the DP cycle time of your configuration displayed for the bus parameters on the programming device.

The following figure will provide you with an overview of the DP cycle time. We assume in this example that each DP slave has 4 bytes of data on average.

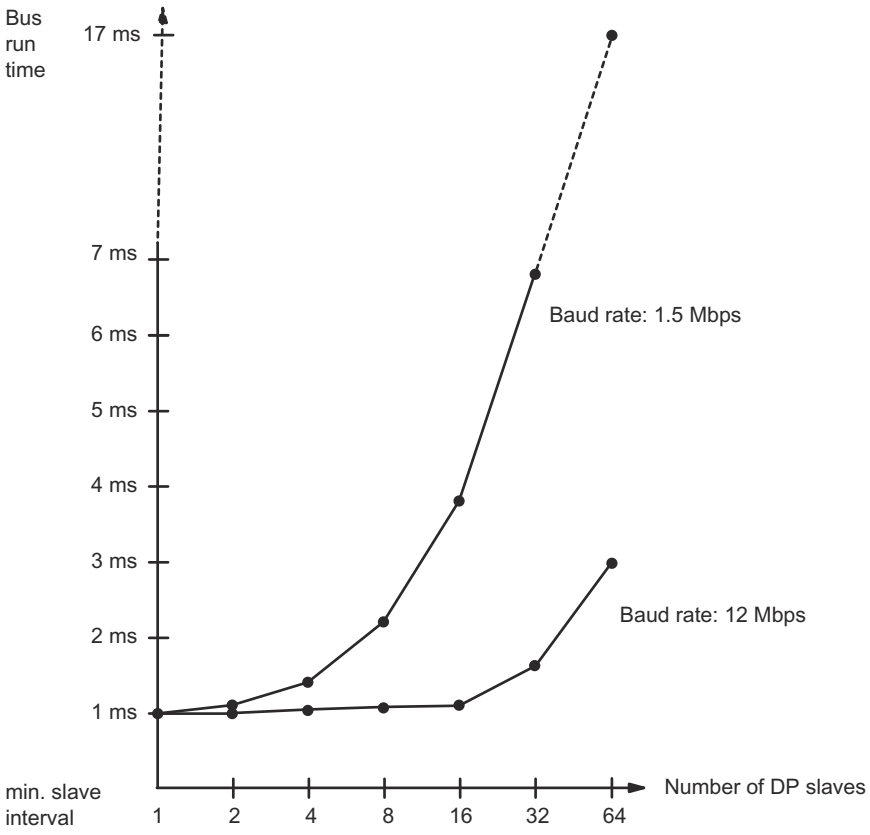


Figure 9-7 DP cycle times on the PROFIBUS DP network

With multi-master operation on a PROFIBUS DP network, you must make allowances for the DP cycle time at each master. That is, you will have to calculate the times for each master separately and then add up the results.

Update cycle in PROFINET IO

The following figure contains an overview of the duration of the update cycle in relation to the number IO devices contained in the cycle.

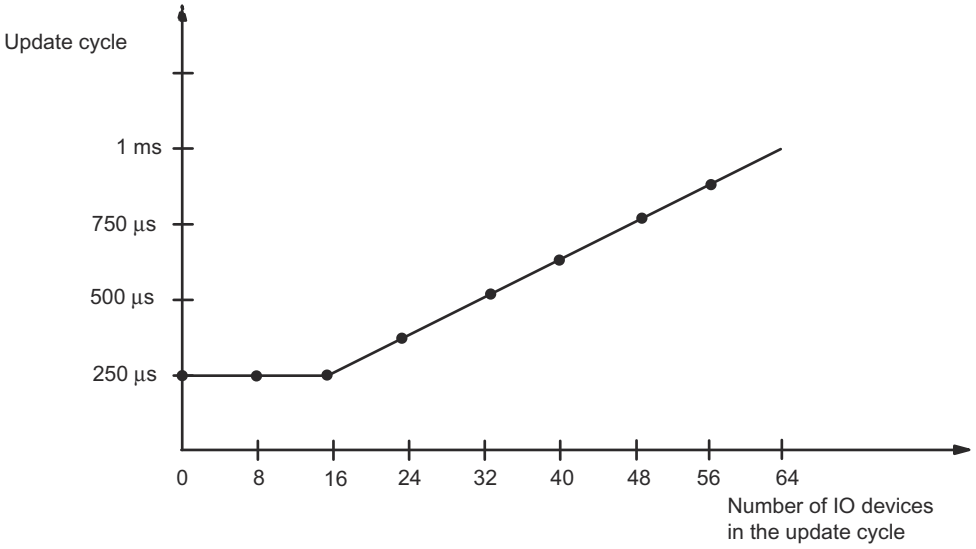


Figure 9-8 Update cycle

Shortest response time

The following figure illustrates the conditions under which the shortest response time can be achieved.

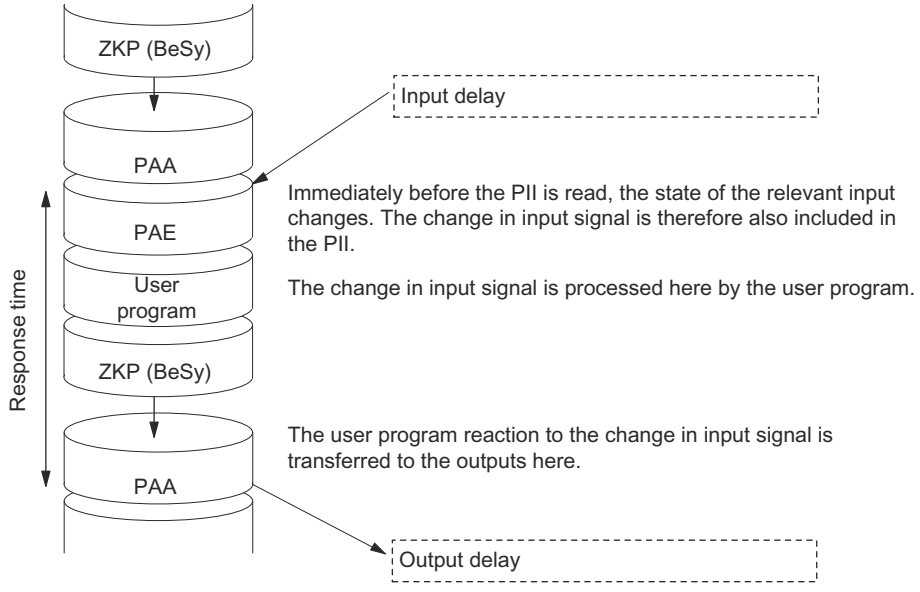


Figure 9-9 Shortest response time

Calculation

The (shortest) response time is made up as follows:

- 1 x process image transfer time for the inputs +
- 1 x process image transfer time for the outputs +
- 1 x program processing time +
- 1 × operating system processing time at the SCC +
- Delay in the inputs and outputs

The result is equivalent to the sum of the cycle time plus the I/O delay times.

Note

If the CPU and signal module are not in the central rack, you will have to add double the runtime of the DP slave frame (including processing in the DP master).

Longest response time

The following figure shows you how the longest response time results.

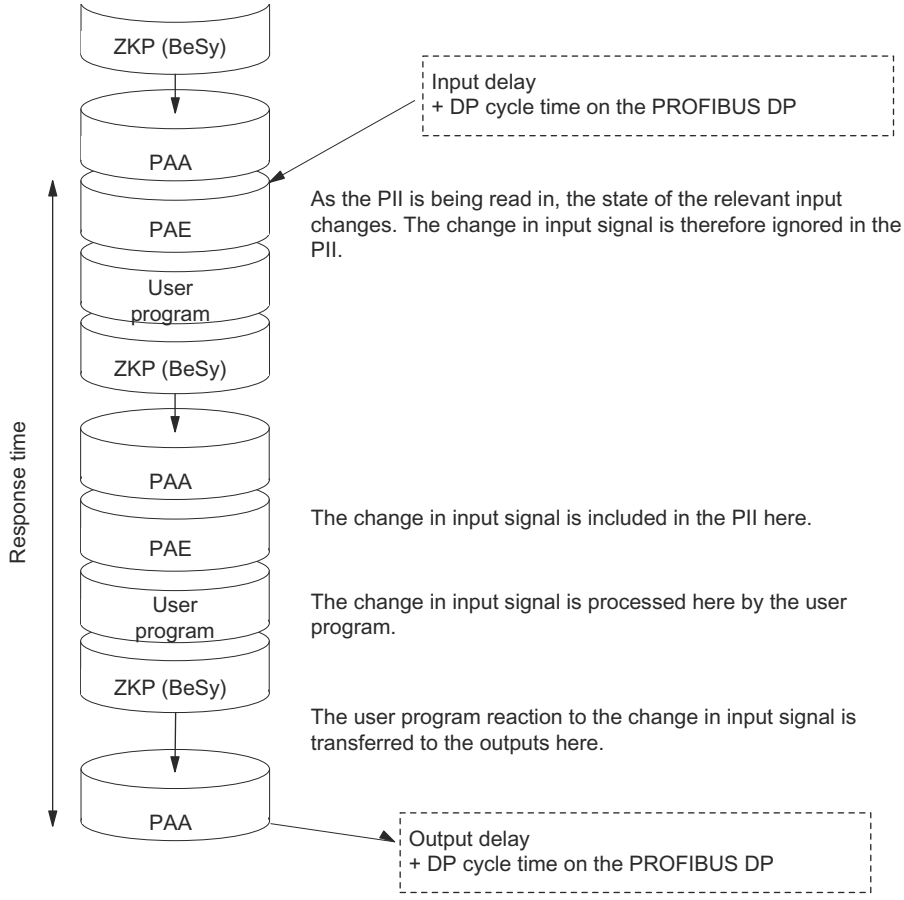


Figure 9-10 Longest response time

Calculation

The (longest) response time is made up as follows:

- 2 x process image transfer time for the inputs +
- 2 x process image transfer time for the outputs +
- 2 × operating system processing time +
- 2 x program processing time +
- 2 x runtime of the DP slave frame (including processing in the DP master) +
- Delay in the inputs and outputs

This is equivalent to the sum of twice the cycle time and the delay in the inputs and outputs plus twice the DP cycle time.

I/O direct accesses

You can achieve faster response times with direct access to the I/O in your user program. For example, you can partially circumvent the response times as described above by using one of the following commands:

- L PIB
- T PQW

Reducing the response time

In this way the maximum response time is reduced to the following components:

- Delay in the inputs and outputs
- Runtime of the user program (can be interrupted by high-priority interrupt handling)
- Runtime of direct accesses
- Twice the bus runtime of DP

The following table lists the execution times of direct accesses by the CPU to I/O modules. The times shown are "ideal values".

Table 9-6 Reducing the response time

Access mode	CPU 412	CPU 414	CPU 416	CPU 417
I/O module				
Read byte	2.3 µs	2.2 µs	2.1 µs	2.1 µs
Read word	3.7 µs	3.7 µs	3.7 µs	3.7 µs
Read double word	6.7 µs	6.7 µs	6.7 µs	6.7 µs
Write byte	2.3 µs	2.2 µs	2.2 µs	2.1 µs
Write word	3.8 µs	3.8 µs	3.8 µs	3.7 µs
Write double word	7.1 µs	7.1 µs	7.1 µs	6.9 µs
Expansion rack with local connection				
Read byte	5.4 µs	5.4 µs	5.4 µs	5.4 µs
Read word	10.4 µs	10.4 µs	10.4 µs	10.4 µs
Read double word	19.9 µs	19.9 µs	19.9 µs	19.9 µs
Write byte	5.2 µs	5.2 µs	5.2 µs	5.2 µs
Write word	10.1 µs	10.1 µs	10.1 µs	10.1 µs
Write double word	19.8 µs	19.8 µs	19.8 µs	19.8 µs
Read byte in the expansion rack via remote connection				
Read byte	11.2 µs	11.2 µs	11.2 µs	11.2 µs
Read word	22.8 µs	22.8 µs	22.8 µs	22.8 µs
Read double word	44.0 µs	44.0 µs	44.0 µs	44.0 µs
Write byte	10.8 µs	10.8 µs	10.8 µs	10.8 µs
Write word	21.8 µs	21.8 µs	21.8 µs	21.8 µs
Write double word	44.0 µs	44.0 µs	44.0 µs	44.0 µs

The specified times are merely CPU processing times and apply, unless otherwise stated, to signal modules in the central rack.

Note

You can similarly achieve fast response times by using hardware interrupts; refer to the section on the interrupt response time.

9.6 Calculating cycle and reaction times

Cycle Time

1. Using the instruction list, determine the runtime of the user program.
2. Calculate and add the transfer time for the process image. You will find approximate values in table 9.3 "Portions of the process image transfer time".
3. Add to it the processing time at the scan cycle checkpoint. You will find approximate values in table 9.4 "Operating system processing time at the scan cycle checkpoint".

The result you achieve is the **cycle time**.

Increasing the Cycle Time with Communication and Interrupts

1. The next step is to multiply the result by the following factor:

$$\frac{100}{100 - \text{"configured communication load in \%"}}$$

2. Using the Instruction List, calculate the runtime of the program sections that hardware interrupts. Add to it the relevant value from table 9.5 "Increase in cycle time by nesting interrupts".
   Multiply this value by the factor from step 1.
   Add this value to the theoretical cycle time as often as the interrupt is triggered or is expected to be triggered during the cycle time.

The result you obtain is approximately the **actual cycle time**. Make a note of the result.

Table 9-7 Example of Calculating the Response Time

Shortest response time	Longest response time
3. Then, calculate the delays in the inputs and outputs and, if applicable, the DP cycle times on the PROFIBUS DP network.	3. Multiply the actual cycle time by a factor of 2.
	4. Then, calculate the delays in the inputs and outputs and the DP cycle times on the PROFIBUS DP network.
4. The result you obtain is the **shortest response time**.	5. The result you obtain is the **longest response time**.

9.7 Examples of Calculating the Cycle Time and Reaction Time

Example I

You have installed an S7-400 with the following modules in the central controller:

- One CPU 414-2
- 2 digital input modules SM 421; DI 32xDC 24 V (4 bytes each in the PI)
- 2 digital output modules SM 422; DO 32xDC 24 V/0.5A (4 bytes each in the PI)

User program

According to the instruction list, the user program runtime is 12 ms.

Calculating the cycle time

The cycle time for the example results from the following times:

- Process image transfer time
  Process image: 5 µs + 16 bytes×1.8 µs = approx. **0.034 ms**
- Operating system runtime at scan cycle checkpoint:
  approx. **0.071 ms**

The total of the listed times is equivalent to the cycle time:

Cycle time = 12.00 ms + 0.034 ms + 0.071 ms **= 12.105 ms**.

Calculation of the actual cycle time

- Allowance for communication load (default value: 20%):
  12.11 ms x 100 / (100-20) **= 15.138 ms.**
- There is no interrupt processing.

The actual rounded cycle time is therefore **15.14 ms.**

Calculating the longest response time

- Longest response time
  15.14 ms * 2 **= 30.28 ms.**
- The delay of the inputs and outputs is negligible.
- All the components are installed in the central rack, so DP cycle times can be ignored.
- There is no interrupt processing.

The longest rounded response time is therefore **30 ms.**

Example II

You have installed an S7-400 with the following modules:

- One CPU 414-2
- 4 digital input modules SM 421; DI 32xDC 24 V (4 bytes each in the PI)
- 3 digital output modules SM 422; DO 16xDC 24 V /2A (each with 2 bytes in the PI)
- 2 analog input modules SM 431; AI 8x13Bit (not in PI)
- 2 analog output modules SM 432; AO 8x13Bit (not in PI)

CPU parameters

The CPU parameters were assigned as follows:

- Cycle load due to communication: 40%

User program

According to the instruction list, the user program runtime is 10.0 ms.

Calculating the cycle time

The theoretical cycle time for the example is derived from the following times:

- Process image transfer time
  Process image: 5 µs + 22 bytes×1.8 µs = approx. **0.045 ms**
- Operating system runtime at scan cycle checkpoint:
  approx. **0.071 ms**

The total of the listed times is equivalent to the cycle time:

Cycle time = 10.0 ms + 0.045 ms + 0.071 ms **= 10.116 ms**.

Calculation of the actual cycle time

- Allowance for communication load (default value 20%):
  10.116 ms x 100 / (100-40) **= 16.86 ms.**
  Every 100 ms, a time-of-day interrupt is triggered with a runtime of 0.5 ms.
  The interrupt can be triggered a maximum of once during a cycle:
  0.5 ms + 0.12 ms (from table "Increase in Increase in cycle time by nesting interrupts") **= 0.62 ms.**
  Under consideration of communication load:
  0.62 ms x 100 / (100-40) **= 1.03 ms.**
- 16.86 ms + 1.03 ms **= 17.89 ms.**

The actual rounded cycle time is therefore **17.9 ms.**

Calculating the longest response time

- Longest response time
  17.9 ms * 2 **= 35.8 ms.**
- Delay times of the inputs and outputs
  - The digital input module SM 421; DI 32xDC 24 V has an input delay of not more than **4.8 ms** per channel
  - The digital output module SM 422; DO 16xDC 24 V/2A has a negligible output delay.
  - The analog input module SM 431; AI 8x13Bit was assigned parameters for 50 Hz interference frequency suppression. The result is a conversion time of 25 ms per channel. As 8 channels are active, a cycle time of the analog input module of **200 ms** results.
  - The analog output module SM 432; AO 8x13-bit was programmed for the measuring range of 0 to 10V. This results in a conversion time of 0.3 ms per channel. Since 8 channels are active, the result is a cycle time of 2.4 ms. The transient time for a resistive load of 0.1 ms must be added to this. The result is a response time of **2.5 ms** for an analog output.
- All the components are plugged into the central controller; DP cycle times do not therefore have to be taken into account.
- Case 1: The system sets an output channel of the digital output module after a digital input signal is read in. The result is as follows:
  Response time = 35.8 ms + 4.8 ms = **40.6 ms**.
- Case 2: The system reads in and outputs an analog value. The result is as follows:
  Response time = 35.8 ms + 200 ms + 2.5 ms **= 238.3 ms**.

9.8 Interrupt Reaction Time

Definition of the Interrupt Response Time

The interrupt response time is the time from when an interrupt signal first occurs to calling the first instruction in the interrupt OB.

General rule: Interrupts having a higher priority take precedence. This means that the interrupt response time is increased by the program processing time of the higher priority interrupt OBs and interrupt OBs with the same priority that have not yet been processed (queue).

Note

Execution of read and write jobs with maximum data length (approx. 460 bytes) can possible delay interrupt response times.
When interrupts are transferred between a CPU and DP master, only a diagnostics **or** hardware interrupt can be currently reported at any time from a DP segment.

Calculation

Table 9-8 Calculating the interrupt response time

Minimum interrupt response time of the CPU + minimum interrupt response time of the signal modules + DP cycle time on PROFIBUS-DP _____ = Shortest response time	Maximum interrupt response time of the CPU + maximum interrupt response time of the signal modules + 2 * DP cycle time on PROFIBUS-DP _____ = Longest response time

Hardware interrupt and diagnostics interrupt response times of CPUs

Table 9-9 Hardware interrupt and diagnostics interrupt response times; maximum interrupt response time without communication

CPU	Hardware interrupt response times		Diagnostic interrupt response times	
	Min.	Max.	Min.	Max.
412	275 µs	328 µs	271 µs	322 µs
414	205 µs	215 µs	203 µs	211 µs
416	139 µs	147 µs	138 µs	145 µs
417	90 µs	100 µs	90 µs	100 µs

Increase of the maximum interrupt response time due to communication load

The maximum interrupt response time is longer when the communication functions are active. The increase is calculated based on the following equation:

tv = 100 µs + 1000 µs x n%

where n = cycle load through communication

Signal modules

The hardware interrupt response time of the signal modules is derived from the following:

- Digital input modules:
  Hardware interrupt response time = internal interrupt processing time + input delay
  You will find the times in the data sheet of the digital input module concerned.
- Analog input modules:
  Hardware interrupt response time = internal interrupt processing time + conversion time
  The internal interrupt processing time of the analog input modules is negligible. The conversion times can be taken from the data sheet of the analog input module concerned.

The diagnostic interrupt response time of the signal modules is the time which elapses between a diagnostics event being detected by the signal module and the diagnostic interrupt being triggered by the signal module. This time is so small that it can be ignored.

Hardware interrupt processing

When the hardware interrupt OB 40 is called, the hardware interrupt is processed. Interrupts with higher priority interrupt hardware interrupt processing, and direct access to the I/O is made when the instruction is executed. When hardware interrupt processing is completed, either cyclic program processing is continued or other interrupt OBs with the same or a lower priority are called and processed.

9.9 Example: Calculating the Interrupt Reaction Time

Parts of the Interrupt Response Time

As a reminder: The hardware interrupt response time comprises the following:

- Hardware interrupt response time of the CPU
- Hardware interrupt response time of the signal module.
- 2 x DP cycle time on PROFIBUS-DP

Example: You will have an S7-400 consisting of a CPU 416-2 and 4 digital modules in the central rack. One digital input module is the SM 421; DI 16×UC 24/60 V; with hardware and diagnostic interrupts. In the parameter assignment of the CPU and the SM, you will have only enabled the hardware interrupt. You do not require time-driven processing, diagnostics and error handling. You will have set an input delay of 0.5 ms for the digital input module. No activities are necessary at the cycle checkpoint. You will have set a cycle load caused by communication of 20%.

Calculation

The hardware interrupt response time for the example results from the following times:

- Hardware interrupt response time of the CPU 416-2: Approx. 0.147 ms
- Extension by communication according to the equation in the table "Hardware interrupt and diagnostic interrupt response times; maximum interrupt response time without communication":

100 µs + 1000 µs x 20 % = 300 µs = 0.3 ms

- Hardware interrupt response time of the SM 421; DI 16xUC 24/60 V:
  - Internal interrupt processing time: 0.5 ms
  - Input delay: 0.5 ms
- Since the signal modules are plugged into the central rack, the DP cycle time on the PROFIBUS-DP is not relevant.

The hardware interrupt response time results from the sum of the listed times:

Hardware interrupt response time = 0.147 ms +0.3 ms + 0.5 ms + 0.5 ms = **approx. 1.45 ms**.

This calculated hardware interrupt response time is the time from a signal being applied across the digital input to the first instruction in OB 40.

9.10 Reproducibility of Time-Delay and Watchdog Interrupts

Definition of "reproducibility"

Time-delay interrupt:

The period that expires between the call of the first operation in the interrupt OB and the programmed time of alarm.

Cyclic interrupt:

The fluctuation range of the interval between two successive calls, measured between the respective initial instructions of the interrupt OB.

Reproducibility

The following table contains the reproducibility of time-delay and cyclic interrupts of the CPUs.

Table 9-10 Reproducibility of time-delay and cyclic interrupts of the CPUs

Module	Reproducibility	
	Time-delay interrupt	Cyclic interrupt
CPU 412	-190 µs / +185 µs	-43 µs / +40 µs
CPU 414	-181 µs / +183 µs	-29 µs / +32 µs
CPU 416	-195 µs / +192 µs	-15 µs / +18 µs
CPU 417	-153 µs / +150 µs	-12 µs / +13 µs

These times only apply if the interrupt can actually be executed at this time and if it is not delayed, for example, by higher-priority interrupts or queued interrupts of equal priority.

9.11 CBA response times

Definition of the Response Time

The response time is the time that it takes a value from the user program of a CPU to reach the user program of a second CPU. This assumes that no time is lost in the user program itself.

Response Time for Cyclic Interconnection

The response time of an interconnection in an S7-400 CPU is composed of the following portions:

- Processing time on the transmitting CPU
- The transmission frequency configured in SIMATIC iMap (fast, medium or slow)
- Processing time on the receiving CPU

You have specified a value for the transmission frequency suited to your plant during the configuration with SIMATIC iMap. Faster or slower response times can occur because the data transmission to the user program is performed asynchronously. Therefore, check the achievable response time during commissioning and change the configuration as required.

Measurements for Cyclic Interconnections in an Example Configuration

To be able to estimate the achievable CBA response time better, consider the following measurements.

The processing times on the transmitting CPU and the receiving CPU basically depend on the sum of the input and output interconnections and the amount of data on them. The following figure shows this relationship using two examples for transmitting 600 bytes and 9600 bytes to a varying number of interconnections:

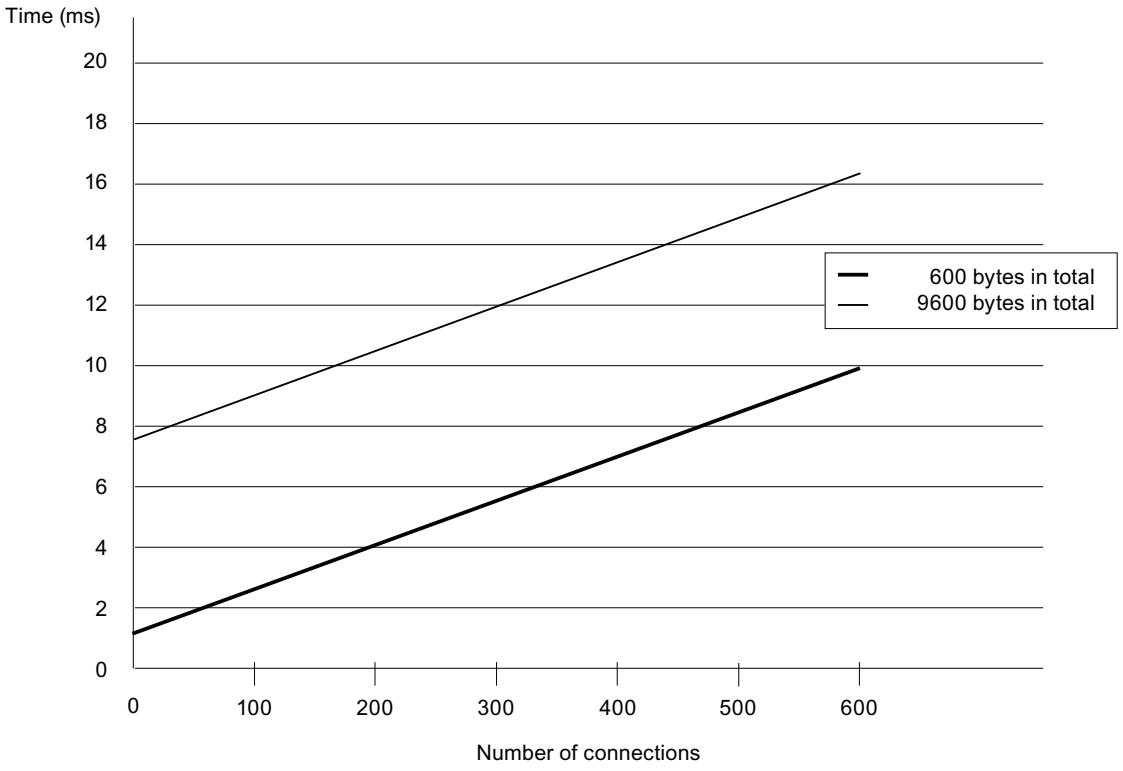


Figure 9-11 Processing time for sending and receiving

You can estimate the CBA response time using the information in this figure and the time you have set for the transmission frequency.

The following applies:

CBA response times =

Processing time on the transmitting CPU* +

Cycle time based on the configured transmission frequency** +

Processing time on the receiving CPU*

*) Add all input and output interconnections of the CPU to determine the processing time. You can read the processing time from the diagram based on the determined number of interconnections and amount of data on them.

**) The configured transmission frequency has a direct relationship to the actual cycle time in the network. For technical reasons, the cycle time is based on the square of the base cycle time of 1ms. The actual cycle time therefore corresponds to the next smaller square of the configure transmission frequency; the following relationships result from the specified values:

(transmission frequency <-> cycle time): 1<->1 | 2<->2 | 5<->4 | 10<->8 | 20<->16 | 50<->32 | 100<->64 | 200<->128 | 500<->256 | 1000<->512

Note

Using iMap as of V3.0 SP1

In iMap as of V3.0 SP1 there are only squares of the base cycle time of 1ms for cyclic interconnections. The preceding footnote **) then no longer applies.

Note on the Processing Times for Cyclic Interconnections

- The processing times are based on 32 remote partners. Few remote partners reduces the processing times by approx. 0.02 ms per partner.
- The processing times are based on byte interconnections (single bytes or arrays).
- The processing times are applicable for situations in which the same transmission frequency is configured for all cyclic interconnections. Increased transmission frequency can improve the performance.
- When acyclic interconnections with the maximum amount of data are simultaneously active, the response times of the cyclic interconnections increase by approx. 33%.
- The example measurements were performed with a CPU 416-3 PN/DP. With a CPU 414-3 PN/DP the processing times increase by up to approx. 20%.

Response Time for Acyclic Interconnections

The resulting response time depends on the configured sampling frequency and the number of cyclic interconnections that are simultaneously active. You can see three examples for the resulting response times in the following table.

Table 9-11 Response time for acyclic interconnections

Configured sampling frequency	Resulting response time without cyclic interconnections	Resulting response time with cyclic interconnections (maximum amount of data)
200 ms	195 ms	700 ms
500 ms	480 ms	800 ms
1000 ms	950 ms	1050 ms

General Information about Achievable CBA Response Times

- The CBA response time increases if the CPU is performing additional tasks, such as programmed block communication or S7 connections.
- If you frequently call SFCs "PN_IN", "PN_OUT" or "PN_DP", you increase the CBA processing times and therefore increase CBA response time.
- A very small OB1 cycle increases the CBA response time when the PN interface is updated automatically (at the cycle control point).

Technical specifications

10

10.1 Technical data of the CPU 412-1 (6ES7412-1XJ07-0AB0)

Data

	6ES7412-1XJ07-0AB0
General information	
Product type designation	CPU 412-1
Hardware version	01
Firmware version	V7.0
Engineering with	
Programming package	As of STEP 7 V5.4 with HSP 261
CiR Configuration in RUN	
CiR synchronization time, base load	100 ms
CiR synchronization time, time per I/O byte	30 µs
Power supply	
Rated value (DC)	
24 V DC	No; voltage supplied via the system voltage supply
Input current	
From backplane bus 5 V DC, typ.	0.7 A
From backplane bus 5 V DC, max.	0.8 A
From the backplane bus 24 V DC, max.	150 mA; 150 mA for each DP interface
From interface 5 V DC, max.	90 mA; at the DP interface
Power loss	
Typical power loss	3.5 W
Power loss, max.	4 W
Memory	
Type of memory	RAM
Work memory	
Integrated	512 KB
integrated (for program)	256 KB
integrated (for data)	256 KB
Expandable	No
Load memory	
Expandable FEPROM	Yes; with memory card (FLASH)
Expandable FEPROM, max.	64 MB
integrated RAM, max.	512 KB

	6ES7412-1XJ07-0AB0
Expandable RAM	Yes; with memory card (RAM)
Expandable RAM, max.	64 MB
Battery backup	
Available	Yes
With battery	Yes; all data
Without battery	No
Battery	
Backup battery	
Backup battery current, typ.	180 µA; to 40 °C
Backup battery current, max.	850 µA
Backup battery time, max.	Covered by the conditions and effects described in the Module data manual
Feed of external backup voltage to the CPU	5 to 15 V DC
CPU processing times	
For bit operations, typ.	31.25 ns
For word operations, typ.	31.25 ns
For integer arithmetic, typ.	31.25 ns
For floating-point arithmetic, typ.	62.5 ns
CPU blocks	
DB	
Number, max.	3000; number range: 1 to 16000
Size, max.	64 KB
FB	
Number, max.	1500; number range: 0 to 7999
Size, max.	64 KB
FC	
Number, max.	1500; number range: 0 to 7999
Size, max.	64 KB
OB	
Size, max.	64 KB
Number of free-cycle OBs	1; OB 1
Number of time-of-day interrupt OBs	2; OB 10. 11
Number of time-delay interrupt OBs	2; OB 20, 21
Number of cyclic interrupt OBs	2; OB 32, 35 (smallest configurable cycle = 500 µs)
Number of hardware interrupt OBs	2; OB 40, 41
Number of DPV1 interrupt OBs	3; OB 55-57
Number of isochronous OBs	2; OB 61-62
Number of multi-computing OBs	1; OB 60
Number of background OBs	1; OB 90
Number of startup OBs	3; OB 100-102
Number of asynchronous error OBs	9; OB 80-88

	6ES7412-1XJ07-0AB0
Number of synchronous error OBs	2; OB 121, 122
Nesting depth	
Per priority class	24
Additional levels within an error OB	1
Counters, timers and their retentivity	
S7 counters	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	C 0 to C 7
Counting range	
Low limit	0
High limit	999
IEC counters	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
S7 timers	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	No retentive timers
Time range	
Low limit	10 ms
High limit	9990 s
IEC timers	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
Data areas and their retentivity	
Retentive data area, total	Total work and load memory (with backup battery)
Bit memories	
Number, max.	4 KB; size of bit memory address area
Retentivity available	Yes
Default retentivity	MB 0 to MB 15
Number of clock memories	8; in 1 memory byte
Local data	

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Adjustable, max.	8 KB
Default	4 KB
Address area	
I/O address area	
Inputs	4 KB
Outputs	4 KB
of which are distributed	
MPI/DP interface, inputs	2 KB
MPI/DP interface, outputs	2 KB
Process image	
Inputs, adjustable	4 KB
Outputs, adjustable	4 KB
Inputs, preset	128 bytes
Outputs, preset	128 bytes
Consistent data, max.	244 bytes
Access to consistent data in the process image	Yes
Process image partitions	
Number of process image partitions, max.	15
Digital channels	
Inputs	32768
of which are central	32768
Outputs	32768
of which are central	32768
Analog channels	
Inputs	2048
of which are central	2048
Outputs	2048
of which are central	2048
Hardware configuration	
Number of expansion units, max.	21
Connectable OP	47
Multicomputing	Yes; max. 4 CPU (with UR1 or UR2)
Interface modules	
Number of plug-in IMs (total), max.	6
Number of plug-in IM 460s, max.	6
Number of plug-in IM 463s, max.	4; IM 463-2
Number of DP masters	
Integrated	1
Via IM 467	4
Via CP	10; CP 443-5 Extended

	6ES7412-1XJ07-0AB0
Mixed IM + CP operation allowed	No; IM 467 cannot be used in combination with CP 443-5 Ext. or CP 443-1 n PROFINET IO mode
Via interface module	0
Number of plug-in S5 modules (via adapter bay, in the central controller), max.	6
Number of IO controllers	
Integrated	0
Via CP	4; max. 4 in central controller; no mixed operation of different CP 443-1 types in PROFINET IO mode
Number of usable FMs and CPs (recommendation)	
FM	Limited by the number of slots and connections
CP, point-to-point	CP 440: limited by the number of slots; CP 441: limited by the number of slots or connections
PROFIBUS and Ethernet CPs	14; in total max. 10 CP as DP master and PROFINET controller, of which up to 10 IM or CP as DP master and up to 4 CP as PROFINET controller
Slots	
Slots required	1
Time of day	
Clock	
Hardware clock (real-time clock)	Yes
With battery backup, can be synchronized	Yes
Resolution	1 ms
Deviation per day (with battery backup), max.	1.7 s; Power off
Deviation per day (without battery backup), max.	8.6 s; with Power on
Operating hours counter	
Number	16
Number/number range	0 to 15
Range of values	SFCs 2, 3 and 4: 0 to 32767 hours SFC 101: 0 to 2^31 - 1 hour
Resolution	1 hour
Retentive	Yes
Time synchronization	
Supported	Yes
on MPI, master	Yes
on MPI, slave	Yes
on DP, master	Yes
on DP, slave	Yes
in the AS, master	Yes
in the AS, slave	Yes
On Ethernet via NTP	No; via CP
On IF 964 DP	No
Time difference in the system with synchronization via	
MPI, max.	200 ms

	6ES7412-1XJ07-0AB0
Interfaces	
Interfaces/bus type	1x MPI/PROFIBUS DP
Number of RS 485 interfaces	1; combination MPI / PROFIBUS DP
1st interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS + MPI
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	MPI: 32, DP: 16
Protocols	
MPI	Yes
DP master	Yes
DP slave	Yes
MPI	
Number of connections	32; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Services	
PG/OP communication	Yes
Routing	Yes
Global data communication	Yes
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
PROFIBUS DP master	
Number of connections, max.	16; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	32
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes

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Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	2 KB
Outputs, max.	2 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	16
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No
Address area, max.	32; virtual slots
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
PG/OP communication	Yes; with active interface
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
Isochronous mode	
Isochronous mode (application synchronized up to terminal)	Yes; only with PROFIBUS
Number of DP masters with isochronous mode	1
User data per isochronous slave, max.	244 bytes
Constant bus cycle time	Yes
Minimum clock cycle	1.5 ms; 0.5 ms without use of SFC 126, 127
Maximum clock cycle	32 ms
Communication functions	
PG/OP communication	Yes

	6ES7412-1XJ07-0AB0
Number of connectable OPs without message processing	47
Number of connectable OPs with message processing	47; when using Alarm_S/SQ and Alarm_D/DQ
Data record routing	Yes
Global data communication	
Supported	Yes
Number of GD circles, max.	8
Number of GD packets, sender, max.	8
Number of GD packets, receiver, max.	16
Size of GD packets, max.	54 bytes
Size of GD packets (of which are consistent), max.	1 variable
S7 basic communication	
Supported	Yes
User data per job, max.	76 bytes
User data per job (of which consistent), max.	1 variable
S7 communication	
Supported	Yes
As server	Yes
As client	Yes
User data per job, max.	64 KB
User data per job (of which consistent), max.	462 bytes
S5-compatible communication	
Supported	Yes; via FC AG_SEND and AG_RECV, maximum via 10 CP 443-1 or 443-5
User data per job, max.	8 KB
User data per job (of which consistent), max.	240 bytes
Number of simultaneous AG-SEND/AG-RECV jobs per CPU, max.	24/24
Standard communication (FMS)	
Supported	Yes; via CP and loadable FBs
Open IE communication	
ISO-on-TCP (RFC1006)	Via CP 443-1 Adv. and loadable FB
Data length, max.	1452 bytes via CP 443-1 Adv.
Web server	
Supported	No
Number of connections	
Total	48
Suitable for PG communication	47
Reserved for PG communication	1
Assignable for PG communication, max.	0
Suitable for OP communication	47
Reserved for OP communication	1
Assignable for OP communication, max.	0

	6ES7412-1XJ07-0AB0
Suitable for S7 basic communication	46
Reserved for S7 basic communication	0
Assignable for S7 basic communication, max.	0
Suitable for S7 communication	46
Reserved for S7 communication	0
Assignable for S7 communication, max.	0
Suitable for routing	23
Reserved for routing	0
Assignable for routing, max.	0
S7 message functions	
Number of stations that can be logged on for signaling functions, max.	47; max. 47 with Alarm_S/SQ and Alarm_D/DQ (OPs); max. 8 with Alarm, Alarm_8, Alarm_8P, Notify and Notify_8 (e.g. WinCC)
Symbol-related messages	Yes
SCAN procedure	Yes
Block-related messages	Yes
Process diagnostics messages	Yes
Simultaneously active Alarm_S blocks, max.	250; simultaneously active Alarm_S/SQ blocks and Alarm_D/DQ blocks
Alarm_8 blocks	Yes
Number of instances for Alarm_8 and S7 communication blocks, max.	300
Preset, max.	150
Process control messages	Yes
Number of archives that can be logged on simultaneously (SFB 37 AR_SEND)	4
Number of messages	
Total, max.	256
In 100 ms interval, max.	0
in 500 ms interval, max.	256
in 1000 ms interval, max.	256
Number of additional values	
In 100 ms interval, max.	0
In 500, 1000 ms interval, max.	1
Test and commissioning functions	
Block status	Yes; up to 16 simultaneously
Single-step	Yes
Number of breakpoints	16
Status/modify	
Status/modify variable	Yes; up to 16 variable tables
Variables	Inputs/outputs, bit memory, DB, I/O inputs/outputs, timers, counters
Number of variables, max.	70; Status / Modify

	6ES7412-1XJ07-0AB0
Forcing	
Forcing	Yes
Force, variables	Inputs/outputs, bit memories, distributed I/O
Number of variables, max.	64
Diagnostics buffer	
Available	Yes
Number of entries, max.	3200
Adjustable	Yes
Default	120
Service data	
Readable	Yes
Standards, approvals, certificates	
UKCA	Yes
CE mark	Yes
CSA approval	Yes
UL approval	Yes
cULus	Yes
FM approval	Yes
RCM (formerly C-TICK)	Yes
KC approval	Yes
CCC	Yes
EAC (formerly Gost-R)	Yes
Use in hazardous areas	
ATEX	ATEX II 3 G Ex ec IIC T4 Gc
Ambient conditions	
Ambient temperature during operation	
Min.	0 °C
Max.	60 °C
Configuration	
Programming	
Instruction set	See instruction list
Nesting levels	7
Access to consistent data in the process image	Yes
System functions (SFC)	See instruction list
System function blocks (SFB)	See instruction list
Programming language	
LAD	Yes
FBD	Yes
STL	Yes
SCL	Yes
CFC	Yes

	6ES7412-1XJ07-0AB0
GRAPH	Yes
HiGraph®	Yes
Number of simultaneously active SFCs	
DPSYC_FR	2; SFC 11; per interface
D_ACT_DP	8; SFC 12; per interface
RD_REC	8; SFC 59; per interface
WR_REC	8; SFC 58; per interface
WR_PARM	8; SFC 55; per interface
PARM_MOD	1; SFC 57; per interface
WR_DPARM	2; SFC 56; per interface
DPNRM_DG	8; SFC 13; per interface
RDSYSST	8; SFC 51
DP_TOPOL	1; SFC 103; per interface
Number of simultaneously active SFBs	
RDREC	8; SFB 52; per interface, but not more than 32 across all external interfaces
WRREC	8; SFB 53; per interface, but not more than 32 across all external interfaces
Know-how protection	
User program/password protection	Yes
Block encryption	Yes; with S7 block privacy
Dimensions	
Width	25 mm
Height	290 mm
Depth	219 mm
Weights	
Weight, approx.	700 g

10.2 Technical data of the CPU 412-2 (6ES7412-2XK07-0AB0)

Data

	6ES7412-2XK07-0AB0
General information	
Product type designation	CPU 412-2
Hardware version	01
Firmware version	V7.0
Engineering with	
Programming package	As of STEP 7 V5.4 with HSP 261
CiR Configuration in RUN	
CiR synchronization time, base load	100 ms
CiR synchronization time, time per I/O byte	30 µs
Power supply	
Rated value (DC)	
24 V DC	No; voltage supplied via the system voltage supply
Input current	
From backplane bus 5 V DC, typ.	0.9 A
From backplane bus 5 V DC, max.	1.1 A
From the backplane bus 24 V DC, max.	300 mA; 150 mA per DP interface
From interface 5 V DC, max.	90 mA; for each DP interface
Power loss	
Typical power loss	4.5 W
Power loss, max.	5.5 W
Memory	
Type of memory	RAM
Work memory	
Integrated	1 MB
integrated (for program)	512 KB
integrated (for data)	512 KB
Expandable	No
Load memory	
Expandable FEPROM	Yes; with memory card (FLASH)
Expandable FEPROM, max.	64 MB
integrated RAM, max.	512 KB
Expandable RAM	Yes; with memory card (RAM)
Expandable RAM, max.	64 MB
Battery backup	
Available	Yes
With battery	Yes; all data
Without battery	No

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Battery	
Backup battery	
Backup battery current, typ.	180 µA; to 40 °C
Backup battery current, max.	850 µA
Backup battery time, max.	Covered by the conditions and effects described in the Module data manual
Feed of external backup voltage to the CPU	5 to 15 V DC
CPU processing times	
For bit operations, typ.	31.25 ns
For word operations, typ.	31.25 ns
For integer arithmetic, typ.	31.25 ns
For floating-point arithmetic, typ.	62.5 ns
CPU blocks	
DB	
Number, max.	3000; number range: 1 to 16000
Size, max.	64 KB
FB	
Number, max.	1500; number range: 0 to 7999
Size, max.	64 KB
FC	
Number, max.	1500; number range: 0 to 7999
Size, max.	64 KB
OB	
Size, max.	64 KB
Number of free-cycle OBs	1; OB 1
Number of time-of-day interrupt OBs	2; OB 10. 11
Number of time-delay interrupt OBs	2; OB 20, 21
Number of cyclic interrupt OBs	2; OB 32, 35 (smallest configurable cycle = 500 µs)
Number of hardware interrupt OBs	2; OB 40, 41
Number of DPV1 interrupt OBs	3; OB 55-57
Number of isochronous OBs	2; OB 61-62
Number of multi-computing OBs	1; OB 60
Number of background OBs	1; OB 90
Number of startup OBs	3; OB 100-102
Number of asynchronous error OBs	9; OB 80-88
Number of synchronous error OBs	2; OB 121, 122
Nesting depth	
Per priority class	24
Additional levels within an error OB	1
Counters, timers and their retentivity	
S7 counters	

	6ES7412-2XK07-0AB0
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	C 0 to C 7
Counting range	
Low limit	0
High limit	999
IEC counters	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
S7 timers	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	No retentive timers
Time range	
Low limit	10 ms
High limit	9990 s
IEC timers	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
Data areas and their retentivity	
Retentive data area, total	Total work and load memory (with backup battery)
Bit memories	
Number, max.	4 KB; size of bit memory address area
Retentivity available	Yes
Default retentivity	MB 0 to MB 15
Number of clock memories	8; in 1 memory byte
Local data	
Adjustable, max.	8 KB
Default	4 KB
Address area	
I/O address area	
Inputs	4 KB
Outputs	4 KB

	6ES7412-2XK07-0AB0
of which are distributed	
MPI/DP interface, inputs	2 KB
MPI/DP interface, outputs	2 KB
DP interface, inputs	4 KB
DP interface, outputs	4 KB
Process image	
Inputs, adjustable	4 KB
Outputs, adjustable	4 KB
Inputs, preset	128 bytes
Outputs, preset	128 bytes
Consistent data, max.	244 bytes
Access to consistent data in the process image	Yes
Process image partitions	
Number of process image partitions, max.	15
Digital channels	
Inputs	32768
of which are central	32768
Outputs	32768
of which are central	32768
Analog channels	
Inputs	2048
of which are central	2048
Outputs	2048
of which are central	2048
Hardware configuration	
Number of expansion units, max.	21
Connectable OP	47
Multicomputing	Yes; max. 4 CPU (with UR1 or UR2)
Interface modules	
Number of plug-in IMs (total), max.	6
Number of plug-in IM 460s, max.	6
Number of plug-in IM 463s, max.	4; IM 463-2
Number of DP masters	
Integrated	2
Via IM 467	4
Via CP	10; CP 443-5 Extended
Mixed IM + CP operation allowed	No; IM 467 cannot be used in combination with CP 443-5 Ext. or CP 443-1 n PROFINET IO mode
Via interface module	0
Number of plug-in S5 modules (via adapter bay, in the central controller), max.	6
Number of IO controllers	

	6ES7412-2XK07-0AB0
Integrated	0
Via CP	4; max. 4 in central controller; no mixed operation of different CP 443-1 types in PROFINET IO mode
Number of usable FMs and CPs (recommendation)	
FM	Limited by the number of slots and connections
CP, point-to-point	CP 440: limited by the number of slots; CP 441: limited by the number of slots or connections
PROFIBUS and Ethernet CPs	14; in total max. 10 CP as DP master and PROFINET controller, of which up to 10 IM or CP as DP master and up to 4 CP as PROFINET controller
Slots	
Slots required	1
Time of day	
Clock	
Hardware clock (real-time clock)	Yes
With battery backup, can be synchronized	Yes
Resolution	1 ms
Deviation per day (with battery backup), max.	1.7 s; Power off
Deviation per day (without battery backup), max.	8.6 s; with Power on
Operating hours counter	
Number	16
Number/number range	0 to 15
Range of values	SFCs 2, 3 and 4: 0 to 32767 hours SFC 101: 0 to 2^31 - 1 hour
Resolution	1 hour
Retentive	Yes
Time synchronization	
Supported	Yes
on MPI, master	Yes
on MPI, slave	Yes
on DP, master	Yes
on DP, slave	Yes
in the AS, master	Yes
in the AS, slave	Yes
On Ethernet via NTP	No; via CP
On IF 964 DP	No
Time difference in the system with synchronization via	
MPI, max.	200 ms
Interfaces	
Interfaces/bus type	1x MPI/PROFIBUS DP, 1x PROFIBUS DP
Number of RS 485 interfaces	2; combination MPI / PROFIBUS DP and PROFIBUS DP
1st interface	
Interface type	Integrated

	6ES7412-2XK07-0AB0
Hardware	RS 485 / PROFIBUS + MPI
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	MPI: 32, DP: 16
Protocols	
MPI	Yes
DP master	Yes
DP slave	Yes
MPI	
Number of connections	32; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Services	
PG/OP communication	Yes
Routing	Yes
Global data communication	Yes
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
PROFIBUS DP master	
Number of connections, max.	16; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	32
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	2 KB
Outputs, max.	2 KB

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User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	16
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No
Address area, max.	32; virtual slots
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
PG/OP communication	Yes; with active interface
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
2nd interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	16
Protocols	
DP master	Yes
DP slave	Yes
PROFIBUS DP master	
Number of connections, max.	16
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	64
Services	

	6ES7412-2XK07-0AB0
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	4 KB
Outputs, max.	4 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	16
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Address area, max.	32
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
Routing	Yes; with active interface
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
Isochronous mode	
Isochronous mode (application synchronized up to terminal)	Yes; only with PROFIBUS
Number of DP masters with isochronous mode	2
User data per isochronous slave, max.	244 bytes
Constant bus cycle time	Yes
Minimum clock cycle	1.5 ms; 0.5 ms without use of SFC 126, 127
Maximum clock cycle	32 ms

	6ES7412-2XK07-0AB0
Communication functions	
PG/OP communication	Yes
Number of connectable OPs without message processing	47
Number of connectable OPs with message processing	47; when using Alarm_S/SQ and Alarm_D/DQ
Data record routing	Yes
Global data communication	
Supported	Yes
Number of GD circles, max.	8
Number of GD packets, sender, max.	8
Number of GD packets, receiver, max.	16
Size of GD packets, max.	54 bytes
Size of GD packets (of which are consistent), max.	1 variable
S7 basic communication	
Supported	Yes
User data per job, max.	76 bytes
User data per job (of which consistent), max.	1 variable
S7 communication	
Supported	Yes
As server	Yes
As client	Yes
User data per job, max.	64 KB
User data per job (of which consistent), max.	462 bytes; 1 variable
S5-compatible communication	
Supported	Yes; via FC AG_SEND and AG_RECV, maximum via 10 CP 443-1 or 443-5
User data per job, max.	8 KB
User data per job (of which consistent), max.	240 bytes
Number of simultaneous AG-SEND/AG-RECV jobs per CPU, max.	24/24
Standard communication (FMS)	
Supported	Yes; via CP and loadable FBs
Open IE communication	
ISO-on-TCP (RFC1006)	via CP 443-1 and loadable FB
Data length, max.	1452 bytes via CP 443-1 Adv.
Web server	
Supported	No
Number of connections	
Total	48
Suitable for PG communication	47
Reserved for PG communication	1
Assignable for PG communication, max.	0
Suitable for OP communication	47

	6ES7412-2XK07-0AB0
Reserved for OP communication	1
Assignable for OP communication, max.	0
Suitable for S7 basic communication	46
Reserved for S7 basic communication	0
Assignable for S7 basic communication, max.	0
Suitable for S7 communication	46
Reserved for S7 communication	0
Assignable for S7 communication, max.	0
Suitable for routing	23
Reserved for routing	0
Assignable for routing, max.	0
S7 message functions	
Number of stations that can be logged on for signaling functions, max.	47; max. 47 with Alarm_S/SQ and Alarm_D/DQ (OPs); max. 8 with Alarm, Alarm_8, Alarm_8P, Notify and Notify_8 (e.g. WinCC)
Symbol-related messages	Yes
SCAN procedure	Yes
Block-related messages	Yes
Process diagnostics messages	Yes
Simultaneously active Alarm_S blocks, max.	250; simultaneously active Alarm_S/SQ blocks and Alarm_D/DQ blocks
Alarm_8 blocks	Yes
Number of instances for Alarm_8 and S7 communication blocks, max.	300
Preset, max.	150
Process control messages	Yes
Number of archives that can be logged on simultaneously (SFB 37 AR_SEND)	4
Number of messages	
Total, max.	256
In 100 ms interval, max.	0
in 500 ms interval, max.	256
in 1000 ms interval, max.	256
Number of additional values	
In 100 ms interval, max.	0
In 500, 1000 ms interval, max.	1
Test and commissioning functions	
Block status	Yes; up to 16 simultaneously
Single-step	Yes
Number of breakpoints	16
Status/modify	
Status/modify variable	Yes; up to 16 variable tables

	6ES7412-2XK07-0AB0
Variables	Inputs/outputs, bit memory, DB, I/O inputs/outputs, timers, counters
Number of variables, max.	70; Status / Modify
Forcing	
Forcing	Yes
Force, variables	Inputs, outputs, bit memories, distributed I/O
Number of variables, max.	64
Diagnostics buffer	
Available	Yes
Number of entries, max.	3200
Adjustable	Yes
Default	120
Service data	
Readable	Yes
Standards, approvals, certificates	
UKCA	Yes
CE mark	Yes
CSA approval	Yes
UL approval	Yes
cULus	Yes
FM approval	Yes
RCM (formerly C-TICK)	Yes
CCC	Yes
KC approval	Yes
EAC (formerly Gost-R)	Yes
Use in hazardous areas	
ATEX	ATEX II 3 G Ex ec IIC T4 Gc
Ambient conditions	
Ambient temperature during operation	
Min.	0 °C
Max.	60 °C
Configuration	
Programming	
Instruction set	See instruction list
Nesting levels	7
Access to consistent data in the process image	Yes
System functions (SFC)	See instruction list
System function blocks (SFB)	See instruction list
Programming language	
LAD	Yes
FBD	Yes

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STL	Yes
SCL	Yes
CFC	Yes
GRAPH	Yes
HiGraph®	Yes
Number of simultaneously active SFCs	
DPSYC_FR	2; SFC 11; per interface
D_ACT_DP	8; SFC 12; per interface
RD_REC	8; SFC 59; per interface
WR_REC	8; SFC 58; per interface
WR_PARM	8; SFC 55; per interface
PARM_MOD	1; SFC 57; per interface
WR_DPARM	2; SFC 56; per interface
DPNRM_DG	8; SFC 13; per interface
RDSYSST	8; SFC 51
DP_TOPOL	1; SFC 103; per interface
Number of simultaneously active SFBs	
RDREC	8; SFB 52; per interface, but not more than 32 across all external interfaces
WRREC	8; SFB 53; per interface, but not more than 32 across all external interfaces
Know-how protection	
User program/password protection	Yes
Block encryption	Yes; with S7 block privacy
Dimensions	
Width	25 mm
Height	290 mm
Depth	219 mm
Weights	
Weight, approx.	700 g

10.3 Technical specifications of CPU 412-2 PN (6ES7412-2EK07-0AB0)

Data

	6ES7412-2EK07-0AB0
General information	
Product type designation	CPU 412-2 PN
Hardware version	01
Firmware version	V7.0
Engineering with	
Programming package	as of STEP 7 V5.5 with HSP 262
CiR Configuration in RUN	
CiR synchronization time, base load	100 ms
CiR synchronization time, time per I/O byte	30 µs
Power supply	
Rated value (DC)	
24 V DC	No; voltage supplied via the system voltage supply
Input current	
From backplane bus 5 V DC, typ.	1.1 A
From backplane bus 5 V DC, max.	1.4 A
From the backplane bus 24 V DC, max.	150 mA; 150 mA for each DP interface
From interface 5 V DC, max.	90 mA; at the DP interface
Power loss	
Typical power loss	5.5 W
Power loss, max.	7 W
Memory	
Type of memory	RAM
Work memory	
Integrated	1 MB
integrated (for program)	512 KB
integrated (for data)	512 KB
Expandable	No
Load memory	
Expandable FEPROM	Yes; with memory card (FLASH)
Expandable FEPROM, max.	64 MB
integrated RAM, max.	512 KB
Expandable RAM	Yes; with memory card (RAM)
Expandable RAM, max.	64 MB
Battery backup	
Available	Yes
With battery	Yes; all data
Without battery	No

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Battery	
Backup battery	
Backup battery current, typ.	180 µA; to 40 °C
Backup battery current, max.	850 µA
Backup battery time, max.	Covered by the conditions and effects described in the Module data manual
Feed of external backup voltage to the CPU	5 to 15 V DC
CPU processing times	
For bit operations, typ.	31.25 ns
For word operations, typ.	31.25 ns
For integer arithmetic, typ.	31.25 ns
For floating-point arithmetic, typ.	62.5 ns
CPU blocks	
DB	
Number, max.	3000; number range: 1 to 16000
Size, max.	64 KB
FB	
Number, max.	1500; number range: 0 to 7999
Size, max.	64 KB
FC	
Number, max.	1500; number range: 0 to 7999
Size, max.	64 KB
OB	
Size, max.	64 KB
Number of free-cycle OBs	1; OB 1
Number of time-of-day interrupt OBs	2; OB 10. 11
Number of time-delay interrupt OBs	2; OB 20, 21
Number of cyclic interrupt OBs	2; OB 32, 35 (smallest configurable cycle = 500 µs)
Number of hardware interrupt OBs	2; OB 40, 41
Number of DPV1 interrupt OBs	3; OB 55-57
Number of isochronous OBs	2; OB 61-62
Number of multi-computing OBs	1; OB 60
Number of background OBs	1; OB 90
Number of startup OBs	3; OB 100-102
Number of asynchronous error OBs	9; OB 80-88
Number of synchronous error OBs	2; OB 121, 122
Nesting depth	
Per priority class	24
Additional levels within an error OB	1
Counters, timers and their retentivity	
S7 counters	

	6ES7412-2EK07-0AB0
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	C 0 to C 7
Counting range	
Low limit	0
High limit	999
IEC counters	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
S7 timers	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	No retentive timers
Time range	
Low limit	10 ms
High limit	9990 s
IEC timers	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
Data areas and their retentivity	
Retentive data area, total	Total work and load memory (with backup battery)
Bit memories	
Number, max.	4 KB; size of bit memory address area
Retentivity available	Yes
Default retentivity	MB 0 to MB 15
Number of clock memories	8; in 1 memory byte
Local data	
Adjustable, max.	8 KB
Default	4 KB
Address area	
I/O address area	
Inputs	4 KB
Outputs	4 KB

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of which are distributed	
MPI/DP interface, inputs	2 KB
MPI/DP interface, outputs	2 KB
DP interface, inputs	
DP interface, outputs	
PN interface, inputs	4 KB
PN interface, outputs	4 KB
Process image	
Inputs, adjustable	4 KB
Outputs, adjustable	4 KB
Inputs, preset	128 bytes
Outputs, preset	128 bytes
Consistent data, max.	244 bytes
Access to consistent data in the process image	Yes
Process image partitions	
Number of process image partitions, max.	15
Digital channels	
Inputs	32768
of which are central	32768
Outputs	32768
of which are central	32768
Analog channels	
Inputs	2048
of which are central	2048
Outputs	2048
of which are central	2048
Hardware configuration	
Number of expansion units, max.	21
Connectable OP	47
Multicomputing	Yes; max. 4 CPU (with UR1 or UR2)
Interface modules	
Number of plug-in IMs (total), max.	6
Number of plug-in IM 460s, max.	6
Number of plug-in IM 463s, max.	4; IM 463-2
Number of DP masters	
Integrated	1
Via IM 467	4
Via CP	10; CP 443-5 Extended
Mixed IM + CP operation allowed	No; IM 467 cannot be used in combination with CP 443-5 Ext. or CP 443-1 n PROFINET IO mode
Via interface module	0

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Number of plug-in S5 modules (via adapter bay, in the central controller), max.	6
Number of IO controllers	
Integrated	1
Via CP	4; max. 4 in central controller; no mixed operation of different CP 443-1 types in PROFINET IO mode
Number of usable FMs and CPs (recommendation)	
FM	Limited by the number of slots and connections
CP, point-to-point	CP 440: limited by the number of slots; CP 441: limited by the number of slots or connections
PROFIBUS and Ethernet CPs	14; in total max. 10 CP as DP master and PROFINET controller, of which up to 10 IM or CP as DP master and up to 4 CP as PROFINET controller
Slots	
Slots required	1
Time of day	
Clock	
Hardware clock (real-time clock)	Yes
With battery backup, can be synchronized	Yes
Resolution	1 ms
Deviation per day (with battery backup), max.	1.7 s; Power off
Deviation per day (without battery backup), max.	8.6 s; with Power on
Operating hours counter	
Number	16
Number/number range	0 to 15
Range of values	SFCs 2, 3 and 4: 0 to 32767 hours SFC 101: 0 to 2^31 - 1 hour
Resolution	1 hour
Retentive	Yes
Time synchronization	
Supported	Yes
on MPI, master	Yes
on MPI, slave	Yes
on DP, master	Yes
on DP, slave	Yes
in the AS, master	Yes
in the AS, slave	Yes
On Ethernet via NTP	Yes; as client
On IF 964 DP	No
Time difference in the system with synchronization via	
Ethernet, max.	10 ms
MPI, max.	200 ms
Interfaces	

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Interfaces/bus type	1x MPI/PROFIBUS DP, 1x PROFINET (2 ports)
Number of RS 485 interfaces	1; combination MPI / PROFIBUS DP
1st interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS + MPI
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	MPI: 32, DP: 16
Protocols	
MPI	Yes
DP master	Yes
DP slave	Yes
MPI	
Number of connections	32; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Services	
PG/OP communication	Yes
Routing	Yes
Global data communication	Yes
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
PROFIBUS DP master	
Number of connections, max.	16; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	32
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes

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DPV1	Yes
Address area	
Inputs, max.	2 KB
Outputs, max.	2 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	16
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No
Address area, max.	32; virtual slots
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
PG/OP communication	Yes; with active interface
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
2nd interface	
Interface type	PROFINET
Hardware	Ethernet RJ45
Electrically isolated	Yes
Automatic determination of transmission rate	Yes; Autosensing
Autonegotiation	Yes
Autocrossing	Yes
Change of the IP address at runtime, supported	Yes; specified by higher-level IO controller or by the user program with SFB 104 "IP_CONF"
Number of connection resources	48

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Interface (physical)	
Number of ports	2
Integrated switch	Yes
Media redundancy	
Supported	Yes
Changeover time at line interruption, typ.	200 ms
Number of nodes on the ring, max.	50
Protocols	
DP master	No
DP slave	No
PROFINET IO controller	Yes
PROFINET IO device	Yes
PROFINET CBA	Yes
Open IE communication	Yes
Point-to-point link	No
PROFINET IO controller	
Transmission rate, max.	100 Mbps
Services	
PG/OP communication	Yes
S7 routing	Yes
S7 communication	Yes
Isochronous mode	Yes; only with IRT and the "high performance" option
Open IE communication	Yes
Shared device	Yes
Number of connectable IO devices, max.	256
of wich IO devices with IRT, max.	64
of which in line, max.	64
Number of IO devices with IRT and the "high flexibility" option	256
of which in line, max.	61
Number of connectable IO devices for RT, max.	256
of which in line, max.	256
Prioritized startup	Yes
Number of IO devices with prioritized startup, max.	32
Enabling/disabling of IO devices	Yes
Max. number of I/O devices that can be enabled/disabled simultaneously	8
Hot-swapping of I/O devices (partner ports), supported	Yes
Number of IO devices per tool, max.	8; 8 parallel calls of SFC 12 "D_ACT_DP" per segment are possible. Hot-swapping of maximum 32 I/O devices (partner ports) supported
Device replacement without swap medium	Yes

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Send clocks	250 µs, 500 µs, 1 ms, 2 ms, 4 ms also for IRT with higher performance: 250 µs to 4 ms at an interval of 125 µs
Update time	250 µs to 512 ms; The minimum value depends on the communication slice set for PROFINET IO, the number of IO devices, and the amount of configured user data; see PROFINET system description
Address area	
Inputs, max.	4 KB
Outputs, max.	4 KB
User data consistency, max.	1024 bytes
PROFINET IO device	
Services	
PG/OP communication	Yes
S7 routing	Yes
S7 communication	Yes
Isochronous mode	No
Open IE communication	Yes
IRT	Yes
Prioritized startup	Yes
Shared device	Yes
Number of IO controllers with shared device, max.	2
Transfer memory	
Inputs, max.	1440 bytes; per IO controller with shared device
Outputs, max.	1440 bytes; per IO controller with shared device
Submodules	
Number, max.	64
User data per submodule, max.	1024 bytes
PROFINET CBA	
acyclic transmission	Yes
cyclic transmission	Yes
Open IE communication	
Number of connections, max.	46
Local port numbers used by the system	0, 20, 21, 25, 80, 102, 135, 161, 34962, 34963, 34964, 65532, 65533, 65534, 65535
Keep Alive function supported	Yes
Isochronous mode	
Isochronous mode (application synchronized up to terminal)	Yes; via PROFIBUS DP or PROFINET interface
Number of DP masters with isochronous mode	1
User data per isochronous slave, max.	244 bytes
Constant bus cycle time	Yes
Minimum clock cycle	1.5 ms; 0.5 ms without use of SFC 126, 127
Maximum clock cycle	32 ms

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Communication functions	
PG/OP communication	Yes
Number of connectable OPs without message processing	47
Number of connectable OPs with message processing	47; when using Alarm_S/SQ and Alarm_D/DQ
Data record routing	Yes
Global data communication	
Supported	Yes
Number of GD circles, max.	8
Number of GD packets, sender, max.	8
Number of GD packets, receiver, max.	16
Size of GD packets, max.	54 bytes
Size of GD packets (of which are consistent), max.	1 variable
S7 basic communication	
Supported	Yes
User data per job, max.	76 bytes
User data per job (of which consistent), max.	1 variable
S7 communication	
Supported	Yes
As server	Yes
As client	Yes
User data per job, max.	64 KB
User data per job (of which consistent), max.	462 bytes; 1 variable
S5-compatible communication	
Supported	Yes; via FC AG_SEND and AG_RECV, maximum via 10 CP 443-1 or 443-5
User data per job, max.	8 KB
User data per job (of which consistent), max.	240 bytes
Number of simultaneous AG-SEND/AG-RECV jobs per CPU, max.	24/24
Standard communication (FMS)	
Supported	Yes; via CP and loadable FBs
Open IE communication	
TCP/IP	Yes; via integrated PROFINET interface and loadable FBs
Number of connections, max.	46
Data length, max.	32 KB
Multiple passive connections per port, supported	Yes
ISO-on-TCP (RFC1006)	Yes; via integrated PROFINET interface or CP 443-1 Adv. and loadable FBs
Number of connections, max.	46
Data length, max.	32 KB; 1452 bytes via CP 443-1 Adv.
UDP	Yes; via integrated PROFINET interface and loadable FBs
Number of connections, max.	46

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Data length, max.	1472 bytes
Web server	
Supported	Yes
Number of HTTP clients	5
User-defined websites	Yes
PROFINET CBA (with configured communication load setpoint)	
Reference setting for CPU communication load	20%
Number of remote interconnection partners	32
Number of master/slave functions	150
Total of all master/slave connections	4500
Data length of all incoming master/slave I/Os, max.	45000 bytes
Data length of all outgoing master/slave connections, max.	45000 bytes
Number of device-internal and PROFIBUS interconnections	1000
Data length of the device-internal and PROFIBUS interconnections, max.	16000 bytes
Data length per connection, max.	2000 bytes
Remote interconnections with non-cyclic transmission	
Sampling rate: Sampling interval, min.	200 ms; Depends on preset communication load, number of interconnections and used data length
Number of incoming interconnections	250
Number of outgoing interconnections	250
Data length of all incoming interconnections, max.	8000 bytes
Data length of all outgoing interconnections, max.	8000 bytes
Data length per connection, max.	2000 bytes
Remote interconnections with cyclic transmission	
Transmission rate: Minimum transmission time	1 ms; Depends on preset communication load, number of interconnections and used data length
Number of incoming interconnections	300
Number of outgoing interconnections	300
Data length of all incoming interconnections, max.	4800 bytes
Data length of all outgoing interconnections, max.	4800 bytes
Data length per connection, max.	450 bytes
HMI variables via PROFINET (non-cyclic)	
Number of stations that can be logged on for HMI variables (PN OPC/IMAP)	2x PN OPC / 1x IMAP
Update of HMI variables	500 ms
Number of HMI variables	1000
Data length of all HMI variables, max.	32000 bytes
PROFIBUS proxy functionality	
Supported	Yes; max. 32 PROFIBUS slaves can be connected
Data length per connection, max.	240 bytes; slave dependent
Number of connections	

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Total	48
Suitable for PG communication	47
Reserved for PG communication	1
Assignable for PG communication, max.	0
Suitable for OP communication	47
Reserved for OP communication	1
Assignable for OP communication, max.	0
Suitable for S7 basic communication	46
Reserved for S7 basic communication	0
Assignable for S7 basic communication, max.	0
Suitable for S7 communication	46
Reserved for S7 communication	0
Assignable for S7 communication, max.	0
Suitable for routing	23
Reserved for routing	0
Assignable for routing, max.	0
S7 message functions	
Number of stations that can be logged on for signaling functions, max.	47; max. 47 with Alarm_S/SQ and Alarm_D/DQ (OPs); max. 8 with Alarm, Alarm_8, Alarm_8P, Notify and Notify_8 (e.g. WinCC)
Symbol-related messages	Yes
SCAN procedure	Yes
Block-related messages	Yes
Process diagnostics messages	Yes
Simultaneously active Alarm_S blocks, max.	250; simultaneously active Alarm_S/SQ blocks and Alarm_D/DQ blocks
Alarm_8 blocks	Yes
Number of instances for Alarm_8 and S7 communication blocks, max.	300
Preset, max.	150
Process control messages	Yes
Number of archives that can be logged on simultaneously (SFB 37 AR_SEND)	4
Number of messages	
Total, max.	256
In 100 ms interval, max.	0
in 500 ms interval, max.	256
in 1000 ms interval, max.	256
Number of additional values	
In 100 ms interval, max.	0
In 500, 1000 ms interval, max.	1
Test and commissioning functions	

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Block status	Yes; up to 16 simultaneously
Single-step	Yes
Number of breakpoints	16
Status/modify	
Status/modify variable	Yes; up to 16 variable tables
Variables	Inputs/outputs, bit memory, DB, I/O inputs/outputs, timers, counters
Number of variables, max.	70; Status / Modify
Forcing	
Forcing	Yes
Force, variables	Inputs/outputs, bit memories, distributed I/O
Number of variables, max.	64
Diagnostics buffer	
Available	Yes
Number of entries, max.	3200
Adjustable	Yes
Default	120
Service data	
Readable	Yes
Standards, approvals, certificates	
UKCA	Yes
CE mark	Yes
CSA approval	Yes
UL approval	Yes
cULus	Yes
FM approval	Yes
RCM (formerly C-TICK)	Yes
CCC	Yes
KC approval	Yes
EAC (formerly Gost-R)	Yes
Use in hazardous areas	
ATEX	ATEX II 3 G Ex ec IIC T4 Gc
Ambient conditions	
Ambient temperature during operation	
Min.	0 °C
Max.	60 °C
Configuration	
Programming	
Instruction set	See instruction list
Nesting levels	7
Access to consistent data in the process image	Yes

	6ES7412-2EK07-0AB0
System functions (SFC)	See instruction list
System function blocks (SFB)	See instruction list
Programming language	
LAD	Yes
FBD	Yes
STL	Yes
SCL	Yes
CFC	Yes
GRAPH	Yes
HiGraph®	Yes
Number of simultaneously active SFCs	
DPSYC_FR	2; SFC 11; per interface
D_ACT_DP	8; SFC 12; per interface
RD_REC	8; SFC 59; per interface
WR_REC	8; SFC 58; per interface
WR_PARM	8; SFC 55; per interface
PARM_MOD	1; SFC 57; per interface
WR_DPARM	2; SFC 56; per interface
DPNRM_DG	8; SFC 13; per interface
RDSYSST	8; SFC 51
DP_TOPOL	1; SFC 103; per interface
Number of simultaneously active SFBs	
RDREC	8; SFB 52; per interface, but not more than 32 across all external interfaces
WRREC	8; SFB 53; per interface, but not more than 32 across all external interfaces
Know-how protection	
User program/password protection	Yes
Block encryption	Yes; with S7 block privacy
Dimensions	
Width	25 mm
Height	290 mm
Depth	219 mm
Weights	
Weight, approx.	750 g

10.4 Technical data of the CPU 414-2 (6ES7414-2XL07-0AB0)

Data

	6ES7414-2XL07-0AB0
General information	
Product type designation	CPU 414-2
Hardware version	01
Firmware version	V7.0
Engineering with	
Programming package	As of STEP 7 V5.4 with HSP 261
CiR Configuration in RUN	
CiR synchronization time, base load	100 ms
CiR synchronization time, time per I/O byte	15 µs
Power supply	
Rated value (DC)	
24 V DC	No; voltage supplied via the system voltage supply
Input current	
From backplane bus 5 V DC, typ.	0.9 A
From backplane bus 5 V DC, max.	1.1 A
From the backplane bus 24 V DC, max.	300 mA; 150 mA per DP interface
From interface 5 V DC, max.	90 mA; for each DP interface
Power loss	
Typical power loss	4.5 W
Power loss, max.	5.5 W
Memory	
Type of memory	RAM
Work memory	
Integrated	2 MB
integrated (for program)	1 MB
integrated (for data)	1 MB
Expandable	No
Load memory	
Expandable FEPROM	Yes; with memory card (FLASH)
Expandable FEPROM, max.	64 MB
integrated RAM, max.	512 KB
Expandable RAM	Yes; with memory card (RAM)
Expandable RAM, max.	64 MB
Battery backup	
Available	Yes
With battery	Yes; all data
Without battery	No

	6ES7414-2XL07-0AB0
Battery	
Backup battery	
Backup battery current, typ.	180 µA; to 40 °C
Backup battery current, max.	850 µA
Backup battery time, max.	Covered by the conditions and effects described in the Module data manual
Feed of external backup voltage to the CPU	5 to 15 V DC
CPU processing times	
For bit operations, typ.	18.75 ns
For word operations, typ.	18.75 ns
For integer arithmetic, typ.	18.75 ns
For floating-point arithmetic, typ.	37.5 ns
CPU blocks	
DB	
Number, max.	6000; number range: 1 to 16000
Size, max.	64 KB
FB	
Number, max.	3000; number range: 0 to 7999
Size, max.	64 KB
FC	
Number, max.	3000; number range: 0 to 7999
Size, max.	64 KB
OB	
Size, max.	64 KB
Number of free-cycle OBs	1; OB 1
Number of time-of-day interrupt OBs	4; OB 10-13
Number of time-delay interrupt OBs	4; OB 20-23
Number of cyclic interrupt OBs	4; OB 32-35 (smallest configurable cycle = 500 µs)
Number of hardware interrupt OBs	4; OB 40-43
Number of DPV1 interrupt OBs	3; OB 55-57
Number of isochronous OBs	3; OB 61-63
Number of multi-computing OBs	1; OB 60
Number of background OBs	1; OB 90
Number of startup OBs	3; OB 100-102
Number of asynchronous error OBs	9; OB 80-88
Number of synchronous error OBs	2; OB 121, 122
Nesting depth	
Per priority class	24
Additional levels within an error OB	1
Counters, timers and their retentivity	
S7 counters	

	6ES7414-2XL07-0AB0
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	C 0 to C 7
Counting range	
Low limit	0
High limit	999
IEC counters	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
S7 timers	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	No retentive timers
Time range	
Low limit	10 ms
High limit	9990 s
IEC timers	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
Data areas and their retentivity	
Retentive data area, total	Total work and load memory (with backup battery)
Bit memories	
Number, max.	8 KB; size of bit memory address area
Retentivity available	Yes
Default retentivity	MB 0 to MB 15
Number of clock memories	8; in 1 memory byte
Local data	
Adjustable, max.	16 KB
Default	8 KB
Address area	
I/O address area	
Inputs	8 KB
Outputs	8 KB

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of which are distributed	
MPI/DP interface, inputs	2 KB
MPI/DP interface, outputs	2 KB
DP interface, inputs	6 KB
DP interface, outputs	6 KB
Process image	
Inputs, adjustable	8 KB
Outputs, adjustable	8 KB
Inputs, preset	256 bytes
Outputs, preset	256 bytes
Consistent data, max.	244 bytes
Access to consistent data in the process image	Yes
Process image partitions	
Number of process image partitions, max.	15
Digital channels	
Inputs	65536
of which are central	65536
Outputs	65536
of which are central	65536
Analog channels	
Inputs	4096
of which are central	4096
Outputs	4096
of which are central	4096
Hardware configuration	
Number of expansion units, max.	21
Connectable OP	63
Multicomputing	Yes; max. 4 CPU (with UR1 or UR2)
Interface modules	
Number of plug-in IMs (total), max.	6
Number of plug-in IM 460s, max.	6
Number of plug-in IM 463s, max.	4; IM 463-2
Number of DP masters	
Integrated	2
Via IM 467	4
Via CP	10; CP 443-5 Extended
Mixed IM + CP operation allowed	No; IM 467 cannot be used in combination with CP 443-5 Ext. or CP 443-1 n PROFINET IO mode
Via interface module	0
Number of plug-in S5 modules (via adapter bay, in the central controller), max.	6
Number of IO controllers	

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Integrated	0
Via CP	4; max. 4 in central controller; no mixed operation of different CP 443-1 types in PROFINET IO mode
Number of usable FMs and CPs (recommendation)	
FM	Limited by the number of slots and connections
CP, point-to-point	CP 440: limited by the number of slots; CP 441: Limited by the number of connections
PROFIBUS and Ethernet CPs	14; in total max. 10 CP as DP master and PROFINET controller, of which up to 10 IM or CP as DP master and up to 4 CP as PROFINET controller
Slots	
Slots required	1
Time of day	
Clock	
Hardware clock (real-time clock)	Yes
With battery backup, can be synchronized	Yes
Resolution	1 ms
Deviation per day (with battery backup), max.	1.7 s; Power off
Deviation per day (without battery backup), max.	8.6 s; with Power on
Operating hours counter	
Number	16
Number/number range	0 to 15
Range of values	SFCs 2, 3 and 4: 0 to 32767 hours SFC 101: 0 to 2^31 - 1 hour
Resolution	1 hour
Retentive	Yes
Time synchronization	
Supported	Yes
on MPI, master	Yes
on MPI, slave	Yes
on DP, master	Yes
on DP, slave	Yes
in the AS, master	Yes
in the AS, slave	Yes
On Ethernet via NTP	No; via CP
On IF 964 DP	No
Time difference in the system with synchronization via	
MPI, max.	200 ms
Interfaces	
Interfaces/bus type	1x MPI/PROFIBUS DP, 1x PROFIBUS DP
Number of RS 485 interfaces	2; combination MPI / PROFIBUS DP and PROFIBUS DP
1st interface	
Interface type	Integrated

	6ES7414-2XL07-0AB0
Hardware	RS 485 / PROFIBUS + MPI
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	MPI: 32, DP: 16
Protocols	
MPI	Yes
DP master	Yes
DP slave	Yes
MPI	
Number of connections	32; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Services	
PG/OP communication	Yes
Routing	Yes
Global data communication	Yes
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
PROFIBUS DP master	
Number of connections, max.	16; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	32
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	2 KB
Outputs, max.	2 KB

	6ES7414-2XL07-0AB0
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	16
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No
Address area, max.	32; virtual slots
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
PG/OP communication	Yes; with active interface
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
2nd interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	16
Protocols	
DP master	Yes
DP slave	Yes
PROFIBUS DP master	
Number of connections, max.	16
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	96
Services	

	6ES7414-2XL07-0AB0
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	6 KB
Outputs, max.	6 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	16
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Address area, max.	32
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
Routing	Yes; with active interface
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
Isochronous mode	
Isochronous mode (application synchronized up to terminal)	Yes; only with PROFIBUS
Number of DP masters with isochronous mode	2
User data per isochronous slave, max.	244 bytes
Constant bus cycle time	Yes
Minimum clock cycle	1 ms; 0.5 ms without use of SFC 126, 127
Maximum clock cycle	32 ms

	6ES7414-2XL07-0AB0
Communication functions	
PG/OP communication	Yes
Number of connectable OPs without message processing	63
Number of connectable OPs with message processing	63; when using Alarm_S/SQ and Alarm_D/DQ
Data record routing	Yes
Global data communication	
Supported	Yes
Number of GD circles, max.	8
Number of GD packets, sender, max.	8
Number of GD packets, receiver, max.	16
Size of GD packets, max.	54 bytes
Size of GD packets (of which are consistent), max.	1 variable
S7 basic communication	
Supported	Yes
User data per job, max.	76 bytes
User data per job (of which consistent), max.	1 variable
S7 communication	
Supported	Yes
As server	Yes
As client	Yes
User data per job, max.	64 KB
User data per job (of which consistent), max.	462 bytes; 1 variable
S5-compatible communication	
Supported	Yes; via FC AG_SEND and AG_RECV, maximum via 10 CP 443-1 or 443-5
User data per job, max.	8 KB
User data per job (of which consistent), max.	240 bytes
Number of simultaneous AG-SEND/AG-RECV jobs per CPU, max.	24/24
Standard communication (FMS)	
Supported	Yes; via CP and loadable FBs
Open IE communication	
ISO-on-TCP (RFC1006)	via CP 443-1 and loadable FB
Data length, max.	1452 bytes via CP 443-1 Adv.
Web server	
Supported	No
Number of connections	
Total	64
Suitable for PG communication	63
Reserved for PG communication	1
Assignable for PG communication, max.	0
Suitable for OP communication	63

	6ES7414-2XL07-0AB0
Reserved for OP communication	1
Assignable for OP communication, max.	0
Suitable for S7 basic communication	62
Reserved for S7 basic communication	0
Assignable for S7 basic communication, max.	0
Suitable for S7 communication	62
Reserved for S7 communication	0
Assignable for S7 communication, max.	0
Suitable for routing	31
Reserved for routing	0
Assignable for routing, max.	0
S7 message functions	
Number of stations that can be logged on for signaling functions, max.	63; max. 63 with Alarm_S/SQ and Alarm_D/DQ (OPs); max. 8 with Alarm, Alarm_8, Alarm_8P, Notify and Notify_8 (e.g. WinCC)
Symbol-related messages	Yes
SCAN procedure	Yes
Block-related messages	Yes
Process diagnostics messages	Yes
Simultaneously active Alarm_S blocks, max.	400; simultaneously active Alarm_S/SQ blocks and Alarm_D/DQ blocks
Alarm_8 blocks	Yes
Number of instances for Alarm_8 and S7 communication blocks, max.	1200
Preset, max.	300
Process control messages	Yes
Number of archives that can be logged on simultaneously (SFB 37 AR_SEND)	16
Number of messages	
Total, max.	512
In 100 ms interval, max.	128
in 500 ms interval, max.	256
in 1000 ms interval, max.	512
Number of additional values	
In 100 ms interval, max.	1
In 500, 1000 ms interval, max.	10
Test and commissioning functions	
Block status	Yes; up to 16 simultaneously
Single-step	Yes
Number of breakpoints	16
Status/modify	
Status/modify variable	Yes; up to 16 variable tables

	6ES7414-2XL07-0AB0
Variables	Inputs/outputs, bit memory, DB, I/O inputs/outputs, timers, counters
Number of variables, max.	70; Status / Modify
Forcing	
Forcing	Yes
Force, variables	Inputs, outputs, bit memories, distributed I/O
Number of variables, max.	256
Diagnostics buffer	
Available	Yes
Number of entries, max.	3200
Adjustable	Yes
Default	120
Service data	
Readable	Yes
Standards, approvals, certificates	
UKCA	Yes
CE mark	Yes
CSA approval	Yes
UL approval	Yes
cULus	Yes
FM approval	Yes
RCM (formerly C-TICK)	Yes
CCC	Yes
KC approval	Yes
EAC (formerly Gost-R)	Yes
Use in hazardous areas	
ATEX	ATEX II 3 G Ex ec IIC T4 Gc
Ambient conditions	
Ambient temperature during operation	
Min.	0 °C
Max.	60 °C
Configuration	
Programming	
Instruction set	See instruction list
Nesting levels	7
Access to consistent data in the process image	Yes
System functions (SFC)	See instruction list
System function blocks (SFB)	See instruction list
Programming language	
LAD	Yes
FBD	Yes

	6ES7414-2XL07-0AB0
STL	Yes
SCL	Yes
CFC	Yes
GRAPH	Yes
HiGraph®	Yes
Number of simultaneously active SFCs	
DPSYC_FR	2; SFC 11; per interface
D_ACT_DP	8; SFC 12; per interface
RD_REC	8; SFC 59; per interface
WR_REC	8; SFC 58; per interface
WR_PARM	8; SFC 55; per interface
PARM_MOD	1; SFC 57; per interface
WR_DPARM	2; SFC 56; per interface
DPNRM_DG	8; SFC 13; per interface
RDSYSST	8; SFC 51
DP_TOPOL	1; SFC 103; per interface
Number of simultaneously active SFBs	
RDREC	8; SFB 52; per interface, but not more than 32 across all external interfaces
WRREC	8; SFB 53; per interface, but not more than 32 across all external interfaces
Know-how protection	
User program/password protection	Yes
Block encryption	Yes; with S7 block privacy
Dimensions	
Width	25 mm
Height	290 mm
Depth	219 mm
Weights	
Weight, approx.	700 g

10.5 Technical data of the CPU 414-3 (6ES7414-3XM07-0AB0)

Data

	6ES7414-3XM07-0AB0
General information	
Product type designation	CPU 414-3
Hardware version	01
Firmware version	V7.0
Engineering with	
Programming package	As of STEP 7 V5.4 with HSP 261
CiR Configuration in RUN	
CiR synchronization time, base load	100 ms
CiR synchronization time, time per I/O byte	15 µs
Power supply	
Rated value (DC)	
24 V DC	No; voltage supplied via the system voltage supply
Input current	
From backplane bus 5 V DC, typ.	1.1 A
From backplane bus 5 V DC, max.	1.3 A
From the backplane bus 24 V DC, max.	450 mA; 150 mA per DP interface
From interface 5 V DC, max.	90 mA; for each DP interface
Power loss	
Typical power loss	5.5 W
Power loss, max.	6.5 W
Memory	
Type of memory	RAM
Work memory	
Integrated	4 MB
integrated (for program)	2 MB
integrated (for data)	2 MB
Expandable	No
Load memory	
Expandable FEPROM	Yes; with memory card (FLASH)
Expandable FEPROM, max.	64 MB
integrated RAM, max.	512 KB
Expandable RAM	Yes; with memory card (RAM)
Expandable RAM, max.	64 MB
Battery backup	
Available	Yes
With battery	Yes; all data
Without battery	No

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Battery	
Backup battery	
Backup battery current, typ.	180 µA
Backup battery current, max.	850 µA
Backup battery time, max.	Covered by the conditions and effects described in the Module data manual
Feed of external backup voltage to the CPU	5 to 15 V DC
CPU processing times	
For bit operations, typ.	18.75 ns
For word operations, typ.	18.75 ns
For integer arithmetic, typ.	18.75 ns
For floating-point arithmetic, typ.	37.5 ns
CPU blocks	
DB	
Number, max.	6000; number range: 1 to 16000
Size, max.	64 KB
FB	
Number, max.	3000; number range: 0 to 7999
Size, max.	64 KB
FC	
Number, max.	3000; number range: 0 to 7999
Size, max.	64 KB
OB	
Size, max.	64 KB
Number of free-cycle OBs	1; OB 1
Number of time-of-day interrupt OBs	4; OB 10-13
Number of time-delay interrupt OBs	4; OB 20-23
Number of cyclic interrupt OBs	4; OB 32-35 (smallest configurable cycle = 500 µs)
Number of hardware interrupt OBs	4; OB 40-43
Number of DPV1 interrupt OBs	3; OB 55-57
Number of isochronous OBs	3; OB 61-63
Number of multi-computing OBs	1; OB 60
Number of background OBs	1; OB 90
Number of startup OBs	3; OB 100-102
Number of asynchronous error OBs	9; OB 80-88
Number of synchronous error OBs	2; OB 121, 122
Nesting depth	
Per priority class	24
Additional levels within an error OB	1
Counters, timers and their retentivity	
S7 counters	

	6ES7414-3XM07-0AB0
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	C 0 to C 7
Counting range	
Low limit	0
High limit	999
IEC counters	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
S7 timers	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	No retentive timers
Time range	
Low limit	10 ms
High limit	9990 s
IEC timers	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
Data areas and their retentivity	
Retentive data area, total	Total work and load memory (with backup battery)
Bit memories	
Number, max.	8 KB; size of bit memory address area
Retentivity available	Yes
Default retentivity	MB 0 to MB 15
Number of clock memories	8; in 1 memory byte
Local data	
Adjustable, max.	16 KB
Default	8 KB
Address area	
I/O address area	
Inputs	8 KB
Outputs	8 KB

	6ES7414-3XM07-0AB0
of which are distributed	
MPI/DP interface, inputs	2 KB
MPI/DP interface, outputs	2 KB
DP interface, inputs	6 KB
DP interface, outputs	6 KB
Process image	
Inputs, adjustable	8 KB
Outputs, adjustable	8 KB
Inputs, preset	256 bytes
Outputs, preset	256 bytes
Consistent data, max.	244 bytes
Access to consistent data in the process image	Yes
Process image partitions	
Number of process image partitions, max.	15
Digital channels	
Inputs	65536
of which are central	65536
Outputs	65536
of which are central	65536
Analog channels	
Inputs	4096
of which are central	4096
Outputs	4096
of which are central	4096
Hardware configuration	
Number of expansion units, max.	21
Connectable OP	63
Multicomputing	Yes; max. 4 CPU (with UR1 or UR2)
Interface modules	
Number of plug-in IMs (total), max.	6
Number of plug-in IM 460s, max.	6
Number of plug-in IM 463s, max.	4; IM 463-2
Number of DP masters	
Integrated	2
Via IM 467	4
Via CP	10; CP 443-5 Extended
Mixed IM + CP operation allowed	No; IM 467 cannot be used in combination with CP 443-5 Ext. or CP 443-1 n PROFINET IO mode
Via interface module	1
Number of plug-in S5 modules (via adapter bay, in the central controller), max.	6
Number of IO controllers	

	6ES7414-3XM07-0AB0
Integrated	0
Via CP	4; max. 4 in central controller; no mixed operation of different CP 443-1 types in PROFINET IO mode
Number of usable FMs and CPs (recommendation)	
FM	Limited by the number of slots and connections
CP, point-to-point	CP 440: limited by the number of slots; CP 441: Limited by the number of connections
PROFIBUS and Ethernet CPs	14; in total max. 10 CP as DP master and PROFINET controller, of which up to 10 IM or CP as DP master and up to 4 CP as PROFINET controller
Slots	
Slots required	2
Time of day	
Clock	
Hardware clock (real-time clock)	Yes
With battery backup, can be synchronized	Yes
Resolution	1 ms
Deviation per day (with battery backup), max.	1.7 s; Power off
Deviation per day (without battery backup), max.	8.6 s; with Power on
Operating hours counter	
Number	16
Number/number range	0 to 15
Range of values	SFCs 2, 3 and 4: 0 to 32767 hours SFC 101: 0 to 2^31 - 1 hour
Resolution	1 hour
Retentive	Yes
Time synchronization	
Supported	Yes
on MPI, master	Yes
on MPI, slave	Yes
on DP, master	Yes
on DP, slave	Yes
in the AS, master	Yes
in the AS, slave	Yes
On Ethernet via NTP	No; via CP
On IF 964 DP	Yes
Time difference in the system with synchronization via	
MPI, max.	200 ms
Interfaces	
Interfaces/bus type	1x MPI/PROFIBUS DP, 1x PROFIBUS DP, 1x PROFIBUS DP (optionally plug-in)
Number of RS 485 interfaces	2; combination MPI / PROFIBUS DP and PROFIBUS DP
Number of other interfaces	1; PROFIBUS DP with IF 964-DP (optionally plug-in; MLFB: 6ES7964-2AA04-0AB0)

	6ES7414-3XM07-0AB0
1st interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS + MPI
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	MPI: 32, DP: 16
Protocols	
MPI	Yes
DP master	Yes
DP slave	Yes
MPI	
Number of connections	32; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Services	
PG/OP communication	Yes
Routing	Yes
Global data communication	Yes
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
PROFIBUS DP master	
Number of connections, max.	16; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	32
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	

	6ES7414-3XM07-0AB0
Inputs, max.	2 KB
Outputs, max.	2 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	16
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No
Address area, max.	32; virtual slots
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
PG/OP communication	Yes; with active interface
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
2nd interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	16
Protocols	
DP master	Yes
DP slave	Yes
PROFIBUS DP master	
Number of connections, max.	16
Transmission rate, max.	12 Mbps

	6ES7414-3XM07-0AB0
Number of DP slaves, max.	96
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	6 KB
Outputs, max.	6 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	16
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Address area, max.	32
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
Routing	Yes; with active interface
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
3rd interface	
Interface type	Plug-in interface module (IF), technical specifications as for 2nd interface
Plug-in interface modules	IF 964-DP (MLFB: 6ES7964-2AA04-0AB0)
Hardware	RS 485 / PROFIBUS

	6ES7414-3XM07-0AB0
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Automatic determination of transmission rate	No
Number of connection resources	16
Protocols	
MPI	No
DP master	Yes
DP slave	Yes
PROFIBUS DP master	
Number of connections, max.	16
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	96
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV0	Yes
DPV1	Yes
Address area	
Inputs, max.	6 KB
Outputs, max.	6 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	16
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No

	6ES7414-3XM07-0AB0
Address area, max.	32
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
PG/OP communication	Yes
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
Isochronous mode	
Isochronous mode (application synchronized up to terminal)	Yes; only with PROFIBUS
Number of DP masters with isochronous mode	3
User data per isochronous slave, max.	244 bytes
Constant bus cycle time	Yes
Minimum clock cycle	1 ms; 0.5 ms without use of SFC 126, 127
Maximum clock cycle	32 ms
Communication functions	
PG/OP communication	Yes
Number of connectable OPs without message processing	63
Number of connectable OPs with message processing	63; when using Alarm_S/SQ and Alarm_D/DQ
Data record routing	Yes
Global data communication	
Supported	Yes
Number of GD circles, max.	8
Number of GD packets, sender, max.	8
Number of GD packets, receiver, max.	16
Size of GD packets, max.	54 bytes
Size of GD packets (of which are consistent), max.	1 variable
S7 basic communication	
Supported	Yes
User data per job, max.	76 bytes
User data per job (of which consistent), max.	1 variable
S7 communication	
Supported	Yes

	6ES7414-3XM07-0AB0
As server	Yes
As client	Yes
User data per job, max.	64 KB
User data per job (of which consistent), max.	462 bytes; 1 variable
S5-compatible communication	
Supported	Yes; via FC AG_SEND and AG_RECV, maximum via 10 CP 443-1 or 443-5
User data per job, max.	8 KB
User data per job (of which consistent), max.	240 bytes
Number of simultaneous AG-SEND/AG-RECV jobs per CPU, max.	24/24
Standard communication (FMS)	
Supported	Yes; via CP and loadable FBs
Open IE communication	
ISO-on-TCP (RFC1006)	via CP 443-1 and loadable FB
Data length, max.	1452 bytes via CP 443-1 Adv.
Web server	
Supported	No
Number of connections	
Total	64
Suitable for PG communication	63
Reserved for PG communication	1
Assignable for PG communication, max.	0
Suitable for OP communication	63
Reserved for OP communication	1
Assignable for OP communication, max.	0
Suitable for S7 basic communication	62
Reserved for S7 basic communication	0
Assignable for S7 basic communication, max.	0
Suitable for S7 communication	62
Reserved for S7 communication	0
Assignable for S7 communication, max.	0
Suitable for routing	31
Reserved for routing	0
Assignable for routing, max.	0
S7 message functions	
Number of stations that can be logged on for signaling functions, max.	63; max. 63 with Alarm_S/SQ and Alarm_D/DQ (OPs); max. 8 with Alarm, Alarm_8, Alarm_8P, Notify and Notify_8 (e.g. WinCC)
Symbol-related messages	Yes
SCAN procedure	Yes
Block-related messages	Yes

	6ES7414-3XM07-0AB0
Process diagnostics messages	Yes
Simultaneously active Alarm_S blocks, max.	400; simultaneously active Alarm_S/SQ blocks and Alarm_D/DQ blocks
Alarm_8 blocks	Yes
Number of instances for Alarm_8 and S7 communication blocks, max.	1200
Preset, max.	300
Process control messages	Yes
Number of archives that can be logged on simultaneously (SFB 37 AR_SEND)	16
Number of messages	
Total, max.	512
In 100 ms interval, max.	128
in 500 ms interval, max.	256
in 1000 ms interval, max.	512
Number of additional values	
In 100 ms interval, max.	1
In 500, 1000 ms interval, max.	10
Test and commissioning functions	
Block status	Yes; up to 16 simultaneously
Single-step	Yes
Number of breakpoints	16
Status/modify	
Status/modify variable	Yes; up to 16 variable tables
Variables	Inputs/outputs, bit memory, DB, I/O inputs/outputs, timers, counters
Number of variables, max.	70; Status / Modify
Forcing	
Forcing	Yes
Force, variables	Inputs, outputs, bit memories, distributed I/O
Number of variables, max.	256
Diagnostics buffer	
Available	Yes
Number of entries, max.	3200
Adjustable	Yes
Default	120
Service data	
Readable	Yes
Standards, approvals, certificates	
UKCA	Yes
CE mark	Yes
CSA approval	Yes

	6ES7414-3XM07-0AB0
UL approval	Yes
cULus	Yes
FM approval	Yes
RCM (formerly C-TICK)	Yes
CCC	Yes
KC approval	Yes
EAC (formerly Gost-R)	Yes
Use in hazardous areas	
ATEX	ATEX II 3 G Ex ec IIC T4 Gc
Ambient conditions	
Ambient temperature during operation	
Min.	0 °C
Max.	60 °C
Configuration	
Programming	
Instruction set	See instruction list
Nesting levels	7
Access to consistent data in the process image	Yes
System functions (SFC)	See instruction list
System function blocks (SFB)	See instruction list
Programming language	
LAD	Yes
FBD	Yes
STL	Yes
SCL	Yes
CFC	Yes
GRAPH	Yes
HiGraph®	Yes
Number of simultaneously active SFCs	
DPSYC_FR	2; SFC 11; per interface
D_ACT_DP	8; SFC 12; per interface
RD_REC	8; SFC 59; per interface
WR_REC	8; SFC 58; per interface
WR_PARM	8; SFC 55; per interface
PARM_MOD	1; SFC 57; per interface
WR_DPARM	2; SFC 56; per interface
DPNRM_DG	8; SFC 13; per interface
RDSYSST	8; SFC 51
DP_TOPOL	1; SFC 103; per interface
Number of simultaneously active SFBs	

	6ES7414-3XM07-0AB0
RDREC	8; SFB 52; per interface, but not more than 32 across all external interfaces
WRREC	8; SFB 53; per interface, but not more than 32 across all external interfaces
Know-how protection	
User program/password protection	Yes
Block encryption	Yes; with S7 block privacy
Dimensions	
Width	50 mm
Height	290 mm
Depth	219 mm
Weights	
Weight, approx.	900 g

10.6 Technical specifications of CPU 414-3 PN/DP (6ES7414-3EM07-0AB0), CPU 414F-3 PN/DP (6ES7414-3FM07-0AB0)

Data

	6ES7414-3EM07-0AB0 **6ES7414-3FM07-0AB0**
General information	
Product type designation	CPU414-3 PN/DP CPU414F-3 PN/DP
Hardware version	01
Firmware version	V7.0
Engineering with	
Programming package	as of STEP 7 V5.5 with HSP 262
CiR Configuration in RUN	
CiR synchronization time, base load	100 ms
CiR synchronization time, time per I/O byte	15 µs
Power supply	
Rated value (DC)	
24 V DC	No; voltage supplied via the system voltage supply
Input current	
From backplane bus 5 V DC, typ.	1.3 A
From backplane bus 5 V DC, max.	1.6 A
From the backplane bus 24 V DC, max.	300 mA; 150 mA per DP interface
From interface 5 V DC, max.	90 mA; for each DP interface
Power loss	
Typical power loss	6.5 W
Power loss, max.	8 W
Memory	
Type of memory	RAM
Work memory	
Integrated	4 MB
integrated (for program)	2 MB
integrated (for data)	2 MB
Expandable	No
Load memory	
Expandable FEPROM	Yes; with memory card (FLASH)
Expandable FEPROM, max.	64 MB
integrated RAM, max.	512 KB
Expandable RAM	Yes; with memory card (RAM)

	6ES7414-3EM07-0AB0 6ES7414-3FM07-0AB0
Expandable RAM, max.	64 MB
Battery backup	
Available	Yes
With battery	Yes; all data
Without battery	No
Battery	
Backup battery	
Backup battery current, typ.	180 µA; to 40 °C
Backup battery current, max.	850 µA
Backup battery time, max.	Covered by the conditions and effects described in the Module data manual
Feed of external backup voltage to the CPU	5 to 15 V DC
CPU processing times	
For bit operations, typ.	18.75 ns
For word operations, typ.	18.75 ns
For integer arithmetic, typ.	18.75 ns
For floating-point arithmetic, typ.	37.5 ns
CPU blocks	
DB	
Number, max.	6000; number range: 1 to 16000
Size, max.	64 KB
FB	
Number, max.	3000; number range: 0 to 7999
Size, max.	64 KB
FC	
Number, max.	3000; number range: 0 to 7999
Size, max.	64 KB
OB	
Size, max.	64 KB
Number of free-cycle OBs	1; OB 1
Number of time-of-day interrupt OBs	4; OB 10-13
Number of time-delay interrupt OBs	4; OB 20-23
Number of cyclic interrupt OBs	4; OB 32, 33, 34, 35 (smallest configurable cycle = 500 µs)
Number of hardware interrupt OBs	4; OB 40-43
Number of DPV1 interrupt OBs	3; OB 55-57
Number of isochronous OBs	3; OB 61-63
Number of multi-computing OBs	1; OB 60
Number of background OBs	1; OB 90
Number of startup OBs	3; OB 100, 101, 102 with CPU414-3 PN/DP 2; OB 100, 102 with CPU 414F-3 PN/DP
Number of asynchronous error OBs	9; OB 80-88

	6ES7414-3EM07-0AB0 **6ES7414-3FM07-0AB0**
Number of synchronous error OBs	2; OB 121, 122
Nesting depth	
Per priority class	24
Additional levels within an error OB	1
Counters, timers and their retentivity	
S7 counters	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	C 0 to C 7
Counting range	
Low limit	0
High limit	999
IEC counters	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
S7 timers	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	No retentive timers
Time range	
Low limit	10 ms
High limit	9990 s
IEC timers	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
Data areas and their retentivity	
Retentive data area, total	Total work and load memory (with backup battery)
Bit memories	
Number, max.	8 KB; size of bit memory address area
Retentivity available	Yes
Default retentivity	MB 0 to MB 15
Number of clock memories	8; in 1 memory byte

	6ES7414-3EM07-0AB0 6ES7414-3FM07-0AB0
Local data	
Adjustable, max.	16 KB
Default	8 KB
Address area	
I/O address area	
Inputs	8 KB
Outputs	8 KB
of which are distributed	
MPI/DP interface, inputs	2 KB
MPI/DP interface, outputs	2 KB
DP interface, inputs	6 KB
DP interface, outputs	6 KB
PN interface, inputs	8 KB
PN interface, outputs	8 KB
Process image	
Inputs, adjustable	8 KB
Outputs, adjustable	8 KB
Inputs, preset	256 bytes
Outputs, preset	256 bytes
Consistent data, max.	244 bytes
Access to consistent data in the process image	Yes
Process image partitions	
Number of process image partitions, max.	15
Digital channels	
Inputs	65536
of which are central	65536
Outputs	65536
of which are central	65536
Analog channels	
Inputs	4096
of which are central	4096
Outputs	4096
of which are central	4096
Hardware configuration	
Number of expansion units, max.	21
Multicomputing	Yes; max. 4 CPU (with UR1 or UR2)
Interface modules	
Number of plug-in IMs (total), max.	6
Number of plug-in IM 460s, max.	6
Number of plug-in IM 463s, max.	4; IM 463-2

	6ES7414-3EM07-0AB0 **6ES7414-3FM07-0AB0**
Number of DP masters	
Integrated	1
Via IM 467	4
Via CP	10; CP 443-5 Extended
Mixed IM + CP operation allowed	No; IM 467 cannot be used in combination with CP 443-5 Ext. or CP 443-1 n PROFINET IO mode
Via interface module	1; IF 964-DP
Number of plug-in S5 modules (via adapter bay, in the central controller), max.	6
Number of IO controllers	
Integrated	1
Via CP	4; max. 4 in central controller; no mixed operation of different CP 443-1 types in PROFINET IO mode
Number of usable FMs and CPs (recommendation)	
FM	Limited by the number of slots and connections
CP, point-to-point	CP 440: limited by the number of slots; CP 441: limited by the number of slots or connections
PROFIBUS and Ethernet CPs	14; in total max. 10 CP as DP master and PROFINET controller, of which up to 10 IM or CP as DP master and up to 4 CP as PROFINET controller
Slots	
Slots required	2
Time of day	
Clock	
Hardware clock (real-time clock)	Yes
With battery backup, can be synchronized	Yes
Resolution	1 ms
Deviation per day (with battery backup), max.	1.7 s; Power off
Deviation per day (without battery backup), max.	8.6 s; with Power on
Operating hours counter	
Number	16
Number/number range	0 to 15
Range of values	SFCs 2, 3 and 4: 0 to 32767 hours SFC 101: 0 to 2^31 - 1 hour
Resolution	1 hour
Retentive	Yes
Time synchronization	
Supported	Yes
on MPI, master	Yes
on MPI, slave	Yes
on DP, master	Yes
on DP, slave	Yes
in the AS, master	Yes

	6ES7414-3EM07-0AB0 6ES7414-3FM07-0AB0
in the AS, slave	Yes
On Ethernet via NTP	Yes; as client
On IF 964 DP	Yes
Time difference in the system with synchronization via	
Ethernet, max.	10 ms
MPI, max.	200 ms
Interfaces	
Interfaces/bus type	1x MPI/PROFIBUS DP, 1x PROFINET (2 ports), 1x PROFIBUS DP (optionally plug-in)
Number of RS 485 interfaces	1; combination MPI / PROFIBUS DP
Number of other interfaces	1; PROFIBUS DP with IF 964-DP (optionally plug-in; MLFB: 6ES7964-2AA04-0AB0)
1st interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS + MPI
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	MPI: 32, DP: 16
Functionality	
MPI	Yes
DP master	Yes
DP slave	Yes
MPI	
Number of connections	32; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Services	
PG/OP communication	Yes
Routing	Yes
Global data communication	Yes
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
DP master	
Number of connections, max.	16; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	32
Services	
PG/OP communication	Yes

	6ES7414-3EM07-0AB0 6ES7414-3FM07-0AB0
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	2 KB
Outputs, max.	2 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
DP slave	
Number of connections	16
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No
Address area, max.	32; virtual slots
User data per address area, max.	32 bytes
Consistent user data per address area, max.	32 bytes
Services	
PG/OP communication	Yes; with active interface
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes

	6ES7414-3EM07-0AB0 **6ES7414-3FM07-0AB0**
Outputs	244 bytes
2nd interface	
Interface type	PROFINET
Hardware	Ethernet RJ45
Electrically isolated	Yes
Integrated switch	Yes
Number of ports	2
Automatic determination of transmission rate	Yes; Autosensing
Autonegotiation	Yes
Autocrossing	Yes
Change of the IP address at runtime, supported	Yes; specified by higher-level IO controller or by the user program with SFB 104 "IP_CONF"
Number of connection resources	64
Media redundancy	
Supported	Yes
Changeover time at line interruption, typ.	200 ms
Number of nodes on the ring, max.	50
Functionality	
DP master	No
DP slave	No
PROFINET IO controller	Yes
PROFINET IO device	Yes
PROFINET CBA	Yes
Open IE communication	Yes
Point-to-point link	No
PROFINET IO controller	
Transmission rate, max.	100 Mbps
Number of connectable IO devices, max.	256
Number of connectable IO devices for RT, max.	256
of which in line, max.	256
Number of IO devices with IRT and the "high flexibility" option	256
of which in line, max.	61
Max. number of IO devices with IRT and the "high performance" option	64
of which in line, max.	64
Shared device	Yes
Prioritized startup	Yes
Number of IO devices, max.	32
Enabling/disabling of IO devices	Yes
Max. number of I/O devices that can be enabled/disabled simultaneously	8

	6ES7414-3EM07-0AB0 **6ES7414-3FM07-0AB0**
Hot-swapping of I/O devices (partner ports), supported	Yes
Number of IO devices per tool, max.	8; 8 parallel calls of SFC 12 "D_ACT_DP" per segment are possible. Hot-swapping of maximum 32 I/O devices (partner ports) supported
Device replacement without swap medium	Yes
Send clocks	250 µs, 500 µs, 1 ms, 2 ms, 4 ms also for IRT with higher performance: 250 µs to 4 ms at an interval of 125 µs
Update time	250 µs to 512 ms; The minimum value depends on the communication slice set for PROFINET IO, the number of IO devices, and the amount of configured user data; see PROFINET system description
Services	
PG/OP communication	Yes
S7 routing	Yes
S7 communication	Yes
Isochronous mode	Yes; only with IRT and the "high performance" option
Open IE communication	Yes
Address area	
Inputs, max.	8 KB
Outputs, max.	8 KB
User data consistency, max.	1024 bytes
PROFINET IO device	
Services	
PG/OP communication	Yes
S7 routing	Yes
S7 communication	Yes
Isochronous mode	No
Open IE communication	Yes
IRT	Yes
Prioritized startup	Yes
Shared device	Yes
Number of IO controllers with shared device, max.	2
Transfer memory	
Inputs, max.	1440 bytes; per IO controller with shared device
Outputs, max.	1440 bytes; per IO controller with shared device
Submodules	
Number, max.	64
User data per submodule, max.	1024 bytes
Open IE communication	
Number of connections, max.	62
Local port numbers used by the system	0, 20, 21, 25, 80, 102, 135, 161, 34962, 34963, 34964, 65532, 65533, 65534, 65535

	6ES7414-3EM07-0AB0 6ES7414-3FM07-0AB0
Keep Alive function supported	Yes
3rd interface	
Interface type	Plug-in interface module (IF)
Plug-in interface modules	IF 964-DP (MLFB: 6ES7964-2AA04-0AB0)
Hardware	RS 485 / PROFIBUS
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Automatic determination of transmission rate	No
Number of connection resources	16
Functionality	
MPI	No
DP master	Yes
DP slave	Yes
DP master	
Number of connections, max.	16
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	96
Services	
PG/OP communication	Yes
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	6 KB
Outputs, max.	6 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
DP slave	

	6ES7414-3EM07-0AB0 **6ES7414-3FM07-0AB0**
Number of connections	16
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No
Address area, max.	32; virtual slots
User data per address area, max.	32 bytes
Consistent user data per address area, max.	32 bytes
Services	
PG/OP communication	Yes
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
Isochronous mode	
Isochronous mode (application synchronized up to terminal)	Yes; via PROFIBUS DP or PROFINET interface
Number of DP masters with isochronous mode	2
User data per isochronous slave, max.	244 bytes
Constant bus cycle time	Yes
Minimum clock cycle	1 ms; 0.5 ms without use of SFC 126, 127
Maximum clock cycle	32 ms
Communication functions	
PG/OP communication	Yes
Number of connectable OPs without message processing	63
Number of connectable OPs with message processing	63; when using Alarm_S/SQ and Alarm_D/DQ
Data record routing	Yes
Global data communication	
Supported	Yes
Number of GD circles, max.	8
Number of GD packets, sender, max.	8
Number of GD packets, receiver, max.	16
Size of GD packets, max.	54 bytes
Size of GD packets (of which are consistent), max.	1 variable
S7 basic communication	

	6ES7414-3EM07-0AB0 6ES7414-3FM07-0AB0
Supported	Yes
User data per job, max.	76 bytes
User data per job (of which consistent), max.	1 variable
S7 communication	
Supported	Yes
As server	Yes
As client	Yes
User data per job, max.	64 KB
User data per job (of which consistent), max.	462 bytes; 1 variable
S5-compatible communication	
Supported	Yes; via FC AG_SEND and AG_RECV, maximum via 10 CP 443-1 or 443-5
User data per job, max.	8 KB
User data per job (of which consistent), max.	240 bytes
Number of simultaneous AG-SEND/AG-RECV jobs per CPU, max.	24/24
Standard communication (FMS)	
Supported	Yes; via CP and loadable FBs
Open IE communication	
TCP/IP	Yes; via integrated PROFINET interface and loadable FBs
Number of connections, max.	62
Data length, max.	32 KB
Multiple passive connections per port, supported	Yes
ISO-on-TCP (RFC1006)	Yes; via integrated PROFINET interface or CP 443-1 Adv. and loadable FBs
Number of connections, max.	62
Data length, max.	32 KB; 1452 bytes via CP 443-1 Adv.
UDP	Yes; via integrated PROFINET interface and loadable FBs
Number of connections, max.	62
Data length, max.	1472 bytes
Web server	
Supported	Yes
Number of HTTP clients	5
User-defined websites	Yes
PROFINET CBA (with configured communication load setpoint)	
Reference setting for CPU communication load	20%
Number of remote interconnection partners	32
Number of master/slave functions	150
Total of all master/slave connections	4500
Data length of all incoming master/slave I/Os, max.	45000 bytes
Data length of all outgoing master/slave connections, max.	45000 bytes

	6ES7414-3EM07-0AB0 **6ES7414-3FM07-0AB0**
Number of device-internal and PROFIBUS interconnections	1000
Data length of the device-internal and PROFIBUS interconnections, max.	16000 bytes
Data length per connection, max.	2000 bytes
Remote interconnections with non-cyclic transmission	
Sampling rate: Sampling interval, min.	200 ms; Depends on preset communication load, number of interconnections and used data length
Number of incoming interconnections	250
Number of outgoing interconnections	250
Data length of all incoming interconnections, max.	8000 bytes
Data length of all outgoing interconnections, max.	8000 bytes
Data length per connection, max.	2000 bytes
Remote interconnections with cyclic transmission	
Transmission rate: Minimum transmission time	1 ms; Depends on preset communication load, number of interconnections and used data length
Number of incoming interconnections	300
Number of outgoing interconnections	300
Data length of all incoming interconnections, max.	4800 bytes
Data length of all outgoing interconnections, max.	4800 bytes
Data length per connection, max.	450 bytes
HMI variables via PROFINET (non-cyclic)	
Number of stations that can be logged on for HMI variables (PN OPC/IMAP)	2x PN OPC / 1x IMAP
Update of HMI variables	500 ms
Number of HMI variables	1000
Data length of all HMI variables, max.	32000 bytes
PROFIBUS proxy functionality	
Supported	Yes; max. 32 PROFIBUS slaves can be connected
Data length per connection, max.	240 bytes; slave dependent
Number of connections	
Total	64
Suitable for PG communication	63
Reserved for PG communication	1
Assignable for PG communication, max.	0
Suitable for OP communication	63
Reserved for OP communication	1
Assignable for OP communication, max.	0
Suitable for S7 basic communication	62
Reserved for S7 basic communication	0
Assignable for S7 basic communication, max.	0
Suitable for S7 communication	62

	6ES7414-3EM07-0AB0 **6ES7414-3FM07-0AB0**
Reserved for S7 communication	0
Assignable for S7 communication, max.	0
Suitable for routing	31
Reserved for routing	0
Assignable for routing, max.	0
S7 message functions	
Number of stations that can be logged on for signaling functions, max.	63; max. 63 with Alarm_S/SQ and Alarm_D/DQ (OPs); max. 8 with Alarm, Alarm_8, Alarm_8P, Notify and Notify_8 (e.g. WinCC)
Symbol-related messages	Yes
SCAN procedure	Yes
Block-related messages	Yes
Process diagnostics messages	Yes
Simultaneously active Alarm_S blocks, max.	400; simultaneously active Alarm_S/SQ blocks and Alarm_D/DQ blocks
Alarm_8 blocks	Yes
Number of instances for Alarm_8 and S7 communication blocks, max.	1200
Preset, max.	300
Process control messages	Yes
Number of archives that can be logged on simultaneously (SFB 37 AR_SEND)	16
Number of messages	
Total, max.	512
In 100 ms interval, max.	128
in 500 ms interval, max.	256
in 1000 ms interval, max.	512
Number of additional values	
In 100 ms interval, max.	1
In 500, 1000 ms interval, max.	10
Test and commissioning functions	
Block status	Yes; up to 16 simultaneously
Single-step	Yes
Number of breakpoints	16
Status/modify	
Status/modify variable	Yes; up to 16 variable tables
Variables	Inputs/outputs, bit memory, DB, I/O inputs/outputs, timers, counters
Number of variables, max.	70; Status / Modify
Forcing	
Forcing	Yes
Force, variables	Inputs/outputs, bit memories, distributed I/O

	6ES7414-3EM07-0AB0 6ES7414-3FM07-0AB0
Number of variables, max.	256
Diagnostics buffer	
Available	Yes
Number of entries, max.	3200
Adjustable	Yes
Default	120
Service data	
Readable	Yes
Standards, approvals, certificates	
UKCA	Yes
CE mark	Yes
CSA approval	Yes
UL approval	Yes
cULus	Yes
FM approval	Yes
RCM (formerly C-TICK)	Yes
CCC	Yes
KC approval	Yes
EAC (formerly Gost-R)	Yes
Use in hazardous areas	
ATEX	ATEX II 3 G Ex ec IIC T4 Gc
Ambient conditions	
Ambient temperature during operation	
Min.	0° C
Max.	60 °C
Configuration	
Programming	
Instruction set	See instruction list
Nesting levels	7
System functions (SFC)	See instruction list
System function blocks (SFB)	See instruction list
Programming language	
LAD	Yes
FBD	Yes
STL	Yes
SCL	Yes
CFC	Yes
GRAPH	Yes
HiGraph®	Yes
Number of simultaneously active SFCs	

	6ES7414-3EM07-0AB0 **6ES7414-3FM07-0AB0**
DPSYC_FR	2; SFC 11; per interface
D_ACT_DP	8; SFC 12; per interface
RD_REC	8; SFC 59; per interface
WR_REC	8; SFC 58; per interface
WR_PARM	8; SFC 55; per interface
PARM_MOD	1; SFC 57; per interface
WR_DPARM	2; SFC 56; per interface
DPNRM_DG	8; SFC 13; per interface
RDSYSST	8; SFC 51
DP_TOPOL	1; SFC 103; per interface
Number of simultaneously active SFBs	
RDREC	8; SFB 52; per interface, but not more than 32 across all external interfaces
WRREC	8; SFB 53; per interface, but not more than 32 across all external interfaces
Know-how protection	
User program/password protection	Yes
Block encryption	Yes; with S7 block privacy
Dimensions	
Width	50 mm
Height	290 mm
Depth	219 mm
Weights	
Weight, approx.	900 g

10.7 Technical data of the CPU 416-2 (6ES7416-2XP07-0AB0), CPU 416F-2 (6ES7416-2FP07-0AB0)

Data

	6ES7416-2XP07-0AB0 **6ES7416-2FP07-0AB0**
General information	
Product type designation	CPU 416-2
Hardware version	01
Firmware version	V7.0
Engineering with	
Programming package	As of STEP 7 V5.4 with HSP 261
CiR Configuration in RUN	
CiR synchronization time, base load	100 ms
CiR synchronization time, time per I/O byte	10 µs
Power supply	
Rated value (DC)	
24 V DC	No; voltage supplied via the system voltage supply
Input current	
From backplane bus 5 V DC, typ.	0.9 A
From backplane bus 5 V DC, max.	1.1 A
From the backplane bus 24 V DC, max.	300 mA; 150 mA per DP interface
From interface 5 V DC, max.	90 mA; for each DP interface
Power loss	
Typical power loss	4.5 W
Power loss, max.	5.5 W
Memory	
Type of memory	RAM
Work memory	
Integrated	8 MB
integrated (for program)	4 MB
integrated (for data)	4 MB
Expandable	No
Load memory	
Expandable FEPROM	Yes; with memory card (FLASH)
Expandable FEPROM, max.	64 MB
integrated RAM, max.	1 MB
Expandable RAM	Yes; with memory card (RAM)
Expandable RAM, max.	64 MB
Battery backup	

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Available	Yes
With battery	Yes; all data
Without battery	No
Battery	
Backup battery	
Backup battery current, typ.	180 µA; to 40 °C
Backup battery current, max.	850 µA
Backup battery time, max.	Covered by the conditions and effects described in the Module data manual
Feed of external backup voltage to the CPU	5 to 15 V DC
CPU processing times	
For bit operations, typ.	12.5 ns
For word operations, typ.	12.5 ns
For integer arithmetic, typ.	12.5 ns
For floating-point arithmetic, typ.	25 ns
CPU blocks	
DB	
Number, max.	10000; number range: 1 to 16000
Size, max.	64 KB
FB	
Number, max.	5000; number range: 0 to 7999
Size, max.	64 KB
FC	
Number, max.	5000; number range: 0 to 7999
Size, max.	64 KB
OB	
Size, max.	64 KB
Number of free-cycle OBs	1; OB 1
Number of time-of-day interrupt OBs	8; OB 10-17
Number of time-delay interrupt OBs	4; OB 20-23
Number of cyclic interrupt OBs	9; OB 30-38 (smallest configurable cycle = 500 µs)
Number of hardware interrupt OBs	8; OB 40-47
Number of DPV1 interrupt OBs	3; OB 55-57
Number of isochronous OBs	4; OB 61-64
Number of multi-computing OBs	1; OB 60
Number of background OBs	1; OB 90
Number of startup OBs	3; OB 100-102
Number of asynchronous error OBs	9; OB 80-88
Number of synchronous error OBs	2; OB 121, 122
Nesting depth	

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Per priority class	24
Additional levels within an error OB	2
Counters, timers and their retentivity	
S7 counters	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	C 0 to C 7
Counting range	
Low limit	0
High limit	999
IEC counters	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
S7 timers	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	No retentive timers
Time range	
Low limit	10 ms
High limit	9990 s
IEC timers	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
Data areas and their retentivity	
Retentive data area, total	Total work and load memory (with backup battery)
Bit memories	
Number, max.	16 KB; size of bit memory address area
Retentivity available	Yes
Default retentivity	MB 0 to MB 15
Number of clock memories	8; in 1 memory byte
Local data	
Adjustable, max.	32 KB

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Default	16 KB	
Address area		
I/O address area		
Inputs	16 KB	
Outputs	16 KB	
of which are distributed		
MPI/DP interface, inputs	2 KB	
MPI/DP interface, outputs	2 KB	
DP interface, inputs	8 KB	
DP interface, outputs	8 KB	
Process image		
Inputs, adjustable	16 KB	
Outputs, adjustable	16 KB	
Inputs, preset	512 bytes	
Outputs, preset	512 bytes	
Consistent data, max.	244 bytes	
Access to consistent data in the process image	Yes	
Process image partitions		
Number of process image partitions, max.	15	
Digital channels		
Inputs	131072	
of which are central	131072	
Outputs	131072	
of which are central	131072	
Analog channels		
Inputs	8192	
of which are central	8192	
Outputs	8192	
of which are central	8192	
Hardware configuration		
Number of expansion units, max.	21	
Connectable OP	95	
Multicomputing	Yes; max. 4 CPU (with UR1 or UR2)	
Interface modules		
Number of plug-in IMs (total), max.	6	
Number of plug-in IM 460s, max.	6	
Number of plug-in IM 463s, max.	4; IM 463-2	
Number of DP masters		
Integrated	2	
Via IM 467	4	

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Via CP	10; CP 443-5 Extended
Mixed IM + CP operation allowed	No; IM 467 cannot be used in combination with CP 443-5 Ext. or CP 443-1 n PROFINET IO mode
Via interface module	0
Number of plug-in S5 modules (via adapter bay, in the central controller), max.	6
Number of IO controllers	
Integrated	0
Via CP	4; max. 4 in central controller; no mixed operation of different CP 443-1 types in PROFINET IO mode
Number of usable FMs and CPs (recommendation)	
FM	Limited by the number of slots and connections
CP, point-to-point	CP 440: limited by the number of slots; CP 441: Limited by the number of connections
PROFIBUS and Ethernet CPs	14; in total max. 10 CP as DP master and PROFINET controller, of which up to 10 IM or CP as DP master and up to 4 CP as PROFINET controller
Slots	
Slots required	1
Time of day	
Clock	
Hardware clock (real-time clock)	Yes
With battery backup, can be synchronized	Yes
Resolution	1 ms
Deviation per day (with battery backup), max.	1.7 s; Power off
Deviation per day (without battery backup), max.	8.6 s; with Power on
Operating hours counter	
Number	16
Number/number range	0 to 15
Range of values	SFCs 2, 3 and 4: 0 to 32767 hours SFC 101: 0 to 2^31 - 1 hour
Resolution	1 hour
Retentive	Yes
Time synchronization	
Supported	Yes
on MPI, master	Yes
on MPI, slave	Yes
on DP, master	Yes
on DP, slave	Yes
in the AS, master	Yes
in the AS, slave	Yes
On Ethernet via NTP	No; via CP
On IF 964 DP	No

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Time difference in the system with synchronization via	
MPI, max.	200 ms
Interfaces	
Interfaces/bus type	1x MPI/PROFIBUS DP, 1x PROFIBUS DP
Number of RS 485 interfaces	2; combination MPI / PROFIBUS DP and PROFIBUS DP
1st interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS + MPI
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	MPI: 44, DP: 32
Protocols	
MPI	Yes
DP master	Yes
DP slave	Yes
MPI	
Number of connections	44; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Services	
PG/OP communication	Yes
Routing	Yes
Global data communication	Yes
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
PROFIBUS DP master	
Number of connections, max.	32; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	32
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes

	6ES7416-2XP07-0AB0 **6ES7416-2FP07-0AB0**
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	2 KB
Outputs, max.	2 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	32
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No
Address area, max.	32; virtual slots
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
PG/OP communication	Yes; with active interface
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
2nd interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA

	6ES7416-2XP07-0AB0 6ES7416-2FP07-0AB0
Number of connection resources	32
Protocols	
DP master	Yes
DP slave	Yes
PROFIBUS DP master	
Number of connections, max.	32
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	125
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	8 KB
Outputs, max.	8 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	32
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Address area, max.	32
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
Routing	Yes; with active interface

	6ES7416-2XP07-0AB0 **6ES7416-2FP07-0AB0**
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
Isochronous mode	
Isochronous mode (application synchronized up to terminal)	Yes; only with PROFIBUS
Number of DP masters with isochronous mode	2
User data per isochronous slave, max.	244 bytes
Constant bus cycle time	Yes
Minimum clock cycle	1 ms; 0.5 ms without use of SFC 126, 127
Maximum clock cycle	32 ms
Communication functions	
PG/OP communication	Yes
Number of connectable OPs without message processing	95
Number of connectable OPs with message processing	95; when using Alarm_S/SQ and Alarm_D/DQ
Data record routing	Yes
Global data communication	
Supported	Yes
Number of GD circles, max.	16
Number of GD packets, sender, max.	16
Number of GD packets, receiver, max.	32
Size of GD packets, max.	54 bytes
Size of GD packets (of which are consistent), max.	1 variable
S7 basic communication	
Supported	Yes
User data per job, max.	76 bytes
User data per job (of which consistent), max.	1 variable
S7 communication	
Supported	Yes
As server	Yes
As client	Yes
User data per job, max.	64 KB
User data per job (of which consistent), max.	462 bytes; 1 variable
S5-compatible communication	
Supported	Yes; via FC AG_SEND and AG_RECV, maximum via 10 CP 443-1 or 443-5
User data per job, max.	8 KB
User data per job (of which consistent), max.	240 bytes
Number of simultaneous AG-SEND/AG-RECV jobs per CPU, max.	64/64
Standard communication (FMS)	
Supported	Yes; via CP and loadable FBs

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Open IE communication	
ISO-on-TCP (RFC1006)	via CP 443-1 and loadable FB
Data length, max.	1452 bytes via CP 443-1 Adv.
Web server	
Supported	No
Number of connections	
Total	96
Suitable for PG communication	95
Reserved for PG communication	1
Assignable for PG communication, max.	0
Suitable for OP communication	95
Reserved for OP communication	1
Assignable for OP communication, max.	0
Suitable for S7 basic communication	94
Reserved for S7 basic communication	0
Assignable for S7 basic communication, max.	0
Suitable for S7 communication	94
Reserved for S7 communication	0
Assignable for S7 communication, max.	0
Suitable for routing	47
Reserved for routing	0
Assignable for routing, max.	0
S7 message functions	
Number of stations that can be logged on for signaling functions, max.	95; max. 95 with Alarm_S/SQ and Alarm_D/DQ (OPs); max. 16 with Alarm, Alarm_8, Alarm_8P, Notify and Notify_8 (e.g. WinCC)
Symbol-related messages	Yes
SCAN procedure	Yes
Block-related messages	Yes
Process diagnostics messages	Yes
Simultaneously active Alarm_S blocks, max.	1000; simultaneously active Alarm_S/SQ blocks and Alarm_D/DQ blocks
Alarm_8 blocks	Yes
Number of instances for Alarm_8 and S7 communication blocks, max.	4000
Preset, max.	600
Process control messages	Yes
Number of archives that can be logged on simultaneously (SFB 37 AR_SEND)	32
Number of messages	
Total, max.	1024

	6ES7416-2XP07-0AB0 **6ES7416-2FP07-0AB0**
In 100 ms interval, max.	128
in 500 ms interval, max.	512
in 1000 ms interval, max.	1024
Number of additional values	
In 100 ms interval, max.	1
In 500, 1000 ms interval, max.	10
Test and commissioning functions	
Block status	Yes; up to 16 simultaneously
Single-step	Yes
Number of breakpoints	16
Status/modify	
Status/modify variable	Yes; up to 16 variable tables
Variables	Inputs/outputs, bit memory, DB, I/O inputs/outputs, timers, counters
Number of variables, max.	70; Status / Modify
Forcing	
Forcing	Yes
Force, variables	Inputs, outputs, bit memories, distributed I/O
Number of variables, max.	512
Diagnostics buffer	
Available	Yes
Number of entries, max.	3200
Adjustable	Yes
Default	120
Service data	
Readable	Yes
Standards, approvals, certificates	
UKCA	Yes
CE mark	Yes
CSA approval	Yes
UL approval	Yes
cULus	Yes
FM approval	Yes
RCM (formerly C-TICK)	Yes
CCC	Yes
KC approval	Yes
EAC (formerly Gost-R)	Yes
Use in hazardous areas	
ATEX	ATEX II 3 G Ex ec IIC T4 Gc
Ambient conditions	

	6ES7416-2XP07-0AB0 6ES7416-2FP07-0AB0
Ambient temperature during operation	
Min.	0 °C
Max.	60 °C
Configuration	
Programming	
Instruction set	See instruction list
Nesting levels	7
Access to consistent data in the process image	Yes
System functions (SFC)	See instruction list
System function blocks (SFB)	See instruction list
Programming language	
LAD	Yes
FBD	Yes
STL	Yes
SCL	Yes
CFC	Yes
GRAPH	Yes
HiGraph®	Yes
Number of simultaneously active SFCs	
DPSYC_FR	2; SFC 11; per interface
D_ACT_DP	8; SFC 12; per interface
RD_REC	8; SFC 59; per interface
WR_REC	8; SFC 58; per interface
WR_PARM	8; SFC 55; per interface
PARM_MOD	1; SFC 57; per interface
WR_DPARM	2; SFC 56; per interface
DPNRM_DG	8; SFC 13; per interface
RDSYSST	8; SFC 51
DP_TOPOL	1; SFC 103; per interface
Number of simultaneously active SFBs	
RDREC	8; SFB 52; per interface, but not more than 32 across all external interfaces
WRREC	8; SFB 53; per interface, but not more than 32 across all external interfaces
Know-how protection	
User program/password protection	Yes
Block encryption	Yes; with S7 block privacy
Dimensions	
Width	25 mm
Height	290 mm
Depth	219 mm

		6ES7416-2XP07-0AB0 **6ES7416-2FP07-0AB0**
Weights		
Weight, approx.	700 g	

10.8 Technical data of the CPU 416-3 (6ES7416-3XS07-0AB0)

Data

	6ES7416-3XS07-0AB0
General information	
Product type designation	CPU 416-3
Hardware version	01
Firmware version	V7.0
Engineering with	
Programming package	As of STEP 7 V5.4 with HSP 261
CiR Configuration in RUN	
CiR synchronization time, base load	100 ms
CiR synchronization time, time per I/O byte	10 µs
Power supply	
Rated value (DC)	
24 V DC	No; voltage supplied via the system voltage supply
Input current	
From backplane bus 5 V DC, typ.	1.1 A
From backplane bus 5 V DC, max.	1.3 A
From the backplane bus 24 V DC, max.	450 mA; 150 mA per DP interface
From interface 5 V DC, max.	90 mA; for each DP interface
Power loss	
Typical power loss	5.5 W
Power loss, max.	6.5 W
Memory	
Type of memory	RAM
Work memory	
Integrated	16 MB
integrated (for program)	8 MB
integrated (for data)	8 MB
Expandable	No
Load memory	
Expandable FEPROM	Yes; with memory card (FLASH)
Expandable FEPROM, max.	64 MB
integrated RAM, max.	1 MB
Expandable RAM	Yes; with memory card (RAM)
Expandable RAM, max.	64 MB
Battery backup	
Available	Yes
With battery	Yes; all data
Without battery	No

	6ES7416-3XS07-0AB0
Battery	
Backup battery	
Backup battery current, typ.	180 µA; to 40 °C
Backup battery current, max.	850 µA
Backup battery time, max.	Covered by the conditions and effects described in the Module data manual
Feed of external backup voltage to the CPU	5 to 15 V DC
CPU processing times	
For bit operations, typ.	12.5 ns
For word operations, typ.	12.5 ns
For integer arithmetic, typ.	12.5 ns
For floating-point arithmetic, typ.	25 ns
CPU blocks	
DB	
Number, max.	10000; number range: 1 to 16000
Size, max.	64 KB
FB	
Number, max.	5000; number range: 0 to 7999
Size, max.	64 KB
FC	
Number, max.	5000; number range: 0 to 7999
Size, max.	64 KB
OB	
Size, max.	64 KB
Number of free-cycle OBs	1; OB 1
Number of time-of-day interrupt OBs	8; OB 10-17
Number of time-delay interrupt OBs	4; OB 20-23
Number of cyclic interrupt OBs	9; OB 30-38 (smallest configurable cycle = 500 µs)
Number of hardware interrupt OBs	8; OB 40-47
Number of DPV1 interrupt OBs	3; OB 55-57
Number of isochronous OBs	4; OB 61-64
Number of multi-computing OBs	1; OB 60
Number of background OBs	1; OB 90
Number of startup OBs	3; OB 100-102
Number of asynchronous error OBs	9; OB 80-88
Number of synchronous error OBs	2; OB 121, 122
Nesting depth	
Per priority class	24
Additional levels within an error OB	2
Counters, timers and their retentivity	
S7 counters	

	6ES7416-3XS07-0AB0
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	C 0 to C 7
Counting range	
Low limit	0
High limit	999
IEC counters	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
S7 timers	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	No retentive timers
Time range	
Low limit	10 ms
High limit	9990 s
IEC timers	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
Data areas and their retentivity	
Retentive data area, total	Total work and load memory (with backup battery)
Bit memories	
Number, max.	16 KB; size of bit memory address area
Retentivity available	Yes
Default retentivity	MB 0 to MB 15
Number of clock memories	8; in 1 memory byte
Local data	
Adjustable, max.	32 KB
Default	16 KB
Address area	
I/O address area	
Inputs	16 KB
Outputs	16 KB

	6ES7416-3XS07-0AB0
of which are distributed	
MPI/DP interface, inputs	2 KB
MPI/DP interface, outputs	2 KB
DP interface, inputs	8 KB
DP interface, outputs	8 KB
Process image	
Inputs, adjustable	16 KB
Outputs, adjustable	16 KB
Inputs, preset	512 bytes
Outputs, preset	512 bytes
Consistent data, max.	244 bytes
Access to consistent data in the process image	Yes
Process image partitions	
Number of process image partitions, max.	15
Digital channels	
Inputs	131072
of which are central	131072
Outputs	131072
of which are central	131072
Analog channels	
Inputs	8192
of which are central	8192
Outputs	8192
of which are central	8192
Hardware configuration	
Number of expansion units, max.	21
Connectable OP	95
Multicomputing	Yes; max. 4 CPU (with UR1 or UR2)
Interface modules	
Number of plug-in IMs (total), max.	6
Number of plug-in IM 460s, max.	6
Number of plug-in IM 463s, max.	4; IM 463-2
Number of DP masters	
Integrated	2
Via IM 467	4
Via CP	10; CP 443-5 Extended
Mixed IM + CP operation allowed	No; IM 467 cannot be used in combination with CP 443-5 Ext. or CP 443-1 n PROFINET IO mode
Via interface module	1
Number of plug-in S5 modules (via adapter bay, in the central controller), max.	6
Number of IO controllers	

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Integrated	0
Via CP	max. 4 in the central device: no mixed operation of different CP 443-1 types in the PROFINET IO operation
Number of usable FMs and CPs (recommendation)	
FM	Limited by the number of slots and connections
CP, point-to-point	CP 440: limited by the number of slots; CP 441: Limited by the number of connections
CP, LAN	
PROFIBUS and Ethernet CPs	14; in total max. 10 CP as DP master and PROFINET controller, of which up to 10 IM or CP as DP master and up to 4 CP as PROFINET controller
Slots	
Slots required	2
Time of day	
Clock	
Hardware clock (real-time clock)	Yes
With battery backup, can be synchronized	Yes
Resolution	1 ms
Deviation per day (with battery backup), max.	1.7 s; Power off
Deviation per day (without battery backup), max.	8.6 s; with Power on
Operating hours counter	
Number	16
Number/number range	0 to 15
Range of values	SFCs 2, 3 and 4: 0 to 32767 hours SFC 101: 0 to 2^31 - 1 hour
Resolution	1 hour
Retentive	Yes
Time synchronization	
Supported	Yes
on MPI, master	Yes
on MPI, slave	Yes
on DP, master	Yes
on DP, slave	Yes
in the AS, master	Yes
in the AS, slave	Yes
On Ethernet via NTP	No; via CP
On IF 964 DP	Yes
Time difference in the system with synchronization via	
MPI, max.	200 ms
Interfaces	
Interfaces/bus type	1x MPI/PROFIBUS DP, 1x PROFIBUS DP, 1x PROFIBUS DP (optionally plug-in)
Number of RS 485 interfaces	2; combination MPI / PROFIBUS DP and PROFIBUS DP

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Number of other interfaces	1; PROFIBUS DP with IF 964-DP (optionally plug-in; MLFB: 6ES7964-2AA04-0AB0)
1st interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS + MPI
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	MPI: 44, DP: 32
Protocols	
MPI	Yes
DP master	Yes
DP slave	Yes
MPI	
Number of connections	44; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Services	
PG/OP communication	Yes
Routing	Yes
Global data communication	Yes
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
PROFIBUS DP master	
Number of connections, max.	32; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	32
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes

	6ES7416-3XS07-0AB0
DPV1	Yes
Address area	
Inputs, max.	2 KB
Outputs, max.	2 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	32
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No
Address area, max.	32; virtual slots
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
PG/OP communication	Yes; with active interface
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
2nd interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	32
Protocols	
DP master	Yes
DP slave	Yes
PROFIBUS DP master	

	6ES7416-3XS07-0AB0
Number of connections, max.	32
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	125
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	8 KB
Outputs, max.	8 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	32
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Address area, max.	32
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
Routing	Yes; with active interface
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
3rd interface	
Interface type	Plug-in interface module (IF), technical specifications as for 2nd interface

	6ES7416-3XS07-0AB0
Plug-in interface modules	IF 964-DP (MLFB: 6ES7964-2AA04-0AB0)
Hardware	RS 485 / PROFIBUS
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Automatic determination of transmission rate	No
Number of connection resources	32
Protocols	
MPI	No
DP master	Yes
DP slave	Yes
PROFIBUS DP master	
Number of connections, max.	32
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	125
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV0	Yes
DPV1	Yes
Address area	
Inputs, max.	8 KB
Outputs, max.	8 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	32
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652

	6ES7416-3XS07-0AB0
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No
Address area, max.	32
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
PG/OP communication	Yes
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
Isochronous mode	
Isochronous mode (application synchronized up to terminal)	Yes; only with PROFIBUS
Number of DP masters with isochronous mode	3
User data per isochronous slave, max.	244 bytes
Constant bus cycle time	Yes
Minimum clock cycle	1 ms; 0.5 ms without use of SFC 126, 127
Maximum clock cycle	32 ms
Communication functions	
PG/OP communication	Yes
Number of connectable OPs without message processing	95
Number of connectable OPs with message processing	95; when using Alarm_S/SQ and Alarm_D/DQ
Data record routing	Yes
Global data communication	
Supported	Yes
Number of GD circles, max.	16
Number of GD packets, sender, max.	16
Number of GD packets, receiver, max.	32
Size of GD packets, max.	54 bytes
Size of GD packets (of which are consistent), max.	1 variable
S7 basic communication	
Supported	Yes
User data per job, max.	76 bytes
User data per job (of which consistent), max.	1 variable

	6ES7416-3XS07-0AB0
S7 communication	
Supported	Yes
As server	Yes
As client	Yes
User data per job, max.	64 KB
User data per job (of which consistent), max.	462 bytes; 1 variable
S5-compatible communication	
Supported	Yes; via FC AG_SEND and AG_RECV, maximum via 10 CP 443-1 or 443-5
User data per job, max.	8 KB
User data per job (of which consistent), max.	240 bytes
Number of simultaneous AG-SEND/AG-RECV jobs per CPU, max.	64/64
Standard communication (FMS)	
Supported	Yes; via CP and loadable FBs
Open IE communication	
ISO-on-TCP (RFC1006)	via CP 443-1 and loadable FB
Data length, max.	1452 bytes via CP 443-1 Adv.
Web server	
Supported	No
Number of connections	
Total	96
Suitable for PG communication	95
Reserved for PG communication	1
Assignable for PG communication, max.	0
Suitable for OP communication	95
Reserved for OP communication	1
Assignable for OP communication, max.	0
Suitable for S7 basic communication	94
Reserved for S7 basic communication	0
Assignable for S7 basic communication, max.	0
Suitable for S7 communication	94
Reserved for S7 communication	0
Assignable for S7 communication, max.	0
Suitable for routing	47
Reserved for routing	0
Assignable for routing, max.	0
S7 message functions	
Number of stations that can be logged on for signaling functions, max.	95; max. 95 with Alarm_S/SQ and Alarm_D/DQ (OPs); max. 16 with Alarm, Alarm_8, Alarm_8P, Notify and Notify_8 (e.g. WinCC)
Symbol-related messages	Yes

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SCAN procedure	Yes
Block-related messages	Yes
Process diagnostics messages	Yes
Simultaneously active Alarm_S blocks, max.	1000; simultaneously active Alarm_S/SQ blocks and Alarm_D/DQ blocks
Alarm_8 blocks	Yes
Number of instances for Alarm_8 and S7 communication blocks, max.	4000
Preset, max.	600
Process control messages	Yes
Number of archives that can be logged on simultaneously (SFB 37 AR_SEND)	32
Number of messages	
Total, max.	1024
In 100 ms interval, max.	128
in 500 ms interval, max.	512
in 1000 ms interval, max.	1024
Number of additional values	
In 100 ms interval, max.	1
In 500, 1000 ms interval, max.	10
Test and commissioning functions	
Block status	Yes; up to 16 simultaneously
Single-step	Yes
Number of breakpoints	16
Status/modify	
Status/modify variable	Yes; up to 16 variable tables
Variables	Inputs/outputs, bit memory, DB, I/O inputs/outputs, timers, counters
Number of variables, max.	70; Status / Modify
Forcing	
Forcing	Yes
Force, variables	Inputs, outputs, bit memories, distributed I/O
Number of variables, max.	512
Diagnostics buffer	
Available	Yes
Number of entries, max.	3200
Adjustable	Yes
Default	120
Service data	
Readable	Yes
Standards, approvals, certificates	
UKCA	Yes

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CE mark	Yes
CSA approval	Yes
UL approval	Yes
cULus	Yes
FM approval	Yes
RCM (formerly C-TICK)	Yes
CCC	Yes
KC approval	Yes
EAC (formerly Gost-R)	Yes
Use in hazardous areas	
ATEX	ATEX II 3 G Ex ec IIC T4 Gc
Ambient conditions	
Ambient temperature during operation	
Min.	0 °C
Max.	60 °C
Configuration	
Programming	
Instruction set	See instruction list
Nesting levels	7
Access to consistent data in the process image	Yes
System functions (SFC)	See instruction list
System function blocks (SFB)	See instruction list
Programming language	
LAD	Yes
FBD	Yes
STL	Yes
SCL	Yes
CFC	Yes
GRAPH	Yes
HiGraph®	Yes
Number of simultaneously active SFCs	
DPSYC_FR	2; SFC 11; per interface
D_ACT_DP	8; SFC 12; per interface
RD_REC	8; SFC 59; per interface
WR_REC	8; SFC 58; per interface
WR_PARM	8; SFC 55; per interface
PARM_MOD	1; SFC 57; per interface
WR_DPARM	2; SFC 56; per interface
DPNRM_DG	8; SFC 13; per interface
RDSYSST	8; SFC 51
DP_TOPOL	1; SFC 103; per interface

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Number of simultaneously active SFBs	
RDREC	8; SFB 52; per interface, but not more than 32 across all external interfaces
WRREC	8; SFB 53; per interface, but not more than 32 across all external interfaces
Know-how protection	
User program/password protection	Yes
Block encryption	Yes; with S7 block privacy
Dimensions	
Width	50 mm
Height	290 mm
Depth	219 mm
Weights	
Weight, approx.	900 g

10.9 Technical specifications of CPU 416-3 PN/DP (6ES7416-3ES07-0AB0), CPU 416F-3 PN/DP (6ES7416-3FS07-0AB0)

Data

	6ES7416-3ES07-0AB0 6ES7416-3FS07-0AB0
General information	
Product type designation	CPU 416-3 PN/DP CPU 416F-3 PN/DP
Hardware version	01
Firmware version	V7.0
Engineering with	
Programming package	as of STEP 7 V5.5 with HSP 262
CiR Configuration in RUN	
CiR synchronization time, base load	100 ms
CiR synchronization time, time per I/O byte	10 µs
Power supply	
Rated value (DC)	
24 V DC	No; voltage supplied via the system voltage supply
Input current	
From backplane bus 5 V DC, typ.	1.3 A
From backplane bus 5 V DC, max.	1.6 A
From the backplane bus 24 V DC, max.	300 mA; 150 mA per DP interface
From interface 5 V DC, max.	90 mA; for each DP interface
Power loss	
Typical power loss	6.5 W
Power loss, max.	8 W
Memory	
Type of memory	RAM
Work memory	
Integrated	16 MB
integrated (for program)	8 MB
integrated (for data)	8 MB
Expandable	No
Load memory	
Expandable FEPROM	Yes; with memory card (FLASH)
Expandable FEPROM, max.	64 MB
integrated RAM, max.	1 MB
Expandable RAM	Yes; with memory card (RAM)
Expandable RAM, max.	64 MB
Battery backup	

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Available	Yes
With battery	Yes; all data
Without battery	No
Battery	
Backup battery	
Backup battery current, typ.	180 µA; to 40 °C
Backup battery current, max.	850 µA
Backup battery time, max.	Covered by the conditions and effects described in the Module data manual
Feed of external backup voltage to the CPU	5 to 15 V DC
CPU processing times	
For bit operations, typ.	12.5 ns
For word operations, typ.	12.5 ns
For integer arithmetic, typ.	12.5 ns
For floating-point arithmetic, typ.	25 ns
CPU blocks	
DB	
Number, max.	10000; number range: 1 to 16000
Size, max.	64 KB
FB	
Number, max.	5000; number range: 0 to 7999
Size, max.	64 KB
FC	
Number, max.	5000; number range: 0 to 7999
Size, max.	64 KB
OB	
Size, max.	64 KB
Number of free-cycle OBs	1; OB 1
Number of time-of-day interrupt OBs	8; OB 10-17
Number of time-delay interrupt OBs	4; OB 20-23
Number of cyclic interrupt OBs	9; OB 30-38 (smallest configurable cycle = 500 µs)
Number of hardware interrupt OBs	8; OB 40-47
Number of DPV1 interrupt OBs	3; OB 55-57
Number of isochronous OBs	4; OB 61-64
Number of multi-computing OBs	1; OB 60
Number of background OBs	1; OB 90
Number of startup OBs	3; OB 100, 101, 102 with CPU 416-3 PN/DP 2; OB 100, 102 with CPU 416F-3 PN/DP
Number of asynchronous error OBs	9; OB 80-88
Number of synchronous error OBs	2; OB 121, 122
Nesting depth	

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Per priority class	24
Additional levels within an error OB	2
Counters, timers and their retentivity	
S7 counters	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	C 0 to C 7
Counting range	
Low limit	0
High limit	999
IEC counters	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
S7 timers	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	No retentive timers
Time range	
Low limit	10 ms
High limit	9990 s
IEC timers	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
Data areas and their retentivity	
Retentive data area, total	Total work and load memory (with backup battery)
Bit memories	
Number, max.	16 KB; size of bit memory address area
Retentivity available	Yes
Default retentivity	MB 0 to MB 15
Number of clock memories	8; in 1 memory byte
Local data	
Adjustable, max.	32 KB

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Default	16 KB
Address area	
I/O address area	
Inputs	16 KB
Outputs	16 KB
of which are distributed	
MPI/DP interface, inputs	2 KB
MPI/DP interface, outputs	2 KB
DP interface, inputs	8 KB
DP interface, outputs	8 KB
PN interface, inputs	8 KB
PN interface, outputs	8 KB
Process image	
Inputs, adjustable	16 KB
Outputs, adjustable	16 KB
Inputs, preset	512 bytes
Outputs, preset	512 bytes
Consistent data, max.	244 bytes
Access to consistent data in the process image	Yes
Process image partitions	
Number of process image partitions, max.	15
Digital channels	
Inputs	131072
of which are central	131072
Outputs	131072
of which are central	131072
Analog channels	
Inputs	8192
of which are central	8192
Outputs	8192
of which are central	8192
Hardware configuration	
Number of expansion units, max.	21
Multicomputing	Yes; max. 4 CPU (with UR1 or UR2)
Interface modules	
Number of plug-in IMs (total), max.	6
Number of plug-in IM 460s, max.	6
Number of plug-in IM 463s, max.	4; IM 463-2
Number of DP masters	
Integrated	1

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Via IM 467	4
Via CP	10; CP 443-5 Extended
Mixed IM + CP operation allowed	No; IM 467 cannot be used in combination with CP 443-5 Ext. or CP 443-1 n PROFINET IO mode
Via interface module	1; IF 964-DP
Number of plug-in S5 modules (via adapter bay, in the central controller), max.	6
Number of IO controllers	
Integrated	1
Via CP	4; max. 4 in central controller; no mixed operation of different CP 443-1 types in PROFINET IO mode
Number of usable FMs and CPs (recommendation)	
FM	limited by the number of slots or connections
CP, point-to-point	CP 440: limited by the number of slots; CP 441: limited by the number of slots or connections
PROFIBUS and Ethernet CPs	14; in total max. 10 CP as DP master and PROFINET controller, of which up to 10 IM or CP as DP master and up to 4 CP as PROFINET controller
Slots	
Slots required	2
Time of day	
Clock	
Hardware clock (real-time clock)	Yes
With battery backup, can be synchronized	Yes
Resolution	1 ms
Deviation per day (with battery backup), max.	1.7 s; Power off
Deviation per day (without battery backup), max.	8.6 s; with Power on
Operating hours counter	
Number	16
Number/number range	0 to 15
Range of values	SFCs 2, 3 and 4: 0 to 32767 hours SFC 101: 0 to 2^31 - 1 hour
Resolution	1 hour
Retentive	Yes
Time synchronization	
Supported	Yes
on MPI, master	Yes
on MPI, slave	Yes
on DP, master	Yes
on DP, slave	Yes
in the AS, master	Yes
in the AS, slave	Yes
On Ethernet via NTP	Yes; as client

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On IF 964 DP	Yes
Time difference in the system with synchronization via	
Ethernet, max.	10 ms
MPI, max.	200 ms
Interfaces	
Interfaces/bus type	1x MPI/PROFIBUS DP, 1x PROFINET (2 ports), 1x PROFIBUS DP (optionally plug-in)
Number of RS 485 interfaces	1; combination MPI / PROFIBUS DP
Number of other interfaces	1; PROFIBUS DP with IF 964-DP (optionally plug-in; MLFB: 6ES7964-2AA04-0AB0)
1st interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS + MPI
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	MPI: 44, DP: 32
Functionality	
MPI	Yes
DP master	Yes
DP slave	Yes
MPI	
Number of connections	44; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Services	
PG/OP communication	Yes
Routing	Yes
Global data communication	Yes
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
DP master	
Number of connections, max.	32; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	32
Services	
PG/OP communication	Yes
Global data communication	No
S7 basic communication	Yes

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S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	2 KB
Outputs, max.	2 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
DP slave	
Number of connections	32
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No
Address area, max.	32; virtual slots
User data per address area, max.	32 bytes
Consistent user data per address area, max.	32 bytes
Services	
PG/OP communication	Yes; with active interface
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
2nd interface	

	6ES7416-3ES07-0AB0 **6ES7416-3FS07-0AB0**
Interface type	PROFINET
Hardware	Ethernet RJ45
Electrically isolated	Yes
Integrated switch	Yes
Number of ports	2
Automatic determination of transmission rate	Yes; Autosensing
Autonegotiation	Yes
Autocrossing	Yes
Change of the IP address at runtime, supported	Yes; specified by higher-level IO controller or by the user program with SFB 104 "IP_CONF"
Number of connection resources	96
Media redundancy	
Supported	Yes
Changeover time at line interruption, typ.	200 ms
Number of nodes on the ring, max.	50
Functionality	
DP master	No
DP slave	No
PROFINET IO controller	Yes
PROFINET IO device	Yes
PROFINET CBA	Yes
Open IE communication	Yes
Point-to-point link	No
PROFINET IO controller	
Transmission rate, max.	100 Mbps
Number of connectable IO devices, max.	256
Number of connectable IO devices for RT, max.	256
of which in line, max.	256
Number of IO devices with IRT and the "high flexibility" option	256
of which in line, max.	61
Max. number of IO devices with IRT and the "high performance" option	64
of which in line, max.	64
Shared device	Yes
Prioritized startup	Yes
Number of IO devices, max.	32
Enabling/disabling of IO devices	Yes
Max. number of I/O devices that can be enabled/disabled simultaneously	8
Hot-swapping of I/O devices (partner ports), supported	Yes

	6ES7416-3ES07-0AB0 **6ES7416-3FS07-0AB0**
Number of IO devices per tool, max.	8; 8 parallel calls of SFC 12 "D_ACT_DP" per segment are possible. Hot-swapping of maximum 32 I/O devices (partner ports) supported
Device replacement without swap medium	Yes
Send clocks	250 µs, 500 µs, 1 ms, 2 ms, 4 ms also for IRT with higher performance: 250 µs to 4 ms at an interval of 125 µs
Update time	250 µs to 512 ms; The minimum value depends on the communication slice set for PROFINET IO, the number of IO devices, and the amount of configured user data; see PROFINET system description
Services	
PG/OP communication	Yes
S7 routing	Yes
S7 communication	Yes
Isochronous mode	Yes; only with IRT and the "high performance" option
Open IE communication	Yes
Address area	
Inputs, max.	8 KB
Outputs, max.	8 KB
User data consistency, max.	1024 bytes
PROFINET IO device	
Services	
PG/OP communication	Yes
S7 routing	Yes
S7 communication	Yes
Isochronous mode	No
Open IE communication	Yes
IRT	Yes
Prioritized startup	Yes
Shared device	Yes
Number of IO controllers with shared device, max.	2
Transfer memory	
Inputs, max.	1440 bytes; per IO controller with shared device
Outputs, max.	1440 bytes; per IO controller with shared device
Submodules	
Number, max.	64
User data per submodule, max.	1024 bytes
Open IE communication	
Number of connections, max.	94
Local port numbers used by the system	0, 20, 21, 25, 80, 102, 135, 161, 34962, 34963, 34964, 65532, 65533, 65534, 65535
Keep Alive function supported	Yes

	6ES7416-3ES07-0AB0 **6ES7416-3FS07-0AB0**
3rd interface	
Interface type	Plug-in interface module (IF)
Plug-in interface modules	IF 964-DP (MLFB: 6ES7964-2AA04-0AB0)
Hardware	RS 485 / PROFIBUS
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Automatic determination of transmission rate	No
Number of connection resources	32
Functionality	
MPI	No
DP master	Yes
DP slave	Yes
DP master	
Number of connections, max.	32
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	125
Services	
PG/OP communication	Yes
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	8 KB
Outputs, max.	8 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
DP slave	
Number of connections	32

	6ES7416-3ES07-0AB0 **6ES7416-3FS07-0AB0**
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No
Address area, max.	32; virtual slots
User data per address area, max.	32 bytes
Consistent user data per address area, max.	32 bytes
Services	
PG/OP communication	Yes
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
Isochronous mode	
Isochronous mode (application synchronized up to terminal)	Yes; via PROFIBUS DP or PROFINET interface
Number of DP masters with isochronous mode	2
User data per isochronous slave, max.	244 bytes
Constant bus cycle time	Yes
Minimum clock cycle	1 ms; 0.5 ms without use of SFC 126, 127
Maximum clock cycle	32 ms
Communication functions	
PG/OP communication	Yes
Number of connectable OPs without message processing	95
Number of connectable OPs with message processing	95; when using Alarm_S/SQ and Alarm_D/DQ
Data record routing	Yes
Global data communication	
Supported	Yes
Number of GD circles, max.	16
Number of GD packets, sender, max.	16
Number of GD packets, receiver, max.	32
Size of GD packets, max.	54 bytes
Size of GD packets (of which are consistent), max.	1 variable
S7 basic communication	
Supported	Yes

	6ES7416-3ES07-0AB0 **6ES7416-3FS07-0AB0**
User data per job, max.	76 bytes
User data per job (of which consistent), max.	1 variable
S7 communication	
Supported	Yes
As server	Yes
As client	Yes
User data per job, max.	64 KB
User data per job (of which consistent), max.	462 bytes; 1 variable
S5-compatible communication	
Supported	Yes; via FC AG_SEND and AG_RECV, maximum via 10 CP 443-1 or 443-5
User data per job, max.	8 KB
User data per job (of which consistent), max.	240 bytes
Number of simultaneous AG-SEND/AG-RECV jobs per CPU, max.	64/64
Standard communication (FMS)	
Supported	Yes; via CP and loadable FBs
Open IE communication	
TCP/IP	Yes; via integrated PROFINET interface and loadable FBs
Number of connections, max.	94
Data length, max.	32 KB
Multiple passive connections per port, supported	Yes
ISO-on-TCP (RFC1006)	Yes; via integrated PROFINET interface or CP 443-1 and loadable FBs
Number of connections, max.	94
Data length, max.	32 KB; 1452 bytes via CP 443-1 Adv.
UDP	Yes; via integrated PROFINET interface and loadable FBs
Number of connections, max.	94
Data length, max.	1472 bytes
Web server	
Supported	Yes
Number of HTTP clients	5
User-defined websites	Yes
PROFINET CBA (with configured communication load setpoint)	
Reference setting for CPU communication load	20%
Number of remote interconnection partners	32
Number of master/slave functions	150
Total of all master/slave connections	6000
Data length of all incoming master/slave I/Os, max.	65000 bytes
Data length of all outgoing master/slave connections, max.	65000 bytes
Number of device-internal and PROFIBUS interconnections	1000

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Data length of the device-internal and PROFIBUS interconnections, max.	16000 bytes
Data length per connection, max.	2000 bytes
Remote interconnections with non-cyclic transmission	
Sampling rate: Sampling interval, min.	200 ms; Depends on preset communication load, number of interconnections and used data length
Number of incoming interconnections	500
Number of outgoing interconnections	500
Data length of all incoming interconnections, max.	16000 bytes
Data length of all outgoing interconnections, max.	16000 bytes
Data length per connection, max.	2000 bytes
Remote interconnections with cyclic transmission	
Transmission rate: Minimum transmission time	1 ms; Depends on preset communication load, number of interconnections and used data length
Number of incoming interconnections	300
Number of outgoing interconnections	300
Data length of all incoming interconnections, max.	4800 bytes
Data length of all outgoing interconnections, max.	4800 bytes
Data length per connection, max.	450 bytes
HMI variables via PROFINET (non-cyclic)	
Number of stations that can be logged on for HMI variables (PN OPC/IMAP)	2x PN OPC / 1x IMAP
Update of HMI variables	500 ms
Number of HMI variables	1500
Data length of all HMI variables, max.	48000 bytes
PROFIBUS proxy functionality	
Supported	Yes; max. 32 PROFIBUS slaves can be connected
Data length per connection, max.	240 bytes; slave dependent
Number of connections	
Total	96
Suitable for PG communication	95
Reserved for PG communication	1
Assignable for PG communication, max.	0
Suitable for OP communication	95
Reserved for OP communication	1
Assignable for OP communication, max.	0
Suitable for S7 basic communication	94
Reserved for S7 basic communication	0
Assignable for S7 basic communication, max.	0
Suitable for S7 communication	94
Reserved for S7 communication	0

	6ES7416-3ES07-0AB0 **6ES7416-3FS07-0AB0**
Assignable for S7 communication, max.	0
Suitable for routing	47
Reserved for routing	0
Assignable for routing, max.	0
S7 message functions	
Number of stations that can be logged on for signaling functions, max.	95; max. 95 with Alarm_S/SQ and Alarm_D/DQ (OPs); max. 16 with Alarm, Alarm_8, Alarm_8P, Notify and Notify_8 (e.g. WinCC)
Symbol-related messages	Yes
SCAN procedure	Yes
Block-related messages	Yes
Process diagnostics messages	Yes
Simultaneously active Alarm_S blocks, max.	1000; simultaneously active Alarm_S/SQ blocks and Alarm_D/DQ blocks
Alarm_8 blocks	Yes
Number of instances for Alarm_8 and S7 communication blocks, max.	4000
Preset, max.	600
Process control messages	Yes
Number of archives that can be logged on simultaneously (SFB 37 AR_SEND)	32
Number of messages	
Total, max.	1024
In 100 ms interval, max.	128
in 500 ms interval, max.	512
in 1000 ms interval, max.	1024
Number of additional values	
In 100 ms interval, max.	1
In 500, 1000 ms interval, max.	10
Test and commissioning functions	
Block status	Yes; up to 16 simultaneously
Single-step	Yes
Number of breakpoints	16
Status/modify	
Status/modify variable	Yes; up to 16 variable tables
Variables	Inputs/outputs, bit memory, DB, I/O inputs/outputs, timers, counters
Number of variables, max.	70; Status / Modify
Forcing	
Forcing	Yes
Force, variables	Inputs/outputs, bit memories, distributed I/O
Number of variables, max.	512

		6ES7416-3ES07-0AB0 **6ES7416-3FS07-0AB0**
Diagnostics buffer		
Available	Yes	
Number of entries, max.	3200	
Adjustable	Yes	
Default	120	
Service data		
Readable	Yes	
Standards, approvals, certificates		
UKCA	Yes	
CE mark	Yes	
CSA approval	Yes	
UL approval	Yes	
cULus	Yes	
FM approval	Yes	
RCM (formerly C-TICK)	Yes	
CCC	Yes	
KC approval	Yes	
EAC (formerly Gost-R)	Yes	
Use in hazardous areas		
ATEX	ATEX II 3 G Ex ec IIC T4 Gc	
Ambient conditions		
Ambient temperature during operation		
Min.	0° C	
Max.	60 °C	
Configuration		
Programming		
Instruction set	See instruction list	
Nesting levels	7	
System functions (SFC)	See instruction list	
System function blocks (SFB)	See instruction list	
Programming language		
LAD	Yes	
FBD	Yes	
STL	Yes	
SCL	Yes	
CFC	Yes	
GRAPH	Yes	
HiGraph®	Yes	
Number of simultaneously active SFCs		
DPSYC_FR	2; SFC 11; per interface	

	6ES7416-3ES07-0AB0 **6ES7416-3FS07-0AB0**
D_ACT_DP	8; SFC 12; per interface
RD_REC	8; SFC 59; per interface
WR_REC	8; SFC 58; per interface
WR_PARM	8; SFC 55; per interface
PARM_MOD	1; SFC 57; per interface
WR_DPARM	2; SFC 56; per interface
DPNRM_DG	8; SFC 13; per interface
RDSYSST	8; SFC 51
DP_TOPOL	1; SFC 103; per interface
Number of simultaneously active SFBs	
RDREC	8; SFB 52; per interface, but not more than 32 across all external interfaces
WRREC	8; SFB 53; per interface, but not more than 32 across all external interfaces
Know-how protection	
User program/password protection	Yes
Block encryption	Yes; with S7 block privacy
Dimensions	
Width	50 mm
Height	290 mm
Depth	219 mm
Weights	
Weight, approx.	900 g

10.10 Technical specifications of CPU 417-4 (6ES7417-4XT07-0AB0)

Data

	6ES7417-4XT07-0AB0
General information	
Product type designation	CPU 417-4
Hardware version	01
Firmware version	V7.0
Engineering with	
Programming package	As of STEP 7 V5.4 with HSP 261
CiR Configuration in RUN	
CiR synchronization time, base load	60 ms
CiR synchronization time, time per I/O byte	7 µs
Power supply	
Rated value (DC)	
24 V DC	No; voltage supplied via the system voltage supply
Input current	
From backplane bus 5 V DC, typ.	1.3 A
From backplane bus 5 V DC, max.	1.6 A
From the backplane bus 24 V DC, max.	600 mA; 150 mA per DP interface
From interface 5 V DC, max.	90 mA; for each DP interface
Power loss	
Typical power loss	6.5 W
Power loss, max.	8 W
Memory	
Type of memory	RAM
Work memory	
Integrated	32 MB
integrated (for program)	16 MB
integrated (for data)	16 MB
Expandable	No
Load memory	
Expandable FEPROM	Yes; with memory card (FLASH)
Expandable FEPROM, max.	64 MB
integrated RAM, max.	1 MB
Expandable RAM	Yes; with memory card (RAM)
Expandable RAM, max.	64 MB
Battery backup	
Available	Yes
With battery	Yes; all data

	6ES7417-4XT07-0AB0
Without battery	No
Battery	
Backup battery	
Backup battery current, typ.	225 µA; to 40 °C
Backup battery current, max.	1275 µA
Backup battery time, max.	See the Module specifications reference manual, section 3.3.
Feed of external backup voltage to the CPU	5 to 15 V DC
CPU processing times	
For bit operations, typ.	7.5 ns
For word operations, typ.	7.5 ns
For integer arithmetic, typ.	7.5 ns
For floating-point arithmetic, typ.	15 ns
CPU blocks	
DB	
Number, max.	16000; number range: 1 to 16000
Size, max.	64 KB
FB	
Number, max.	8000; number range: 0 to 7999
Size, max.	64 KB
FC	
Number, max.	8000; number range: 0 to 7999
Size, max.	64 KB
OB	
Size, max.	64 KB
Number of free-cycle OBs	1; OB 1
Number of time-of-day interrupt OBs	8; OB 10-17
Number of time-delay interrupt OBs	4; OB 20-23
Number of cyclic interrupt OBs	9; OB 30-38 (smallest configurable cycle = 500 µs)
Number of hardware interrupt OBs	8; OB 40-47
Number of DPV1 interrupt OBs	3; OB 55-57
Number of isochronous OBs	4; OB 61-64
Number of multi-computing OBs	1; OB 60
Number of background OBs	1; OB 90
Number of startup OBs	3; OB 100-102
Number of asynchronous error OBs	9; OB 80-88
Number of synchronous error OBs	2; OB 121, 122
Nesting depth	
Per priority class	24
Additional levels within an error OB	2
Counters, timers and their retentivity	
S7 counters	

	6ES7417-4XT07-0AB0
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	C 0 to C 7
Counting range	
Low limit	0
High limit	999
IEC counters	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
S7 timers	
Number	2048
Retentivity	
Adjustable	Yes
Low limit	0
High limit	2047
Default	No retentive timers
Time range	
Low limit	10 ms
High limit	9990 s
IEC timers	
Available	Yes
Type	SFB
Number	Unlimited (limited only by the work memory)
Data areas and their retentivity	
Retentive data area, total	Total work and load memory (with backup battery)
Bit memories	
Number, max.	16 KB; size of bit memory address area
Retentivity available	Yes
Default retentivity	MB 0 to MB 15
Number of clock memories	8; in 1 memory byte
Local data	
Adjustable, max.	64 KB
Default	32 KB
Address area	
I/O address area	
Inputs	16 KB
Outputs	16 KB

	6ES7417-4XT07-0AB0
of which are distributed	
MPI/DP interface, inputs	2 KB
MPI/DP interface, outputs	2 KB
DP interface, inputs	8 KB
DP interface, outputs	8 KB
Process image	
Inputs, adjustable	16 KB
Outputs, adjustable	16 KB
Inputs, preset	1024 bytes
Outputs, preset	1024 bytes
Consistent data, max.	244 bytes
Access to consistent data in the process image	Yes
Process image partitions	
Number of process image partitions, max.	15
Digital channels	
Inputs	131072
of which are central	131072
Outputs	131072
of which are central	131072
Analog channels	
Inputs	8192
of which are central	8192
Outputs	8192
of which are central	8192
Hardware configuration	
Number of expansion units, max.	21
Connectable OP	119
Multicomputing	Yes; max. 4 CPU (with UR1 or UR2)
Interface modules	
Number of plug-in IMs (total), max.	6
Number of plug-in IM 460s, max.	6
Number of plug-in IM 463s, max.	4; IM 463-2
Number of DP masters	
Integrated	2
Via IM 467	4
Via CP	10; CP 443-5 Extended
Mixed IM + CP operation allowed	No; IM 467 cannot be used in combination with CP 443-5 Ext. or CP 443-1 n PROFINET IO mode
Via interface module	2
Number of plug-in S5 modules (via adapter bay, in the central controller), max.	6
Number of IO controllers	

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Integrated	0
Via CP	4; max. 4 in central controller; no mixed operation of different CP 443-1 types in PROFINET IO mode
Number of usable FMs and CPs (recommendation)	
FM	Limited by the number of slots and connections
CP, point-to-point	CP 440: limited by the number of slots; CP 441: Limited by the number of connections
PROFIBUS and Ethernet CPs	14; of which a maximum of 10 can be CPs or IMs as DP master, maximum 4 PROFINET controllers
Slots	
Slots required	2
Time of day	
Clock	
Hardware clock (real-time clock)	Yes
With battery backup, can be synchronized	Yes
Resolution	1 ms
Deviation per day (with battery backup), max.	1.7 s; Power off
Deviation per day (without battery backup), max.	8.6 s; with Power on
Operating hours counter	
Number	16
Number/number range	0 to 15
Range of values	SFCs 2, 3 and 4: 0 to 32767 hours SFC 101: 0 to 2^31 - 1 hour
Resolution	1 hour
Retentive	Yes
Time synchronization	
Supported	Yes
on MPI, master	Yes
on MPI, slave	Yes
on DP, master	Yes
on DP, slave	Yes
in the AS, master	Yes
in the AS, slave	Yes
On Ethernet via NTP	No; via CP
On IF 964 DP	Yes
Time difference in the system with synchronization via	
MPI, max.	200 ms
Interfaces	
Interfaces/bus type	1x MPI/PROFIBUS DP, 1x PROFIBUS DP, 2x PROFIBUS DP (optionally plug-in)
Number of RS 485 interfaces	2; combination MPI / PROFIBUS DP and PROFIBUS DP
Number of other interfaces	2; PROFIBUS DP with IF 964-DP (optionally plug-in; MLFB: 6ES7964-2AA04-0AB0)

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1st interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS + MPI
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	MPI: 44, DP: 32
Protocols	
MPI	Yes
DP master	Yes
DP slave	Yes
MPI	
Number of connections	44; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Services	
PG/OP communication	Yes
Routing	Yes
Global data communication	Yes
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
PROFIBUS DP master	
Number of connections, max.	32; a diagnostics repeater in the segment reduces the number of connection resources on the segment by 1
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	32
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	

	6ES7417-4XT07-0AB0
Inputs, max.	2 KB
Outputs, max.	2 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	32
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No
Address area, max.	32; virtual slots
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
PG/OP communication	Yes; with active interface
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
2nd interface	
Interface type	Integrated
Hardware	RS 485 / PROFIBUS
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Number of connection resources	32
Protocols	
DP master	Yes
DP slave	Yes
PROFIBUS DP master	
Number of connections, max.	32
Transmission rate, max.	12 Mbps

	6ES7417-4XT07-0AB0
Number of DP slaves, max.	125
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV1	Yes
Address area	
Inputs, max.	8 KB
Outputs, max.	8 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	32
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Address area, max.	32
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
Routing	Yes; with active interface
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
3rd interface	
Interface type	Plug-in interface module (IF), technical specifications as for 2nd interface
Plug-in interface modules	IF 964-DP (MLFB: 6ES7964-2AA04-0AB0)
Hardware	RS 485 / PROFIBUS

	6ES7417-4XT07-0AB0
Electrically isolated	Yes
Power supply at interface (15 to 30 V DC), max.	150 mA
Automatic determination of transmission rate	No
Number of connection resources	32
Protocols	
MPI	No
DP master	Yes
DP slave	Yes
PROFIBUS DP master	
Number of connections, max.	32
Transmission rate, max.	12 Mbps
Number of DP slaves, max.	125
Services	
PG/OP communication	Yes
Routing	Yes; S7 routing
Global data communication	No
S7 basic communication	Yes
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Support for constant bus cycle time	Yes
Isochronous mode	Yes
SYNC/FREEZE	Yes
Enabling/disabling of DP slaves	Yes
Direct data exchange (peer-to-peer)	Yes
DPV0	Yes
DPV1	Yes
Address area	
Inputs, max.	8 KB
Outputs, max.	8 KB
User data per DP slave	
User data per DP slave, max.	244 bytes
Inputs, max.	244 bytes
Outputs, max.	244 bytes
Slots, max.	244
Per slot, max.	128 bytes
PROFIBUS DP slave	
Number of connections	32
GSD file	https://support.industry.siemens.com/cs/ww/en/view/113652
Transmission rate, max.	12 Mbps
Automatic baud rate detection	No

	6ES7417-4XT07-0AB0
Address area, max.	32
User data per address area, max.	32 bytes
of which consistent, max.	32 bytes
Services	
PG/OP communication	Yes
Routing	
S7 routing	Yes; with active interface
Global data communication	No
S7 basic communication	No
S7 communication	Yes
S7 communication, as client	Yes
S7 communication, as server	Yes
Direct data exchange (peer-to-peer)	No
DPV1	No
Transfer memory	
Inputs	244 bytes
Outputs	244 bytes
4th interface	
Interface type	Plug-in interface module (IF), technical specifications as for 2nd interface
Plug-in interface modules	IF 964-DP (MLFB: 6ES7964-2AA04-0AB0)
Isochronous mode	
Isochronous mode (application synchronized up to terminal)	Yes; only with PROFIBUS
Number of DP masters with isochronous mode	4
User data per isochronous slave, max.	244 bytes
Constant bus cycle time	Yes
Minimum clock cycle	1 ms; 0.5 ms without use of SFC 126, 127
Maximum clock cycle	32 ms
Communication functions	
PG/OP communication	Yes
Number of connectable OPs without message processing	119
Number of connectable OPs with message processing	119; when using Alarm_S/SQ and Alarm_D/DQ
Data record routing	Yes
Global data communication	
Supported	Yes
Number of GD circles, max.	16
Number of GD packets, sender, max.	16
Number of GD packets, receiver, max.	32
Size of GD packets, max.	54 bytes
Size of GD packets (of which are consistent), max.	1 variable
S7 basic communication	

	6ES7417-4XT07-0AB0
Supported	Yes
User data per job, max.	76 bytes
User data per job (of which consistent), max.	1 variable
S7 communication	
Supported	Yes
As server	Yes
As client	Yes
User data per job, max.	64 KB
User data per job (of which consistent), max.	462 bytes; 1 variable
S5-compatible communication	
Supported	Yes; via FC AG_SEND and AG_RECV, maximum via 10 CP 443-1 or 443-5
User data per job, max.	8 KB
User data per job (of which consistent), max.	240 bytes
Number of simultaneous AG-SEND/AG-RECV jobs per CPU, max.	64/64
Standard communication (FMS)	
Supported	Yes; via CP and loadable FBs
Open IE communication	
ISO-on-TCP (RFC1006)	via CP 443-1 and loadable FB
Data length, max.	1452 bytes via CP 443-1 Adv.
Web server	
Supported	No
Number of connections	
Total	120
Suitable for PG communication	119
Reserved for PG communication	1
Assignable for PG communication, max.	0
Suitable for OP communication	119
Reserved for OP communication	1
Assignable for OP communication, max.	0
Suitable for S7 basic communication	118
Reserved for S7 basic communication	0
Assignable for S7 basic communication, max.	0
Suitable for S7 communication	118
Reserved for S7 communication	0
Assignable for S7 communication, max.	0
Suitable for routing	59
Reserved for routing	0
Assignable for routing, max.	0
S7 message functions	

	6ES7417-4XT07-0AB0
Number of stations that can be logged on for signaling functions, max.	119; max. 119 with Alarm_S/SQ and Alarm_D/DQ (OPs); max. 16 with Alarm, Alarm_8, Alarm_8P, Notify and Notify_8 (e.g. WinCC)
Symbol-related messages	Yes
SCAN procedure	Yes
Block-related messages	Yes
Process diagnostics messages	Yes
Simultaneously active Alarm_S blocks, max.	1000; simultaneously active Alarm_S/SQ blocks and Alarm_D/DQ blocks
Alarm_8 blocks	Yes
Number of instances for Alarm_8 and S7 communication blocks, max.	10000
Preset, max.	1200
Process control messages	Yes
Number of archives that can be logged on simultaneously (SFB 37 AR_SEND)	64
Number of messages	
Total, max.	1024
In 100 ms interval, max.	128
in 500 ms interval, max.	512
in 1000 ms interval, max.	1024
Number of additional values	
In 100 ms interval, max.	1
In 500, 1000 ms interval, max.	10
Test and commissioning functions	
Block status	Yes; up to 16 simultaneously
Single-step	Yes
Number of breakpoints	16
Status/modify	
Status/modify variable	Yes; up to 16 variable tables
Variables	Inputs/outputs, bit memory, DB, I/O inputs/outputs, timers, counters
Number of variables, max.	70; Status / Modify
Forcing	
Forcing	Yes
Force, variables	Inputs, outputs, bit memories, distributed I/O
Number of variables, max.	512
Diagnostics buffer	
Available	Yes
Number of entries, max.	3200
Adjustable	Yes
Default	120
Service data	

	6ES7417-4XT07-0AB0
Readable	Yes
Standards, approvals, certificates	
UKCA	Yes
CE mark	Yes
CSA approval	Yes
UL approval	Yes
cULus	Yes
FM approval	Yes
RCM (formerly C-TICK)	Yes
CCC	Yes
KC approval	Yes
EAC (formerly Gost-R)	Yes
Use in hazardous areas	
ATEX	ATEX II 3 G Ex ec IIC T4 Gc
Ambient conditions	
Ambient temperature during operation	
Min.	0 °C
Max.	60 °C
Configuration	
Programming	
Instruction set	See instruction list
Nesting levels	7
Access to consistent data in the process image	Yes
System functions (SFC)	See instruction list
System function blocks (SFB)	See instruction list
Programming language	
LAD	Yes
FBD	Yes
STL	Yes
SCL	Yes
CFC	Yes
GRAPH	Yes
HiGraph®	Yes
Number of simultaneously active SFCs	
DPSYC_FR	2; SFC 11; per interface
D_ACT_DP	8; SFC 12; per interface
RD_REC	8; SFC 59; per interface
WR_REC	8; SFC 58; per interface
WR_PARM	8; SFC 55; per interface
PARM_MOD	1; SFC 57; per interface
WR_DPARM	2; SFC 56; per interface

	6ES7417-4XT07-0AB0
DPNRM_DG	8; SFC 13; per interface
RDSYSST	8; SFC 51
DP_TOPOL	1; SFC 103; per interface
Number of simultaneously active SFBs	
RDREC	8; SFB 52; per interface, but not more than 32 across all external interfaces
WRREC	8; SFB 53; per interface, but not more than 32 across all external interfaces
Know-how protection	
User program/password protection	Yes
Block encryption	Yes; with S7 block privacy
Dimensions	
Width	50 mm
Height	290 mm
Depth	219 mm
Weights	
Weight, approx.	900 g

10.11 Technical specifications of the memory cards

Data

Name	Article number	Current consumption at 5 V	Backup currents
MC 952 / 64 KB / RAM	6ES7952-0AF00-0AA0	typ. 20 mA max. 50 mA	typ. 0.5 µA max. 20 µA
MC 952 / 256 KB / RAM	6ES7952-1AH00-0AA0	typ. 35 mA max. 80 mA	typ. 1 µA max. 40 µA
MC 952 / 1 MB / RAM	6ES7952-1AK00-0AA0	typ. 40 mA max. 90 mA	typ. 3 µA max. 50 µA
MC 952 / 2 MB / RAM	6ES7952-1AL00-0AA0	typ. 45 mA max. 100 mA	typ. 5 µA max. 60 µA
MC 952 / 4 MB / RAM	6ES7952-1AM00-0AA0	typ. 45 mA max. 100 mA	typ. 5 µA max. 60 µA
MC 952 / 8 MB / RAM	6ES7952-1AP00-0AA0	typ. 45 mA max. 100 mA	typ. 5 µA max. 60 µA
MC 952 / 16 MB / RAM	6ES7952-1AS00-0AA0	typ. 100 mA max. 150 mA	typ. 50 µA max. 125 µA
MC 952 / 64 MB / RAM	6ES7952-1AY00-0AA0	typ. 100 mA max. 150 mA	typ. 100 µA max. 500 µA
MC 952 / 64 KB / 5V FLASH	6ES7952-0KF00-0AA0	typ. 15 mA max. 35 mA	–
MC 952 / 256 KB / 5V FLASH	6ES7952-0KH00-0AA0	typ. 20 mA max. 45 mA	–
MC 952 / 1 MB / 5V FLASH	6ES7952-1KK00-0AA0	typ. 40 mA max. 90 mA	–
MC 952 / 2 MB / 5V FLASH	6ES7952-1KL00-0AA0	typ. 50 mA max. 100 mA	–
MC 952 / 4 MB / 5V FLASH	6ES7952-1KM00-0AA0	typ. 40 mA max. 90 mA	–
MC 952 / 8 MB / 5V FLASH	6ES7952-1KP00-0AA0	typ. 50 mA max. 100 mA	–
MC 952 / 16 MB / 5V FLASH	6ES7952-1KS00-0AA0	typ. 55 mA max. 110 mA	–
MC 952 / 32 MB / 5V FLASH	6ES7952-1KT00-0AA0	typ. 55 mA max. 110 mA	–
MC 952 / 64 MB / 5V FLASH	6ES7952-1KY00-0AA0	typ. 55 mA max. 110 mA	–
Dimensions WxHxD (in mm)		7.5 x 57 x 87	
Weight		max. 35 g	
EMC protection		Provided by construction	
Standards, approvals, certificates			
UKCA		Yes	
CCC		Yes	
ATEX		ATEX II 3 G Ex ec IIC T4 Gc	

IF 964-DP interface module

11

11.1 Using the IF 964-DP interface module

Article numbers

Use the IF 964-DP interface module with the article number 6ES7964-2AA04-0AB0 in the CPUs of the S7-400 as of firmware version 4.0.

The interface module identifier is on the front panel and can therefore be identified when it is installed.

Properties

The IF 964-DP interface module is used to connect distributed I/Os via "PROFIBUS DP". The module has an electrically isolated RS485 interface. The maximum transmission rate is 12 Mbps.

The permitted cable length depends on the transmission rate and the number of nodes. On a point-to-point link at a transmission rate of 12 Mbps, a cable length of 100 m is possible and at 9.6 Kbps, a length of 1200 m can be achieved.

Up to 125 slave stations/slaves can be connected to the interface module, depending on the CPU used.

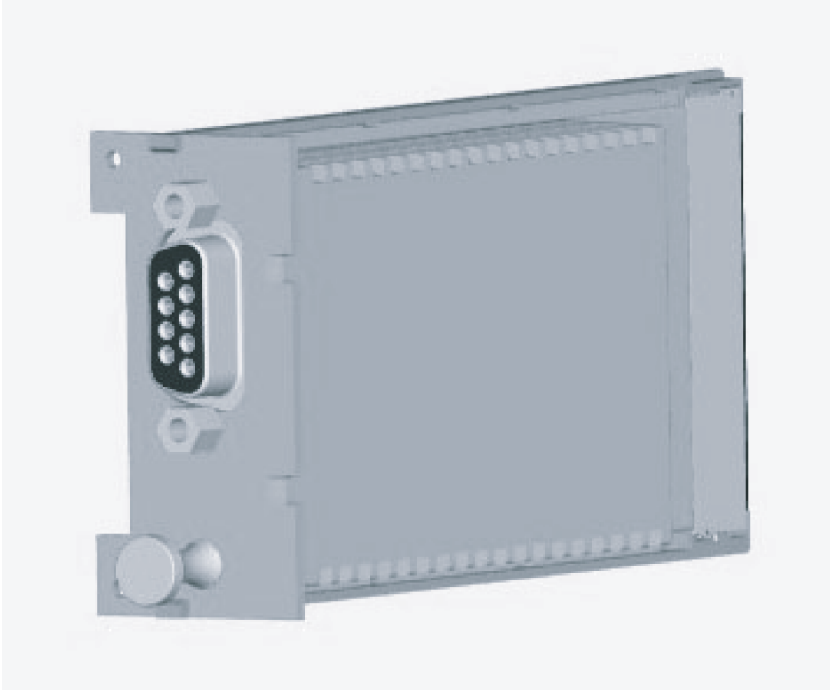

Figure 11-1 IF 964-DP interface module

Additional information

You can find information on "PROFIBUS DP" in the following brochures and manuals:

- Manuals for the DP masters, for example the *S7-300 Programmable Controller* or *S7-400 Automation System* for the PROFIBUS DP interface
- Manuals for the DP slaves, for example, *ET 200M Distributed I/O Station* or *ET 200C Distributed I/O Station*
- Manuals for STEP 7

11.2 Technical specifications

Technical specifications

The IF 964-DP interface module obtains its power from the CPU. The following technical specifications include the necessary current consumption to allow dimensioning of the power supply unit.

Dimensions and weight	
Dimensions W x H x D (mm)	26 x 54 x 130
Weight	0.065 kg
Performance features	
Transmission rate	9.6 Kbps to 12 Mbps
Length of cable • at 9.6 Kbps • at 12 Mbps	 maximum 1200 m maximum 100 m
Number of stations	≤125 (depending on the CPU used)
Physical interface characteristics	RS-485
Isolation	Yes
Voltages, Currents	
Power supply	supplied by the S7-400
Current consumption from the S7-400 bus The CPU does not consume any current at 24 V, it only makes this voltage available at the MPI/DP interface.	Total current consumption of the components connected to the DP interface, however maximum of 150 mA
Possible load of the floating 5 V ($P5_{ext}$)	Maximum 90 mA
Possible load of the 24 V	Maximum 150 mA
Module identifier	C_H
Power loss	1 W

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  6ES7 416-2XP07-0AB0, 308
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