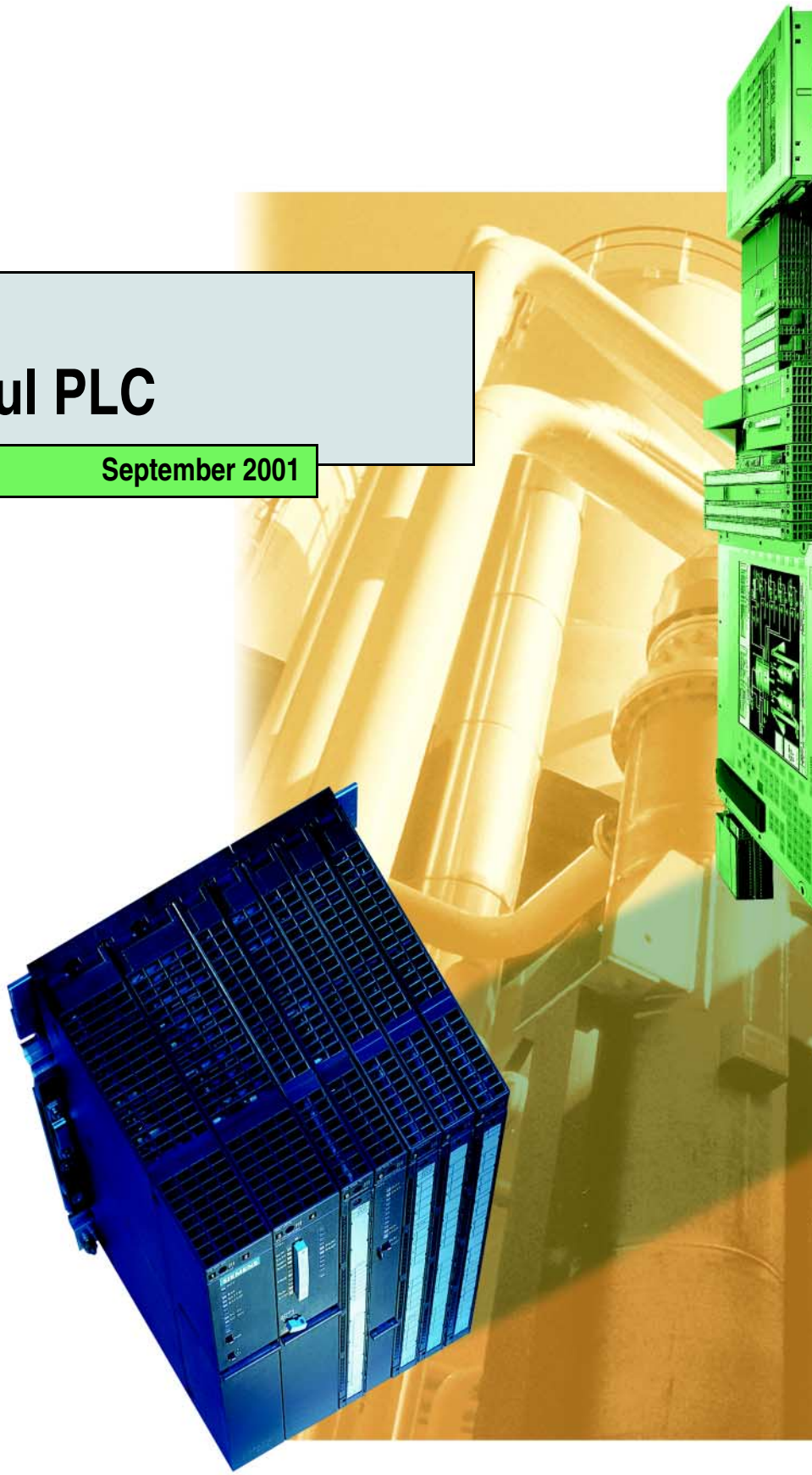
SIEMENS

SIMATIC S7-400
The most powerful PLC

Product Brief **September 2001**



SIMATIC S7-400: the PLC for production and process engineering

The SIMATIC® S7-400® is the most powerful PLC for all high-end performance applications in automation – both in production and process engineering. Available as a standard PLC or as a fault-tolerant or fail-safe system – the S7-400 provides a platform for all applications and reduces engineering, training and storage costs. Its modular structure and scalable quantity framework mean that the S7-400 is ideally suited to any applications. The comprehensive system functionality and convenient user interface make the SIMATIC S7-400 the best technical and economical solution for a wide range of automation functions in the following areas:

- the automobile industry (e.g. production lines)
- mechanical engineering, inc. specialist machine construction
- warehousing
- building systems automation
- the steel industry
- energy generation and energy distribution
- the paper and printing industry
- the food and beverages industry
- process engineering, e.g. water supply and disposal
- chemical and petrochemical industries

SIMATIC Controller

General characteristics

The main features of the S7-400 are as follows:

- extremely short instruction processing times to enable extremely rapid program execution
- deterministic output signal reaction times to changes in an input signal of less than 0.5 ms
- operation without fans and hot swapping of centralized and distributed signal modules
- graded range of CPUs, extensive range of I/Os and wide selection of function blocks with interface to the whole world of PROFIBUS – to enable the integrated solution of Motion Control applications, among other things
- bit-modular structure of CPU performance in a unit by means of multi-computing
- extremely efficient configuration in conjunction with the higher-level languages based on STEP® 7 and graphical engineering tools
- all project data, inc. program source code and customer specific data, stored on the CPU
- interface to the world of IT (web sites and e-mail) via Ethernet.
- fault tolerant and fail-safe versions for automation of processes with special requirement in terms of power outage and fail-safety

An S7-400 system consists of the following components:

- backplane
- power supply module (PS) for connection to the mains voltage
- central processing unit (CPU) with integrated interface to distributed I/O
- signal modules (SM) for digital (DI/DO) and analog (AI/AO) inputs/outputs
- communications processors (CP) for bus connection and point-to-point connections
- function modules (FM) for demanding functions such as counting, positioning and cam control

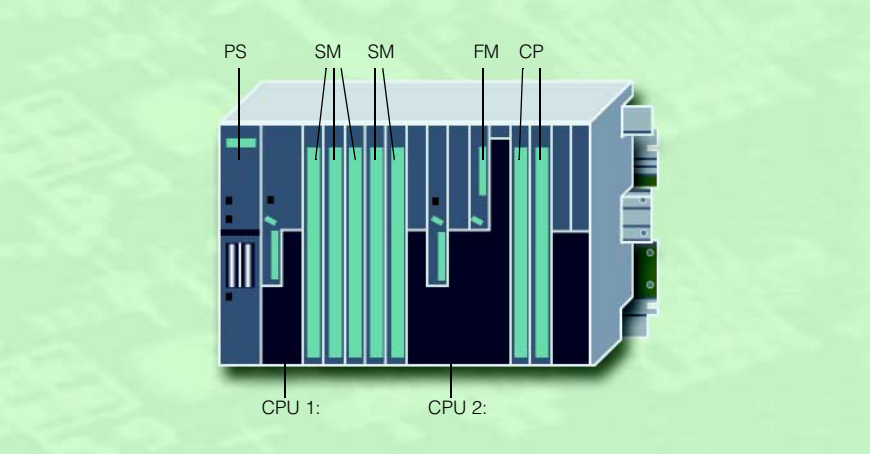


Figure 1: Configuration of the S7-400

Design

The S7-400 is made up of any number of modules which can be combined on a modular basis. This means you can set up a controller which is exactly suited to the job in hand.

Various racks are available with an integrated backplane bus, so all you need to do is insert the modules and fix them by means of screws. This ensures a rugged design and electromagnetic compatibility. The PLC has a defined mounting depth, as all the connections and connectors are sunken into the modules and covered with cover flaps.

When you are setting up the system, you do not have to observe any slot rules. The signal modules are also hot swappable, i.e. they can be connected and disconnected while the process is running, without having to pause production. As there are no active components on the backplane, the system as a whole is extremely reliable.

All the hardware settings can be set by means of software, making DIP switches and jumpers a thing of the past.

Standards

The SIMATIC S7-400 fulfils the following national and international standards:

- DIN, EN, IEC
- UL certificate
- CSA certificate
- FM class 1 div. 2; groups A, B, C and D
- Temperature group T4 (≤ 135 °C)
- Marine approvals from:
  American Bureau of Shipping
  Bureau Veritas
  Des Norske Veritas
  Germanischer Lloyd
  Lloyds Register of Shipping
- Ambient temperature 0 to 60 °C for all components
- Earthquake-proof

Interface to the world of IT

The S7-400 allows you to integrate the modern world of IT into automation. The pluggable CP (CP 443-1 IT) enables the following functions:

- Creation of your own web pages using any HTML tools, and the process variables for the S7-400 can simply be assigned to the HTML objects
- Monitoring of the S7-400 through these web pages using a standard browser
- Sending of e-mails from the user program of the S7-400 by means of function calls
- Remote programming through the telephone network (e.g. ISDN) using the WAN properties of TCP/IP.

Range of CPUs, multi-computing

Range of CPUs

There are a number of different CPUs with different performance levels which you can use to configure a programmable controller.

- All the CPUs have a combined programming and PROFIBUS-DP interface. This means they can be accessed at any time from the OP or programming device/PC or networked with various controllers. This interface can also be used for connecting distributed PROFIBUS-DP devices. This means that all the CPUs can be operated directly with distributed I/O.
- All the CPUs, except the entry level CPU 412-1, also incorporate a PROFIBUS-DP interface whose main function is to act as the interface to distributed I/O, but which can also be configured to be used for communications with the OP or programming device/PC.
- The higher-end CPUs also have free slots for PROFIBUS-DP interface modules in order to connect additional DP lines.

Otherwise, the only difference between the CPUs is the performance scope, e.g. RAM, address range, number of modules which can be connected and processing time.

Multi-computing

Multi-computing, i.e. running more than one CPU in a S7-400 central controller, has a number of benefits to the user.

- Multi-computing means that the overall performance of an S7-400 can be split up. For example, complex technical functions, such as controlling, computing or communicating, can be separated and assigned to different CPUs. And each CPU can be assigned its own, local I/O.

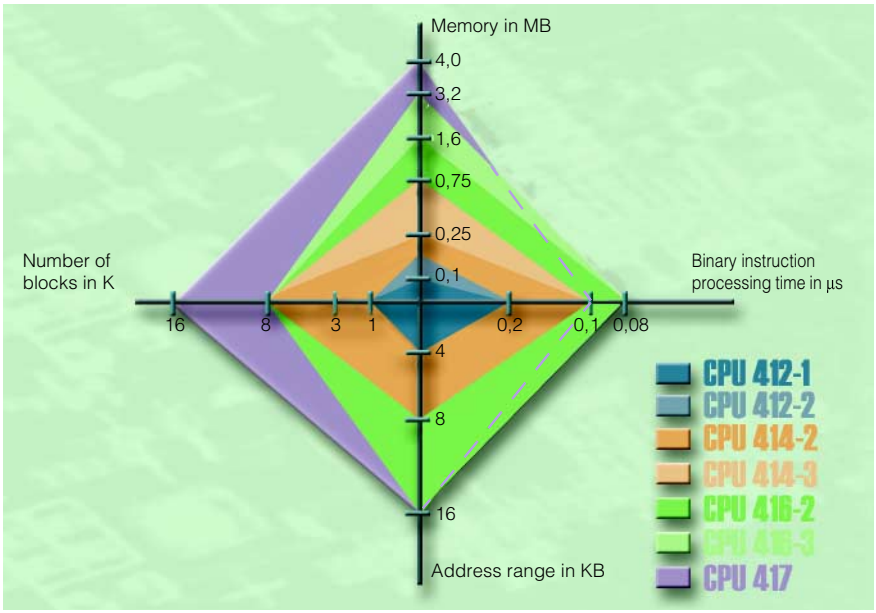


Figure 2: CPU range for the S7-400

- Multi-computing also enables different functions to be separated from one another, so, for example, one CPU can process the time-critical processing functions and another CPU the non-time critical functions.

In multi-computing mode, all the CPUs together act as a single CPU, i.e. if one CPU goes into STOP mode, all the other CPUs stop at the same time. Synchronization calls enable the actions of multiple CPUs to be coordinated for each individual instruction.

At the same time, data transfer between the CPUs is extremely fast thanks to the “Global Data” mechanism.

S7-400H fault tolerant PLC

Based on standard S7-400 modules, the S7-400H is a fault tolerant (redundant) PLC which drastically reduces the risk of production downtime. Its fault tolerant structure makes the S7-400H ideally suited to applications in which MTTR and downtimes need to be avoided where possible, e.g. for energy generation / distribution, the chemical industry, mining, transport, etc.

The fault tolerance is achieved by means of two parallel central controllers whose CPUs are connected by means of fiber optic conductors and which control the redundant I/O via redundant PROFIBUS-DP lines. In the event of an error, there is a bumpless transfer of control, i.e. the intact standby device takes over execution at the point of interruption, with no loss of information.

When setting up a fault-tolerant S7-400H controller, the user can concentrate entirely on the job in hand:

- The S7-400H is programmed in the same way as a non-redundant standard S7-400 system using any STEP 7 language.
  All redundancy-specific functions can be configured using a easy-to-use STEP 7 option package.
  A program written for a standard non-redundant system can easily be ported to a redundant system (and vice versa).
- The S7-400H consists almost exclusively of standard components from the SIMATIC S7 range and is an integral part of Totally Integrated Automation® (TIA).

Further information can be found in the “SIMATIC S7-400H: the fault-tolerant power PLC” product brief.

Figure 3: SIMATIC S7-400H fault tolerant PLC

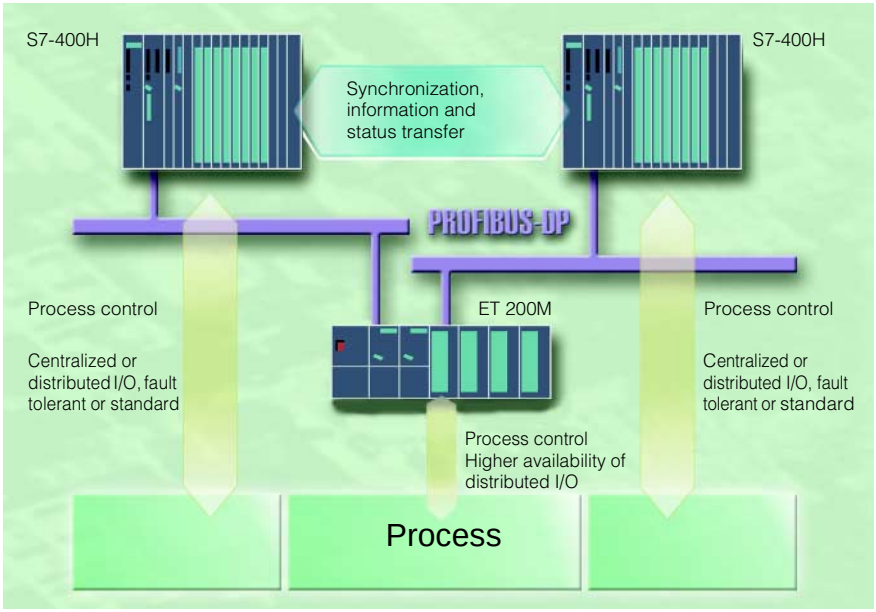


Figure 4: Configuration of the SIMATIC S7-400H

S7-400F/FH fail-safe PLC

The new SIMATIC S7-400F/FH is an addition to the range of SIMATIC S7 controllers. It is a fail-safe controller based on the technology of the fault tolerant S7-400H.

The SIMATIC S7-400F/FH enters a safe state immediately when an error occurs or remains in a safe mode, thus guaranteeing a high level of safety for man, machine, the environment and the process. The S7-400F/FH has a **TÜV approval** (TÜV = German Technical Inspectorate) and fulfils all relevant standards.

The S7-400F/FH can also be used as a standard or fault tolerant controller. This means that the SIMATIC S7-400F/FH combines standard automation functions and safety-related technology in a single system.

The CPUs of the SIMATIC S7-400F/FH are based on the CPUs of the SIMATIC S7-400H system, with the addition of what is known as an F-library.
This F-library contains pre-assembled, TÜV-approved basic function blocks as well as a parameterization tool for the fail-safe I/O modules.
The CFC Engineering Tool is used to call blocks from the F-library and interconnect them, i.e. there is no additional familiarization time for the programming.

These ET200®M fail-safe I/O modules are connected to PROFIBUS and controlled by means of the new *PROFI*Safe PROFIBUS profile for safety-related applications.
There is also an additional advantage in the fact that a S7-400F/FH fail-safe controller largely consists of standard components and is an integral part of Totally Integrated Automation (TIA).

This means the S7-400F can now be used for areas of automation which, up to a few years ago, were the exclusive domain of conventional electro-mechanical controllers, e.g. automobile shell construction using presses and robots, burner management systems, transportation of persons on cableways and, last but not least, process automation.

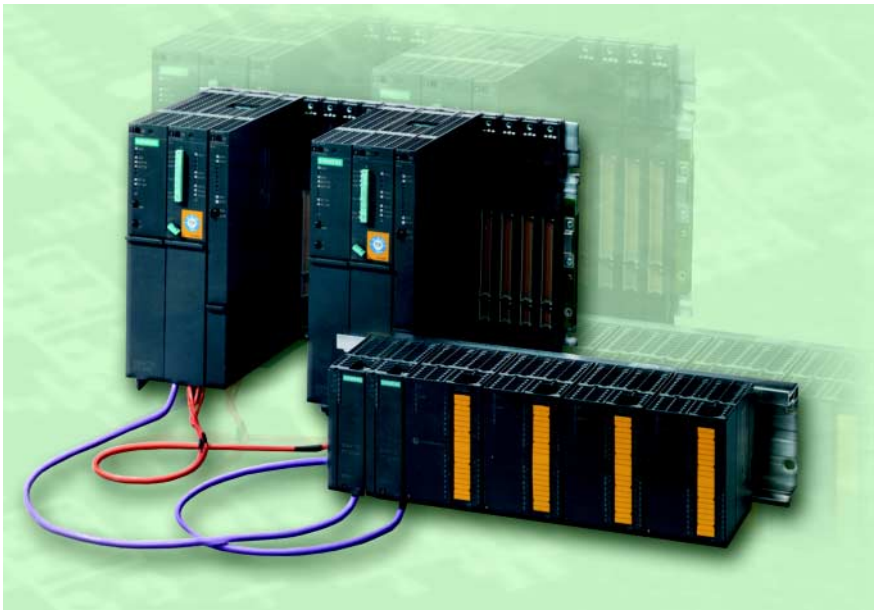


Figure 5: SIMATIC S7-400F/FH fail-safe PLC

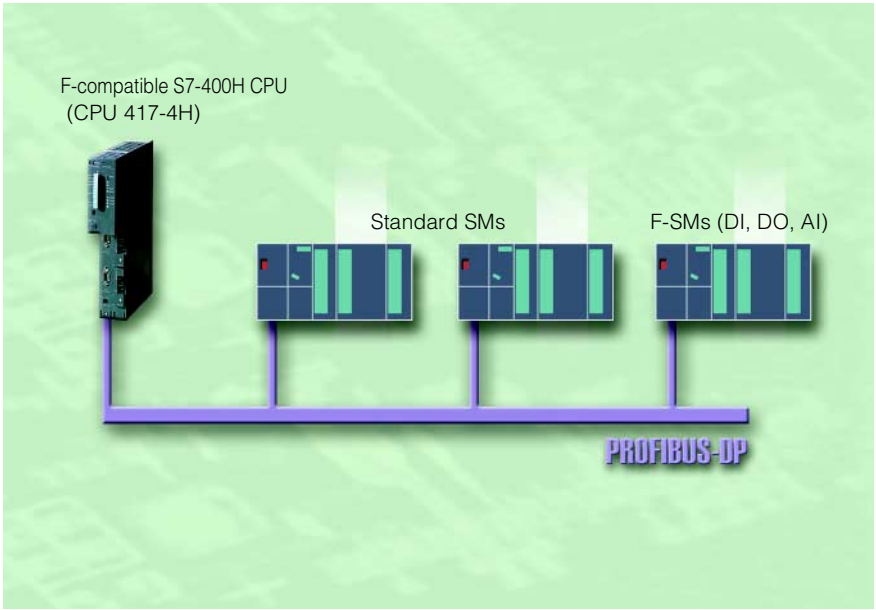


Figure 6: Standard PROFIBUS-DP connection of I/Os with additional fail-safe DP communication (PROFISafe)

Further information can be found in the "SIMATIC S7-400F/FH: the fail-safe standard PLC" product brief.

Memory strategy, diagnostics

All S7-400 CPUs have two types of memory:

- Load memory for all project data, e.g. blocks, configuration, parameterization data, symbols and comments, as well as all customer files.
- Working memory for process-related blocks – half each for code blocks and data blocks.

This splitting of the working memory improves performance by around 100 %. While a standard processor accesses its RAM memory at least twice, the special S7-400 processor accesses the code memory and the data memory simultaneously in a single cycle. This is made possible by the separate code and data bus. This is direct performance which is of benefit to the customer!

The size of the working memory is determined by selecting the appropriate CPU from the finely graded range of CPUs. In the CPU 417, the working memory can be expanded to up to 20 MB by slotting in extra memory modules.

The integrated memory (RAM) is adequate for small to medium-sized programs. For larger programs, the memory can be increased by slotting in extra RAM. Additional plug-in flash memory cards are available to enable retentive memory without the use of a battery.

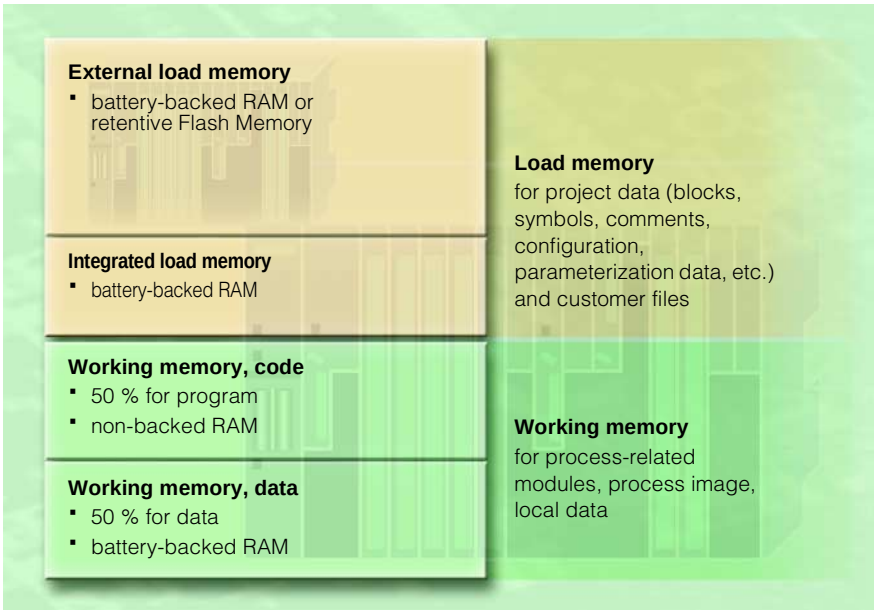


Figure 7: Memory types for the SIMATIC S7-400

Diagnostics

The CPUs' intelligent diagnostics system permanently monitors the functionality of the system and the process, and registers errors and specific system events (CPU black-box); there is also the option of adding extra diagnostic messages.

The diagnostics function can determine whether the signal logging (for digital modules) or analog processing (analog modules) functions of the module are in good working order. In the event of a diagnostics message (e.g. "no supply to encoder"), the module triggers a diagnostics interrupt.

The CPU then interrupts the processing of the user program and executes the appropriate diagnostics interrupt block.

Process interrupts mean that process signals can be monitored and reactions to signal changes can be triggered.

CPUs – Integrated interfaces

In automation, there is a trend towards distributed systems.The required data transfer between the individual parts of the system means that communications capability is taking on an increasingly important role. The SIMATIC S7-400 takes this into account: Interfaces integrated directly into the CPUs mean you can set up a high-performance communications environment using conventional bus technology.

The programming interface

All CPUs have a combined programming and PROFIBUS-DP interface which can be accessed at any time by up to 125 programming devices/PCs or OPs and can also be networked with other controllers. This interface can also be used for connecting up to 31 distributed PROFIBUS-DP devices.

- By means of data communication, this interface enables the transfer of process data between various different controllers, e.g. one CPU can access the inputs or outputs of another CPU.
- The programming interface also has all the functionality of a DP interface.

PROFIBUS-DP interface (or "centralized = distributed")

In terms of configuration and programming, there is no difference between centralized and distributed I/O.

To make setting up relatively large distributed structures economically viable, the SIMATIC S7-400 can be connected as a master to the PROFIBUS-DP open fieldbus (in accordance with EN 50170). This allows communications with a number of partners, from the SIMATIC controller to field devices from other manufacturers. Up to 125 stations can be controlled by one DP interface. More than 400 PROFIBUS slaves can be connected to a CPU with 4 interfaces; this means an S7-400 station can drive more than 1600 PROFIBUS slaves.

It can also communicate with existing SIMATIC S5 or SIMATIC 505 systems without any problems.

Firmware release V 3.0 and later (from July 2001) provides the S7-400 with even more networking functionalities. On the one hand, the S7-400 can now also be used as an intelligent slave on PROFIBUS-DP, permitting intelligent, distributed preprocessing. On the other hand, following integration of the DP V1 functions according to IEC 1158 Parts 3-6, new, standardized PROFIBUS-DP functions are now also available in the S7-400 for communication with non-Siemens systems.

Furthermore, the operating parameters of field devices can be modified during operation, thus reducing conversion times. Finally, expanded diagnostics functions facilitate troubleshooting and help reduce down times.

Shared functions

PG functions, e.g. programming by programming device/PC over long distances, are possible using either interface type. A programming device (PG) can also operate more than one CPU, or more than one programming device can access a CPU.

There is also a routing function whereby a programming device connected to any point in the network can access all the stations on the network.

HMI functions

HMI functions are already integrated into the operating system of the S7-400 and transfer data to connected SIMATIC Operator Panels or Operator Stations without the need for any programming.

As with the PG functions, the control and monitoring functions are compatible with either the programming or the DP interface.

To ensure safe control of the process, SIMATIC HMI® (Human Machine Interface) provides a complete range of innovative control and monitoring solutions. Push Button Panels, Text Displays, Operator Panels, Touch Panels and multi-functional platforms based on Windows CE, plus PC-based display systems and process display systems to meet even the most exacting of requirements.

For all panels in the SIMATIC HMI range, the configuration software used is SIMATIC ProTool/Pro® - a consistent, uniform, Windows-based system which accesses the STEP 7 database and thus avoids duplicate entries.

More advanced functions, e.g. connection to bus systems, can be achieved using communications modules.

CPUs - Technical specifications

	CPU 412-1	CPU 412-2	CPU 414-2	CPU 414-3
Working memory				
▪ integrated	96 Kbyte	144 Kbyte	256 Kbyte	768 Kbyte
▪ in instructions	32 K	32 K	84 K	84 K
▪ for program	48 Kbyte	72 Kbyte	128 Kbyte	384 Kbyte
▪ for data	48 Kbyte	72 Kbyte	128 Kbyte	384 Kbyte
Load memory				
▪ integrated	256 Kbyte RAM	256 Kbyte RAM	256 Kbyte RAM	256 Kbyte RAM
▪ expandable to	64 Kbyte	64 Kbyte	64 Kbyte	64 Kbyte
Backup	Yes	Yes	Yes	Yes
Number of blocks				
▪ FB	256	256	2048	2048
▪ FC	256	256	2048	2048
▪ DB	512 (DB 0 reserved)	512 (DB 0 reserved)	4096 (DB 0 reserved)	4096 (DB 0 reserved)
Program execution				
▪ free cycle	1	1	1	1
▪ timed interrupts	2	2	4	4
▪ delay interrupts	2	2	4	4
▪ time interrupts	2	2	4	4
▪ process interrupts	2	2	4	4
▪ multi-computing interrupt	1	1	1	1
▪ startup	3	3	3	3
Execution times				
▪ bit operations	2 µs	2 µs	0.1 µs	0.1 µs
▪ word operations	2 µs	2 µs	0.1 µs	0.1 µs
▪ fixed point arithmetic	2 µs	2 µs	0.1 µs	0.1 µs
▪ floating point arithmetic	3 µs	3 µs	0.6 µs	0.6 µs
Bit memories/timers/counters				
▪ Bit memories	4 Kbyte	4 Kbyte	8 Kbyte	8 Kbyte
▪ S7 timers/S7 counters	256/256	256/256	256/256	256/256
▪ IEC timers/IEC counters	SFB/SFB	SFB/SFB	SFB/SFB	SFB/SFB
Design				
▪ Number of expansion units	21	21	21	21
▪ Number of DP masters per CPU	max. 10	max. 10	max. 10	max. 10
▪ Number of FMs	limited by number of slots and number of connections	limited by number of slots and number of connections	limited by number of slots and number of connections	limited by number of slots and number of connections
▪ Number of CPs	limited by number of slots and number of connections	limited by number of slots and number of connections	limited by number of slots and number of connections	limited by number of slots and number of connections
Programming interface				
▪ Number of stations	16	16	32	32
▪ Transmission speed	max. 12 Mbit/s	max. 12 Mbit/s	max. 12 Mbit/s	max. 12 Mbit/s
DP interface				
▪ Number of stations	32	32 + 64	32 + 96	32 + 2 x 96
▪ Transmission speed	max. 12 Mbit/s	max. 12 Mbit/s	max. 12 Mbit/s	max. 12 Mbit/s
Address ranges				
▪ Total I/O address area	4 Kbyte /4 Kbyte	4 Kbyte /4 Kbyte	8 Kbyte /8 Kbyte	8 Kbyte /8 Kbyte
▪ I/O process image	4 Kbyte /4 Kbyte	4 Kbyte /4 Kbyte	8 Kbyte /8 Kbyte	8 Kbyte /8 Kbyte
▪ Total digital channels	32768/32768	32768/32768	65536/65536	65536/65536
▪ Total analog channels	2048/2048	2048/2048	4096/4096	4096/4096
MLFB group	6ES7412-1XF...	6ES7412-2XG...	6ES7414-2XG...	6ES7414-3XJ...

CPUs - Technical specifications (continued)

	CPU 416-2	CPU 416-3	CPU 417-4
Working memory			
▪ integrated	1.6 Mbyte	3.2 Mbyte	4 Mbyte
▪ in instructions	530 K	1065 K	1335 K
▪ for program	0.8 Mbyte	1.6 Mbyte	2 Mbyte
▪ for data	0.8 Mbyte	1.6 Mbyte	2 Mbyte
Load memory			
▪ integrated	256 Kbyte RAM	256 Kbyte RAM	256 Kbyte RAM
▪ expandable to	64 Kbyte	64 Kbyte	64 Kbyte
Backup	Yes	Yes	Yes
Number of blocks			
▪ FB	2048	2048	6144
▪ FC	2048	2048	6144
▪ DB	4096 (DB 0 reserved)	4096 (DB 0 reserved)	8192 (DB 0 reserved)
Program execution			
▪ free cycle	1	1	1
▪ timed interrupts	8	8	8
▪ delay interrupts	4	4	4
▪ time interrupts	9	9	9
▪ process interrupts	8	8	8
▪ multi-computing interrupt	1	1	1
▪ startup	3	3	3
Execution times			
▪ bit operations	0.08 µs	0.08 µs	0.1 µs
▪ word operations	0.08 µs	0.08 µs	0.1 µs
▪ fixed point arithmetic	0.08 µs	0.08 µs	0.1 µs
▪ floating point arithmetic	0.48 µs	0.48 µs	0.6 µs
Bit memories/timers/counters			
▪ Bit memories	16 Kbyte	16 Kbyte	16 Kbyte
▪ S7 timers/S7 counters	512/512	512/512	512/512
▪ IEC timers/IEC counters	SFB/SFB	SFB/SFB	SFB/SFB
Design			
▪ Number of expansion units	21	21	21
▪ Number of DP masters per CPU	max. 10	max. 10	max. 10
▪ Number of FMs	limited by number of slots and number of connections	limited by number of slots and number of connections	limited by number of slots and number of connections
▪ Number of CPs	limited by number of slots and number of connections	limited by number of slots and number of connections	limited by number of slots and number of connections
Programming interface			
▪ Number of stations	64	64	64
▪ Transmission speed	max. 12 Mbit/s	max. 12 Mbit/s	max. 12 Mbit/s
DP interface			
▪ Number of stations	32 + 125	32 2 x 125	32 + 3 x 125
▪ Transmission speed	max. 12 Mbit/s	max. 12 Mbit/s	max. 12 Mbit/s
Address ranges			
▪ Total I/O address area	16 Kbyte /16 Kbyte	16 Kbyte /16 Kbyte	16 Kbyte /16 Kbyte
▪ I/O process image	16 Kbyte /16 Kbyte	16 Kbyte /16 Kbyte	16 Kbyte /16 Kbyte
▪ Total digital channels	131072/131072	131072/131072	131072/131072
▪ Total analog channels	8192/8192	8192/8192	8192/8192
MLFB group	6ES7416-2XK..	6ES7416-3XL...	6ES7417-4XL...

Programming

The configuration and programming of the S7-400 is based on STEP 7. STEP 7 offers functions for every phase of an automation project – from configuration to startup, testing and servicing.

STEP 7

STEP 7 incorporates the SIMATIC Manager, the central tool for the software-related handling of the project. This relates not only to a single CPU, but to the whole plant – irrespective of how many controllers, drives and HMI devices the solution consists of. Using STEP 7 also ensures that the data is kept consistent throughout the project.

STEP 7 incorporates both the hardware configuration of the plant and the parameterization of the modules, so there are no more hardware settings to be made. STEP 7 also includes the three basic languages: statement list (STL), ladder diagram (LAD) and function block diagram (FBD). STEP 7 also makes it possible to parameterize high-speed data communications between networked CPUs.

Engineering tools

As the S7-400 is generally used for executing large programs, there are also higher-level languages and graphical engineering tools based on STEP 7. These have the additional functionality to enable you to program automation solutions in a function-oriented manner and using a user-friendly interface.

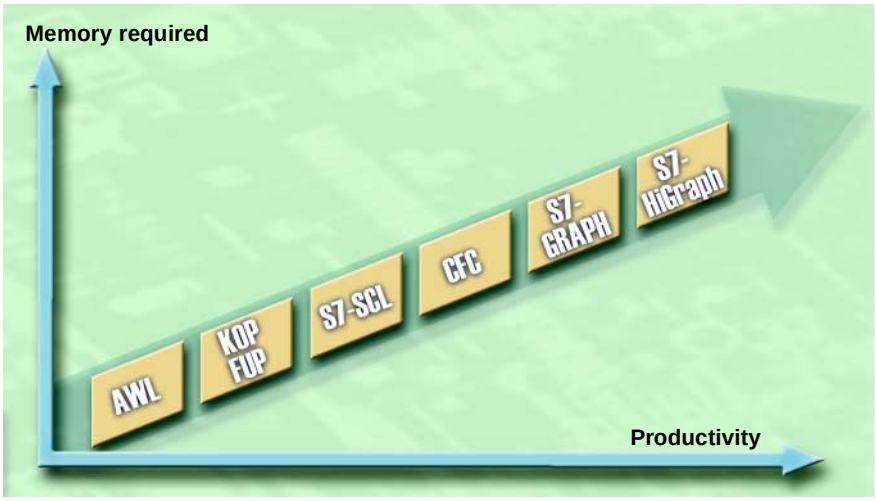


Figure 8: Memory required for engineering tools

The following tools are available for programming:

S7-SCL

(**S**tructured **C**ontrol **L**anguage), PASCAL-based higher-level language for programming SIMATIC S7/C7 controllers

S7-GRAPH

enables graphical configuration of sequential control systems for SIMATIC S7/C7

S7-HiGraph®

for graphical description of sequential or asynchronous process with status diagrams for SIMATIC S7/C7

CFC

(**C**ontinuous **F**unction **C**hart), the technology-oriented diagram which enables graphical interconnection of complex functions for SIMATIC S7

Data storage

The new STEP 7 Version 5.1 allows any data to be saved to the CPU, i.e. if you are servicing or upgrading the system, the personnel can still access not only the programs running, but also the whole project, including any comments and symbols. If you are using higher-level languages or graphical engineering tools, the program source code is also immediately available in its original form or in graphical format. Last but not least, it is also possible to save customer-specific operating instructions, manuals and machine documentation directly on the CPU in all standard file formats.

Communication

Totally Integrated Automation

A single, completely integrated and consistent system with which you can execute any automation functions!

An element of central importance within the system is **the communications network**:

Industrial Ethernet (IEEE 802-3 and 802.3u) – the international standard for area and cell networking – with a connection to the IT environment.

PROFIBUS (IEC 61158/EN 50170) – the international standard for the cell and field levels.

AS-Interface (EN 50295) – the international standard for communications with sensors and actuators.

EIB (EN 50090, ANSI EIA 776) – the global standard building installation system and the basis for building services automation.

Point to point connection – for communication between two stations with special protocols. The point to point structure represents the simplest form of communication. Various different special protocols are used (e.g. RK 512, 3694(R) and ASCII) (see also page 3).

Process or field communications

Process or field communication are used to connect actuators/sensors to a CPU.

Process or field communication with the S7-400 is supported by PROFIBUS-DP. To make this possible, the S7-400 can be connected to PROFIBUS-DP as a master – either by means of the interface integrated into each CPU, a special interface module or a communications processor (CP). The AS interface and EIB networks and other bus systems are accessible from the S7-400 via the PROFIBUS gateways.

Data communications

Data communications enable data transfer between automation systems or between an automation system and an intelligent partner (PC, computer, etc.).

This is achieved either through the programming interface or by means of PROFIBUS and Industrial Ethernet.

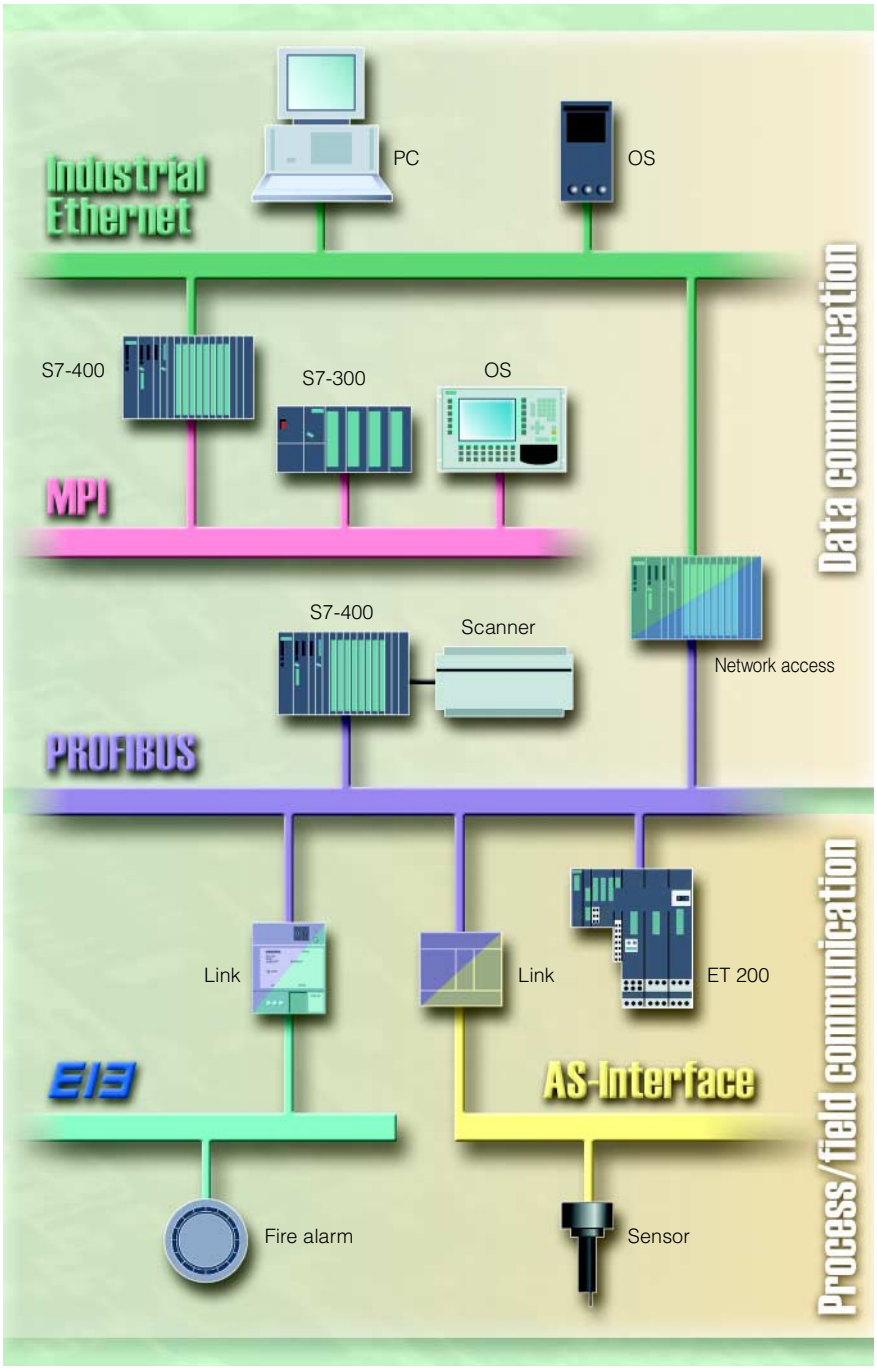


Figure 9: Communication options for the SIMATIC S7-400

The programming interface enables simple cyclical data transfer on the one hand (no acknowledgment) and programmed transfer of relatively large volumes of data on the other (with or without acknowledgment). Specific communications processors (CP) are used for the connection to PROFIBUS and Industrial Ethernet; which means that the TCP/IP protocol can be accessed direct from the program.

Range of modules

In addition to the range of specific S7-400 modules, the S7-400 also gives access to the world of PROFIBUS through the integrated PROFIBUS-DP interface. This means that a large number of I/O modules are available with which the S7-400 can be adapted to a wide range of functions. Users of the system have access to PROFIBUS-DP modules from Siemens as well as modules from other manufacturers.

Naturally, there is also a wide range of S7-400 modules which can be used in central controllers and expansion units:

- intelligent power supplies (redundant, diagnostics-compatible) to secure the supply of all operating voltages
- digital and analog I/O modules for nearly all signal types, including some with interrupt processing and diagnostics
- function modules for counting/ measurement, all types of positioning functions, cam control, motion control and computing
- communications modules for serial point to point connection and bus communications by means of PROFIBUS and Industrial Ethernet
- interface modules for connecting expansion units to the central controller

The following documents contain additional information on the range of modules and on communications:

- “Counting and positioning using SIMATIC S7/C7” product brief
- “Closed-loop control with SIMATIC S7/C7” product brief
- Flyer on “Point-to-point interface modules”
- Multimedia CD on “SIMATIC technology … in action”
- Overview of “Industrial communications for automation”
- Leaflet on “FM 458 high-performance controller module

Communication	Technology
Point to point connection with data rates of up to 115 Kbit/s and various protocols, e.g. for connecting modems, printers, scanners, drives, external devices, etc.	Counting in various modes, up to 500 kHz
Connection to PROFIBUS using either the DP or the FMS protocol (DP V0 and DP V1)	Cam control for up to 16 cam lines per module
Connection to Industrial Ethernet using the ISO/TCP or TCP/IP data communications protocol	Any type of positioning function: controlled positioning using the rapid/creep feed process (3 axes per module)
Connection to the Internet via Ethernet for loading websites and using e-mail	Point to point positioning and velocity profiles (position control) with stepper and servo motors (3 axes per module)
	PID controller with backup functionality and integrated online self-configuration for various types of controller (continuous controllers, stepper controllers, pulse controllers)
	Freely programmable, highly dynamic controller for up to 100 axes per module

Expansion options

Not only can a S7-400 system be expanded using PROFIBUS-DP, but additional racks can also be linked directly to the central processing unit. Distances of up to 600 m can be covered without any performance loss of the backplane bus. The power supply can also be looped through for shorter distances.

Racks with 18 or 9 slots are available as the central controller. Using interface modules, up to 21 expansion units, each with either 18 or 9 slots for S7-400 modules, can be connected.

I/O modules – Properties
Selection aid for digital inputs/outputs

Signal modules are the interface between the SIMATIC S7-400 and the process. A wide range of different digital and analog modules provide exactly the right inputs/outputs required for the function in question. However, the S7-400 signal modules represent only a subset of the modules which can be connected to the S7-400 via PROFIBUS-DP.

Easy to install

The sensors/actuators simply connect to the front connector. When replacing the module, all you need to do is plug the connector into the new module of the same type. You do not need to change the wiring. The coding of the front connector prevents confusing of modules.
SIMATIC TOPconnect simplifies the wiring still further – with its pre-wired front connectors and terminal blocks.

High level of packaging density

The large number of channels on the modules is one reason for the space-saving design of the S7-400: Modules are available with 8 to 32 channels (digital) or 8 to 16 channels (analog) per module.

Simple to configure

The modules are configured and parameterized using STEP 7, there are no fiddly switch settings. The data is stored centrally and automatically transferred to the new module after a module is replaced, which prevents transfer errors. No software upgrade is required when new modules are installed.

Alarms

Many modules also monitor signal acquisition (diagnostics interrupt) and the signals from the process (process interrupt). This means the system can react quickly to any irregularities and to every process event. How and whether the controller reacts can be configured in STEP 7.
For the digital input modules, a process interrupt can be triggered on a rising edge, a falling edge or both edges of a signal status change, or based on channel groups.

The following pages list criteria to help you select the appropriate signal module for a given application.

Regularly updated, extensive technical information can be found in the interactive CA 01 catalog at any time (Internet: http://www.siemens.de/automation/ca01).

Module type	**Selection aid for digital inputs**					
Special features of this module	Very fast, interrupt-capable 24 V DC input module	24 V DC standard input module – extremely high packaging density	Highest packaging density for the 120 V market	Input module for higher, variable voltages	Interrupt-capable input module for lower, variable voltages	Specially for the US-dominated AC market channel-oriented isolation
Type of voltage	DC	DC	UC	UC	UC	AC
Input voltage	24 V	24 V	120 V	120/230 V	24 to 60 V	120 V
Interrupt capability	Yes	No	No	No	Yes	No
Number of channels	16	32	32	16	16	16
MLFB group	6ES7 421-7BH..-...	6ES7 421-1BL..-...	6ES7 421-1EL..-...	6ES7 421 1FH..-...	6ES7 421-7DH..-...	6ES7 421-5EH..-...

Module type	**Selection aid for digital outputs**							
Special features of this module	DC output module for high currents	DC output module for variable voltages	24 V DC standard output module – high poss. packaging density	Very fast, interrupt-capable 24 V DC input module	AC output module for high currents and channel-oriented isolation	AC standard output module	AC output module for variable voltages and channel-oriented isolation	Relay output module
Type of voltage	DC	DC	DC	DC	AC	AC	AC	Relay
Output voltage	24 V	20 - 138 V	24 V	24 V	120/230 V	120/230 V	20-120 V	5-125 VDC
Output current	2 A	1.5 A	0.5 A	0.5 A	5 A	2 A	2 A	5 A
Interrupt capability	Yes	No	No	Yes	No	No	No	No
Number of channels	16	16	32	32	8	16	16	16
MLFB group	6ES7 422-1BH..-...	6ES7 422-5EH1.-...	6ES7 422-1BL..-...	6ES7 422-7BL..-...	6ES7 422-1FF..-...	6ES7 422-1FH..-...	6ES7 422-5EH0.-...	6ES7 422-1HH..-...

I/O modules – selection aid for analog inputs

	Selection aid for analog inputs					
Physical measured variable	Voltage					
Special features of this module	Standard module with 16 inputs	Standard module with 8 inputs	Numerous voltage ranges	Very rapid analog value acquisition	Generation of diagnostics and process value interrupts at 16 bit resolution	Channel-oriented isolation and generation of diagnostic and process value interrupts
Measurement range Encoder	+/-1 V 1 - 5 V	+/-1 V +/-10 V 1 - 5 V	+/-80 mV +/-250 mV +/-500 mV +/-1 V +/-2.5 V +/-5 V +/-10 V 1 - 5 V	+/-1 V 1 - 5 V +/-10 V	+/-25 mV +/-50 mV +/-80 mV +/-250 mV +/-500 mV +/-1 V +/-2.5 V +/-5 V +/-10 V 1 - 5 V	+/-25 mV +/-50 mV +/-80 mV +/-250 mV +/-500 mV +/-1 V +/-2.5 V +/-5 V +/-10 V 1 - 5 V
Interrupt capability	No	No	No	No	Yes	Yes
Isolation	No	Yes	Yes	Yes	Yes	Yes
Number of channels	16	8	8	8	16	8
Resolution	13 bit	13 bit	14 bit	14 bit	16 bit	16 bit
Conversion time per channel	55/65 ms	23/25 ms	20/23 ms	52 µs	6/21/23 ms	–
MLFB group	6ES7 431-0HH..-....	6ES7 431-1KF0.-....	6ES7 431-1KF1.-....	6ES7 431-1KF2.-....	6ES7 431-7QH..-....	6ES7 431-7KF0.-....

	Selection aid for analog inputs					
Physical measured variable	Current					
Special features of this module	Standard module with 16 inputs	Standard module with 8 inputs	Standard module with 8 inputs	Very rapid analog value acquisition	Generation of diagnostics and process value interrupts at 16 bit resolution	Channel-oriented isolation and generation of diagnostic and process value interrupts
Measurement range Encoder	4-20 mA +/-20 mA	4 - 20 mA +/-20 mA	4 - 20 mA 0 - 20 mA	4 - 20 mA +/-20 mA	4 - 20 mA 0 - 20 mA +/-5 mA +/-10 mA +/-20 mA	4 - 20 mA 0 - 20 mA +/-5 mA +/-10 mA +/-20 mA +/-3.2 mA
Interrupt capability	No	No	No	No	Yes	Yes
Isolation	No	Yes	Yes	Yes	Yes	Yes
Number of channels	16	8	8	8	16	8
Resolution	13 bit	13 bit	14 bit	14 bit	16 bit	16 bit
Conversion time per channel	55/65 ms	23/25 ms	20/23 ms	52 µs	6/21/23 ms	–
MLFB group	6ES7 431-0HH.-....	6ES7 431-1KF0.-....	6ES7 431-1KF1.-....	6ES7 431-1KF2.-....	6ES7 431-7QH..-....	6ES7 431-7KF0.-....

I/O modules – selection aid for analog inputs (continued)

	Selection aid for analog inputs			
Physical variable	Resistance			
Special features of this module	Standard module	Numerous measurement ranges	High-speed analog value acquisition and generation of process interrupts	Many measurement ranges and generation of process and diagnostics interrupts
Encoder measurement range	0 - 600 Ω	0 - 48 Ω, 0 - 150 Ω, 0 - 300 Ω, 0 - 600 Ω, 0 - 6000 Ω	0 - 600 Ω	0 - 48 Ω, 0 - 150 Ω 0 - 300 Ω, 0 - 600 Ω, 0 - 6000 Ω
Interrupt capability	No	No	No	Yes
Isolation	Yes	Yes	Yes	Yes
Number of channels	4	4	4	8
Resolution	13 bit	14 bit	14 bit	16 bit
Conv. time per channel	23/25 ms	20/23 ms	52 µs	6/21/23 ms
MLFB group	6ES7 431- 1KF0.-....	6ES7 431- 1KF1.-....	6ES7 431- 1KF2.-....	6ES7 431- 7QH..-....

	Selection aid for analog inputs		
Physical variable	Thermocouples		
Special features of this module	Standard module with 8 channels	16 channels with 16 bit resolution and generation of process and diagnostics interrupts	Channel-oriented isolation and generation of process and diagnostics interrupts
Types	B, E, N, J, K, L, R, S, T, U	B, E, N, J, K, L, R, S, T, U	B, E, N, J, K, L, R, S, T, U
Interrupt capability	No	Yes	Yes
Isolation	Yes	Yes	Yes
Number of channels	8	16	8
Resolution	14 bit	16 bit	16 bit
Conv. time per channel	20/23 ms	6/21/23 ms	–
MLFB group	6ES7 431- 1KF1.-....	6ES7 431- 7QH..-....	6ES7 431- 7KF0.-....

	Selection aid for analog inputs		
Physical variable	Resistance thermometer		
Special features of this module	Standard module with 4 channels	Generation of process and diagnostics interrupts	Generation of process and diagnostics interrupts
Types	Pt 100, Pt 200, Pt 500, Pt 1000, Ni 100	Pt 100, Pt 200, Pt 500, Pt 1000, Ni 100, Ni 1000	Pt 100, Pt 200, Pt 500, Pt 1000, Ni 100, Ni 1000
Interrupt capability	No	Yes	Yes
Isolation	Yes	Yes	Yes
Number of channels	4	8	8
Resolution	14 bit	16 bit	16 bit
Conv. time per channel	20/23 ms	6/21/23 ms	–
MLFB group	6ES7 431- 1KF1.-....	6ES7 431- 7QH..-....	6ES7 431-7KF1.-....

I/O modules – selection aid for analog outputs

	Selection aid for analog inputs
Physical measured variable	Voltage, current
Encoder measurement range	+/-10 V, 0 - 10 V, 1 - 5 V, +/-20 mA, 0 - 20 mA, 4 - 20 mA
Interrupt capability	No
Isolation	Yes
Number of channels	8
Resolution	13 bit
Conversion time per channel	420 µs
MLFB group	6ES7 432-1HF..-....

Information on this product can be found in the Internet at

http://www.siemens.de/simatic-s7

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