SIEMENS

SIMATIC

Automation System S7-400 Configuration and Use

System Description

This manual has the order number:
6ES7498-8AA00-8BB0

Edition 10/2005

A5E00442711-02

Safety Guidelines

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

Danger

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

Warning

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

Caution

with a safety alert symbol indicates that minor personal injury can result if proper precautions are not taken.

Caution

without a safety alert symbol indicates that property damage can result if proper precautions are not taken.

Notice

indicates that an unintended result or situation can occur if the corresponding notice is not taken into account.

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

Qualified Personnel

The device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by qualified personnel. Within the context of the safety notices in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

Prescribed Usage

Note the following:

Warning

This device and its components may only be used for the applications described in the catalog or the technical description, and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens.

Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.

Trademarks

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

Disclaim of Liability

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

SIEMENS AG
Automation and Drives
Postfach 4848
90437 NÜRNBERG
GERMANY

A5E00442711-02
10/2005

Preface

Purpose of this System Description

The information in this system description is intended to help you do the following:

- Get an overview of the S7-400 automation system.
- Decide if the S7-400 automation system is the optimal controller for your automation task.
- Decide which S7-400 CPU and modules are the best solution for you special application.

When putting a SIMATIC S7-400 into operation, you will need the documentation package, ”S7-400 Programmable Controller”.

Contents of this System Description

This system description provides you with an overview of the S7-400 automation system.

The system description includes the following topics:

- Features of the S7-400
- Communication with the S7-400
- Configuration Options for the S7-400
- Programming the S7-400
- Operator Control and Monitoring with the S7-400

When putting a SIMATIC S7-400 into operation, you will need the documentation package, ”Automation System S7-400”.

Required Level of Knowledge

General knowledge about the field of automation engineering is required to understand the system description.

You also need basic knowledge about the use of computers or resources similar to PCs (e. g. programming devices) running under the Windows 2000 or XP operating systems.

Scope of this System Description

This system description applies to the S7-400 automation system. It reflects the technological level of development applicable in the year of publication.

Approvals

Chapter 9 provides detailed information about approvals and standards.

Position in the Information Landscape

This system description can be separately ordered with the order number 6ES7498-8AA00-8AB0.

Guide

You can quickly access specific information in the manual by using the following aids:

- At the start of the system description you will find a complete table of contents and a list of the figures and tables that appear in the publication.
- At the end of the system description you will find a comprehensive index to help you quickly find the information you are looking for.

Contents

Figures

Tables

SIMATIC S7 - an Overview

1

Overview

The following information is contained in this chapter:

- The differences among the WinAC, S7-300 and S7-400 automation systems in regard to their respective features.
- The components with which you can assemble an S7-400.
- The possible configuration variations of the SIMATIC S7-400 and their respective technical requirements.

You should soon ”get a feeling” while reading the beginning of this brochure as to whether or not the capabilities of the S7-400 will provide a suitable technical solution for your automation tasks.

1.1 SIMATIC S7 - a Few Highlights

SIMATIC - Trend Setter in Automation Engineering

Three decades of innovation have not only made SIMATIC the global leader, it has also made it a synonym for programmable memory controllers.

SIMATIC has not only influenced PLC engineering, it has also set the tone time and again as a trend setter. The early introduction of structured programming and the expansion of the product range with ever-more powerful - yet compatible - central processing units (CPUs) are only a few examples from among many.

The system basis has been maintained despite all the innovations. For the fast changing electronics market this is quite an unusually success story.

SIMATIC S7 - Control for TIA

Totally Integrated Automation (TIA) is the comprehensive and integrated range of products and systems for the automation of the entire production workflow. SIMATIC is responsible for manufacturing and process automation in this range.

SIMATIC S7 - Consistent Compatibility

One of the exceptional features of SIMATIC is the consistent compatibility of the system. This compatibility is reflected in the following aspects:

- Programming
- Configuration
- Data storage
- Communication
- Documentation
- Operator control and monitoring

SIMATIC S7 - Certified Quality

Quality for SIMATIC S7 is implicit. Careful work and continuous controls guarantee consistently high quality. The quality management of the SIMATIC S7 fulfills DIN ISO 9001 - this has been confirmed by the Germany Association for Quality Assurance (Deutsche Gesellschaft für Qualitätssicherung - DQS).

SIMATIC S7 - Products Conforming to Standards

The S7-400 automation system fulfills the requirements and criteria of the IEC 61131-2 standard (Programmable Logic Controllers, part 2: Equipment Requirements and Verifications).

SIMATIC S7 - Environmentally-friendly Product Design

The compact design of the SIMATIC S7 saves on material, weight and packaging. Environmentally hazardous components are not used. The materials used are labeled, environmentally-friendly and recyclable.

SIMATIC S7 - Tiered Systems

SIMATIC S7 consists of the following automation systems tiered in their range of performance and features:

- SIMATIC S7-300, the modular small controller for the lower performance range.
- SIMATIC S7-400, high-performance, optimized for systems in the middle and upper performance range.
- The PC-based control system, the WinAC Slot version offers the functionality of S7-400 CPUs in PC plug-in cards.

1.2 What are the features of the S7-400?

Optimized performance for every area of application

This means the following:

- A tiered CPU landscape
- Upward compatible CPUs
- Quick response times and large performance reserves
- Large user memory
- Simultaneous operation of multiple CPUs in a single automation system

Almost unlimited expansion potential

This means the following:

- Configuration of up to 396 modules in a maximum of 22 racks
- Simple assembly
- Compact modules with high component density
- Operation without fans
- Robust design
- No slot rules for signal and function modules
- Recessed and covered connectors for plugs
- Hot pulling and plugging of the modules

Integrated functionality

This means the following:

- Integrated MPI/DP interface
- Integrated PROFIBUS DP interface
- Integrated system functions, including communication

System-wide compatibility

This means the following:

- Uniform device design, identical display and operator control components
- Uniform programming software, STEP 7
- Uniform configuration, parameter assignment and data storage for all modules
- Uniform programming, operator control and monitoring devices

Special Applications

The following SIMATIC S7-400 versions are available for special applications:

- S7-400F, with CPU 416-2F for fail-safe applications.
- The fault-tolerant S7-400H, with CPUs 414-4H and 417-4H for fail-safe applications. As the S7-400HF, this can also be used for fault-tolerant applications.
- WinAC Slot, S7-400 CPUs as PC plug-in cards for PC-based applications.

Performance Characteristics

Table 1-1 lists a few of the performance characteristics of the automation systems, which may make it easier to decide if a system the right one for you.

Table 1-1 Performance characteristics of the automation systems, as of 06/05

Performance Characteristics	S7-300	S7-400	WinAC Slot
Maximum user memory	512 KB	20 MB	3.2 MB
for approx. instructions	170 K	6.7 M	1.1 M
Execution times			
• Bit operations	0.1 µs	0.03 µs	0.04 µs
• Word operations	0.1 µs	0.03 µs	0.04 µs
• Fixed-point arithmetic	0.1 µs	0.03 µs	0.04 µs
• Floating-point arithmetic	0.6 µs	0.09 µs	0.12 µs
Adress areas Inputs/outputs)	8 KB/8 KB	16 KB/16 KB	16 KB/16 KB
Maximum digital inputs/outputs	65536/65536	131072/131072	via PROFIBUS DP 131073/131073
Maximum analog inputs/outputs	4096/4096	8192/8192	via PROFIBUS DP 8192/8192
Expansions with maximum configuration	4 expansion devices	21 expansion devices	-
Maximum space between modules	30 m	605 m	-
Distributed I/O available	Yes	Yes	Yes
Number of DP masters			
• integrated	2	4	2
• via interface modules	-	2	-
• via CP	4	10	-
Networking via integrated interfaces or via CP	MPI PROFIBUS DP PROFINET/ Industrial Ethernet	MPI PROFIBUS DP PROFINET/ Industrial Ethernet	MPI PROFIBUS DP Industrial Ethernet

1.3 An Overview of S7-400 Components

Introduction

In order for the S7-400 to adapt to and fulfill each and every task, a tiered range of components varying in performance is available for a wide range of functions.

All of these components are matched to one another and can therefore be easily integrated to form a complete system.

Figure 1-1 shows a configuration of an S7-400 with several modules in a rack.

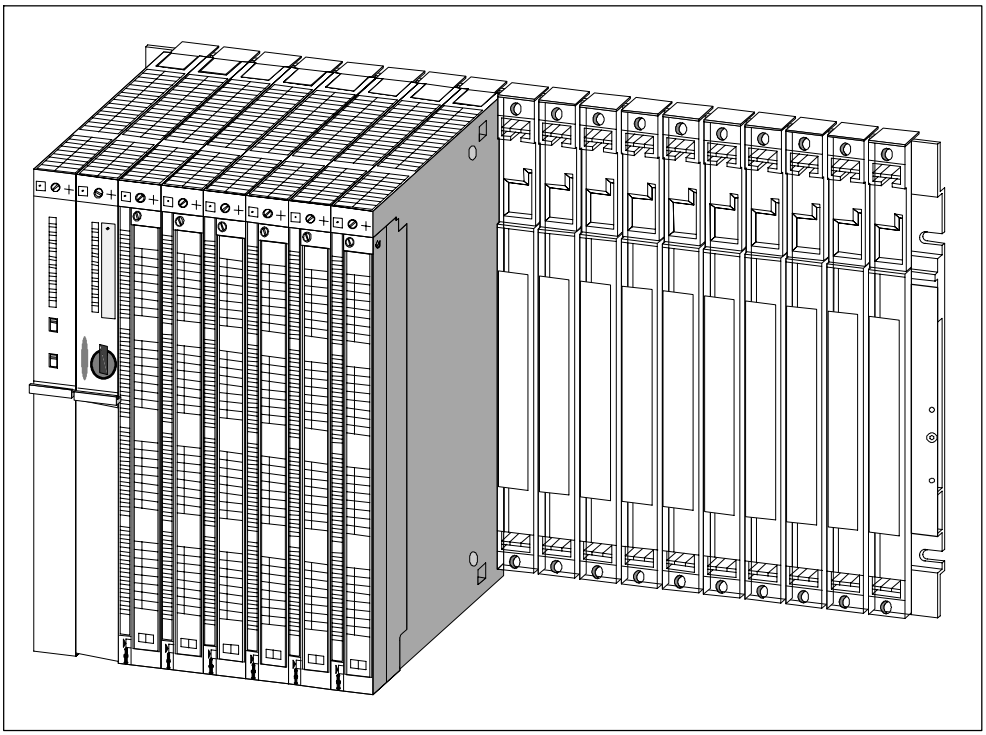


Figure 1-1 An S7-400 configuration

CPU

The CPU is responsible for the control and regulation of the processes. CPUs with varying performance capability are offered for the S7-400. They differ from one another in the size of the user memory, the processing speed and number of interfaces they offer.

Racks

The various modules of the S7-400 automation system are inserted and fastened in a rack. The backplane bus of the rack is divided into two different bus systems:

- I/O bus: The P bus is a parallel backplane bus, which is designed for fast exchange of input and output signals.
- C bus: The C bus is a serial backplane bus, which is designed for the exchange of larges amounts of data.

A total of 22 racks can be connected with one another via interface modules.

Power Supply

The power supply module provides the required operating voltage via the backplane bus of the rack. The available supply voltage and required drive power of the modules determines the selection of the correct power supply. Power supplies are also available with diagnostics and can be configured redundantly if required.

Signal Modules

A wide variety of digital and analog input and output modules (signal modules, SM) are available for adapting to a wide-range of actuators and sensor signals. Signal modules are also available with alarm processing and diagnostics.

Function Modules

Function modules (FM) are specialists for integrating the following plant functions:

- Counting and measuring
- Positioning
- Controlling
- Cam controlling

Interface Modules

Interface modules (IM) are needed to interconnect racks in multi-tier configurations.

Communication Modules

Communication tasks can be realized directly via the interfaces of the CPU or using special communication modules (communication processors, CP) to connect to the following networks or couplers:

- PROFIBUS DP
- PROFINET
- Industrial Ethernet (including IT functionality)
- Point-to-point connections

1.4 S7-400 - Configuration Variants

Configuration Variants for various Automation Task

There is a suitable solution for every automation task. This means to cover a large range of demands for quantity and connection with the process by choosing the appropriate configuration variant.

Table 1-2 provides examples of configuration variants of the S7-400.

Table 1-2 Configuration variants of the S7-400

Selection criteria	Medium-sized plant	Large plant	Large plant with distributed signal monitoring via PROFIBUS DP	
Digital input/outputs*	approx. 2000	approx. 11000	more than 11000	
Analog input/outputs*	approx. 1000	approx. 5500	more than 5500	
Number of modules	maximum 72	maximum 396	more than 396	
Distance (cable length)	3 m between first and last rack	up to 605 m between first and last rack	up to 50 m between 2 devices up to 1000 m with RS485 repeater	up to 23800 m between 2 devices
The solution for your task	Configuration with 4 racks and local link	Configuration with 22 racks and remote link	Communication via MPI interface	Communication via PROFIBUS DP

* The number only applies when only this type of module is used. This table is only intended to give you an overview of the information. Mixed combinations are also possible, of course. The decision depends on the type pf processes to be controlled and the local, on-site conditions.

CPUs of the S7-400

2

Overview

The following information is contained in this chapter:

- A few of the exceptional features of the S7-400 CPUs.
- A comparison of the areas of application and performance characteristics of these CPUs.

2.1 CPUs of the S7-400 - System-wide Compatibility

Introduction

There is a tiered range of CPUs within the S7-400. You can therefore select the most suitable and economic solution for your application.

The following will describe a few of the features that the S7-400 CPUs have in common and exemplify the system-wide compatibility. Figure 2-1 shows a double-width CPU with its interfaces, operator controls and display components.

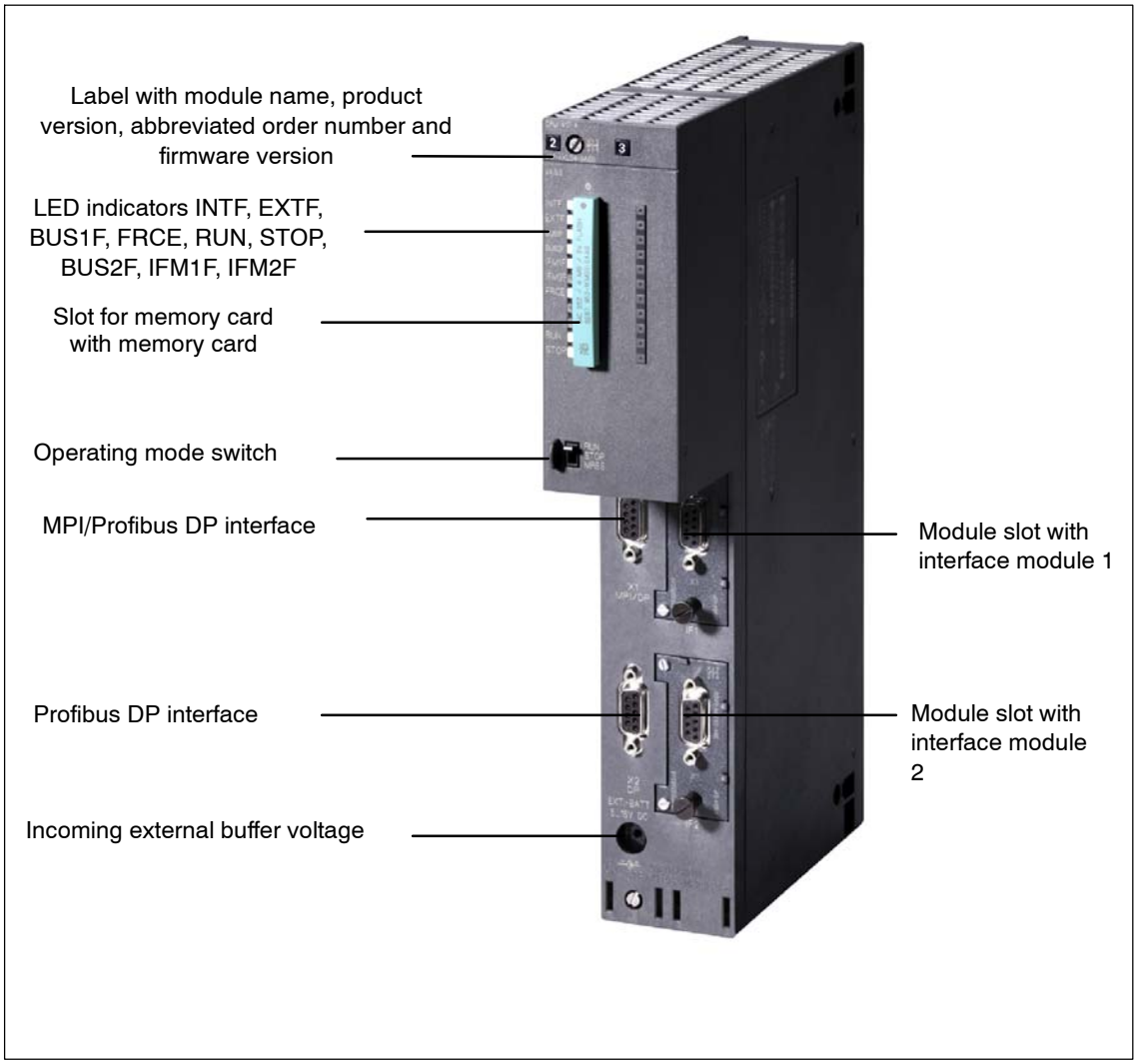


Figure 2-1 Arrangement of the S7-400 CPUs' operator controls and display components

Operating Mode Switch of the S7-400

You can use the operating mode switch to set the CPU in the operating modes RUN or STOP or to bootstrap the CPU. The operating mode switch is a toggle switch.

You can also change the operating mode in STEP 7.

Uniform Displays

The following applies to the status and error displays of the S7-400:

- Identical errors are always displayed in the same way.
- Identical displays are always located at the same location on the front of the module.
- The meaning of flash frequencies is always the same.

To summarize, once you understand the display principle of one module, you can interpret the displays of all other modules.

MPI/DP Interface

All CPUs feature an integrated interface with multi-point capability (MPI).

The MPI interfacce is used for the following tasks:

- Programming and parameter assignment
- Operator control and monitoring
- Configuring simple network structures between CPUs
  S7-300 and S7-400 CPUs exchange data via the MPI interface using a variety of communication functions.

Using this interface as a DP interface and the CPU as a DP master, you can operate up to 32 DP slaves.

Profibus DP Interface

Except for the CPU 412-1, all CPUs feature at least one other interface for connecting to Profibus DP in addition to the MPI/DP interface.

The Profibus DP interfacce is used for the following tasks:

- The CPU acts as the DP master to accees all stations on the Profibus DP.
- The CPU itself is a DP slave on a DP interface.

You can equip CPUs 41x-3 and 41x-4 with interface modules to provide additional DP interfaces.

I/O Expansion

Any CPU can be used in the S7-400 product range.

Password Protection

You can assign three levels of access rights for CPUs from the programming device in STEP 7. To assign a protection level, you specify a password, which has to be entered before unrestricted access to a ”protected” CPU is allowed.

Table 2-1 shows an example of a selection of CPU functions and how they are assigned to the various levels of protection.

Table 2-1 Protection levels of a CPU

CPU function	Protection level 1	Protection level 2	Protection level 3
Displays of the block list	Access allowed	Access allowed	Access allowed
Tag monitoring	Access allowed	Access allowed	Access allowed
S7 communication	Access allowed	Access allowed	Access allowed
Read and set time	Access allowed	Access allowed	Access allowed
Status block	Access allowed	Access allowed	Password required
Download program to programming device	Access allowed	Access allowed	Password required
Download program to CPU	Access allowed	Password required	Password required
Delete blocks	Access allowed	Password required	Password required
Download user program to memory card	Access allowed	Password required	Password required
Control tags	Access allowed	Password required	Password required
Bootstrap via programming device	Access allowed	Password required	Password required

If you do not know the password, you can remove the configured security level by bootstraping the CPU using the operating mode switch. No flash card should be inserted in the CPU.

Block Protection

You can protect individual blocks. The blocks can then no longer be opened. The know-how contained in a block remains hidden to anyone not in possession of the program sources.

Uniform Instruction Set

The STEP 7 programming package is used to program the S7-400. The STEP 7 instruction set is the same for every CPU. This compatibility means that user programs can run on any CPU. The CPUs only differ in the execution time of the instructions and the volume (see table 2-2).

The fault-tolerant CPUs of the S7-400H are also programmed with the same instructions as the S7-400 CPUs. The functional differences between the S7-400 and S7-400H only involve the number of integrated functions and blocks.

Integrated Functions

The operating system of each CPU features the following integrated functions, which simplify the user program considerably:

- Operating control and monitoring functions
- Functions for communication
- Functions for diagnostics
- Functions for transmission of data records
- Functions for program control
- Functions for interrupt handling
- Functions for generating messages

The integration of these functions in the operating system means that there is no need for tedious programming and the cycle time load of the CPU is reduced.

Diagnostics Buffer

Each CPU features a diagnostics buffer, in which error and diagnostic messages are entered and stored.

Messages are entered into the diagnostics buffer either by the CPU or other modules. User-defined diagnostic messages can also be entered by the user program.

These messages can be read by the programming device at any time. The date and time of the entry is also included. Messages can also be sent to operator control and monitoring stations. The diagnostics buffer entries cannot be manipulated. The most recent 120 entries are retained even after ”bootstrapping”.

2.2 Performance Characteristics of the CPUs

Introduction

This chapter compares the performance characteristics of the S7-400 and S7-400H CPUs.

Table 2-2 Performance Characteristics of the S7-400 CPUs

CPU	412-1	412-2	414-2	414-3	416-2 416-2F	416-3	417-4
User memory							
• integrated	144 KB	256 KB	512 KB	1.4 MB	2.8 MB	5.6 MB	20 MB
• for program	72 KB	128 KB	256 KB	700 KB	1.4 MB	2.8 MB	10 MB
• for data	72 KB	128 KB	256 KB	700 KB	1.4 MB	2.8 MB	10 MB
Loading memory							
• integrated	256 KB RAM						
• expandable to	64 MB						
Buffering	Yes						
Number of blocks							
• FC	256		2048				6144
• FB	256		2048				6144
• DB DB0 reserved	511		4095				8191
Program execution							
• Free cycle	1		1		1		1
• Time interrupts	2		4		8		8
• Delay interrupts	2		4		4		4
• Watchdog interrupts	2		4		9		9
• Hardware interrupts	2		4		8		8
• Multicomputing interrupts	1		1		1		1
• Clock synchronization interrupts	4		4		4		4
• Startup	3		3		3		3
Execution times							
• Bit operations	0.1 µs		0.06 µs		0.04 µs		0.03 µs
• Word operations	0.1 µs		0.06 µs		0.04 µs		0.03 µs
• Fixed-point arithmetic	0.1 µs		0.06 µs		0.04 µs		0.03 µs
• Floating-point arithmetic	0.3 µs		0.18 µs		0.12 µs		0.09 µs
Memory bits, timers, counters							
• Memory bits	4 KB		8 KB		16 KB		
• S7 timers / S7 counters	2048/2048		2048/2048		2048/2048		
• IEC timers / IEC counters	SFB/SFB		SFB/SFB		SFB/SFB		

Table 2-2 Performance Characteristics of the S7-400 CPUs, continued

CPU	412-1	412-2	414-2	414-3	416-2 416-2F	416-3	417-4
Structure							
• Number Expansion devices	21						
• Number DP master via CP	maximum 10						
• Number FM	limited by number of slots and number of connections						
• Number CP	limited by number of slots and number of connections						
MPI/DP interface							
• DP slaves	maximum 32						
• Transmission rate	up to 12 Mbps						
DP interface							
• Number	-	1	1	2	1	2	3
• DP slaves	-	64	96	96 each	125	125 each	125 each
• Transmission rate	-	up to 12 Mbps	up to 12 Mbps	up to 12 Mbps	up to 12 Mbps	up to 12 Mbps	up to 12 Mbps
• Plug-in interface modules	-	-	-	1 x DP	-	1 x DP	2 x DP
I/O address area							
• Total address area	4 KB / 4 KB		8 KB / 8 KB		16 KB / 16 KB		
• Process image	4 KB / 4 KB		8 KB / 8 KB		16 KB / 16 KB		
• Digital channels	32768/32768		65536/65536		131072/131072		
• Analog channels	2048/2048		4096/4096		8192/8192		

Table 2-3 CPU features of the S7-400H

CPU	414-4H	417-4H
User memory		
• integrated	1.4 MB	20 MB
• for program	700 KB	10 MB
• for data	700 KB	10 MB
Loading memory		
• integrated	256 KB RAM	
• expandable to	64 MB	
Buffering	Yes	
Number of blocks		
• FC	2048	6144
• FB	2048	6144
• DB DB0 reserved	4095	8191
Program execution		
• Free cycle	1	1
• Time interrupts	4	8
• Delay interrupts	4	4
• Watchdog interrupts	4	9
• Hardware interrupts	4	8
• Startup	2	2

Table 2-3 CPU features of the S7-400H, continued

CPU	414-4H	417-4H
Execution times		
• Bit operations	0.06 µs	0.03 µs
• Word operations	0.06 µs	0.03 µs
• Fixed-point arithmetic	0.06 µs	0.03 µs
• Floating-point arithmetic	0.18 µs	0.09 µs
Memory bits, timers, counters	8 KB	16 KB
• Memory bits	2048/2048	2048/2048
• S7 timers / S7 counters	SFB/SFB	SFB/SFB
• IEC timers / IEC counters		
Structure		
• Number Expansion devices	21	
• Number DP master via CP	maximum 10	
• Number FM	limited by number of slots and number of connections	
• Number CP 441	limited by number of connections, maximum 30	
MPI/DP interface		
• DP slaves	maximum 32	
• Transmission rate	up to 12 Mbps	
DP interface		
• Number	1	1
• DP slaves	96 each	125 each
• Transmission rate	up to 12 Mbps	up to 12 Mbps
I/O address area		
• Total address area	8 KB / 8 KB	16 KB / 16 KB
• Process image	8 KB / 8 KB	16 KB / 16 KB
• Digital channels	65536/65536	131072/131072
• Analog channels	4096/4096	8192/8192

2.3 Memory Concept

Introduction

The CPUs of the S7-400 have the following types of memory:

- Loading memory for project data, for example, blocks, configuration and parameter assignment data including symbols and comments.
- User memory for the runtime-relevant blocks (code blocks and data blocks) and the system memory.

Loading Memory

The loading memory consists of a plug-in memory card (RAM or FLASH EPROM). An integrated RAM is provided for test purposes or for reloading/correcting blocks when a FLASH EPROM memory card is used.

Additional information is stored in the loading memory along with the project data. This might include format identifications, symbols and comments, to enable full decompiling of the user program with any programming device. The loading memory also stores the parameter blocks for other modules used in the automation system.

User Memory

The user memory (integrated RAM) is used to hold the parts of the user program that are relevant for executing the program. The program is executed exclusively in the area of the user and system memory.

System Memory

The system memory contains the memory elements that each CPU makes available to the user program, such as the process image of the inputs and outputs and local data.

Buffering

The CPUs of the SIMATIC S7-400 are buffered by the power supply module, enabling them to retain their entire memory contents if a power failure occurs. The power supply modules feature either one or two batteries. They can also be operated with a back-up battery, however.

The CPUs can also be backed up by an external power source.

Retention of Timers, Counters, Memory Bits and Data Blocks

Timers, counters, memory bits and data blocks can retain their old values even after reboot. All you have to do for this is to define these operands as non-volatile using STEP 7.

2.4 Multicomputing

Introduction

Multicomputing mode is the simultaneous operation of several (maximum of four) CPUs in a single central controller of the S7-400.

The CPUs involved automatically change their modes synchronously. In other words, they start up together and change to STOP mode together. The user program runs on each CPU irrespective of the user programs in the other CPUs. This makes it possible to execute controller tasks in parallel.

Multicomputing mode is not available with the CPUs of the S7-400H.

When do you use multicomputing?

It is advantageous to use multicomputing in the following cases:

- If your user program is too large for a single CPU and memory is limited, you can distribute your program over several CPUs.
- If a certain part of your system is supposed to be processed quickly, separate the relevant program section from the overall program and have it processed by a dedicated, “fast” CPU.
- If your system consists of several different parts that can be easily separated from one another and can therefore be controlled relatively independently, let CPU1 process system part 1, CPU 2 system part 2 and so on.

Assigning Modules to the CPUs

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

Each interrupt-capable module is therefore assigned to a CPU. Interrupts originating from such a module cannot be received by the other CPUs.

I/O Volume

The typical I/O volume of an automation system in multicomputing mode corresponds to the volume of the CPU with the most resources

2.5 Configuration in Run

Introduction

The ability to modify the system during operation using CiR (Configuration in RUN) allows you to make certain changes to the configuration in the RUN mode. Processing is halted for a brief period in order to accomplish this. During this time, the process inputs retain their most recent value.

Area of Application

You can modify the system during operation using CiR in system segments with distributed I/O. This can be done with all standard CPUs of the S7-400 and for the fault-tolerant S7-400H-CPUs running in single mode.

Permitted Configuration Changes in Run Overview

The following modifications can be made to the system in the Run mode:

- Modules can be added to the modular DP slave ET 200M, if it has not been connected as a DPV0 slave (using a GSD file).
- ET 200M modules can be reconfigured, for example, another interrupt limit can be selected or previously unused channels can be used.
- A previously unused channel in a module or a module for the modular slaves ET 200M, ET 200S, ET 200iS can be used.
- DP slaves can be added to an existing DP master system.
- PA slaves (field devices) can be added to an existing PA master system.
- DP/PA couplers can be added downstream from an IM157.
- PA links (including PA master systems) can be added to an existing DP master system.
- Modules can be assigned to a process image partition.
- Existing modules in ET 200M stations (standard modules and fail-safe signal modules in standard mode) can be reconfigured.
- Changes can be reversed: added modules, DP slaves and PA slaves (field devices) can be removed.

Configuration Changes in Run with Fault-tolerant CPUs

In addition to the system changes described above, you can make the following configuration changes in Run when using fault-tolerant automation systems:

- Upgrade to a newer product version
- Switch the master with only one available redundancy coupling

2.6 Clock Synchronicity

Introduction

Clock synchronicity is the synchronous coupling of the signal detection and signal output via the distributed I/O and the program execution to the PROFIBUS clock pulse.

Clock synchronicity is not available with the CPUs of the S7-400H.

Advantages

Clock synchronicity offers the following advantages:

- The input data are always read in the same intervals and the output data are always generated in the same intervals.
- All input and output data are transmitted in a consistent manner. All the data in the process image belong together in both a logical and a chronological sense.
- The user program, the acquisition of the input data and the generation of output data are synchronized. The process reaction times are therefore always the same.

2.7 The CPUs S7-400H for Fault-tolerant Controllers

Introduction

You use redundant automation systems to increase availability and avoid production losses.

The higher the costs of a production standstill, the more worthwhile it is to use a fault-tolerant system. The investment costs associated with a fault-tolerant system is quickly offset by the savings resulting from decreased production downtime.

The S7-400H automation system meets the high requirements for availability, intelligence and distributed operation that are required of modern automation systems. It also features all the functions for acquiring and preparing process data and for controlling, regulating and monitoring equipment and plants.

Tiered Availability with Redundant Components

The S7-400H is designed with redundancy so that it remains available in every situation.

This includes the CPU, the power supply and the hardware for interconnecting the two CPUs.

The two CPUs form the core of the S7-400H. You set the rack numbers of the CPUs with a switch at the back. The two subsystems can be identified by their respective rack number.

You yourself can decide which components to implement redundantly to increase their availability based on the process you are automating.

Synchronization Modules

Synchronization modules are used for the communication between two redundant S7-400H CPUs. They are integrated into the CPUs and interconnected via fiber optic cables. You need two synchronization modules for each CPU.

There are two types of synchronization modules, one with a cable length of 10 m between the CPUs and another with a cable length of up to 10 km.

You can replace a synchronization module when it is energized. This supports the repair scenario for H systems and thus can overcome the failure of the redundant connection without having to bring the plant to a stop.

Linking and Synchronizing

There are two methods for linking and synchronizing:

- In a “normal” link and synchronization procedure, the fault-tolerant system should change from single mode to **redundant** system mode. The two CPUs then process the same program synchronously.
- In the case of a link and synchronization with **master**/**standby switch-over**, the second CPU with modified components may take over process control. Either the hardware configuration or the memory configuration can be modified.

  In order to return to redundant system mode, a “normal“ link and synchronization must be subsequently performed.

Programming an H System

When you configure and program a fault-tolerant automation system with H CPUs, certain differences to the standard S7-400 CPUs become apparent. On the one hand, compared to a standard S7-400 CPU, a fault-tolerant CPU has additional functions, while on the other hand an H CPU does not support certain other functions. This has to be taken in account particularly if you wish to run a program that was created for a standard S7-400 CPU on an H CPU.

Fault-tolerant Connections

The controller and the I/O can be redundantly configured for a fault-tolerant controller. With growing demands on the availability of an overall system, it is necessary to increase the fault tolerance of the communication. To do this, configure redundant communication and use fault-tolerant S7 connections.

Unlike the S7 connection, a fault-tolerant S7 connection consists of at least two lower-level partial connections. From the point of view of the user program, the configuration and the connection diagnostics, the fault-tolerant S7 connection with its subordinate partial connections is represented by exactly one ID (like a standard S7 connection). Depending on the configuration, it can consist of up to four partial connections, of which two are always established (active). This maintains communications in the event of an error. The number of partial connections depends on possible alternative paths and is determined automatically.

If the active partial connection fails, a previously established second partial connection assumes responsibility for communications.

Self-test

Disruptions or errors have to be detected, located and reported as quickly as possible. Consequently, wide-ranging self-test functions have been implemented in the S7-400H that run automatically and entirely in the background.

The following components and functions are tested:

- Interconnection of the central controllers
- Internal memory of the CPU
- I/O bus

If the self-test detects an error, the fault-tolerant system tries to eliminate it or to suppress its effects.

Single-channel, One-way I/O

In the single-channel, one-way configuration, there are single input/output modules (single-channel). The input/output modules are located in just one of the subsystems and are only addressed by that subsystem.

The single-channel, one-way I/O configuration is recommended for individual input/output channels for which normal availability of the I/O is sufficient.

Single-channel, Switched I/O

In the single-channel, switched configuration, there are single input/output modules (single-channel). In redundant mode, they can be addressed by both subsystems. The single-channel, switched I/O configuration is recommended for devices that tolerate the failure of individual modules.

The single-channel, switched I/O configuration is possible with the ET 200M und ET 200 iSP distributed I/O devices or redundant standard slaves, for example.

PROFIBUS PA can be connected to a redundant system using DP/PA Link. A single-channel DP master system can be connected to a redundant system using a Y-coupler.

Redundant I/O

I/O modules are considered redundant when there are two of each and they are configured and operated as redundant pairs. The use of redundant I/O provides the highest degree of availability since it means that failure of a CPU failure and failure of a signal module are both tolerated.

The implementation of redundant I/O is supported by the software blocks integrated in STEP 7.

Redundant Input Modules

With redundant input modules, the measured values or input signals are read by both modules and the results are compared. When the results are the same or within a configured tolerance window, they are further processed.

Redundant Digital Output Modules

The fault-tolerant control of an actuator can be achieved by connecting two outputs of two digital output modules in parallel

Redundant Analog Output Modules

You can redundantly operate analog output modules with power outputs.

The value to be output is halved and each module outputs one half of the value. If one of the modules fails, this is detected and the remaining module outputs the full value. This reduces any current surge to the output module when an error occurs.

Single Operation

You can also use an H CPU in a standard SIMATIC-400 station.

This allows you to use the following applications that cannot be used with the standard CPUs from the S7-400 range:

- Use of fault-tolerant connections
- Configuration of the S7-400F/FH fail-safe automation system

System-wide Compatibility

The S7-400H automation system and all other SIMATIC components such as the SIMATIC PCS7 control system are perfectly matched. Full system compatibility, from the control console to the sensors and actuators, guarantees maximum system performance.

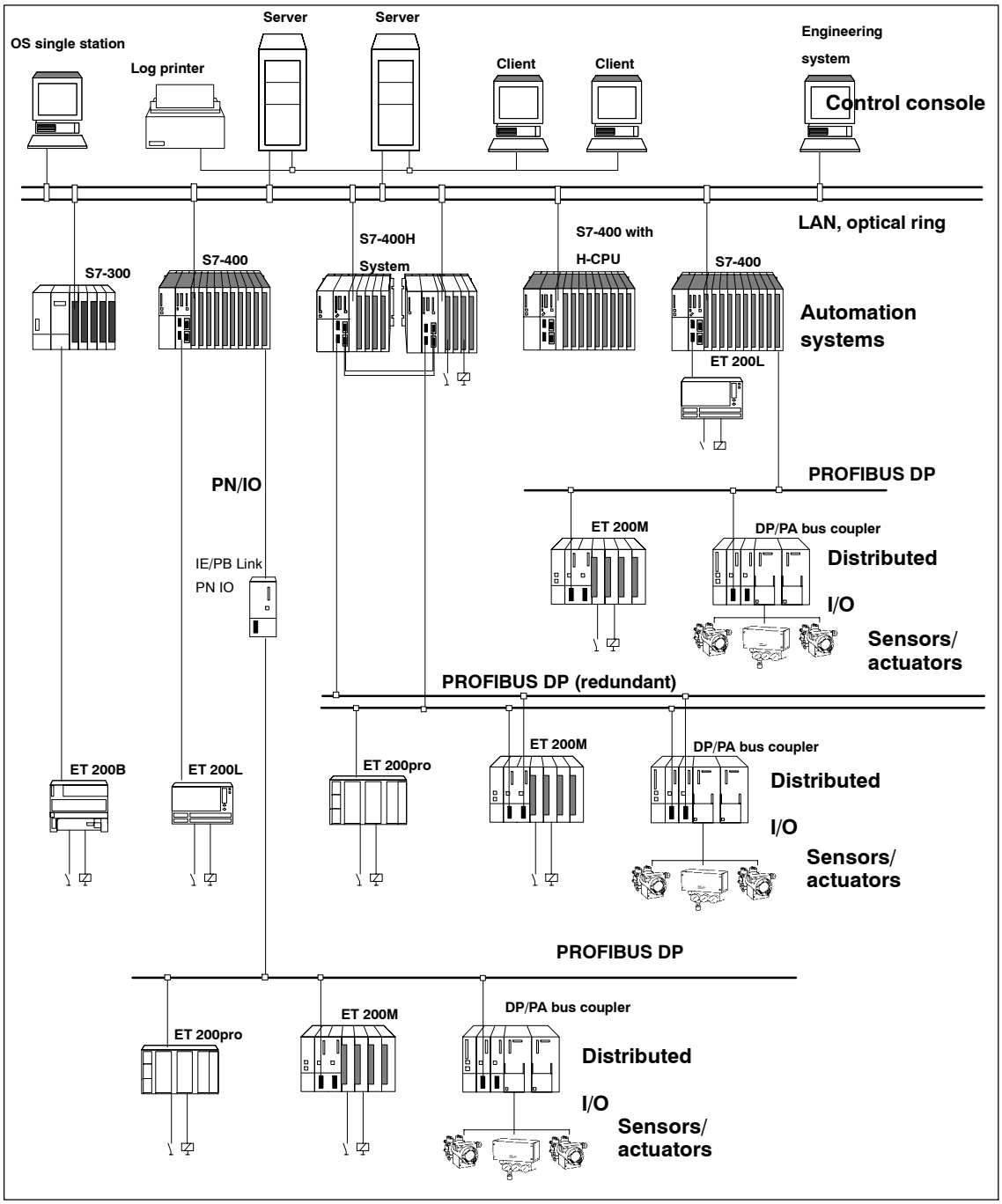


Figure 2-2 Compatible automation solutions with SIMATIC

2.8 CPU 416F for Fail-safe Controlling (Distributed Safety)

Introduction

Fail-safe, S7 Distributed Safety is used in the area of machine and personnel protection (for example, for emergency stop devices for machining and processing equipment) and in the process industry (for example, for implementation of protection functions for small instrumentation and control devices and small burners).

S7-400F Automation System

An S7-400F automation system is built with a CPU 416F. The CPU 416F is based on the corresponding standard CPU 416. Its hardware and operating system is enhanced by several protection mechanisms that allow the CPU 416F to execute safety programs.

Safety Requirements

F-systems S7 Distributed Safety can fulfill the following safety requirements:

- Requirement class AK1 to AK6 in accordance with DIN V 19250/DIN V VDE 0801
- Safety class (Safety Integrity Level) SIL1 to SIL3 in accordance with IEC 61508
- Category 2 to 4 in accordance with EN 954-1

Principle of Safety Functions S7 Distributed Safety

Fail-safe behavior is achieved by means of safety functions primarily in the software. Safety functions are executed by the S7 F Distributed Safety programmable controller in order to return the system to a safe state, or keep it in a safe state when a hazardous event occurs. The safety functions are primarily incorporated in the following components:

- In the safety-related user program on the central processing unit
- In the fail-safe input/output modules

The fail–safe I/O ensure safe processing of field information (emergency OFF buttons, light barriers, motor control). They contain all of the required hardware and software components for safe processing, in accordance with the required safety class. The user only programs the user safety function. The safety function for the process can be provided through a user safety function or a fault reaction function. In the event of a fault, if the F-system can no longer execute its actual user safety function, it executes the fault reaction function; for example, the associated outputs are deactivated and the F-CPU switches to STOP mode, if necessary.

Hardware Components

The hardware components of an S7 Distributed Safety include the following:

- F-capable CPU, e. g. CPU 416-2F
- Fail-safe I/O

In addition, the F-system can be expanded with standard components of the S7-400.

Software Components

The software components of an S7 Distributed Safety include the following:

- Optional package on the programming device/ES for configuring and programming the F-system
- Safety program in the F-CPU

Optional Package S7 Distributed Safety

S7 Distributed Safety is the configuration and programming software for the S7 Distributed Safety fail-safe system. With S7 Distributed Safety, you receive the following:

- Support for configuring the F-I/O in STEP 7 using HW Config
- Support for creating the safety program and integrating error detection functions into the safety program
- F-library containing fail-safe application blocks that you can use in your safety program.

Moreover, S7 Distributed Safety offers functions for comparing safety programs and for assisting you with the system acceptance test.

2.9 The CPUs 41xH for Fail-safe and Fault-tolerant Controllers (F/FH Systems)

Introduction

Fail-safe S7 F/FH systems are used in process engineering and instrumentation and control systems in which a safe state can be attained by switching off the fail-safe outputs.

S7-400F Automation System

An S7-400F system consists of a fail-safe capable CPU such as CPU 417-4 H that can run a fail-safe user program

S7-400FH Automation System

An S7-400FH system consists of a fault-tolerant S7 400H system (master and standby) running a fail-safe user program

An S7-400FH automation system is built with S7-400H CPUs. You increase the availability by implementing a redundant power supply, CPU, communication and I/O.

Safety Requirements

Fail-safe S7 F/FH Systems can satisfy the following safety requirements:

- Requirement class AK1 to AK6 in accordance with DIN V 19250/DIN V VDE 0801
- Safety class (Safety Integrity Level) SIL1 to SIL3 in accordance with IEC 61508
- Category 2 to Category 4 in accordance with EN 954–1

Principle of Safety Functions

Functional safety is implemented principally through safety functions in the software. Safety functions are executed by the fail-safe S7 F/FH system to place or maintain the system in a safe state in case of a dangerous occurrence.The safety function for the process can be provided through a user safety function or a fault reaction function. In the event of a fault, if the F-system can no longer execute its actual user safety function, it executes the fault reaction function. For example, the associated outputs are deactivated, and the safety program or parts of the safety programm are disabled, if necessary.

Hardware Components

An F-System consists of hardware components that fulfill certain safety requirements, such as:

- A CPU, such as the CPU 417-4H, with an F-copy license
- F-I/Os

You can also expand the F–System with standard components.

Software Components

The software components of a S7 F-System include the following:

- S7 F Systems (Programming)
- S7 F Configuration Pack (Configuration of the F-I/Os)
- The fail-safe user program (F user program) on the CPU

Creating a Fail-safe User Program

You create the fail-safe user program in CFC using fail-safe blocks from the ”Fail-safe Blocks” library. For the connection to the F-I/Os, you use F channel and module driver blocks, to which you have to assign parameters. Some of the parameters are assigned automatically as a result of the hardware configuration of the F-I/Os.

When the executable fail-safe user program is generated, safety tests are carried out automatically and additional fault detection functions incorporated.

Signal Modules of the S7-400

3

Overview

The following information is contained in this chapter:

- Configuration of the S7-400 signal modules using STEP 7 on the programming device.
- Addressing the S7-400 signal modules.
- An overview of the S7-400 signal modules with their most important performance characteristics.

3.1 Signal Modules

Introduction

There are numerous signal modules for the S7-400 automation system. You can therefore select the most suitable and economic solution for your application.

Digital and Analog Modules

Digital and analog modules are collectively referred to as ”signal modules” (SM). The ’SM’ abbreviation that is printed on these modules stands for the international designation, ”signal module”.

Advantages

The modules of the S7-400 offer you the following advantages:

- The modules of the S7-400 are compact and feature high channel density.
- The modules of the S7-400 require little space and are extremely easy to mount.
- The modules of the S7-400 are designed with uniform connection and display features.
- All connections are located behind a hinged cover on the front of the modules.
- All modules are configured using the programming software, STEP 7.
- The modules can be hot pulled and plugged.

3.2 Assigning Parameters to Signal Modules

Introduction

In this chapter you will learn more about the options available for configuring and assigning parameters to the modules of SIMATIC S7.

Parameter Assignment with Software

STEP 7 enables you to easily enter all parameters in guided dialogs. For example, the measurement range for analog modules is set using STEP 7.

The parameters are transferred to the CPU with STEP 7. The CPU then distributes the parameters to the modules at startup.

Advantages

Parameter assignment using STEP 7 offers you the following advantages:

- The modules are easily configured, you can easily change and conveniently document the parameter assignments.
- It is impossible to make incorrect settings when exchanging modules.
- Since the parameters and addresses are stored in STEP 7, you can always copy, document and easily change these settings for a whole series of similar controllers.

3.3 Addressing Signal Modules

Introduction

The address ranges of the S7-400 are adapted to the requirements for easy-to-operate, high-performance controllers. In this chapter, you will learn which address areas are used for SIMATIC S7 and how the addresses are assigned.

Address Ranges

The following address ranges are used for working with SIMATIC S7:

- I/O area

  Inputs/outputs of digital and analog modules, function modules

- System data area

  Parameter sets, diagnostic data

Access to the I/O Area of Digital Modules

The process image is accessed indirectly. The information from the inputs and to the outputs is stored in the process image. Direct access is also possible here.

Access to the I/O Area of Analog Modules

The inputs and outputs are access directly. In other words, currently queued values at the inputs are processed in the program and the results are immediately forwarded to the outputs. Indirect access is also possible via the process image.

Access to System Data

System calls are integrated in the CPU. The system calls allow access to system data for parameter sets and diagnostic data for each slot and are performed in the user program.

Addressing with STEP 7

You can use STEP 7 to set the addresses for communicating with the modules. No hardware settings using jumpers or switches are needed.

3.4 Overview of the Performance Characteristics of the Signal Modules

Introduction

Varying signal types (analog and digital) and signal levels (voltage levels) of the actuators and sensors required different signal modules to process the signals in the CPU.

The S7-400 offers a wide range of signal modules to handle any type of controller signals.

Process Interrupt

The signals of the modules are read by the CPU in cycles and processed in the user program.

Some applications, however, require fast response to certain signal transitions in the I/O. This task demands signal modules that are capable of triggering process interrupts. The process interrupt stops the processing and user program and calls up a configured interrupt OB.

Diagnostics

When an fault occurs, a wire-break at the module, for example, the cyclic program is stopped, a diagnostic interrupt triggered and a specific error program started. A diagnostic message is also entered in the diagnostics buffer of the CPU.

Performance Characteristics of the Digital Modules

Table 3-1 provides an overview of the performance characteristics of the S7-400 digital modules.

Table 3-1 Performance Characteristics of the Digital Modules

Module	Performance characteristics
Digital input module SM 421	
DI 32 x 24 V DC 6ES7421-1BLxx-0AA0	• 32 inputs, isolated in a group of 32 • Rated input voltage 24 V DC • Suitable for switches and 2/3/4 wire proximity switches (BEROs, IEC 61131-2; Typ 1)
DI 16 x 24 V DC 6ES7421-7BHxx-0AB0	• 16 inputs, isolated in 2 groups of 8 • Very fast signal processing: Input filter from 50 µs • Rated input voltage 24 V DC • Suitable for switches and 2/3/4 wire proximity switches (BEROs, IEC 61131-2; Typ 2) • 2 short-circuit-proof encoder supplies for 8 channels each • Optional external redundant power supply to supply encoders • “Encoder supply (Vs) OK” status display • Group error display for internal and external faults • Programmable diagnostics • Programmable diagnostic interrupt • Programmable hardware interrupt • Programmable input delays • Programmable substitute values in the input range
DI 16 x 24/60 V UC 6ES7421-7DHxx-0AB0	• 16 inputs, isolated in 16 groups of 1 • Rated input voltage 24 V UC to 60 V UC • Suitable for switches and 2-wire proximity switches (BEROs) • Suitable as active high and active low input • Group error display for internal and external faults • Programmable diagnostics • Programmable diagnostic interrupt • Programmable hardware interrupt • Programmable input delays
DI 16 x 120/230 V UC 6ES7421-1FHxx-0AA0	• 16 inputs, isolated in 4 groups of 4 • Rated input voltage 120/230 V UC • Suitable for switches and 2-wire proximity switches With a second version: • Input characteristic curve according to IEC 61131-2; Type 2

Table 3-1 Performance Characteristics of the Digital Modules, continued

Module	Performance characteristics
Digital input module SM 422	
DO 16 x 24 V DC / 2 A 6ES7422-1BHxx-0AA0	• 16 outputs, isolated in 2 groups of 8 • Output current 2 A • Rated load voltage 24 V DC
DO 32 x 24 V DC / 0.5 A 6ES7422-1BLxx-0AA0	• 32 outputs, isolated in one group of 32 • Power is supplied to groups of 8 channels. • Output current 0.5 A • Rated load voltage 24 V DC
DO 32 x 24 V DC / 0.5 A with diagnostics 6ES7422-7BLxx-0AB0	• 32 outputs, fused and isolated in 4 groups of 8 • Output current 0.5 A • Rated load voltage 24 V DC • Group error display for internal and external faults • Programmable diagnostics • Programmable diagnostic interrupt • Programmable substitute value output
DO 16 x 120/230 V AC / 2 A 6ES7422-1FHxx-0AA0	• 16 outputs, isolated in 4 groups of 4 • Output current 2 A • Rated load voltage 120/230 V AC
Relay output module SM 422	
DO 16 x 30/230 V UC / Rel. 5 A 6ES7422-1HHxx-0AA0	• 16 outputs, isolated in 8 groups of 2 • Output current 5 A • Rate load voltage 230 V AC / 125 V DC

Performance Characteristics of the Analog Modules

Table 3-2 provides an overview of the performance characteristics of the S7-400 analog modules.

Table 3-2 Performance Characteristics of the Analog Modules

Module	Performance characteristics
Analog input module SM 431	
AI 8 x 13 Bit 6ES7431-1KF0x-0AB0	All-purpose and easy to use module which is sufficient for many automation technology applications. • 8 inputs for voltage/current measurement • 4 inputs for resistance measurement • Different measuring ranges can be set simultaneously • 13-bit resolution • Analog section isolated from CPU • The maximum permissible common mode voltage between the channels and between the reference potential of the connected encoders and M_{ANA} 30 V AC.
AI 8 x 14 Bit 6ES7431-1KF1x-0AB0	All-purpose module which can be used for all measuring ranges (U, I, R, RTD, TC). Suitable for applications which rely on Common Mode Voltage (UCM) which occur for example, in plants spread out over a large area. • 8 inputs for voltage/current measurement • 4 inputs for resistance and temperature measurement • Different measuring ranges can be set simultaneously • 14-bit resolution • Especially suitable for measuring temperatures • Temperature encoder types can be configured • Linearization of the encoder characteristic curves • Power supply: 24 V DC required only for the connection of 2-wire transmitters • Analog section isolated from CPU • The maximum permissible common mode voltage between the channels and between the channel and the central ground point is 120 V AC.
AI 8 x 14 Bit with rapid A/D changeover 6ES7431-1KF2x-0AB0	• Rapid A/D changeover, therefore particularly suitable for highly dynamic processes • 8 inputs for voltage/current measurement • 4 inputs for resistance measurement • Different measuring ranges can be set simultaneously • 14-bit resolution • Power supply: 24 V DC required only for the connection of 2-wire transmitters • Analog section isolated from CPU • The maximum permissible common mode voltage between the channels and between the reference potential of the connected encoders and M_{ANA} 8 V AC.

Table 3-2 Performance Characteristics of the Analog Modules, continued

Module	Performance characteristics
AI 16 x 13 Bit 6ES7431-0HHxx-0AB0	Simple module for current and voltage measurement, offers high channel density at a very low channel price. • 16 inputs for voltage/current measurement • Different measuring ranges can be set simultaneously • 13-bit resolution • Analog section non-isolated from CPU • The maximum permissible common mode voltage between the channels and the reference potentials of the connected encoders and central ground point is 2 V AC/DC.
AI 16 x 16 Bit 6ES7431-7QHxx-0AB0	Can be used univerally due to its ability to cover all measuring ranges (U, I, R, RTD, TC). Suitable for applications requiring higher and highest precision and resolution, for example, in process engineering plants. • 16 inputs for voltage/current and temperature measurement with thermocouples (TC) • 8 inputs for resistance and temperature measurement with resistance thermometers (RTD) • Different measuring ranges can be set simultaneously • 16-bit resolution • Programmable diagnostics • Programmable diagnostic interrupt • Programmable interrupt for limit violation • Programmable end-of-cycle interrupt • Analog section isolated from CPU • The maximum permissible common mode voltage between the channels and between the channel and the central ground point is 120 V AC.
AI 8 x RTD x 16 Bit 6ES7431-7KF1x-0AB0	Special module for temperature acquisition via resistance thermometer (RTD). Very high precision and resolution with a short basic conversion time (25 ms for all 8 channels) allow it to be used even in high-speed processes. • 8 differential inputs for the resistance thermometer • Programmable resistance thermometer • Linearization of the resistance thermometer characteristic curves • 16-bit resolution • Update rate of 25 ms for 8 channels • Programmable diagnostics • Programmable diagnostic interrupt • Programmable interrupt for limit violation • Analog section isolated from CPU • The maximum permissible common mode voltage between the channel and the central ground point is 120 V AC.

Table 3-2 Performance Characteristics of the Analog Modules, continued

Module	Performance characteristics
AI 8 x 16 Bit 6ES7431-7KF0x-0AB0	This module makes high-speed acquisition of temperatures via thermocouple (TC) possible, Every channel has its own A/D converter and the basic conversion time is therefore independent of the number of active channels. Resoulution and precision are independent of the module speed. This means that very precise and high-speed processes can be controlled, such as monitoring of the storage temperature of turbines, for example. • 8 isolated differential inputs for voltage/current/temperature measurement • 26 settings for the measuring range • Linearization of the thermocouple characteristic curves • 16-bit resolution • Programmable diagnostics • Programmable diagnostic interrupt • Programmable interrupt for limit violation • Analog section isolated from CPU • The maximum permissible common mode voltage between the channels and between the channel and the central ground point is 120 V AC. • Field connection (6ES7431-7K00-6AA0) with internal reference temperature (included with the product)
Analog output module SM 432	
AO 8 x 13 Bit 6ES7431-1HFxx-0AB0	All-purpose and easy to use module, for general use in automation technology. • 8 outputs • Output channels can be programmed as voltage outputs or current outputs • 13-bit resolution • Analog section isolated from CPU and load voltage • Maximum permissible common mode voltage between the channels and the channels against M_{ANA} 3 V DC.

Technological Functions of the S7-400

4

Overview

The following information is contained in this chapter:

- The technological functions provided by the function modules
- The technological functions provided by the software package

4.1 S7-400 - The Right Solution for Every Technological Task

Introduction

Automation tasks with high technological requirements demand special solutions that can be simply and economically integrated into the system.

For the S7-400 automation system, the available function modules can handle even the most complex process because that are specialized for specific tasks.

Another way to realize technological functions is the integration of software packages in the controller. The wide-range of packages available enable you to cover a wide field of applications quickly and with little effort.

4.2 Function Modules - the Specialists

Introduction

Function modules enable you to find fast solutions for complex technological tasks. The function modules use the same address ranges and are configured in the same way as signal modules using STEP 7. Function modules are offered for the following application areas:

- Counting and frequency measurement
- Positioning
- Controlling

Counting and Frequency Measurement

The following function module is available for counting and frequency measurement tasks:

- FM 450 counter module for fast counting up to 500 kHz cut-off frequency, 2-channel

Positioning

The following function modules are available for positioning tasks depending on the application:

- FM 451 rapid/creep positioning, 3-channel
- FM 452 electronic cam controller, 1-channel
- FM 453 positioning with stepping motors, 3-channel
- FM 454 positioning with servomotors, 3-channel
- FM 458-1 DP high-dynamic closed-loop positioning

Controlling

The following function module is available for controlling tasks:

- FM 455 with 16 channels

Access to Function Modules

Function modules are accessed via function blocks that are called from the user program.

Advantages

The realization of technological functions using function modules offers the following advantages:

- Tasks do not depend on the CPU and are therefore processed independent of the cycle time.
- Economic solutions
- Uniform configuration of all function modules using STEP 7 reduces engineering costs
- Easy, convenient operation due to common data storage

4.3 Counting with the FM 450-1

Introduction

You can use the intelligent counter module, FM 450-1, for a wide range of high-frequency counting tasks. It provides the following features to relieve the load on the CPU:

- Direct evaluation of the signals from incremental encoders
- Direct evaluation of gate signals such as those from photoelectric barriers via integrated digital inputs
- Comparison operations and response output via integrated digital outputs

Counter functions of the FM 450-1

The FM 450-1 provides you with the following counter functions:

- Continuous counting
- Single counting
- Periodic counting

Performance Characteristics of the FM 450-1

The FM 450-1 has the following performance characteristics:

- Maximum counting frequency
  - 500 kHz with 5 V encoders
  - 200 kHz with 24 V encoders
- Maximum counting width
  - 32 bit
- Connectable encoders
  - 5-V incremental encoder with RS 422 interface
  - 24 V incremental encoder
  - 24 V directional encoder
  - 24 V pulse generator

4.4 Controlled Positioning with the FM 451

Introduction

The FM 451 positioning module is used to set and position mechanical axes with the rapid/creep method. It provides the following features to relieve the load on the CPU:

- Monitoring of standstill and target approach
- Setting of actual value / actual value on-the-fly
- Zero offset
- Setting of reference point
- Deleting of distance remaining

Functions of the FM 451

The FM 451 provides you with the following functions:

- Configuration in inching mode
- Absolute/relative incremental approach
- Reference point approach
- Loop traverse

Performance characteristics of the FM 451

The FM 451 has the following performance characteristics:

- Number of axes:
  - 3 linear or rotary axis
- Inputs and outputs
  - 4 digital inputs per axis
  - 4 digital outputs per axis
- Typical drives
  - Standard motor, contactor controlled
  - Standard motor with frequency converter, e.g. Micromaster
  - Asynchronous motor connected to power unit with vector control
- Connectable encoders:
  - Incremental encoder 5 V differential signal, symmetrical
  - Incremental encoder with 24 V signal, asymmetrical
  - SSI absolute encoder

4.5 Cam Controlling with the FM 452

Introduction

The FM 452 is an electronic cam controller that triggers functions based on position or time. It provides the following features to relieve the load on the CPU:

- Setting and resetting of electronic cams based on actual values

Functions of the FM 452

The FM 452 provides you with the following functions:

- Position-based cam controlling
- Time-based cam controlling

Each can be implemented as a position or time cam. You can optionally configure two counter cam tracks and one brake cam track.

Performance characteristics of the FM 452

The FM 452 has the following performance characteristics:

- Number of axes:
  - 1 linear or rotary axis
- Number of cams
  - Configurable, 16, 32, 64 or 128
- Inputs and outputs
  - 11 digital inputs, 8 of these enable inputs
  - 16 digital outputs as cam tracks
- Connectable encoders:
  - Incremental encoder 5 V differential signal, symmetrical
  - Incremental encoder with 24 V signal, asymmetrical
  - SSI absolute encoder

4.6 Controlled Positioning with the FM 453

Introduction

The FM 453 is a positioning module for servo-controlled positioning with stepping motors and servomotors. It provides the following features to relieve the load on the CPU:

- Actual-value acquisition and servo-control positioning
- Data storage on the FM 453

Functions of the FM 453

The FM 453 provides you with the following functions:

- Configuration in inching mode
- Controlling
- Reference point approach
- Incremental mode, relative
- Manual data input (MDI)
- Automatic and automatic single block

Performance characteristics of the FM 453

The FM 453 has the following performance characteristics:

- Number of axes:
  - 3 linear or rotary axes
- Inputs and outputs
  - 4 digital inputs per axis
  - 4 digital outputs per axis
- Typical drives
  - Asynchronous motor
  - DC motor
- Connectable encoders for positioning with servomotors:
  - Incremental encoder 5 V differential signal, symmetrical
  - SSI absolute encoder

4.7 Controlling with the FM 455

Introduction

The FM 455 is a universal controller module. The FM 455C is a continuous controller for controlling analog actuators and the FM 455S is a step controller for controlling motor-driven actuators. The FM 455 provides the following features to relieve the load on the CPU:

- Temperature controller (fuzzy controller)
- PID controller

Functions of the FM 455

The FM 455 provides you with the following functions:

- Fixed setpoint control
- Follow-up control
- Three-component control
- Cascade control
- Ratio control
- Blending control
- Split-range control

Performance characteristics of the FM 455

The FM 455 has the following performance characteristics:

- Number of controllers:
  - 16 independent controllers in 16 channels
- Inputs and outputs
  - 16 digital inputs
  - 32 digital outputs on the FM 455S
  - 16 analog inputs
  - 16 analog outputs on the FM 455C
  - 1 reference junction input for compensation of thermocouples
- Connectable sensors for actual value acquisition:
  - Current sensor 0 to 20 mA
  - Current sensor 4 to 20 mA
  - Voltage sensor 0 to 10 V
  - Pt 100, -200 ... 850 °C
  - Pt 100, -200 ... 556 °C, double resolution
  - Pt 100, -200 ... 130 °C, quadruple resolution
  - Thermocouple types B, J, K, R und S and free thermocouple

4.8 High-dynamic Closed-loop Positioning with the FM 458-1 DP

Introduction

With the FM 458-1 DP application module you can configure high-performance controlling and technological applications in a SIMATIC S7-400. Together with two additional plug-in expansion modules, the FM 458-1 DP allows the implementation of a a large number of high-dynamic applications, especially drive-related applications.

Functions of the FM 458-1 DP

The FM 458-1 DP provides you with the following functions:

- Torque controls
- Speed controls
- Position and closed-loop position controls

Performance characteristics of the FM 458-1 DP

The FM 458-1 DP has the following performance characteristics:

- Cycle time 0.5 ms typical
- DRAM user memory (16 MB) 12 MB for user programs
- SRAM (256 KB)
- Exchangeable program memory MMC (2, 4, or 8 MB)
- 8 interrupt tasks can be called via 8 digital inputs.
- Profibus DP Interface
- RS-232 interface (V.24)
- LE bus

Configuring the FM 458-1 DP

Control engineering functions can be easily configured using the graphic configuration interface, CFC (Continuous Function Chart). You can take blocks from a library comprising approximately 250 function blocks and place them on a page using simple drag-and-drop. The block I/Os are interconnected by clicking on an output and an input. For inputs assigned with a fixed value and are not to be connected, the value is specified in a parameter assignment dialog.

The configuration created in this way is then compiled by CFC, the graphic configuration interface, and downloaded to the FM 458-1 DP application module.

Expansion Module EXM 438-1

The EXM 438-1 I/O expansion module provides the following additional inputs and outputs as well as interfaces for incremental and absolute value encoders:

- 16 digital inputs, 24 V
- 8 digital outputs, 24 V
- 5 analog inputs
- 4 analog outputs 12 bit
- 4 analog outputs 16 bit
- 8 interfaces for incremental encoders
- 4 interfaces for absolute value encoders, SSI or EnDat

Expansion Module EXM 448

The communication expansion module EXM 448 has the following interfaces:

- Profibus DP, master or slave
- RS 232

You can optionally use MASTERDRIVES plug-in modules, e.g. SLB for SIMOLINK and SBM2 for higher-resolution multi-turn encoders.

Expansion Module EXM 448-2

The communication expansion module EXM 448-2 has the following interfaces:

- SIMOLINK with master function for controlling up to 200 MASTERDRIVES
- SIMOLINK with slave function for fast coupling to SIMADYN D or multiple FM 458-1 DP

4.9 Software Solutions

Introduction

Some automation tasks can be quickly and easily solved by integrating blocks in the CPU. It is important within this context for the adopted solution to be supported by a user-friendly graphic interface. This chapter gives you an overview of the numerous solutions for technological tasks provided by software packages.

Easy Motion Control

Easy Motion Control consists of a set of function blocks (FBs) that contain algorithms for closed-loop positioning. You can assemble your positioner my interconnected individual blocks.

The function blocks from Easy Motion Control were developed according to the ”Technical Specification V1.0” from PLCopen.

Easy Motion Control is used to position an axis on a target with selectable acceleration, velocity and deceleration or move it at constant velocity. The required travel movements are started by triggering travel function blocks.

Easy Motion Control provides the following functions:

- Inching
- Reference point approach
- Absolute/relative positioning
- Electronic gears
- Reference point setting
- Velocity override
- Closed-loop controlling
- Simulation
- Preassembled drivers for encoders or analog output modules

Modular PID Control

Modular PID Control consists of a set of function blocks (FBs) that contain algorithms for generating control engineering functions. You can assemble your controller structure my interconnected individual blocks.

The block library is supplemented by a number of ready-to-use controller structures (single-loop fixed setpoint controller, ratio controller etc.) in the form of examples. You can copy and adapt these examples to suit your own control task.

A wide-range of plant controls can be easily configured using the control call distributor. This is especially useful when numerous control loops need to be configured at varying intervals - but still equidistant - based on the inertia of the respective process. This also ensures that the workload on the CPU is evenly distributed.

To help you install and test individual control loops, the Modular PID Control Tool configuration software is provided. It contains a loop monitor, a graphic plotter for operating and monitoring process variables, and an algorithm for optimizing the PID parameters.

Standard PID Control

Standard PID Control consists of two function blocks (FBs) and a function (FC), which contain the algorithms for generating control and signal-processing functions for continuous or step controllers.

The behavior of the controller itself and the properties of the functions in the measuring and adjusting channel are realized or simulated by means of the numerical algorithms of the function block. The data required for these cyclic calculations is saved in data blocks for the specific control loop. An FB is only required once to create several controllers.

There are also ready-to-use controller structures (step controller, blend controller, cascade controller etc.) in the form of examples. You can copy and adapt these examples to suit your own control task.

A wide-range of plant controls can be easily configured using the control call distributor. This is especially useful when numerous control loops need to be configured at varying intervals - but still equidistant - based on the inertia of the respective process. This also ensures that the workload on the CPU is evenly distributed.

PID Temperature Control

PID Temperature Control consists of two function blocks (FBs), which contain the algorithms for generating control and signal-processing functions for temperature controllers.

The respective blocks are used to assemble the following controllers:

- Temperature controller for actuators with a continuous or pulsed input signal. This controller block also includes a self-tuning function for the PI/PID parameters.
- Temperature step controller for actuators with an integral component such as a positioning motor.

The **temperature controller** operates with the PID control algorithm and features additional functions for temperature processes. The controller supplies analog manipulated values and pulse-duration modulated actuating signals. The controller outputs signals to one actuator; in other words, you can use the controller for either a pure heating process or a pure cooling process.

To improve the control response, the block includes a control zone and reduction of the P component if there is a setpoint step change. The controller can set the PI/PID parameters itself using a controller tuning function.

The **temperature step controller** operates with the PI control algorithm of the sampling controller, supplemented by function groups for generating the binary output signal from the analog actuating signal. You can also use the controller in a cascade control as a secondary position controller, for example, for temperature control with heating power regulation using pulse-break activation and cooling control using a butterfly valve.

You can externally influence the manipulated value signals of the temperature step controller. The step controller operates without a position feedback signal.

PID Self-Tuner

The PID Self-Tuner enables you to expand the following PID controllers from SIMATIC S7 to create self-tuning PID controllers.

- Standard PID Control
- Modular PID Control
- Controller module FM 455

PID Self-Tuners are particularly useful for the following:

- Temperature controls
- Liquid level controls
- Flow controls (not for pure control value regulation)

PMC (Process Monitoring and Controlling)

Many operating and monitoring functions demand signals to be monitored and messages to be displayed when they change. This functionality can be quickly and easily realized with this software package.

In the configuration phase you determine which binary signals should be monitored for change, whether it be inputs, outputs, memory bits or data bits. You can configure up to 2048 signals, depending on the CPU. Each operand is assigned is own message text. The CPU monitors the configured signals in a specific time pattern (scan cycle). Each change to the configured signals is reported by the CPU to the connected HMI device, which then displays the assigned message texts.

In addition to the change messages, the CPU can send up to ten values from the CPU to the HMI station.

Interfaces, Networks and Data Communication for the S7-400

5

In this Chapter

The following information is contained in this chapter:

- The connection of multiple automation systems via the MPI interface of the CPU. An example is provided to show how easy it is to realize data communication among three central controller modules.
- The I/O connection via PROFIBUS DP to couple S7-400 with the distributed I/O and devices from the SIMATIC S5 automation series.
- The I/O connection via PROFINET IO to interface distributed I/O directly to Industrial Ethernet.
- The point-to-point communication via the communication modules CP 440, CP 441-1 and CP 441-2
- Data exchange via communication functions

5.1 The Right Solution for Every Communication Task.

Introduction

The demands placed on modern automation systems can no longer be met by centralized solutions alone. But relying on autonomous systems and subsystems brings problems of data communication among the individual units.

Communication Solutions

S7-400 offers numerous solutions for communication. The following characteristics can be underscored:

- A tiered range of performance (volume capabilities)
- A convenient user interface integrated in STEP 7
- Integration of communication tasks in the components

Data communication can be performed via the following:

- Integrated MPI/DP interfaces in the CPU
- Communication modules for a variety of networks
  - CP 443-5 on PROFIBUS
  - CP 443-1 on Industrial Ethernet
  - CP 440, CP 441-1 and CP 441-2 for point-to-point -connection

Using system functions (SFCs and SFBs), you can perform data communication using the user program and a variety of communication networks. The SFBs and SFCs are integrated in the operating system of the CPU.

5.2 Interfaces

5.2.1 MPI - the Interface with Numerous Functions

What is an interface with multi-point capability?

An interface with multi-point capability allows you to connect multiple devices, which then can communicate amongst themselves. The abbreviation ”MPI” stands for ”Multi-Point Interface”.

Characteristics of the MPI Interface

Table 5-1 provides you with an overview of the characteristics of the MPI interface.

Table 5-1 Characteristics of the MPI

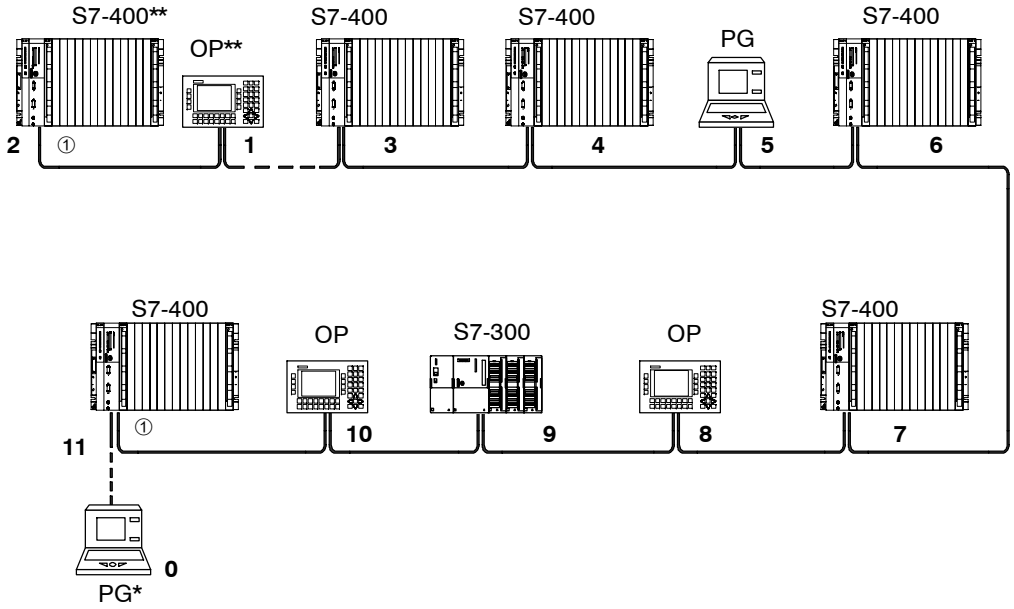
Characteristics	
Number of connectable devices	Maximum 32
connectable devices	• S7-300, S7-400 • programming device • Text display • Operator panel
Transfer rates	187.5 Kbps to 12 Mbps
Distance between first and last device, without booster (RS 485 repeater)	Maximum 50 m cable length
Distance between two boosters (RS 485 repeaters)	Maximum 1100 m cable length

MPI Interface as PROFIBUS DP Interface (Master/Slave)

You can also configure the MPI interface of the CPU as a DP interface. This allows you to configure a PROFIBUS-DP master system with a DP line of up to 32 slaves or to use the CPU as a PROFIBUS-DP slave.

Simple Access to Multiple Devices

Figure 5-1 shows an example of a ”multi-point” application. Several operator panels (OPs) are connected to the S7-400 automation systems via the MPI interface. You can also connect a programming device without having to remove the operator panel.



* only connected by a spur line for commissioning/maintenance work (with default MPI address)
** retro-connected to the MPI network (with default MPI address)
0 ... x MPI addresses of the stations
① Terminal resistor on

Figure 5-1 Example of a MPI network

Simple Access to all Modules

The multi-point interface enables central access to all programmable modules within a configuration. Additional cabling is not required, for example, in order to access the data of a CP from a programming device.

Maximum Distance

The distance between the communication partners is determined by the length of the cable. The total length of cabling is 50 m maximum without signal amplification.

You need an RS 485 repeater as a signal booster to bridge greater distances. For example, with two RS 485 repeaters, you can bridge a distance of 1100 m between communication partners. Additional RS 485 repeaters enable even greater distances.

In Figure 5-2 you can see an example of a MPI network configuration with greatest possible distances for an MPI network.

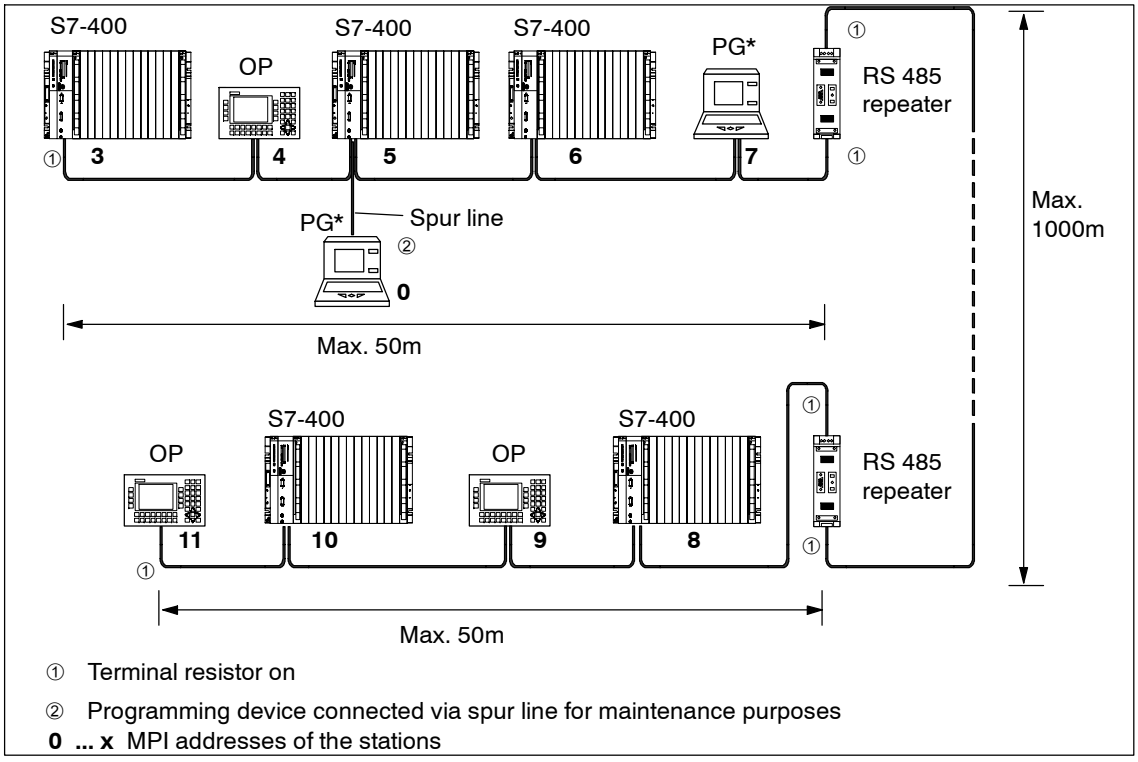


Figure 5-2 Configuration of an MPI network

Components for Communication via the MPI Interface

You can use the network components of PROFIBUS DP to configure a network using the MPI interface.

5.2.2 I/O Interface via PROFIBUS DP

Introduction

The flexibility of a controller is a crucial factor for the productivity of a manufacturing plant. To achieve the highest degree of flexibility, complex control tasks can be grouped and distributed to several devices. This brings the following advantages:

- Signals can be acquired locally, saving costs.
- You get easy-to-handle small units. You can easily configure, commission, perform diagnostics, change, operation and monitor the entire process.
- You have more control over your plant. If a unit fails, the remaining system can continue operating.

The solution is called PROFIBUS DP.

You can meet the increasing demand on data volume and the associated transfer speeds needed for this with PROFIBUS DP.

With the DP interface of the S7-400 CPU, connecting ET 200 distributed I/O and standard slaves poses no problem.

Use and Area of Application

I/O interfacing via PROFIBUS DP can be used in the following situations:

- You want a distributed configuration for you plant.
- You want to use the S7-400 with the tried-and-proven components of the ET 200 distributed I/O system.

Typical Configuration

PROFIBUS DP consists of a DP master and multiple DP slaves, PROFIBUS with the DP protocol and STEP 7 for assigning parameters to the PROFIBUS DP configuration.

- DP master: The DP master links the controller with the distributed I/O systems. It exchanges data with the distributed I/O via PROFIBUS DP and monitors the fieldbus.
- DP slaves: I/O devices are connected as DP slaves. The DP slaves prepare the encoder and actuator data on-site so that they can be transmitted via PROFIBUS DP.
- Programming device / PC: STEP 7, installed on the programming device or PC, is used to configure the assembly and put PROFIBUS DP into service.

S7-400 as DP Master / DP Slave

You can integrate the S7-400 as a DP master or a DP slave in PROFIBUS DP.

DP slaves

Numerous stations are available as DP slaves, for example:

- Distributed I/O from the ET 200 series
- Drives (power converters, frequency converters)
- CNC controllers
- Standard slaves from other manufacturers

Characteristics of PROFIBUS DP

Table provides you with an overview of the characteristics of the PROFIBUS DP.

Table 5-2 Characteristics of PROFIBUS DP

Connectable devices	Field devices such as drives, valves, distributed I/O
Maximum number of slaves	125
Maximum data volume per slave	244 bytes inputs, 244 bytes outputs
Transfer rates	9.6 Kbps to 12 Mbps
Typical reaction time	1 ms (at 12 Mbps and 16 DP slaves)
Transmission medium	Shielded two-wire cables or fiber-optic cables (glass or plastic)
Distance	Two-wire cable: 9.6 km Fiber-optic cable: 23.8 km
Typical degree of protection for the slave module	IP20 to IP67
Standard	PROFIBUS according to IEC 61158 / IEC 61784-1:2002 Ed1 CP 3/1

Access to Distributed I/O

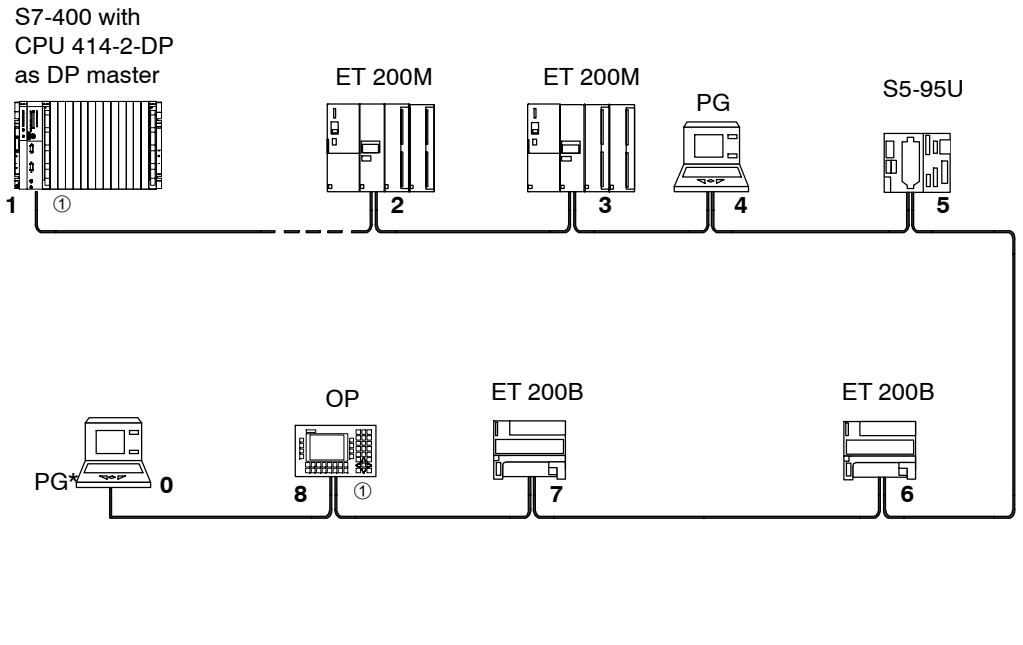
I/O is addressed via PROFIBUS DP as easily as the central I/O in the CPU.

The distributed I/O modules have the same functions as the modules connected directly to the central rack, for example:

- You can trigger diagnostic interrupts.
- You can trigger process interrupts.
- You can assign parameters with the user program.

Example of a PROFIBUS DP Configuration

Figure 5-5 shows an example of a PROFIBUS DP configuration with devices from the SIMATIC S7, SIMATIC S5 and ET 200 series. The S7-400 is the DP master in this configuration, all other devices are DP slaves.



***** only connected by a spur line for commissioning/maintenance work (with PROFIBUS DP address = 0)

0 ... x PROFIBUS DP addresses of the stations

① Terminal resistor on

Figure 5-3 Example of a PROFIBUS DP network

5.2.3 I/O Interface via PROFINET IO

Introduction

Full communication from the field to the control center is one of the most important demands in automation engineering today. The technology employed must meet the following requirements:

- Standardized connection systems
- Uniform network management
- IT access mechanisms
- Comprehensive diagnostic options

PROFINET IO

PROFINET is an open and vendor-independent Industrial Ethernet standard for automation. PROFINET IO allows you to connect I/O directly to Industrial Ethernet.

Typical Configuration

PROFINET IO operates with a provider-consumer model. The provider is the sender, who transmits his data without request from the communication partner. The consumer process the data. The assignment as a provider or consumer is specified in the configuration.

The following device types are used for PROFINET IO.

- IO controller: The controller of the automation system
- IO devices: The distributed I/O that is assigned to an IO controller.
- IO supervisor: A programming device, PC or HMI device for commissioning and diagnostics.
- IE PB Link PN IO: This enables the integration of existing PROFIBUS fieldbus system without having to change the existing devices.

Configuration

You configure the IO devices with STEP 7. The devices are uniquely identified by description files (General Station Description, GSD). The description files can be imported in STEP 7.

Communication Processor CP 443-1 Advanced

The communication processor CP 443-1 Advanced is designed for operation in an S7-400 automation system (not in H systems or H CPUs). It enables the connection of the S7-400 to Industrial Ethernet.

With its services for PROFINET IO, CP 443-1 Advanced allows direct access to PROFINET IO devices via Industrial Ethernet

Characteristics of PROFINET IO

Table provides you with an overview of the characteristics of the PROFINET IO.

Table 5-3 Characteristics of PROFINET IO

Connectable devices	Field devices such as drives, valves, distributed I/O
Maximum number of devices	125
Data record length	Max. 1432 bytes
Transfer rates	100 Mbps switching technology
Typical reaction time	1 ms

Table 5-3 Characteristics of PROFINET IO, continued

Transmission medium	Shielded two-wire cables or fiber-optic cables (glass or plastic)
Cable length between network components or between terminals and network components	Two-wire cable: Max. 100 m Multimode fiber-optic cable: 3000 m Monomode fiber-optic cable: Max. 26 km
Standard	PROFINET according to IEC 61158

Example of a PROFINET IO Configuration

Figure 5-5 shows an example of a PROFINET IO configuration with devices from the SIMATIC S7, SIMATIC S5 and ET 200 series.

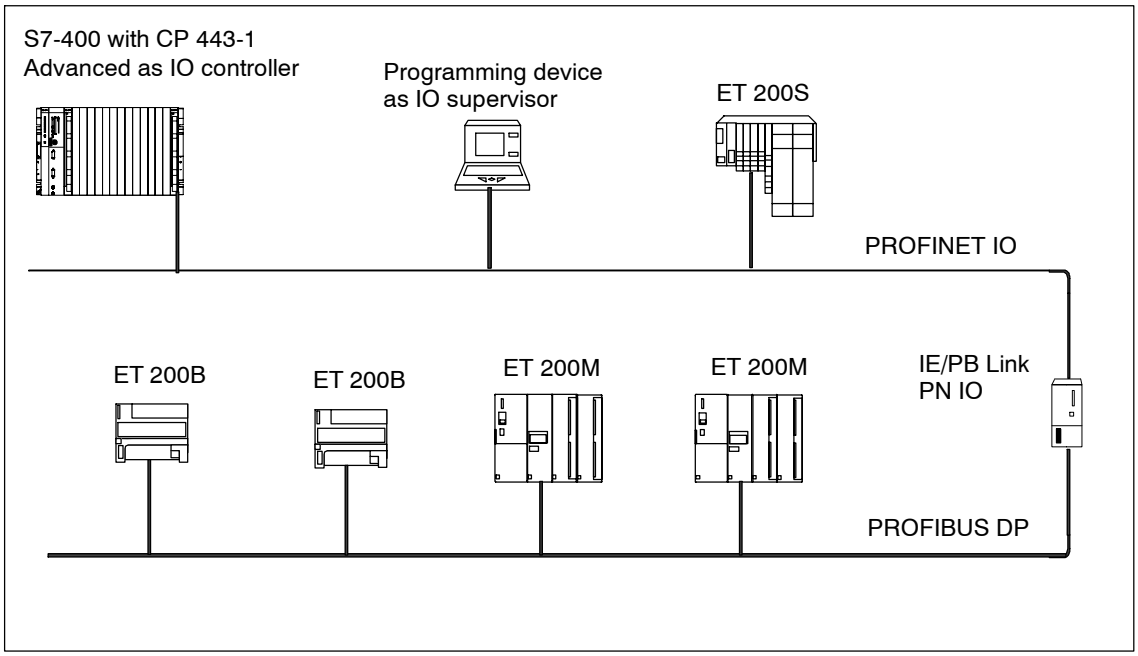


Figure 5-4 Example of a PROFINET IO configuration

5.2.4 From point-to-point: CP 440, CP441-1 and CP 441-2

Introduction

The point-to-point connection is a high-performance, economic alternative to the bus systems. It enables the connection of barcode readers, scales and displays, for example. But it can also be used to interconnect to other automation systems.

Point-to-point with CP 441-1 and CP 441-2

You can select two communication modules (CP) for point-to-point connection:

- CP 440
- CP441-1 with a plug-in interface module
- CP441-2 with two plug-in interface modules

Plug-in interface modules

A variety of interface modules can be plugged into the CP. The following are available:

- TTY module
- RS 232C module
- RS 422/485 module

ASCII, 3964 (R) and RK 512 drivers are available as protocols.

Loadable Drivers

Additional loadable CP drivers are available for special protocols.

5.3 Data Exchange via Communication Functions

Introduction

Data exchange via a variety of bus systems, such as MPI and Industrial Ethernet, PROFIBUS DP or point-to-point connection can be triggered and controlled in the user program.

You determined the desired functionality for this program-driven communication by calling a communication function in the user program. This might be a point in time, the amount of data or the transmission method.

Corresponding communication functions (SFCs, SFBs, loadable FC/FBs) are available on the S7-400 for data exchange.

SFCs for S7 Basic Communication via an MPI Subnet

You can transmit up to 76 bytes of data via an MPI subnet using these functions. A connection configuration is not necessary.

SFC		Description
SFC 65 SFC 66	X_SEND X_RCV	Secure transfer of a data block to the communication partner. This means that data transmission is not completed until the receive function (X_RCV) in the communication partner has accepted the data.
SFC 67	X_GET	This SFC can be used to read a variable from a communication partner without having to place a corresponding SFC in the communication partner.
SFC 68	X_PUT	This SFC can be used to write a variable to a communication partner without having to place a corresponding SFC in the communication partner.
SFC 69	X_ABORT	This SFC can be used to abort an existing link explicitly without having to transfer data.

SFCs for S7 Basic Communication via an S7 Station

You can access all communication partners that can be addressed via the I/O addresses of a station (e.g. FM 355) with these communication SFCs. The links to the communication partners are dynamically established when the SFCs are called. A connection configuration is not necessary.

SFC		Description
SFC 72	I_GET	This SFC can be used to read a variable from a communication partner without having to place a corresponding SFC in the communication partner.
SFC 73	I_PUT	This SFC can be used to write a variable to a communication partner without having to place a corresponding SFC in the communication partner.
SFC 74	I_ABORT	This SFC can be used to abort an existing link to a communication partner without having to transfer variables. This allows the corresponding link resources to be released again on both sides.

SFBs for S7 Communication (Configured S7 Connections)

These SFBs can be used to realize acknowledged data transmission via configured S7 connection. The communication functions are not limited to data transfer, additional functions can be used to control and monitor the communication partner. Communication is only possible within an S7 project.

The communication SFBs can be categorized in four function classes:

Send and receive functions

You can use these communication SFBs to transfer data between two communication partners. Approximately 400 bytes of data can be transferred.

SFB		Description
SFB 8 SFB 9	USEND URCV	Uncoordinated data transfer independent of the time taken to process the communication function (URCV) by the communication partner (e.g. operating and maintenance signals). The data can be overwritten with more up-to-date data at the communication partner.
SFB 12 SFB 13	BSEND BRCV	Transfer of a data block to the communication partner. This means that data transmission is complete only when the receive function (BRCV) in the communication partner has accepted the data.
SFB 14	GET	Program-controlled reading of variables without the need for additional communication functions in the user program of the communication partner.
SFB 15	PUT	Program-controlled writing of variables without the need for additional communication functions in the user program.
SFB 16	PRINT	Sends data to a printer.

Control functions

Using these SFBs, you can control the operating status of a communication partner.

SFB		Description
SFB 19	START	This triggers a restart or complete restart for a CPU when it is in the STOP state.
SFB 20	STOP	Brings a CPU to STOP when it is in the RUN, HALT or starting state.
SFB 21	RESUME	This triggers a warm restart for an S7-400 CPU when it is in the STOP state.

Monitoring functions

Using these SFBs, you can obtain information about the operating status of a communication partner.

SFB		Description
SFB 22	STATUS	Provides the operating status of a communication partner in response to a request.
SFB 23	USTATUS	Receives the operating status of an S7-400-CPU when the operating status changes

Query functions

With this function you can obtain information about the internal status of the local communication SFBs and the corresponding connection in the program.

SFC		Description
SFC 62	CONTROL	Queries the status of a connection

FBs for open TCP/IP communication via Industrial Ethernet

With these FBs you can exchange data with other TCP/IP-capable communication partners via the program.

SFB		Description
FB 65	TCON	Establishes the connection
FB 66	TDISCON	Closes the connection
FB 63	TSEND	Sends data (1432 bytes)
FB 64	TRCV	Receives data (1432 bytes)

TCP/IP communication is based on the connection. Data is only transferred once a connection to the communication partner has been established. The CPU can use several connections to the communication partner simultaneously.

The following protocol variants are supported:

- TCP/IP native
- ISO on TCP according to RFC 1006

FCs for S5-Compatible Communication

These FCs are used for communication within SIMATIC S7 and for communication between SIMATIC S7 and SIMATIC S5 as well as non-S7 stations (e.g. PCs). Communication between stations in different STEP 7 projects is possible.

The blocks are part of the NCM add-on package.

SFC		Description
FC 5	AG_SEND	Sends data blocks via a configured link to a communication partner (max. 240 bytes)
FC 6	AG_RECV	Receives data blocks via a configured link from a communication partner (max. 240 bytes)
FC 50	AG_LSEND	Sends data blocks via a configured link to a communication partner (max. 8 KB)
FC 60	AG_LRECV	Receives data blocks via a configured link from a communication partner (max. 8 KB)
FC 7	AG_LOCK	Disables external data access
FC 8	AG_UNLOCK	Enables external data access

FBs for Standard Communication (FMS)

These FBs are used for the exchange of data with non-Siemens systems on PROFIBUS DP using open communication on Layer 7 of the ISO reference model according to the PROFIBUS standard. Data volumes of up to 237 bytes can be transferred.

SFC		Description
FB 3	READ	This FB can be used to read a variable from a communication partner without having to place a corresponding FB in the communication partner.
FB 6	WRITE	This FB can be used to write a variable to a communication partner without having to place a corresponding FB in the communication partner.
FB 4	REPORT	Sends a structured variable to the communication partner without acknowledgment.
FB 2	IDENTIFY	Reads the identification of a non-Siemens system.
FB 5	STATUS	Reads the status of a remote device on request.

SFBs for Point-to-Point Connections

Using the point-to-point connection via CP 441, you can link to all communication partners that can handle the 3964(R), RK 512 or ASCII procedures. Non-Siemens protocols are implemented with loadable drivers.

The communication SFBs require a point-to-point connection configured with STEP 7. This connection runs from the CPU to the CP.

The communication SFBs that you can use are listed in the following table:

SFC		Description
SFB 12 SFB 13	BSEND BRCV	Transfer of a data block to the communication partner. The point-to-point CP acknowledges receipt of the data.
SFB 14	GET	Reads data from a communication partner.
SFB 15	PUT	Writes data to a communication partner.
SFB 16	PRINT	Sends a message containing up to four variables to a printer.
SFB 22	STATUS	Provides the status of the CPs and the RS 232 interface.

Function blocks for specific CPs are also supplied with the respective CPs.

Configuration Variants of the S7-400

6

Overview

The following information is contained in this chapter:

- The structural design of the SIMATIC S7-400.
- The most important components for the configuration of an S7-400.
- How easily you can wire and exchange modules.
- The configuration of an S7-400 in one or more racks.
- The dimensions of a variety of S7-400 configurations and the spacing between adjacent equipment, cabinet walls, etc.
- When the S7-400 should be grounded and ungrounded.
- The configuration resources for your S7-400 assembly.

6.1 The Structural Design of the S7-400 - Simple and Modular

Introduction

The modular structural design of the SIMATIC S7-400 makes it flexible, user-friendly and capable of expanding to meet the requirements of your automation task.

Structural Design

All modules of the S7-400 are simply plugged into and bolted to a module rack.

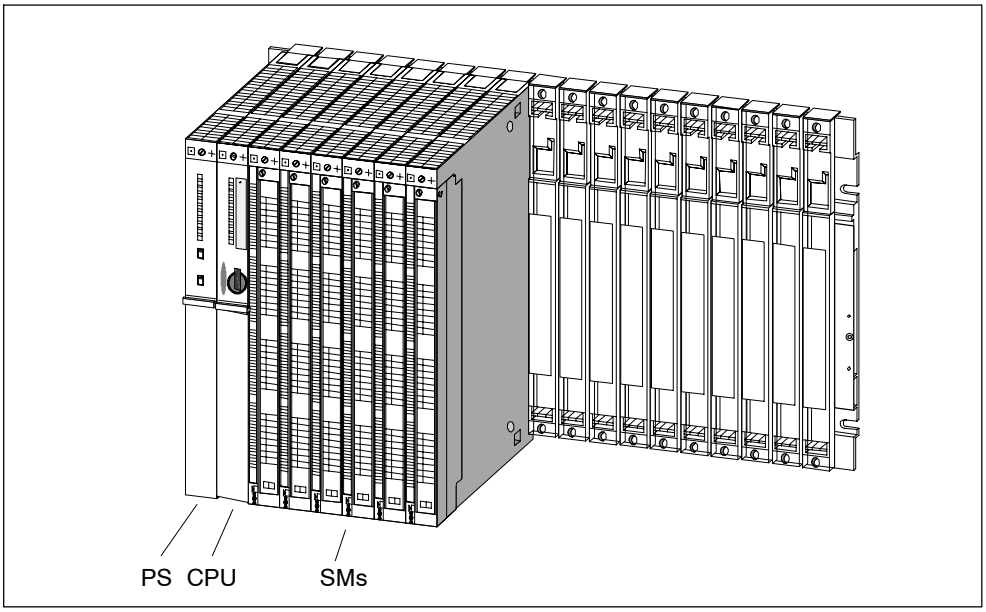


Figure 6-1 Module rack in the S7-400 system with components

Simple Exchange of Modules

You only have to loosen two fastening screws to change a module.

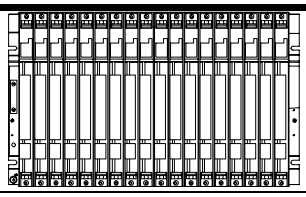
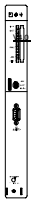
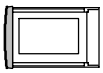
Uniform Mounting Depth

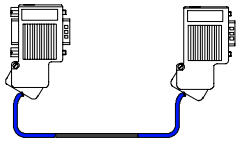
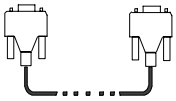
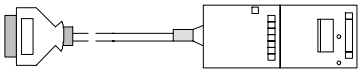
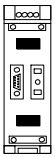
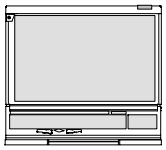
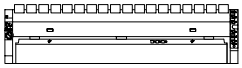
All connections and plugs are recessed in the modules and protected by hinged covers. The mounting depth is a uniform 230 mm.

6.2 An Overview of S7-400 Components

Introduction

The S7-400 has a simple modular design. The most important components of an S7-400 are described in this chapter.

Component	Function	Image
Racks (UR = Universal Rack) (CR = Central Rack) (ER = Extension Rack)	Racks provide the mechanical and electrical connections between the S7-400 modules.	
Power supply modules (PS = Power Supply) Accessories: Back-up battery	Power supply modules convert the mains voltage (120/230 V AC or 24 V DC) into the operating voltage required by the S7-400, 5 V DC and 24 V DC.	
CPUs (CPU = Central Processing Unit)	CPUs execute the user program; they communicate with other CPUs and with programming devices.	
Memory cards	Memory cards are used to store the user program and parameters.	
Interface module IF 964-DP	The interface module IF 964-DP is used to connect the distributed I/O via ”PROFIBUS-DP	
Signal Modules (SM = Signal Module) (digital input modules, digital output modules, analog input modules analog output modules) Accessories: Front connectors with three different connection systems	Signal modules adapt various process signal levels to the S7-400. Signal modules form the interface between the PLC and the process.	
Interface Modules (IM = Interface Module) Accessories: Cable Terminal plug	Interface modules interconnect separate racks of an S7-400.	
Cable duct	The cable duct is used lay cables and for ventilation.	

Component	Function	Image
PROFIBUS bus cable	PROFIBUS bus cables connect CPUs and programming devices.	
Programming device cable	Programming device cables connect a CPU with a programming device.	
PROFIBUS components e.g. PROFIBUS bus terminal	PROFIBUS components connects an S7-400 to other S7-400s or programming devices.	
RS 485 repeater	The RS 485 repeater boosts data signals on bus lines and couples bus segments.	
Programming device (PG) or PC with the STEP 7 software package	STEP 7 is used to configure, assign parameters, program and test the S7-400.	
Fan subassembly (for special areas of application)	The fan subassembly ventilates modules in special applications; it can be operated with or without a filter.	

6.3 Connection System of S7-400 Signal Modules

Introduction

This chapter describes how you can quickly and easily establish S7-400 connections to sensors and actuators.

Wiring with Front Connectors

You can use front connectors to wire the S7-400. The connection between the signal modules of your S7-400 and the sensors and actuators of your plant is performed in two steps:

1. Wire the front connectors, insert the cables to and from the sensors/actuators into the front connectors.
2. Mount the front connectors

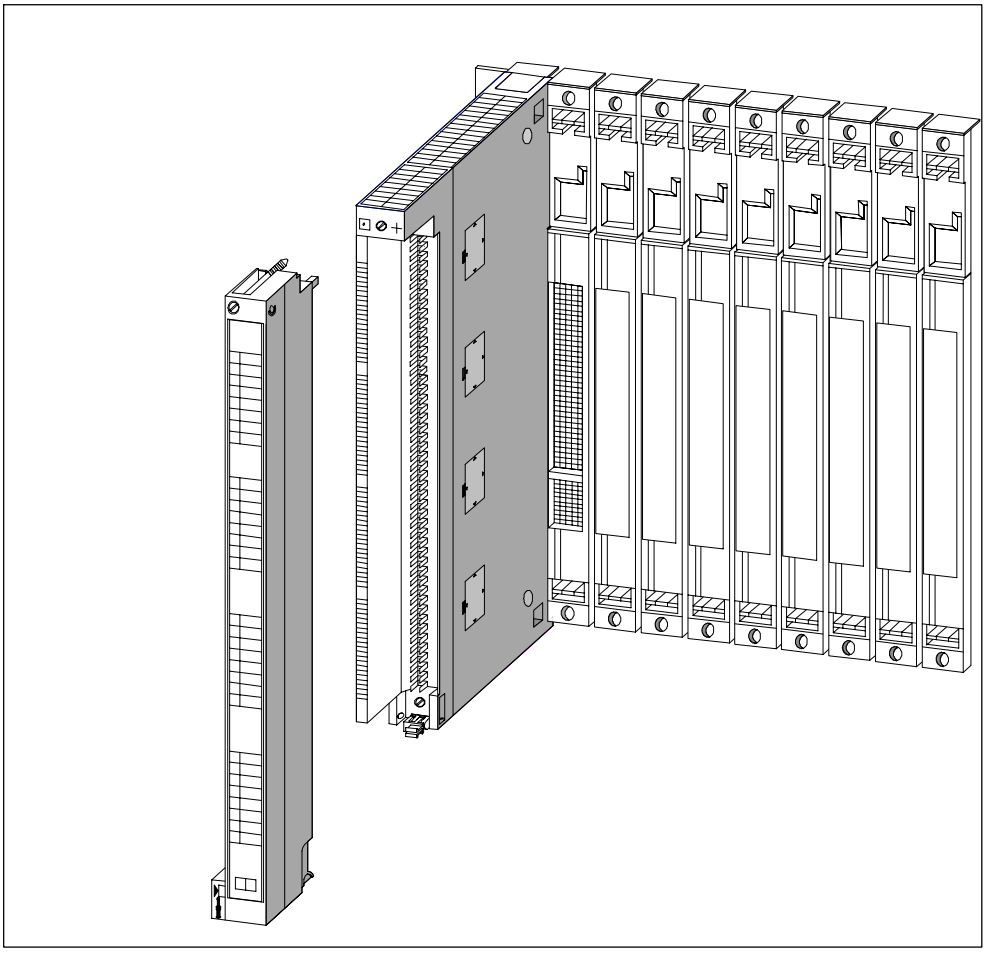


Figure 6-2 Front connectors and module

Advantages

Wiring the S7-400 with front connectors offers you the following advantages:

- Front connectors allow you to use pre-assembled cables.
- You save time and money during assembly.
- The capability to pull and plug a completely wired front connector makes exchanging modules fast and easy.
- It makes it difficult to accidentally insert the front connectors in the wrong direction, since they have mechanical polarization; front connectors and modules are assigned to one another.

Fully Modular Connection

Signals can not only be connected directly to the signal modules, they can also be connected to a remote terminal. The terminal is connected to a front connector module that is plugged into the signal module instead of the front connector. The distance between the terminal and signal module can reach up to 30 m.

Advantages

Wiring with a fully modular connection offers the following advantages:

- Fast, low-cost wiring
- High degree of wiring safety, orderly cabinet wiring
- The supply voltage for the module can be connected to the front connector module or to the terminal block.

6.4 S7-400 Assembly in a Rack

Introduction

Regardless of the S7-400 CPU you decide to use, you can equip the module rack where the CPU is located with up to 16 other modules in addition to the CPU and the power supply module.

Only Two Slot Rules

You only have to observe two rules when arranging modules in a rack:

- The power supply module must be inserted in slot 1 in all racks. Redundant power supply modules are inserted in slots 1 and 3.
- The receive IM in the expansion device must always be install at the far right.

Maximum Assembly with One Rack

Figure 6-3 shows an example of a module configuration in an S7-400 assembly fully equipped with a power supply module, a CPU and 16 other modules.

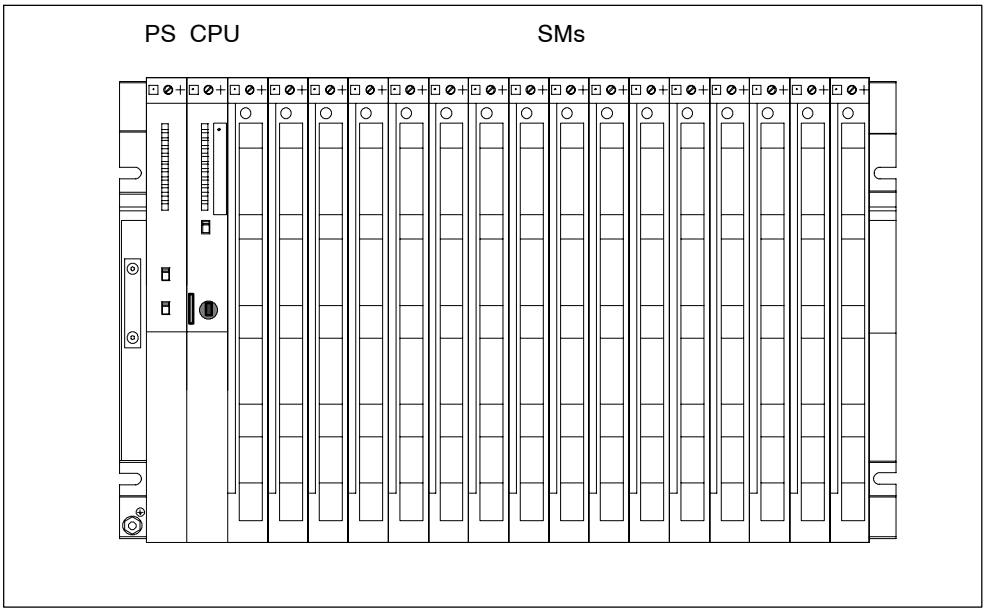


Figure 6-3 Rack in the S7-400 system with components

There are racks with 4, 9 or 18 slots for the S7-400.

6.5 Segmented and Split Rack

Introduction

The S7-400 allows you to install two CPUs in one rack and thereby centrally control two processes independently.

Two Central Controllers in a Segmented Rack

Segmented racks makes it possible to install two CPUs in a single rack. The I/O bus is divided into two segments in such a rack. A CPU can be installed in each segment.

The CPUs operate independent of one another and access separate signal modules. Operating state transitions of one CPU do not affect the other CPU.

The CPUs can access each other via the MPI interface without addition hardware because they share the communication bus.

Figure 6-4 shows a segmented rack with two I/O segments and the common communication bus.

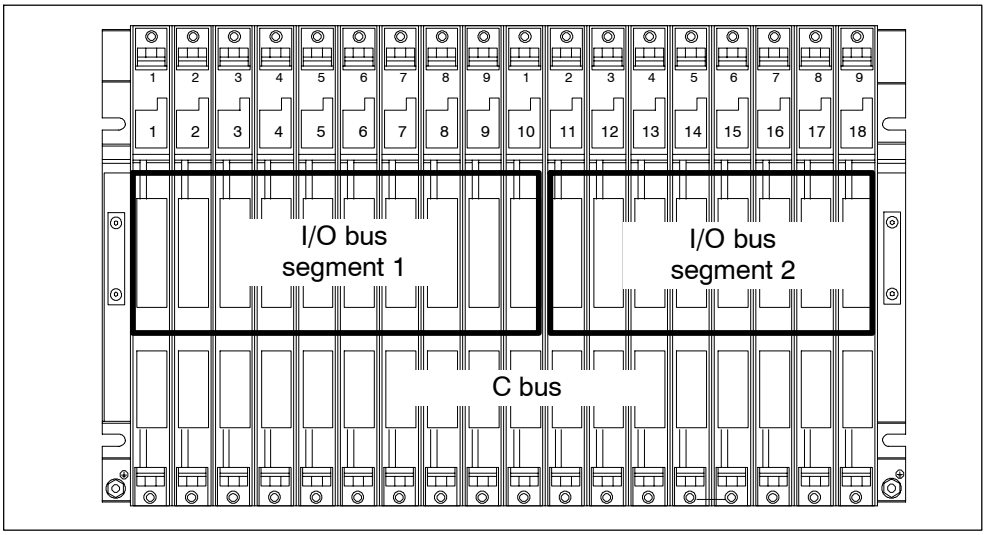


Figure 6-4 Segmented rack

Advantages

Integrating two CPUs in a single rack not only results in a compact assembly, it also saves on costs since only one rack and one power supply are needed.

Two CPUs in a Split Rack

With split racks, the I/O bus and communication bus are divided into two segments. A CPU can be installed in each segment.

Functionally, a split rack represents two electrically isolated racks on the same mounting rail.

Figure 6-5 shows a configuration of a split rack with 2x9 slots.

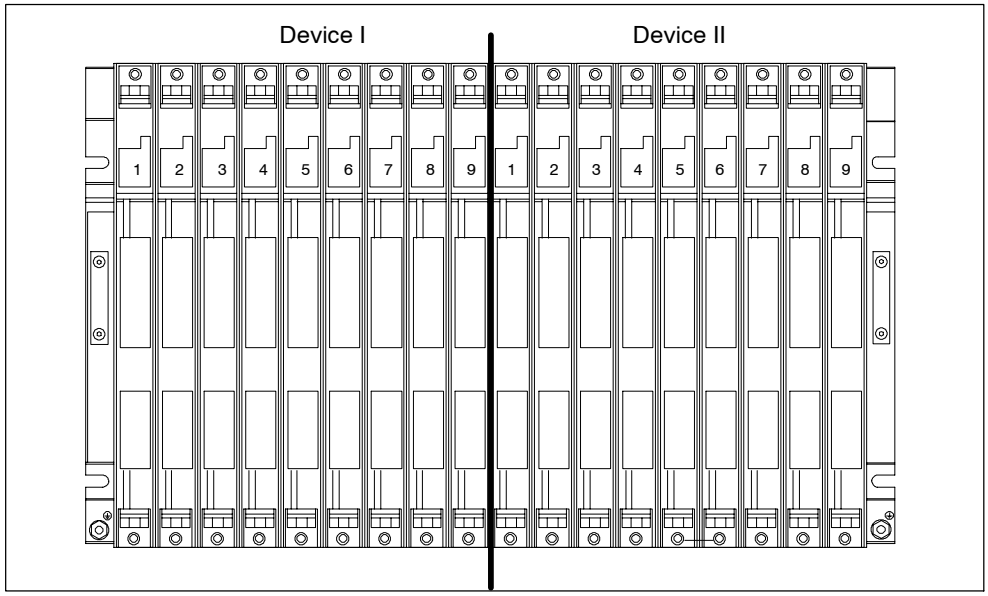


Figure 6-5 Split rack

Advantages

Split racks are usually used for compact redundant S7-400H systems (two devices or systems in a single rack).

6.6 S7-400 Assembly in Multiple Racks

Introduction

If you need more than 16 modules (signal, function and communication modules) in your automation task, you can install the S7-400 in multiple racks and interconnect them using interface modules (IM).

Remote interfacing and local interfacing are used to assemble an S7-400, depending on the interface modules used to connect the expansion devices with the central controller.

Local Interfacing

Local interfacing is suitable for small plants in which the I/O is located in the vicinity of the central controller. This can be built with or without current transfer, based on the functionality and current demands of the modules in the connected expansion device.

Remote Interfacing

The effort required for cabling the I/O and the susceptibility of the connections increases in large, extensive plants. Such scenarios demand remote interfacing, where the distance between the central controller and the most remotely located expansion device can reach up to 605 m.

Table 6-1 Characteristics of Local and Remote Interfacing

	Local interfacing		**Remote interfacing**	
Send IM	460-0	460-1	460-3	460-4
Receive IM	461-0	461-1	461-3	461-4
Maximum number of connectable EDs per line	4	1	4	4
Maximum distance	5 m	1.5 m	102.25 m	605 m
5 V transfer	No	Yes	No	No
Maximum current transfer per interface	-	5 A	-	-
Use of modules that use the C bus (e.g. FMs, CPs)	Yes	No	Yes	No

Interfacing Rules

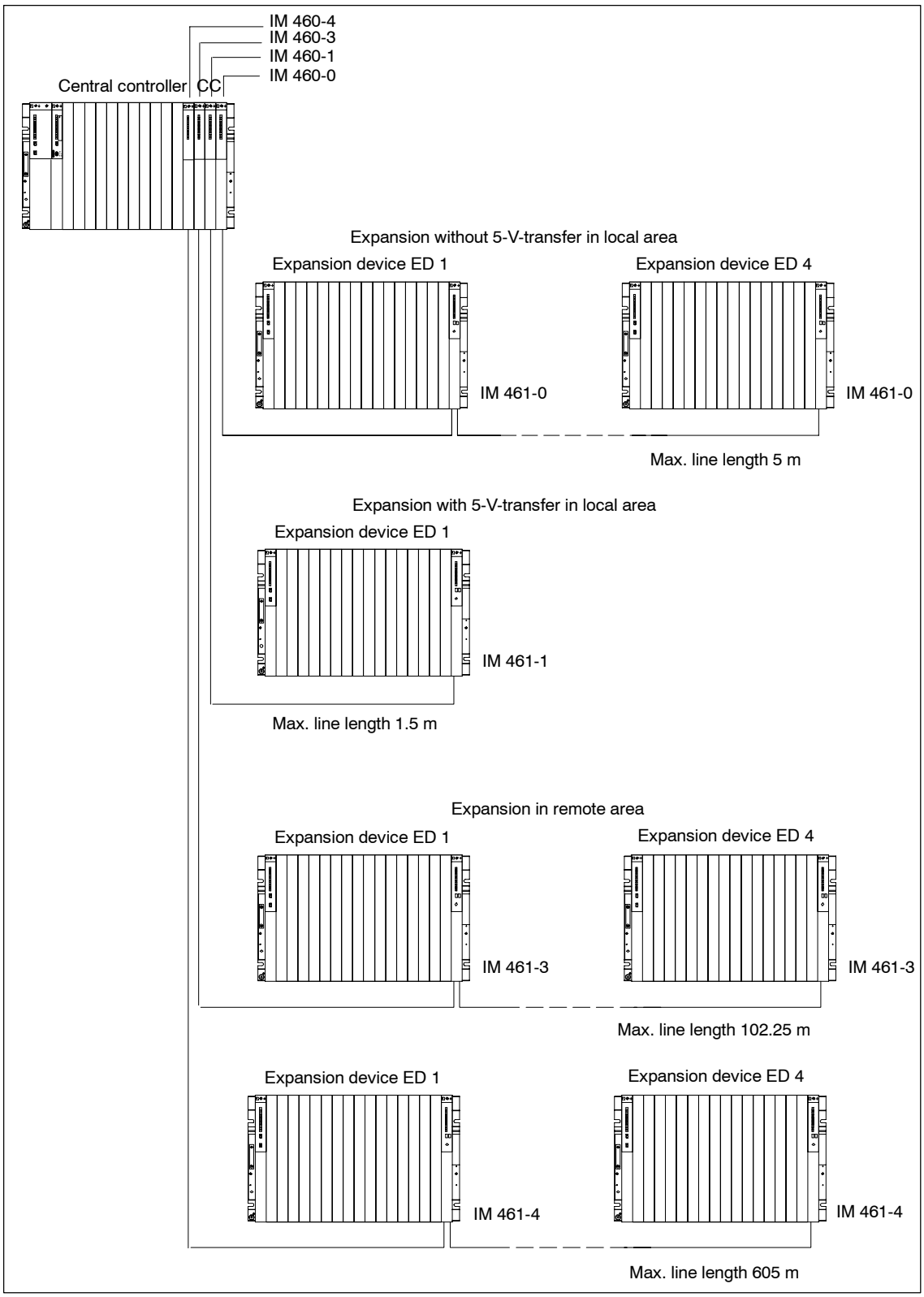
Interface modules are divided into send IMs and receive IMs A send IM sends signals to the connected expansion device, the corresponding receive IM receives and forwards the signals. The following rules apply to connecting interface modules:

- The send IM must always be located in the central controller.
- You can connect up to four receive IM to one send IM.
- Up to six send IMs can be installed in the central controller.

Maximum of 22 Racks

Interfacing with send and receive IMs, you can connect up to 21 expansion devices to a central controller.

Interfacing Options for Central Controllers and Expansion Devices



6.7 Mounting Dimensions of an S7-400 Assembly

Introduction

This chapter describes the varying mounting dimensions of an S7-400 assembly.

Mounting height

The mounting height of an S7-400 assembly is determined by the height of the rack. The height of the rack is 290 mm.

Special Height

If you use a fan subassembly or a cable duct in a rack, the mounting height of the rack increases by the mounting height of these components.

Mounting depth

The mounting depth of a S7-400 assembly is 227.5 mm. All connectors and plugs are recessed and are within the maximum mounting depth.

Width of an S7-400 Assembly

The width of an S7-400 assembly is determined by the width of the rack used. The mounting width is:

- 132 mm for a rack with 4 slots
- 258 mm for a rack with 9 slots
- 483 mm for a rack with 18 slots

Clearance for a Complete Assembly

Figure 6-6 shows the minimum clearance between adjacent equipment, cabinet walls, etc., required for a standard S7-400 assembly with a single rack containing 18 slots.

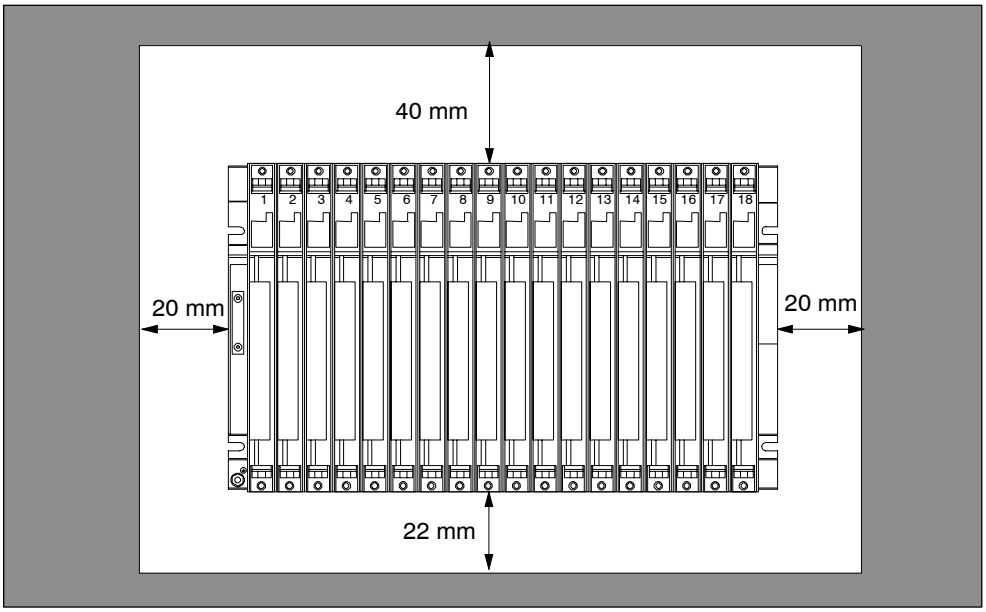


Figure 6-6 Minimum clearance for an S7-400 assembly

Maintaining this clearance ensures the following:

- You ensure heat dissipation for the S7-400 modules.
- You will have enough space to insert and remove S7-400 modules.
- You will have enough space to lay cables.

6.8 Grounded / Ungrounded S7-400 Configurations

Introduction

Depending on the requirements in the plant, you can build the S7-400 with either grounded or ungrounded reference potential.

Application

You should usually select a grounded configuration. A grounded configuration guarantees a high degree of interference immunity. Any interference current that occurs is discharged to building ground. In large, extensive plants, however, you may be required to build the S7-400 ungrounded.

Connection Scheme

A removable bridge on the rack forms a galvanic connection to the building ground. If this bridge is removed, the rack is connected to the building ground via an RC network and therefore configured ungrounded. RF interference is discharged through this RC network and static charges are prevented. Figure 6-7 shows the rack and the removable bridge.

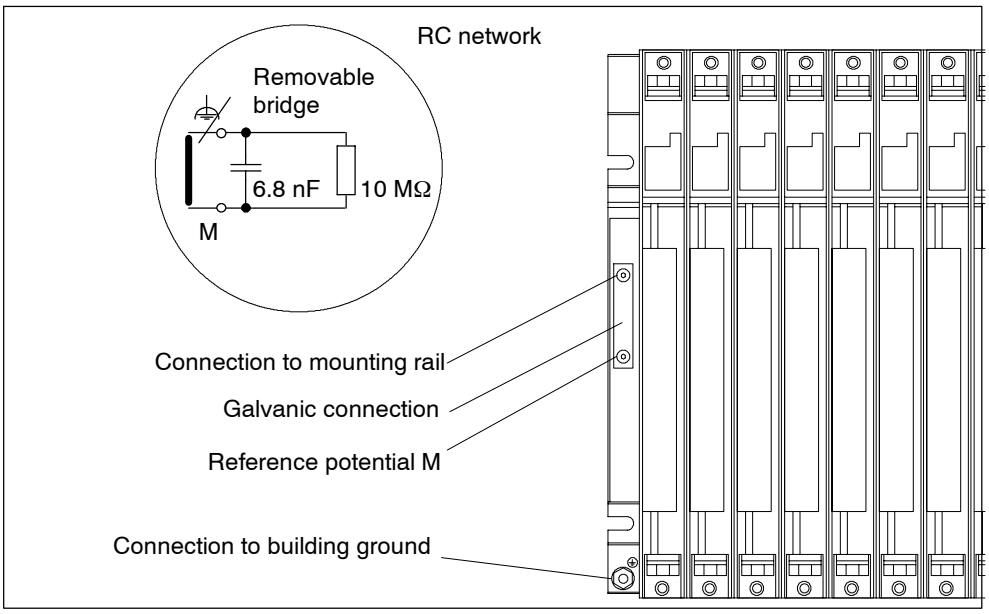


Figure 6-7 S7-400 assembly with the removable bridge

6.9 Utilities for Configuring and Assigning Parameters to an S7-400 Assembly

Introduction

One task involved in configuring a plant is assigning parameters to the hardware of the automation system. Increasingly complex automation tasks require more and more effort to configure.

Configuration with STEP 7

STEP 7 provides system software to help you configure and assign parameters to your plant. It is characterized by easy handling (selection, setting marks and filling out dialog forms).

You can also use STEP 7 to configure modules such as CPUs and FMs. Modules are selected from an electronic catalog. The configuration and parameter assignment data are transferred to the CPU and automatically distributed to the individual modules at startup.

If you do not specify special values, the system automatically starts up with its default settings. In other words, parameter assignment is possible but not necessary.

Programming the S7-400

7

Overview

This chapter provides you with information about the system software, STEP 7. STEP 7 is used for programming, configuring, assigning parameters, testing and performing diagnostics for the S7-400.

It also provides you with information about the programming devices and PCs in use.

7.1 STEP 7 - the Programming Package for S7-400

Introduction

The software for programming, testing and commissioning SIMATIC S7 is called STEP 7. STEP 7 comes in programming packages for different ranges of performance.

Software User Interface

STEP 7 runs under the MS Windows 2000 Professional and MS Windows XP Professional operating systems and is adapted to their graphic, object-oriented operation style.

STEP 7 is based on DIN EN 6 1131-3

The STEP 7 programming software is based on the international standard DIN EN 6 1131-3. This means that STEP 7 has the same appearance as other IEC programming languages for programmable logic controllers.

Advantage

The advantage of a programming language based on DIN EN 6 1131-3 is how little time it takes a programmer to become acquainted with it. Programming controllers from different manufacturers is very similar using these programming languages.

Comprehensive Help for STEP 7

Comprehensive online help is provided to help you to a quick start and support your work with the various tools. It features context-sensitive instructions as well as a wide range of reference information.

Program Structure

STEP 7 offers you the option of dividing the user program into separate program segments. There are a variety of blocks with defined properties for the various program segments. The blocks can be easily tested and used over and over.

Blocks to Access the System

There are block types for structuring a program, FB (function blocks), FC (functions) and OB (organization blocks). You do not have to program every function yourself. You can program communication functions, for example, using pre-configured blocks that are available in the operating system on the CPUs.

Program and Data Storage

Projects are used to store the data and programs which are created when you put together an automation solution. The data collected together in a project include:

- Configuration data on the hardware structure and parameters for modules
- Configuration data for communication in networks
- Programs for programmable modules

Data are stored in a project in object form. The objects in a project are arranged in a tree structure (project hierarchy). The display of the hierarchy in the project window is similar to that of the Windows Explorer.

Program Editor

The program editor enables you to program in conformity to the IEC 1131 standard for the S7-400 automation system. You can use both symbolic and absolute addressing of the operands when writing programs.

Programming Languages

- LAD (Ladder Logic) is a graphic programming language. Its syntax for the instructions is similar to a circuit diagram. Ladder allows you to track the power flow between power rails as it passes through various contacts, complex elements, and output coils.
- STL (Statement List) is a textual programming language similar to machine code. If a program is written in Statement List, the individual instructions correspond to the steps with which the CPU executes the program. To make programming easier, Statement List has been extended to include some high-level language constructions (such as structured data access and block parameters).
- FBD (Function Block Diagram) is a graphic programming language and uses the logic boxes familiar from Boolean algebra to represent the logic. Complex functions (for example, math functions) can be represented directly in conjunction with the logic boxes.
- SCL (Structured Control Language) is a programming language resembling Pascal used especially for programming complex algorithms and mathematical functions or for task definitions from the area of data processing.
- CFC (Continuous Function Chart) enables you to accomplish technological tasks in completed, executable automation programs with minimal effort. You can insert the ready-to-use blocks from a library into a CFC chart using drag-and-drop, graphically interconnect them and assign parameters to them. In-depth programming knowledge is not needed.

Data Storage in the Programming Device

The programming device stores the data for all S7-400 components. This means you only have to enter your data once and then it is available for configuration, programming and for operator control and monitoring functions.

7.2 Programming Devices for SIMATIC S7

Introduction

A programming device (PG) is a special industrial-grade personal computer with a compact design. It is fully equipped for programming SIMATIC automation systems.

Characteristics of the Programming Devices

A PG or PC with the meeting the following requirements is needed to work effectively with STEP 7:

PG/PC Properties	Recommendation
Operating system and user interface	Microsoft Windows 2000, Windows XP
Processor	Pentium • for Windows 2000 P 600 • for Windows XP P 600
Main memory	at least 256 MB 512 MB recommended
Free disk space	300 to 600 MB, depending on scope of the installation
Graphics	XGA 1024x768,16-bit color depth
Color monitor, keyboard and mouse	Windows-compatible

If you have large STEP 7 projects or HW configurations, you should use a programming device or a PC with processing power that corresponds with what is currently available on the market.

7.3 Convenient Testing and Diagnostic Options

Testing Functions

SIMATIC S7 provides convenient testing functions for testing the user program. You can monitor both the block status and the variable status.

The test functions allow you to perform quick commissioning and easily locate errors.

Information Functions

High-performance information functions are provided in addition to the testing functions. The CPUs provide information about:

- Type and version of the CPU
- Their ”performance specifications” (e.g. type and number of operands)
- Available and used memory capacity
- Current status of the automation system (e.g. module(s) ”Ok”, configuration of the automation system, error events that have occurred, chronology of the events).

Diagnostics in the User Program

You can include blocks for error handling in the user program with STEP 7.

Example: Organization blocks (OBs) for handling programming and device errors, for example, for calling unloaded blocks, for unacknowledged modules or for battery failure.

Not only CPUs can trigger an OB call, diagnostic-capable modules can also do this. These modules generate a diagnostic interrupt that results in the call of an error OB. The error OBs provide detailed information about the type, location and time of the error.

Diagnostics with PG or OP

What must you do to have diagnostic data displayed by the display system such as a programming device or operator panel? The answer in the easiest case is nothing! For example, when the CPU is set to STOP by an error, it automatically sends the most recent diagnostic message to the connected display system, providing you with immediate feedback about what is happening in the automation system.

Every diagnostic event, even one that does not result in a CPU STOP, can be evaluated with the connected display system. Several options are available for an evaluation:

- Evaluation of the current status of the automation system
- Evaluation of the ”history” of diagnostic events

Diagnostics Buffer

A diagnostics buffer in the CPU is available for evaluating the history of diagnostic events. The size of this diagnostics buffer depends on the type of CPU used

Example: A CPU with a diagnostics buffer for 200 diagnostic entries show the last 200 diagnostics entries. New incoming diagnostic messages overwrite the ”oldest” diagnostic entries.

Advantages

The testing and diagnostic options for the S7-400 offers you the following advantages:

- Easy to understand because of a uniform system solution
- Less time needed for program testing and commissioning
- Fast error analysis and correction, increases plant availability
- Permits verification of prohibited and incorrect operations and manipulations based on the entries in the diagnostics buffer (e.g. STOP SWITCH ACTIVATED 10/20/04 23:59; module removed ...)

Operator Control and Monitoring with the S7-400

8

Overview

This chapter provides you with information about the operator control and monitoring devices for S7-400 and their easy and convenient operation.

8.1 Convenient Operator Control and Monitoring of Complex Processes with SIMATIC HMI

Introduction

The more complex automation processes are, the more important a process-based ”human-machine interface” becomes. SIMATIC HMI is a mature system for convenient process control and monitoring.

Touch Panels and Operator Panels

Operator panels (OPs) and touch panels (TPs) enable fast intervention on the machine. They are usually used at a station or by service personnel. You can use them to change parameters for specific machines alphanumerically and graphically.

You can enter data on the touch panels using a touch-sensitive display and on membrane keyboards on an operator panel.

Mobile Panel

The portable HMI devices allow you to perform operator control and monitoring at the actual location where something is occurring with direct access and visible contact to the process. It offers simple and safe hot pulling and plugging, and can therefore be used flexible at machines or plants.

Win CC flexible

Win CC flexible is the engineering software for all HMI devices. It allows comprehensive configuration of every HMI device and even PC-based visualization stations. Once a configuration is created, you can use it anywhere in the SIMATIC HMI product range.

WinCC flexible is available in a variety of versions based on price and performance and tailored to the individual classes of HMI devices.

Standards, Certificates and Approvals

9

In this Chapter

This chapter describes the standards, certificates and approvals maintained and fulfilled by the modules and components of the S7-400 automation system.

Warning

This chapter describes the standards, certificates and approvals. You will find the current approvals on the rating plate of the respective products.

9.1 Standards, Certificates and Approvals

Warning

Open equipment

Death, serious injury, or considerable damage to property may occur.

Modules of the S7 400 are open equipment. This means you can only install the S7-400 in enclosures or cabinets.

The enclosures or cabinets may only be access by a key or with a tool and only by authorized personnel.

IEC 61131-2

The S7-400 automation system fulfills the requirements and criteria of the IEC 61131-2 standard (Programmable Logic Controllers, part 2: Equipment Requirements and Verifications).

CE Label

Our products fulfill the requirements and protection goals of the following EC guidelines and matches the harmonized European standards (EN) that have been published for the programmable logic controllers in the official journals of the European communities:

- 73/23/EEC ”Electrical Equipment for Use within Fixed Voltage Ranges” (Low-Voltage Directive)
- 89/336/EEC ”Electromagnetic Compatibility” (EMC Directive)
- 94/9/EC ”Equipment and protective systems intended for use in potentially explosive atmospheres” (Explosion Protection Directive)

The EC declarations of conformity are kept available for the responsible authorities at the following address:

Siemens Aktiengesellschaft
Automation and Drives
A&D AS RD ST
P.O. Box 1963
D-92209 AmbergFederal Republic of Germany

You can find this for downloading at the Internet customer support site under the heading of ”Conformity Declarations”.

EMC Guidelines

SIMATIC products are designed for use in industrial environment.

Table 9-1 Use in industrial environment

Area of application	Requirement for	
	Emitted interference	Immunity to interference
Industry	EN 61000-6-4 : 2001	EN 61000-6-2 : 2001

Low Voltage Directive

Modules and components of the S7-400 subject to the low voltage directive fulfill the EU directive 73/23/EEC. Adherence to this EU directive was tested in accordance with DIN EN 61131-2 (corresponds to IEC 61131-2).

Explosion Protection Directives

In accordance with EN 50021 (Electrical apparatus for potentially explosive atmospheres; type of protection ”n”)

II 3 G EEx nA II T3..T6

Mark for Australia and New Zealand

Our products satisfy the requirements of standard AS/NZS CISPR 11 (Class A).

Warning

You will recognize the approval, UL/CSA or cULus, assigned to your product from the mark on the rating plate.

UL Approval

UL Recognition Mark
Underwriters Laboratories (UL) according to Standard UL 508:

- Report E 85972

CSA Approval

CSA Certification Mark
Canadian Standard Association (CSA) according to Standard C 22.2 No. 142:

- Certification Record 212191-0-000

or

cULus Approval

Underwriters Laboratories Inc. according to

- UL 508 (Industrial Control Equipment)
- CSA C22.2 No. 142 (Process Control Equipment)

or cULus Approval, Hazardous Location

CULUS Listed 7RA9 INT. CONT. EQ. FOR HAZ. LOC.
Underwriters Laboratories Inc. according to

- UL 508 (Industrial Control Equipment)
- CSA C22.2 No. 142 (Process Control Equipment)
- UL 1604 (Hazardous Location)
- CSA-213 (Hazardous Location)

APPROVED for Use in

- Cl. 1, Div. 2, GP. A, B, C, D T4A
- Cl. 1, Zone 2, GP. IIC T4

Please read the notes below.

or cULus Approvals, Hazardous Location for Relay Modules

CULUS Listed 7RA9 INT. CONT. EQ. FOR HAZ. LOC.

Underwriters Laboratories Inc. according to

- UL 508 (Industrial Control Equipment)
- CSA C22.2 No. 142 (Process Control Equipment)
- UL 1604 (Hazardous Location)
- CSA-213 (Hazardous Location)

APPROVED for Use in

- Cl. 1, Div. 2, GP. A, B, C, D T4A
- Cl. 1, Zone 2, AEx nC IIC T4
- Cl. 1, Zone 2, Ex nC IIC T4

Please read the notes below.

Warning

This plant has to be mounted according to the NEC (National Electric Code) stipulations.

When used in environments according to class I, division 2 (see above) , S7-400 must be mounted in an enclosure that corresponds to at least IP54 according to EN 60529.

FM Approval

Factory Mutual Approval Standard Class Number 3611, Class I, Division 2, Group A, B, C, D.

Temperature class: T4 at 60 °C ambient temperature

Warning

Personal injury and property damage can occur.

In hazardous areas, personal injury or property damage can result if you create or break an electrical circuit during operation of an S7-400 (for example, by means of plug-in connections, fuses, switches).

Do not create or break live electric circuits unless you are certain there is no danger of explosion.

If you use S7-400 under FM conditions, it has to be mounted in an enclosure, which at least corresponds to IP54 in accordance with EN 60529.

Marine Type Approval

Classification organizations:

- ABS (American Bureau of Shipping)
- BV (Bureau Veritas)
- DNV (Det Norske Veritas)
- GL (Germanischer Lloyd)
- LRS (Lloyds Register of Shipping)
- Class NK (Nippon Kaiji Kyokai)

Safety Requirements for Installation

The S7-400 automation systems are “open type” equipment according to the IEC 61131-2 standard and therefore adhere to the EU directive 73/23/EEC “Low-Voltage Directive” and are UL/CSA certified as such.

To fulfill requirements for safe operation with regard to mechanical stability, flame retardence, stability, and shock-hazard protection, the following alternative types of installation are specified:

- Installation in a suitable cabinet
- Installation in a suitable enclosure
- Installation in a suitably equipped, enclosed operating area

Further Information

10

Documentation Landscape

This appendix presents you with the documentation landscape for SIMATIC S7. The following types of documentation are available, addressing a variety of goals and user groups:

- Catalogs
- System-based brochures
- Product-based manuals

Catalogs

Our catalogs include information and order information for the hardware and software components that you can use with SIMATIC S7.

Manuals

Our manual are based on products and provide you with comprehensive information and the explicit instructions you need to solve your automation task using SIMATIC S7.

Getting Started

Getting Started manuals provide step-by-step instructions for initial commissioning of specific products. A Getting Started manual allows you to become acquainted with a product using a concrete example of an application.

Documentation in the Internet

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

http://www2.automation.siemens.com/simatic/portal/html_00/techdoku.htm

You can download manuals there free of charge.

The online catalog and the online ordering system is located at:

http://www2.automation.siemens.com/simatic/controller/html_00/ecommerce/ecommerce.htm

Manual Collection

All SIMATIC manuals are available in electronic form in the SIMATIC Manual Collection. It provides fast access to information for commissioning and servicing, and for office use where you can save the space often required by paper documents.

The SIMATIC Manual Collection includes the electronic form of the manuals for the following product ranges:

- LOGO!
- SIMADYN
- SIMATIC Bus Components
- SIMATIC C7
- SIMATIC Distributed I/O
- SIMATIC HMI
- SIMATIC M7
- SIMATIC Machine Vision
- SIMATIC NET
- SIMATIC PC-Based Automation
- SIMATIC PCS 7
- SIMATIC PG/PC
- SIMATIC S7
- SIMATIC Software
- SIMATIC TDC

The SIMATIC Manual Collection in five languages consists of the following components:

- 5 CD-ROMs with the SIMATIC Manual Collection without SIMATIC HMI
- 2 CD-ROMs with the SIMATIC HMI Manual Collection
- 1 DVD with both manual collections in all five languages

The collection is update several time a year.

Courses

We offer a number of courses to help you become familiar with the SIMATIC S7 automation system. Please contact your regional training center or our central training center in D 90327 Nuremberg, Germany for details:

Tel.: +49 (911) 895-3200.

Internet: `http://www.sitrain.com`

Index

G

I

L

M

O

P

R

S

T

U

W