The SIMATIC PCS 7 Process Control System

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SIMATIC PCS 7

Answers for industry.
As one of the leading international process control systems, SIMATIC PCS 7 with the functional variety, flexibility, and performance of the current version 8.0, has the potential for implementing innovative solutions that meet the special challenges of the process industry. Since function spectrum and application area extend far beyond the limits of a typical process control system, SIMATIC PCS 7 opens undreamed of possibilities and many new perspectives.

SIMATIC PCS 7 benefits from its seamless integration in Siemens Totally Integrated Automation (TIA), a complete range of matched products, systems, and solutions for all hierarchy levels of industrial automation - from the enterprise management level, to the control level, all the way down to the field level. This enables uniform, customer-specific automation in all sectors of manufacturing, process, and hybrid industry.
An essential advantage of the consistency of the product and system spectrum and the solutions based upon this spectrum is that faster and more precise control sequences, as well as integrated security functions of shared hardware, engineering, and engineering tools can be used for automation of continuous and discontinuous processes. Perfect interplay of all components makes it possible for you to sustainably produce in higher quality and to establish new products significantly faster on the market.
Progress you trust

Siemens is oriented around the requirements of its customers and their markets. We continuously optimize our products and services to secure the competitive edge of our customers through this systematic further development.

In doing so, we always keep our attention on the requirements and trends in process automation: Our products, systems and solutions ensure more sustainability, and help to save time and costs, and our control system know-how makes a crucial contribution to boosting plant performance.

Siemens has years of experience in all process industries, and our experts know the processes and support you with their knowledge on a daily basis when optimizing your plants. Intelligent automation and service concepts contribute decisively to the value added. They increase plant availability, profitability, and process and plant safety, and they are designed to protect investments and sharpen your competitive edge.

Siemens places high demands on process management and implementation. As a partner in plant projects of all kinds and sizes, we are at your side with our specialist knowledge – based on globally standardized quality, and with the help of specially trained experts for fast and efficient implementation.

Thanks to extensive research and development work, an innovative corporate culture, our understanding as a trendsetter in automation, and representation on international committees, we want to do justice to our role as a motor of innovation, and we consider ourselves capable, together with customers and partners, of leading the way with further developments in the process industry.

With consistent customer orientation, years of experience, high innovation, and a comprehensive product and service portfolio, Siemens creates a foundation for trustworthy business relationships and satisfied customers.
Performance you trust

In process plants, the process control system is the starting point for optimal value added: All procedures and processes can be operated, monitored and influenced with the process control system.

The process control system is the interface to the process, and it enables safe process and plant control and at the same time serves as the central database from which further optimization potential can be tapped into. The more powerful the process control system, the more effectively this potential can be used. For this reason, performance is in the foreground with SIMATIC PCS 7, alongside scalability, flexibility, and integration. Starting with planning and engineering, the process control system offers powerful tools, functions and features for cost-effective and efficient plant operation through all phases of the plant life cycle.

Performance through integration

Integration is one of the special strengths of SIMATIC PCS 7 and is evident in many aspects:

- Horizontal integration into TIA
- Vertical integration into hierarchical communication
- System-integrated tools for engineering tasks
- Integrated functions, e.g. for batch process automation, process safety, energy management, telecontrol tasks, etc.
- Integration of the fieldbus level including drives, switchgear, etc.

Horizontal integration

A system for integrated automation of the entire process chain, from incoming raw materials to outgoing goods – this is one of the decisive advantages resulting from the seamless integration of SIMATIC PCS 7 into Totally Integrated Automation.

The process control system is mainly responsible for automating the primary processes here, but it can do very much more: All ancillary facilities such as the electrical infrastructure in the form of low-voltage or medium-voltage switchgear, or the building management system, can also be integrated into the system.

Integration of selected SIMATIC standard components – automation systems, industrial PCs, network components, or distributed I/O units – into the process control system guarantees optimal interaction of individual components, and secures economic benefits such as simple selection, reduced stock keeping, or global support.
**Vertical integration**

The hierarchal communication of a company encompasses the field level, the control level, and the process level, up to management and enterprise resource planning (ERP). Thanks to standardized interfaces, based on international industry standards as well as internal interfaces, SIMATIC PCS 7 is able to provide process data for analysis, planning, coordination, and optimization of plant sequences or production and business processes – in real time, and at any location in the company!

**Central engineering**

SIMATIC PCS 7 convinces with graded functional diversity, consistent operator control philosophy, and uniformly structured engineering and management tools. A central engineering system with a coordinated range of tools for integrated system engineering and configuring of batch automation, safety functions, material transport or telecontrol systems creates value added over the entire life cycle. Reductions in configuring and training costs result in minimization of total cost of ownership (TCO).

**Functional diversity**

Depending on the typical process automation or customized requirements, SIMATIC PCS 7 can be functionally expanded for the following, for example:

- Batch process automation (SIMATIC BATCH)
- Functional safety and protection functions (Safety Integrated for Process Automation)
- Route control for material transport (SIMATIC Route Control)
- Telecontrol of remote units (SIMATIC PCS 7 TeleControl)
- Automation of electrical switchgears (SIMATIC PCS 7 PowerControl)

Further additional functions that are also integrated, or can be integrated, seamlessly into the control system make optimization of processes and reductions in operating costs possible. SIMATIC PCS 7 has, for example, tools for energy and asset management, and it offers higher quality closed-loop control functions, as well as industry-specific automation solutions and libraries.
Customized performance

Thanks to a unique scalable system architecture, SIMATIC PCS 7 creates the ideal basis for cost-effective implementation of individual automation solutions, and economic operation of process plants.

SIMATIC PCS 7 users derive sustained profit from a modular system platform based on standard SIMATIC components. Its uniformity enables flexible scaling of hardware and software, as well as perfect interaction within the system – but also perfect interaction beyond system limits. The architecture of the SIMATIC PCS 7 process control system is designed in such a manner that instrumentation and control can be configured in accordance with customer requirements and optimally matched to the dimensions of the plant. The control system can be subsequently expanded or reconfigured at any time if there is an increase in capacity or a technological modification. When the plant grows, SIMATIC PCS 7 simply grows along with it – without the provision of expensive reserve capacities!

The scalability applies for all levels of the system. Just on the control level alone there are multiple function-compatible automation systems with graduated price/performance ratios that are available to the user:

- SIMATIC S7 AS mEC RTX modular embedded controller in S7-300 design with ready-to-use pre-installed Windows operating system as a low-cost automation system
- Compact SIMATIC PCS 7 AS RTX Microbox automation system
- Modular automation systems of the S7-400 range as standard, fault-tolerant and safety-related systems

The automation performance can be optimally matched to the requirements of the plant/unit. Expensive excess capacity can thus be avoided.

Performance in engineering

With regard to planning and engineering, performance can be equated with minimizing time and costs. SIMATIC PCS 7 offers a unique approach here in conjunction with COMOS: Integrated planning workflow from the description of the process to the automation program.

A standardized system interface, strictly object-oriented working, and centralized data management mean data consistency across all planning steps including automatically updated system documentation.

With the Advanced Engineering (AdvES) option package, SIMATIC PCS 7 also handles engineering with other planning tools with maximum efficiency since plant data can be imported without problems from CAD/CAE tools.

In addition, it also allows automatic generation of the AS configuration thanks to simple multiplication of process tag types and model solutions, as well as parameter processing.
Performance in operation

Process control also becomes more complex as the multi-layer nature of automation engineering increases and it merges more and more with information technology. At the same time, rising pressure of costs makes intuitive and error-free operator input increasingly important to enable efficiency in operating personnel and to minimize downtimes and service work. SIMATIC PCS 7 supports operators optimally in their tasks and enables safe and user-friendly process control. Versatile tools are available here for reliable process optimization.

Process control and maintenance

As well as transparent process control, SIMATIC PCS 7 also offers monitoring of product quality and key performance figures for the efficient operation of your process plants, and it ensures more flexible processes, higher plant availability, and investment security.

The operator system of SIMATIC PCS 7 is the window to the process and the basis for safe and intuitive control of plants: Its architecture is flexibly scalable – from single-user systems to multi-user systems with redundant client-server architecture. The operator interface takes account of the current specifications of NAMUR (user association of automation technology in the process industries) and PI (Profibus International) and offers a high level of user-friendliness and simple, intuitive interaction with the plant. Ergonomic symbols, task-oriented faceplates, uniform representation of status information, and optimized alarm functions allow safe process control.

The integrated alarm management system of SIMATIC PCS 7 is a further performance feature for guaranteeing safe and cost-effective plant operation. It focuses on essentials alarms, allows selective operator prompting in exceptional situations, and consistently contributes towards reducing the work load of plant personnel.

Preventive and predictive maintenance strategies reduce total cost of ownership. With the plant asset management system of SIMATIC PCS 7, you always have a watchful eye on critical production equipment such as pumps, valves, distillation columns or motors, and you can carry out the relevant maintenance measures in good time before service is required – without an established maintenance plan and without the risk of an unplanned plant standstill.
Process optimization

As well as these functions for improving plant and process control, SIMATIC PCS 7 offers a wealth of tools and features that support optimization of the processes. These include

- Control Performance Monitoring
- Advanced Process Control and
- Process Historian

Monitoring of the quality of control control loop ensures the maintenance of efficient plant operation. Control Performance Monitoring allows timely, and above all selective, maintenance or controller optimization when performance capability wanes.

With Advanced Process Control (APC), including multi-variable control, predictive control, or override controls, SIMATIC PCS 7 offers decisive levers for improving plant efficiency, cost effectiveness, product quality, safety, or environmental protection. These APC solutions are already stored in the standard block library, and can thus be implemented at very low cost.

Current and historic process data form the basis of all optimization. Secure and user-friendly real-time data storage and analysis is handled using Process Historian. The long-term archive for information such as process tags, process alarms, or batch data allows fast access to this historic plant data. The information server makes the information available to you again from the Process Historian – prepared in a clear and user-specific way with the standard reporting system of Microsoft Reporting Services.

SIMATIC PCS 7 is one of the world’s leading process control systems. An essential requirement for this leading position is the success of our customers who achieve maximum performance levels in their day-to-day work using ideas, products and solutions from Siemens. See for yourself:

Put your trust in performance – back SIMATIC PCS 7.
SIMATIC PCS 7
performance you trust
Process automation with Siemens – more than just reliable technology

Mature technologies, powerful SIMATIC hardware and software, and industry-specific automation solutions create the optimal basis for your success. In addition, you will find Siemens to be a globally positioned vendor of automation technology - one you can trust.

▷ Innovation you trust

Siemens backs continuous technological innovation for your economic success today and in the future. As a trendsetter, we build on sustainable development strategies, increased use of renewable energy forms, the efficient use of raw materials, and the minimization of environmental pollution. Siemens is currently carrying out worldwide research with approximately 30,000 employees at 160 locations in more than 30 countries, and is cooperating with research facilities in leading universities. In the 2011 fiscal year, investments for research and development amounted to approximately 4 billion Euros. In this period, a total of approximately 8,600 inventions were registered, corresponding to around 40 inventions per day. This high innovative strength is channeled into our products and thus has a positive effect on your results.

▷ Expertise you trust

Each sector makes special demands on automation technology, follows individual trends, and must meet special challenges. Siemens recognized this years ago and responded with special sector orientation: Our experts concentrate on individual branches of industry. This guarantees that your contact person will be familiar with your processes and your markets. Profit from this experience and know-how in process control and optimization, especially for your sector! Our comprehensive, industry-specific range of engineering and consulting services covers the entire life cycle of your plant, from planning to modernization, and it accompanies you in each phase with optimizing service.

▷ Partner you trust

When you choose SIMATIC PCS 7 from Siemens, you have opted for a strong, experienced partner who is at your side with sound know-how in process automation and project management. For efficient and fast project execution, we have set up tried and tested guidelines and processes with which our teams worldwide ensure a uniformly high quality standard, regardless of the size of the plant or the scope of the project. We have established a tightly woven network of experts to support our process control system customers throughout the world. This includes Siemens system specialists as well as highly qualified and authorized external partners who provide first-class service and support in more than 190 countries of the world – from the initial consulting discussion, through the entire project execution, right up to support for individual products or comprehensive life cycle services.

We regard our close cooperation with partners and system integrators as a key to success in process automation. In order to expand and intensify this collaboration, we have created the Siemens Solution Partner program with a bandwidth that is currently unique on the market. It combines outstanding technology and application expertise with experience and comprehensive product and system know-how to form a tailor-made overall package for each individual plant project.
Engineering System
System-wide engineering with the central engineering system

The use of a central engineering system with a uniform and matched range of tools minimizes the configuration overhead. The engineering tools for the application software, the hardware components and the communications functions are called from a central project manager (SIMATIC Manager). This is also the basic application for the creation, management, saving and documentation of a project.

The architecture of the Engineering System depends on how the SIMATIC PCS 7 project is processed:

- Locally, on a central engineering station
- In the engineering network (concurrent engineering, multiproject engineering)

The powerful SIMATIC PCS 7 Industrial Workstations with pre-installed Windows 7 Ultimate 64-bit operating system (Single Station version) or Windows Server 2008 R2 Standard 64-bit (Server version) offer an optimum starting point for this. These can be used in the office sector as well as in industrial environments, and can control up to four process monitors via a multi-monitor graphics card.

The basis for defining the license volume and billing unit for the SIMATIC PCS 7 Engineering is the number of configurable process objects (POs). In accordance with requirements, SIMATIC PCS 7 Engineering Stations V8.0 are inherently used only for plant configuring (including 2-hour OS test operation). However, with additive OS software and OS volume licenses, a combined engineering/operator station can also be configured.

The basic functionality covered by the ES standard software for operator system and automation system (AS/OS or AS) can be optionally expanded depending on the project-specific task and its implementation.

Engineering toolset

The complete functionality for the system-wide and project-oriented engineering – which is also the basis for asset management of the I&C equipment – is available to the planning engineer as an optimally coordinated engineering toolset.
This engineering toolset encompasses tools for effective engineering of the following components and functions:

- Mass data engineering and cooperation with CAD/CAE planning tools (Advanced Engineering System)
- Control system hardware including I/O and field devices
- Communication networks
- Automation functionality for continuous and batch processes (AS engineering)
- HMI functionality (OS engineering)
- Diagnostics and asset management functionality
- Batch processes, automated with SIMATIC BATCH
- Material transport, controlled by SIMATIC Route Control
- Safety applications (Safety Integrated for Process Automation)

SIMATIC Manager

The SIMATIC Manager is the integration platform for the engineering toolset as well as the configuration basis for all engineering tasks of the SIMATIC PCS 7 process control system. All aspects of the SIMATIC PCS 7 project are managed, archived and documented here.

Technologists as well as process and production engineers can plan and configure in the environment they are familiar with by utilizing the engineering toolset designed for technological needs and the predefined blocks and charts. The uniform database of the engineering system guarantees that data which have been entered once are available system-wide.

Creating hierarchy folders implements a project structure, the technological hierarchy (TH). By storing CFC and SFC charts for automation systems, and pictures and reports for operator stations in a hierarchy folder along with additional documentation, the configuring engineer implicitly determines the hierarchical assignment.

The hardware required for use in a SIMATIC project – such as automation systems, communication components and process I/Os – is stored in an electronic catalog, and is configured and parameterized using the HW Config application.

Function blocks (FBs) and functions (FCs) can be encrypted and decrypted with the S7-Block Privacy application to protect know-how. Following encryption, the blocks and their attributes can no longer be modified. Only the interfaces of the blocks are then visible.

In order to implement the automation logic, predefined function blocks are linked to other blocks in the graphic configuration tool CFC. An SFC editor is available for graphical configuring and commissioning of sequential controls.

With the optional Advanced Engineering System, configuring and commissioning can be effectively rationalized, e.g. by means of automatic generation of the hardware configuration or multiple use of standardized software modules. The Advanced Engineering System can also exchange data with higher-level planning systems for this purpose.

Complete SIMATIC PCS 7 projects or all applications of a project can be compiled and loaded into the target systems in one operation. The engineering system automatically ensures the correct sequence. A central dialog displays and controls the operation.

Selective changes to the configuration can be loaded online into the corresponding system components. Short turnaround times result in short waiting times for the commissioning engineer and have a positive impact on the commissioning costs. Changes to the configuration which are relevant to automation systems can be debugged in a test system before being downloaded into the target system of the running plant.

The SIMATIC Manager supports the various tasks when creating a plant project by providing the following project views:

- **Component view (HW Config)**
  Configuration of hardware, such as automation systems, bus components, or process IO
- **Process object view**
  Central development environment for all aspects of process tags/process objects

In addition, the project data for engineering of the operator systems is organized with the SIMATIC Manager. All the relevant process tag data relevant to operation and monitoring are generated when the automation function is defined. A powerful Graphics Designer is available for generation of the process displays. The basis for generating process displays is provided by static symbols and dynamic block icons and faceplates that are organized in libraries and combined with the parameters of the function blocks.
Engineering software

**Process object view**

The process object view of the SIMATIC Manager supports the work carried out by a process engineer by providing a universal view of the process tag. It shows the plant hierarchy of the plant (presented in tree form) in combination with a tabular view of all aspects of the process tag/object (general data, blocks, parameters, signals, messages, picture objects, archive tags, hierarchy folders, equipment properties and global declarations). This provides the technologist with fast orientation.

All objects in the marked branch of the hierarchy are displayed in the table so that they can be directly processed with user-friendly edit, filter, replace, import and export functions. A special test mode offers the facility for testing process tags and CFCs online and for starting them up.

The OS areas and the picture hierarchy for process control, as well as the SIMATIC PCS 7 asset management, can be derived from the plant hierarchy. Furthermore, this also forms the basis for plant-oriented identification of process objects.

Group displays can be positioned in pictures by means of the picture hierarchy, and automatically linked to subordinate images. The configuration engineer only has to ensure the correct positioning. Since the number of group display fields and their semantics can be configured, it is also possible to implement customized alarm configurations.

I&C messages and process messages are already pre-configured in the function blocks, and operator input messages in the faceplates, and they are generated automatically when the trigger event occurs. If required, message texts can be modified or message priorities defined.

Using the process object view, “Smart Alarm Hiding” can also be configured. This refers to the dynamic hiding of alarms that, under certain plant conditions, are of less importance to the safe and interference-free operation of the plant. Depending on the operating status of a unit (startup, service, etc.), messages of the technological blocks grouped in this unit are shown or hidden according to the preceding configuration. By checking various option boxes in the alarm matrix of the process object view, you can define the show/hide status of the alarms individually for as many as 32 operating states. Although hidden alarms are not signaled visually and audibly, they are still logged and archived as before.

**Continuous Function Chart (CFC)**

The CFC editor is the tool for user-friendly graphical configuration and commissioning of continuous automation functions. Instances of function block types can be positioned on CFCs, parameterized, and interconnected with this tool. The block attribute "Op_Level" can be used to specify operator privilege levels for the instances back at the block level. Detailed operator privileges can be implemented in this manner.

Special configuration techniques such as chart-in-chart for implementing hierarchical charts, or the multiple usage of chart block types (individual control units/process tag types) and SFC types (standardized sequential controls) in the form of instances, offer additional rationalization potential.
The CFC editor supports the following types of standardized software modules:

- **Function block type**
  The function block types for recurring functions supplied with I&C libraries are the smallest standardized software modules. Process engineering equipment such as valves or motors are modeled in I&C terms with function blocks. They have connections for actuating and control signals, and for parameterization and monitoring functions, and they contain some interlocking functions for automatic transition to defined safety settings.

- **Process tag type**
  Process tag types each represent a standardized CFC chart implemented with function blocks for the basic automation of specific I&C functions, e.g. a level controller. Their instances can be manually adapted and linked depending on requirements, but they can be modified centrally by the type-instance concept.

- **Individual control module type**
  The individual control module type (CMT) marks a new type of standardized software module. In conjunction with the Advanced Engineering System, this offers even more efficient engineering than classic process tag types. A CMT can contain blocks, charts, control variables (block I/Os such as signals and parameters) and messages.

When creating a new CFC, a new runtime group with the same name as the chart is created. All the blocks that are subsequently entered in the chart are automatically added to this runtime group. Each block is therefore already assigned runtime properties when inserting, and configuration engineers can optimize these properties by means of modifications in the runtime editor or by using algorithms. The algorithm first determines the optimum block sequence separately for each runtime group, and then the optimum sequence of runtime groups.

In addition to convenient editing functions, the scope of CFC functions also includes powerful test and commissioning functions as well as individually configurable documentation functions.

**Sequential Function Chart (SFC)**

The SFC editor is used for the graphical configuration and commissioning of sequential controls for batch production operations. It possesses convenient editing functions as well as powerful test and commissioning functions. Using a sequential control, basic automation functions usually created using CFC are controlled and selectively processed by means of changes in operating mode and status. Depending on the subsequent use, the sequential controls can be created either as a SFC or SFC type.

**SFC**

The SFC can be used to implement sequential controls which can be applied once and which access several partial areas of the production plant. Each SFC contains standardized inputs and outputs for status information and for control by the user program or the user. The SFC can be positioned and interconnected as a block in the CFC. The required CFC block I/Os are selected by simple operations and connected to the steps and transitions of the step sequences.

A status manager conforming to ISA-88 enables the configuration of up to 8 separate sequencers within a single SFC, e.g. for states such as RUNNING, HOLDING or ABORTING, or for different operating modes.

**SFC type**

SFC types are standardized sequential controls which can be applied repeatedly and which access one partial area of the production plant. They can be organized in libraries, and handled like normal function blocks, i.e. they can be selected from a catalog and positioned, interconnected and parameterized as an instance in a CFC chart. Changes to the original automatically result in corresponding changes in all instances. An SFC type may contain up to 32 sequences. Using the function “Create/update block icons”, a block icon is automatically positioned and interconnected in the associated process display for all SFC instances with HMI features.
Examples of OS standard displays (faceplates) from the SIMATIC PCS 7 Advanced Process Library, Valves

Process Control Libraries

The use of library elements plays a major role in minimizing the amount of engineering required and thus also the project costs. In the engineering standard software of SIMATIC PCS 7, two I&C libraries are integrated - the Advanced Process Library installed as standard, as well as the SIMATIC PCS 7 Standard Library installed as required.

Preconfigured and tested blocks, faceplates and symbols are organized in these libraries and form the basic elements for the graphic configuration of automation solutions. The comprehensive range of blocks can be categorized as follows:

- Blocks for mathematical operations, analog and digital logic
- Interlocking blocks
- Technological function blocks with integral display, operation and signaling functions, e.g.:
  - Standard Control and Advanced Process Control blocks
  - Motor and valve blocks
  - Counter blocks
  - Dosing blocks
- Blocks for integration of field devices
- Operator control and monitoring blocks
- Signaling and diagnostics blocks

Furthermore, preconfigured process tag types for process equipment such as pumps, valves, dosing units and controllers (cascade, spit-range) etc. extend the scope of library elements.

Advanced Process Library

The Advanced Process Library (APL) is the standard library for SIMATIC PCS 7 V8.0. It is based on the extensive experience of project engineers and plant operators, taking into account current NAMUR recommendations and PI specifications.

New and improved functionalities as well as visually attractive GUIs for a high level of operator convenience facilitate and also force interaction of operators with the plant. Alternative, small versions of function blocks reduced to core functions, whose block icons and faceplates take up less space in the process display, improve clarity in complex process displays. Other features worth mentioning are:

- Special operating modes
  - ”Local” for integration and application of local control options
  - ”Out of service” for deactivating a process tag for maintenance and service
- Several faceplate views
  - ”Preview” with status information on the I/O signals, automatic control and possible/ permissible operator inputs as well as display of actual process values for simulation
  - ”Memo view” for temporary information from operating personnel
- Convenient interlocking blocks with initial signal information, can be directly called from the technological function blocks (e.g. from a motor block)
- Flexible scaling of functions in the library blocks
- Commissioning support through direct simulation on the operator station
- Protection against operator errors as the result of detailed grading of user privileges
- Explicit enabling/disabling of operations for a process tag for individual operator stations of the plant using the function ”Local operator enabling”
- Integration of any compact drives and switch/starter objects via standard PROFIBUS profiles
- Function for coordination of multiple access operations, e.g. of SFC/SIMATIC BATCH, to equipment such as valves, dosing units or pumps
- Tacking of operator input windows facilitates repeated, successive operations

Industry Library

The Industry Library expands the standard functionality of the APL with specific sector functionalities. It contains:

- Blocks for building automation (heating, air-conditioning, ventilation)
- Blocks for operating and monitoring using Touch Panels
- Blocks for integrating SIMATIC S7 package units (optimized for S7-300)
- Other technological blocks, e.g. for expanding measured value monitoring, or specifying a setpoint curve

All display icons, function blocks and faceplates of the Industry Library are designed in the APL style.
Shared configuration tasks

**Concurrent engineering**
With concurrent engineering, multiple project engineers can work concurrently on one project in CFC and SFC, without having to split the project up into sub-projects beforehand. During commissioning, for example, charts can be used in the online (debug) mode and at the same time changes can be made to the project.

The project is localized on one of the participating Engineering Stations, the project server. The Engineering Stations working as "Project Clients" can access the project data via LAN/WAN. CFC and SFC charts can be opened and viewed by multiple project engineers concurrently. However, the system rejects concurrent write accesses to the database.

Every Engineering Station in the network (project server/client) is able to download configuration data to a SIMATIC PCS 7 subsystem provided it has the required communication connections.

**Multiproject engineering**
Multiproject engineering permits division of a complex project into several subprojects in accordance with technological criteria in order to allow several teams to work on the project in parallel. To achieve this, a host "Multiproject" is defined in the SIMATIC Manager. The individual projects can be added or removed from a multiproject at any time.

The technological division and combination of projects is supported by the Branch & Merge functions. For the charts or units copied into another project for editing, cross-project interconnections, typically e.g. for interlocks, become textual interconnections. When merging, textual interconnections – even ones which you have entered yourself – can be closed at the press of a button. Charts with the same name in the original object are overwritten.

Central configuration functions for multiprojects help to reduce the configuration overhead. For example, a hierarchy folder can be created automatically in all projects. Then, although only the original can be modified in the original project, objects can be inserted in all folders. All block types used in a multiproject can be updated centrally.

The subprojects in a multiproject are stored on a central server and moved to the local engineering stations for editing. The engineering performance is thus unaffected by network access.
Access check and change verification

SIMATIC Logon, the user administration and access control function integrated into the engineering system, offers the plant operator excellent system support when verifying changes in combination with the detailed recordings in the change logbook.

With SIMATIC Logon, the administrator can divide users into groups with different access rights and control the access to data in this way. Access rights for stations of the process control system and operator privileges for blocks can both be set up. Configurable modification reports allow the recording of all access operations to the engineering system as well as all online changes concerning the automation systems, operator systems, SIMATIC BATCH or SIMATIC Route Control.

If you link the modification reports during the evaluation with the data of SIMATIC Logon, it is possible to verify clearly who has made a particular change and at what exact time this was done. Such verifications are often the object of sector-specific requirements, formulated, for example, in FDA 21 CFR Part 11 or GAMP.

Version Cross Manager

The Version Cross Manager is a user-friendly tool for determining the differences between various versions of individual projects or multiprojects by:

- Tracing missing, additional or differing objects by comparing hardware configuration, communication, plant hierarchy, CFCCs/SFCs, SFC details, block types, alarms, global variables, signals and run sequences
- Graphic display of comparison results in a combination of tree and tabular formats
- Clear hierarchical structuring according to the plant hierarchy of the plant
- Color-coded identification of the differences

Version Trail

The SIMATIC Version Trail which operates together with SIMATIC Logon is suitable for version-specific archiving of libraries, projects and multiprojects. SIMATIC Version Trail tags the with a version ID when archiving, and enters the following information in the version history:

- Version
- Version name
- Date and time
- Users
- Comment

Individual versions can be retrieved from the archive, and used further. SIMATIC Logon organizes the access protection.

Archiving and retrieval procedures can be automated on a time-driven basis. Retrieval of block parameters from the automation system can be coupled with the archiving procedure, but it can also be performed independently of this on a time-driven basis and with version assignment.

The version history managed by Version Trail can be displayed and printed. An already completed version cannot be modified at a later date. In conjunction with the Version Cross Manager, an archived version can be compared with an existing project or a second archived version.

Project documentation

The reporting system integrated into the engineering system can be used to document the engineering project in accordance with standards. The project report records:

- Mimic diagrams and picture objects with properties, events, actions, and direct links
- Variables, properties, and communication links
- Message classes, message blocks, and messages
- Archive tags, and configuration data for archives
- User groups and users
- Source text of actions/functions
- Texts of text library
- Basic Process Control configuration data

The project data can be freely-structured, edited in the form of standardized circuit manuals, and printed in a uniform layout. You can incorporate your own cover sheets, layouts, graphics, logos or title block data. A convenient output control function allows you to select a complete project or individual parts of a project for printing.

SIMATIC PCS 7 Advanced Engineering System (AdvES)

Using the AdvES, consulting engineers and planning offices as well as end customers can significantly reduce their configuration and commissioning costs while simultaneously improving the engineering quality.

The AdvES which can be called in the SIMATIC Manager from a SIMATIC PCS 7 project expands the functionality for plant configuration in cooperation with higher-level CAD/CAE planning tools. It acts as a link between standard engineering tools from the SIMATIC PCS 7 Engineering Toolset (CFC, HW Config, plant hierarchy) and tools for basic and detailed planning, e.g. EPlan, ELCAD or SmartPlant.
Data flow when using the Advanced Engineering System

AdvES uses various data import options in order to collect existing engineering data from the SIMATIC PCS 7 process control system and from process tag and signal lists in Microsoft Excel format and to prepare these for utilization in the SIMATIC PCS 7 engineering system.

Data from process tag and signal lists can be automatically imported into AdvES. Integrated change management supports the repeated importing of modified data from Microsoft Excel.

AdvES recognizes process tags in Excel lists after the first assignment, automatically assigns them to process tag types of any PCS 7 project library, and then generates the following data:

- PCS 7 process tag instances with signal and parameter settings
- Plant hierarchy (PH)
- Hardware configuration

Inconsistencies can be detected quickly by means of plausibility and data consistency checks, displayed in a log, and then eliminated in a targeted manner.

Manual processing functions for editing plant hierarchies and process tags as well as for interconnection of signals between process tags allow completion of the imported data. Special editors for mass data processing offload the project engineer from time-consuming routine work.

With the support of integrated design templates, the different table views of the AdvES data can also be displayed as reports and printed.
Engineering of intelligent field devices and field components using the SIMATIC PDM Process Device Manager

SIMATIC PDM (Process Device Manager) is a universal, vendor-independent tool for the configuration, parameterization, commissioning, diagnostics and servicing of intelligent field devices (sensors and actuators) and field components (remote I/Os, multiplexers, control room devices, compact controllers), which in the following sections will be referred to simply as devices. Using one software, SIMATIC PDM enables the processing of more than 2 500 devices from Siemens and over 200 vendors worldwide on one homogeneous GUI. Parameters and functions for all supported devices are displayed in a consistent and uniform fashion independent of their communications interface.

From the viewpoint of device integration, SIMATIC PDM is the most powerful open device manager available in the world. Devices which previously were not supported can be integrated in SIMATIC PDM at any time by simply importing their device descriptions (EDD). This provides security and saves investment, training and consequential costs.

Integrated into SIMATIC PCS 7 Asset Management, SIMATIC PDM provides more detailed information for all devices described by means of an Electronic Device Description (EDD), e.g.

- Detailed diagnostics information (manufacturer information, information on error diagnostics and troubleshooting, further documentation)
- Information on changes (audit trail report)
- Parameter information

Possible applications

- Integrated in the SIMATIC PCS 7 engineering system
  - SIMATIC PDM PCS 7
  - SIMATIC PDM PCS 7-FF with support for the FOUNDATION Fieldbus H1
- Stand-alone as a service tool on mobile PCs
  - SIMATIC PDM Single Point for one single field device (point-to-point coupling)
  - SIMATIC PDM Service for enhanced servicing

Core functions

- Adjustment and modification of device parameters
- Comparing (e.g. project and device data)
- Validation of data input
- Device identification and testing
- Device status indication (operating modes, alarms, states)
- Simulation
- Diagnostics (standard, detail)
- Export/import (parameter data, reports)
- Commissioning functions, e.g. measuring circuit tests of device data
- Device replacement (lifecycle management)
- Global and device-specific change log for user operations (audit trail)
- Device-specific calibration reports
- Graphic presentations of echo envelope trends, trend displays, valve diagnostics results etc.
- Document manager for integration of up to 10 multimedia files
Support of system management

SIMATIC PDM supports the operative system management in particular through:

- Uniform presentation and operation of devices
- Indicators for preventive maintenance and servicing
- Detection of changes in the project and device
- Increasing the operational reliability
- Reducing the investment, operating and maintenance costs
- Graded user privileges including password protection

Device Integration

SIMATIC PDM supports all devices described by EDD (Electronic Device Description). Based on EN 50391 and IEC 61804, EDD is the most widely used standardized technology for device integration. At the same time it is the directive of the established organizations for

- PROFIBUS (PNO: PROFIBUS user organization)
- HART (HCF: HART Communication Foundation)
- FF (Fieldbus Foundation)

The devices are integrated in SIMATIC PDM through a company-specific EDD, through the current HCF catalog, or through the current Fieldbus Foundation catalog. To achieve improved transparency, they can be managed in project-specific device catalogs.

PROFIBUS devices are described in the EDD in terms of functions and construction using the Electronic Device Description Language (EDDL). Using this description, SIMATIC PDM automatically creates its user interface with the specific device data. The range of devices of the catalog integrated in SIMATIC PDM can be updated and expanded simply by importing the manufacturer’s device-specific EDD.

Fieldbus Foundation provides pre-defined device descriptions (standard DD) for the basic functions of specific field device types. The basic functions are implemented using various standard function and transmission blocks.

User interface

Using SIMATIC PDM it is very easy to navigate in highly complex stations such as remote I/Os and even down to the connected field devices. The GUI satisfies the requirements of the VDI/VDE GMA 2187 and IEC 65/349/CD directives. Due to expansion of the EDDL, it is also possible to display image elements in an excellent manner. Even complex devices with several hundred parameters can be represented clearly and processed quickly.

SIMATIC PDM, parameter view and trend window

Communication

SIMATIC PDM supports several communication protocols and components for communicating with devices that have the following interfaces:

- PROFIBUS DPI/PA interface
- FF interface
- HART interface
- Modbus interface
- Special interface from Siemens

Routing

From the central engineering system of the SIMATIC PCS 7 process control system it is possible with SIMATIC PDM to reach every EDD-parameterizable device in the field plant-wide through the various bus systems and remote I/Os. SIMATIC PDM can thus perform the following from a central position:

- Read diagnostics information from the devices
- Modify device settings
- Adjust and calibrate devices
- Monitor process values
- Generate simulation values
- Reassign device parameters
Engineering System highlights

- Central hardware and software configuration which is uniform throughout the system through use of one engineering system
  - User-friendly GUI
  - Configurable modification reports
  - Parameterization of communication without complex configuring
  - Same configuration for redundant and non-redundant plants
  - Integrated configuration for field devices and safety-related applications

- Integral user administration with access control

- Central dialog for compilation and loading of all AS, OS and SIMATIC BATCH modifications
  - Optimization of all steps and summary in a dialog with execution check
  - Compilation and loading in one run with minimum turnaround times

- Online loading of selective configuration modifications into the corresponding system components

- Technology-oriented configuration without requiring special programming skills
  - Functional hierarchy with up to 8 levels, organized according to plants, units and technical equipment
  - Hardware-independent engineering: AS assignment and I/O modules can be subsequently selected
  - Area-oriented OS compilation and loading of the server-relevant data
  - Expandable on industry-specific basis using standard data exchange interfaces

- Process object view for display and processing of all aspects of process tags/objects
  - Convenient editing in tables
  - Project library with process tag types and import/export functions
  - Online mode for testing and commissioning of process tags and CFCs

- Shared configuration tasks: Concurrent Engineering or Multiproject Engineering with Branch & Merge

- Customized alarm configuration through free configuration of up to 8 group display fields

- Configuration-dependent hiding of alarms for specific operating states

- Configurable archive tags (archiving, long-term archiving, no archiving)

- Special SFC functionalities
  - SFC type: standardized sequential control for multiple use, application of SFC instances as block in the CFC
  - SFC for sequential controls for single use, also with chart I/Os
  - Status management conforming to ISA-88 for configuration of separate sequences for statuses such as HOLDING, ABORTING or SAFE STATE

- Advanced Process Control functions with integrated blocks and templates

- Reduction in engineering and validation overhead through:
  - Advanced Process Library with off-the-shelf function blocks, faceplates, icons, and process tag types
  - Process object view with import/export function for all aspects of process tags/process objects
  - Type-instance concept with central modification option for all instances
  - Advanced Engineering System for bulk engineering and data exchange with planning tools
  - Central updating of all block types used in a multi-project
  - Numerous automatic configuration steps (auto engineering)
  - Simple duplication of units by copying, renaming and compilation

- High-performance version management with version comparison and version history

- Identification of MIS/MES-relevant information for interfacing to SIMATIC IT

- Automatic generation of diagnostics displays for the maintenance station on the basis of the project data

- Implementation of digital production planning through integrated engineering workflow with Comos planning tools
Operator system

Safe and user-friendly process control with the SIMATIC PCS 7 Operator System

The operator system of the SIMATIC PCS 7 process control system permits user-friendly and secure execution of the process by the operating personnel. Operators can monitor the process sequence using various views, and intervene as necessary. The operator system architecture is extremely variable and can be flexibly adapted to different plant architectures and customer requirements.

The basis is formed by perfectly coordinated operator stations for single-user systems (OS Single Stations) and for multiple station systems with client/server architecture.

Operator stations

All operator stations are based on modern SIMATIC PCS 7 Industrial Workstations optimized for use as OS single station, OS client or OS server. SIMATIC PCS 7 Industrial Workstations are characterized by powerful industrial PC technology combined with the Microsoft Windows 7 Ultimate 64-bit or Server 2008 R2 Standard 64-bit operating system. They can be used in harsh industrial conditions as well as in the office area. Standard components and interfaces from the PC world offer generous scope for system-, customer- or sector-specific options and expansions.

The connection of as many as 4 process monitors via an optional multi-monitor graphics card permits the user-friendly control of multiple plant areas from a single operator station.

The system software of the operator stations can be expanded flexibly using cumulative SIMATIC PCS 7 OS Runtime licenses for 100, 1 000 and 5 000 process objects (POs) up to following configuration limits:

- 5 000 POs per OS Single Station
- 8 500 POs per OS Server (with client/server architecture)

Single-user system (OS single station)

In a single-user system architecture, all operator control and monitoring functions for a complete project (plant/unit) are concentrated in one station. This OS single station can be operated on the plant bus together with other single-user systems or in parallel with a multiple station system. Redundant operation of two OS single stations is also possible (SIMATIC PCS 7 Single Station Redundancy).

The OS single station can be connected to the Industrial Ethernet plant bus in two ways:

- CP 1613 A2/CP 1623 communication module for communication with a maximum of 64 automation systems of any type
- Simple 10/100/1000 Mbit/s Ethernet network card and Basic Communication Ethernet for communication with up to 8 automation systems (single stations)

Two 10/100/1000 Mbit/s Ethernet RJ45 ports are always integrated onboard for use as desired.

Multiple station system with client/server architecture

With a multi-user system, one or more OS Servers supply up to 32 operator stations (OS clients) with data (project data, process values, archives, and messages) via a terminal bus. The terminal bus can share the transmission medium with the plant bus or it can be designed as a separate bus (Ethernet with TCP/IP).

In this architecture, redundant OS servers may be set up to meet higher availability requirements. Critical applications are monitored by health check for software faults. If a fault is detected, switchover to the redundant system is triggered. Synchronization of the redundant OS servers takes place automatically and at high speed.
Operator system

Multiple station system with client/server architecture

OS clients can access the data of not only one OS server/server pair, but of several at the same time (multi-client mode). This makes it possible to divide a plant into technological units and to distribute the data accordingly to various OS servers/pairs of servers.

In addition to scalability, the advantage of distributed systems is the ability to decouple plant areas from each other, which results in higher availability.

SIMATIC PCS 7 supports multiple station systems with up to 12 servers or 12 redundant pairs of servers. In multi-client mode, OS clients can access data from one or more of the 12 servers/pairs of servers in parallel (up to 32 OS clients simultaneously can access all).

The OS servers are designed in addition with client functions which permit them to access the data (archives, messages, tags, variables) from the other OS servers of the multiple station system. This means that process graphics on one OS server can also be linked with variables on other OS servers (area-independent displays).

Like the OS single stations, the OS servers can be connected to the plant bus using a CP 1613 A2/CP 1623 communication module or a simple Ethernet network card. Two 10/100/1000 Mbit/s Ethernet RJ45 ports are integrated onboard and can be used for connecting to the terminal bus.

Performance

The SIMATIC PCS 7 Operator System is optimized for processing large quantities of data. It impresses by means of its simple and intuitive operation and its high performance – even with large quantity frameworks.

Many individual measures reduce the system load and improve the image selection and updating times, e.g.:

- Combination of status and analog values with alarm information into expanded status displays
- Suppression of nuisance alarms and triggering of renewed transmission via acknowledgment
- Data transmission from the automation system only following changes instead of with every cycle
- Blocking/enabling of messages for individual process tags or all tags of an area
- Hiding messages, depending on the operating state of the unit

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</table>

1) If every OS client has access to all OS servers/pairs of servers
OS software

Examples of OS process control, at top with freely-positionable windows

Graphical user interface (GUI)

The predefined GUI of the operator system has all the features typical of a control system. It is multilingual, clearly structured, ergonomic and easy to understand. Operators can survey the process extremely easily, and rapidly navigate between different views of the plant. The system supports them in this process with hierarchical display structures that can be configured as required. These facilitate the direct selection of lower-level areas during process control. The current position within the hierarchy can always be seen in a window of the Picture Tree Manager.

Mimic diagrams and process tags can also be called directly by their name, or by a “Loop-in-alarm” starting from a selected message. An online language selector permits the user to change the display language during runtime.

A standard view and a server view are available for the technological representation of a process cell, each with variously designed area overviews. Features provided in both views include:

- Message line for the last received message, configurable for priority-based display of message with highest message class or priority
- Date, time and name of the operator
- Area overview; number of displayed areas depends on resolution: up to 36 (lowest/XGA), up to 144 (highest/WQXGA)
- Working area for plant displays and movable windows for faceplates, trends, messages etc.
- System function keys

Based on this, the operator can combine and save individual image compositions, and recall them later.

The operator system software supports the representative functional display of the plant with a high-quality and modern design; depending on the versions of the graphics controller and process monitor, display is possible in:

- 4:3/5:4 formats with resolutions of 1024 x 768 to 1600 x 1200
- 16:9/16:10 panorama formats with resolutions of 1680 x 1050 to 2560 x 1600

The global appearance can be set using predefined or user-specific designs (color palette, colors, styles, optical effects, etc.). These central design settings can be changed locally for each picture object. In addition, the design can be fundamentally influenced using a wide range of attractive elements provided in the Engineering System for OS configuration:

- Object palettes with styles, controls, standard objects and smart objects
- Global symbol library with standardized display objects
- Symbols and faceplates of the Advanced Process Library
Trend Controls for table displays and trend displays

The Trend Controls function permits operators to display archived values of archive tags from the process value archive as well as online values of process tags from the tag management in relation to time (table/trend window) or in relation to another value (function window). The time can be defined statically or dynamically (in relation to the actual system time) as:

- Start and end times
- Start time and period
- Start time and number of measuring points

All Trend Controls have scrolling functions and a function for directly selecting the start or end.

During runtime, operators can individually adapt the Trend Controls functions which have already been predefined during plant configuration, and save the settings globally or user-specific. They are able to change the data link during runtime, and to access other data. It is also possible to integrate exported archive databases online.

The displayed data can be processed further by:

- Exporting per CSV file
- Output in a predefined print job

**Table window**

- Display of one or more process value columns in relation to a time column
- Each line displays the process values recorded at a particular time
- Several separate time/value relations can be combined in a table

**Trend window**

- One or more time axes correlate with one or more value axes (linear, logarithmic, percentage or freely-configurable scales)
- Freely-selectable number of displayed trends
- Individual configuration of styles and colors, possibly with value-dependent change in color
- Grid lines and rulers for improvement of readability
- Trends can be grouped in one window with common time and value axes
- Multiple trend windows can be linked for comparison purposes (common time axis, zoom, scroll bar and ruler)

**Function window**

- Display of process values in relation to other process values, e.g. pressure depending on temperature
- Fixed or dynamic value range with linear or logarithmic scaling for X and Y axes
- Displayed time range can be defined separately for each trend
- Optional consideration of setpoint trends from user archives
- Properties, functions and configuration options largely identical to trend window

A ruler window can display the following information for a time or time range selected by a ruler in the trend/table window:

- X and Y coordinates of the trend points at the points of intersection of the rulers
- Values in the selected range
- Statistical information on the selected range: minimum, maximum, average, standard deviation, integral
Operator system

AlarmControl function for message display and processing

Up to 150 000 messages can be configured per OS single station/OS server:

- Predefined system messages, triggered by a system event
- Individual or group messages, initiated by a change in process states
- Operator input messages, resulting from the manual operation of objects

The message system integrated in the operator system records these process messages and local events, saves them in message archives, and displays them in various standardized lists by means of the freely-configurable AlarmControl function (message window):

- Entered state list: currently present, unacknowledged messages
- Acknowledged list: currently present, acknowledged messages
- Exited state list: unacknowledged messages, but already exited
- Operator list: current and archived operator input messages
- Process control list: current and archived I&C messages
- Chronicle: all currently present and archived messages arranged in chronological order
- List of manually or automatically suppressed messages
- List of messages to be suppressed when they occur

The lists are provided with a scrolling function and can be selected by the operator in the toolbar.

Parallel to the display, all messages recorded during runtime and their changes in state can be documented in chronological order in a message sequence log.

Flexible setting options for audible output and priorities which can be defined using signal variables additionally support the signaling of messages through a sound card or by controlling external horns via a signal module.

Operators can individually adapt the AlarmControl function during runtime by filtering, selecting or sorting the display according to the contents of individual message blocks, e.g. chronologically according to message priority or fault location, and save the settings globally or user-specific. It is also possible to integrate exported archive databases online.

The displayed data can be processed further by:

- Exporting per CSV file
- Output in a predefined print job

After a power failure, the last messages can be reloaded from the message archive to the message window. Thus, when the system is restarted, the last message map prior to the power failure can be reconstructed.

In the case of large quantity structures with a high volume of messages, the following measures can improve transparency and perceptibly offload the operating personnel:

- Visual and audible hiding of messages which are of reduced importance in certain situations for the safe and fault-free operation of the plant, e.g. operating messages (logging and archiving are not influenced):
  - Dynamically, i.e. depending on preconfigured definition for up to 32 operating states (Smart Alarm Hiding)
  - Manually, for a limited period
- Assignment of priorities using up to 16 message priorities as additional attribute to the known message classes
- Intentional blocking and enabling of messages from an individual process tag or all process tags of the display/area by the operator in the event of faults on a sensor/actuator or during commissioning (recording of blocking and enabling in the operator activity log)

The "Loop-in-alarm" and "Select display using process tag" functions support the quick evaluation and elimination of faults. Using "Loop-in-alarm", the operator can jump directly from a message selected in the message window to the mimic diagram with the object which caused the fault, and can then call up the associated faceplate (loop display) through the process tag whose block symbol is colored (cyan). The faceplate window (loop display) can be anchored so that it remains visible even when the display is changed.

Group displays visually signal the messages currently present in the mimic diagram. They do not provide information on whether messages are disabled or not.

The last received message is displayed at the top of the standard view. Using the button "Extended message line", the AlarmControl function can be displayed as a window with all received messages. A list of all messages currently present with maximum priority 16 can also be directly called using a button.

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Operator system

Reporting and logging system

Whereas the reporting system is provided to document the project during its configuration, the logging system is used to print out the data recorded during operation in a clear manner. Different types of predefined logs are available:

- Message sequence log
- Message and archive log
- Measured value log
- Operator activity log
- System message log
- User log

However, a page layout editor can be used to create completely new page layouts or to individually adapt predefined ones. Log objects to be printed are simply selected from the editor’s object palette, positioned and configured.

The current data of the log defined in the page layout is output on the printer by means of a predefined or self-generated print job. Prior to output on the printer, the logs can be saved in EMF format and displayed as a preview on the screen. Print jobs can be started manually, time-driven or event-driven. Operators are able to scan the status of the print jobs online.

Archiving

The OS single stations and OS servers have an integral high-performance archiving system which can be configured during runtime and which is based on Microsoft SQL server technology. With this, process values and messages/events (alarms) can be temporarily recorded in circular archives. Data and OS reports can be transferred from this circular archive to an archive server for long-term archiving on a time-driven or event-driven basis.

Central user management, access protection and electronic signatures

With the integrated SIMATIC Logon, the operator system has central user administration with access control that complies with the validation requirements of 21 CFR Part 11. The administrator can divide the users into groups and assign differently defined access rights (roles) to these groups. The operator obtains the specific rights when logging on within the scope of the access control. Apart from the keyboard, an optional chip card reader, for example, can be used as the logon device.

SFC visualization

The SFC visualization function of the operator system enables display and operation of the sequential controls configured with the SFC editor in the same way as on the engineering system. This does not involve any extra configuration effort.

In an overview display it is possible, for example, to open step and transition displays and to present step comments or dynamically supplied step enabling conditions.

Sign-of-life monitoring

With the "Sign-of-life monitoring function", the operator system is able to monitor the correct operation of all subordinate systems connected to the plant bus. A graphical plant configuration display shows the status of each monitored component. Additional functionality in this respect is offered by the SIMATIC PCS 7 Maintenance Station.

Clock synchronization

Together with a SICLOCK time generator, the operator system of the SIMATIC PCS 7 process control system can implement system-wide synchronization on the basis of UTC (Universal Time Coordinated). This feature is especially beneficial for widely distributed plants present in different time zones, e.g. pipelines.
Operator system highlights

- Flexible, modular architecture with scalable hardware and software components for single-user and multiple station systems
- Powerful, rugged operator stations based on standard PC technology, that can be used in office and industrial environments
- OS single stations and OS servers that can also be configured as redundant pairs
- Client/server multiple station systems with up to 12 OS servers/pairs of servers, each for 8 500 POs and up to 32 OS clients per server/pair of servers
- User-friendly process control and high reliability with ergonomic graphical user interface
- Health check for important server applications
- Modification and copying of modifications without interrupting runtime operations, and online testing with selective loading of redundant servers
- Optimized AS/OS communication:
  - Data transmission only following change in data, independent of AS reply cycle
- Versatile, user-friendly controls for alarms and trends
- Variable, customer-oriented logging system
- User-friendly process control and high operational reliability
- Highly effective alarm management to offload operators
  - Assignment of priorities with up to 16 message priorities as additional attribute to the message classes
  - Visual and audible hiding of messages which are irrelevant depending on the operating state (dynamic or manual)
  - Suppression of alarms from a sensor/actuator during commissioning or in event of malfunction
- High-performance archiving system with circular archives and integral archive backup, that can be combined with a separate archive server for long-term archiving (Process Historian)
- Central user management, access control, electronic signature
- Sign-of-life monitoring for subordinate systems connected to the plant bus
- System-wide time synchronization based on Universal Time Coordinated (UTC)
Operating and monitoring via Internet/intranet

The SIMATIC PCS 7 process control system also supports global operator control and monitoring of a plant via Internet/intranet. Here the operator has access via the PCS 7 Web client to the project data provided by the PCS 7 Web server. The PCS 7 Web client uses Internet Explorer and plug-ins which can be installed via Internet/intranet.

The PCS 7 Web server uses the Web View Publisher to convert process displays and scripts into a form suitable for display with the Internet Explorer. It accesses project-specific process data in the lower-level OS servers using the mechanisms of a multi-client. The integrated OS user management guarantees a high degree of security here.

Using the PCS 7 Web client, the plant can be operated in the same manner as with a PCS 7 OS client. The operator must log on in the same way here, and the rules for assigning rights are also identical. The input operations made on the PCS 7 web client are recorded in the OS operating log.

Licensing

With regard to licensing, a distinction is made between the following constellations:

- **Standard**
  Up to 50 PCS 7 web clients access the data of a PCS 7 web server over intranet/Internet. The number of PCS 7 Web clients that have simultaneous access to the PCS 7 Web server is scalable with cumulative 1, 5 and 10 PCS 7 Web server licenses. In addition, the PCS 7 Web server requires a SIMATIC PCS 7 Web Server Basic license.

- **Diagnostics**
  One or only a few PCS 7 web clients have access to several PCS 7 web servers for remote operation, diagnostics or monitoring. Each system involved requires a PCS 7 Web diagnostics license (server/client).

Load balancing

If the project requires simultaneous operation of a large number of Web operator stations, several PCS 7 Web servers can also be configured and networked together. With the load balancing function, the load caused by the PCS 7 Web clients can be distributed evenly over the configured PCS 7 Web servers. This results at the same time in high availability of the PCS 7 Web clients. If a PCS 7 Web server fails, the PCS 7 Web clients assigned to it are automatically routed to one of the other participating PCS 7 Web servers. Load balancing can be used on up to 32 networked PCS 7 Web servers.

When operating and monitoring via the World Wide Web, the plant is exposed to diverse threats to IT security. To guarantee safe operation, suitable protective measures must thus be taken (you can find more information on this in the section “Industrial Security”).
Process data archiving and reporting

Process Historian and Information Server

Process values and messages, as well as batch data from SIMATIC BATCH, can be swapped out of the circular logs from the operator stations to the Process Historian on a time-driven or event-driven basis for long-term archiving.

The Process Historian is suitable for all plant sizes and can be scaled with the cumulative SIMATIC PCS 7 OS/PH archive licenses. The number of archivable single stations, servers or server pairs is unrestricted.

The process values and alarms managed in the database of the Process Historian on the OS clients and OS single stations can be visualized in a user-friendly and clear manner. Data selection is supported by integrated filter functions. Alarms and process values can be shown in table form, and process values also in graphic form. Tables of process values can be exported to CSV format for processing in other Windows applications, e.g. Microsoft Excel.

Methods of accessing the Process Historian data stock
Visualization of the data from the Process Historian database is supported by an additive reporting system, the Information Server. Based on the Microsoft Reporting Services, it allows Web-based thin-client access to the historical data. Add-ins for Microsoft Word and Excel offer additional methods of accessing the Process Historian database. The number of clients that have access to the Information Server can be defined and adapted with cumulative Client-Access licenses.

The data managed by the Process Historian can be transferred to commercially available storage media (backup/restore). The operating system of the Process Historian supports additional hardware and software for this purpose, e.g., a DVD burner with appropriate burner software.

Suitably, either the server version of the most powerful SIMATIC PCS 7 Industrial Workstation (IPC847C) or a Fujitsu Primergy Server is used for the Process Historian. A RAID 5 hard disk configuration with high data transfer rates is used for the database. An additional, separate hard disk must be provided for the operating system and the SIMATIC PCS 7 software.

The Information Server can be operated on the Process Historian hardware or on separate hardware. Any server or single station version of the SIMATIC PCS 7 Industrial Workstation is suitable for separate operation.

The Process Historian and Information Server do not need a connection to the plant bus. They can be connected to the OS and batch stations of the SIMATIC PCS 7 system via the terminal bus.

Both can run under the Windows Server 2008 R2 Standard 64-bit operating system, and the Information Server can also run on separate hardware under Windows 7 Ultimate 32/64-bit or Windows Server 2003 R2 Standard 32-bit.
Maintenance Station

Plant Asset Management with the Maintenance Station

The Maintenance Station supplements SIMATIC PCS 7 with a valuable instrument for minimizing the total cost of ownership of a plant.

If one considers the total maintenance involved in an enterprise then the Maintenance Station is focused on the area of Plant Asset Management. Asset management for plant engineering is the administration and management of plant equipment, particularly the I&C equipment, as well as all activities and measures that serve to retain or increase the value of a plant. This includes the following maintenance strategies:

- **Corrective maintenance:**
  - Response to existing fault and diagnostics messages
  - Failures are risked or minimized by redundant configurations
  - Maintenance in the form of a repair or replacement
- **Preventative maintenance:**
  - Preventative diagnostics and maintenance
  - Appropriate maintenance measures are initiated before a fault even occurs
  - Maintenance in the form of time-dependent or status-dependent maintenance (dependent on degree of wear)
- **Predictive maintenance:**
  - Predictive diagnostics for timely detection of potential problems and to determine the remaining service life.

While the plant operator obtains all relevant information that is necessary for focused intervention in a process via the operator system, maintenance and service personnel can check the hardware components of the automation system (assets) and process their diagnostic messages and maintenance requests using the Maintenance Station. For this the Maintenance Station offers access to:

- Components of the process control system: Intelligent field devices and I/O modules, fieldbus, controller, network components, and plant bus, as well as servers and clients of the operator systems
- Assets that do not belong directly to the process control system, such as pumps, motors, centrifuges, heat exchangers (mechanical assets) or control loops – represented by proxy objects in which the diagnostics rules are stored

Typical maintenance cycle

A typical maintenance cycle has the following actions:

- Monitoring the status of components/devices:
  - Recording of diagnostics information via network components and PC basic devices per OPC coupling
  - Intelligent sensors detect and signal impending failures long before the actual failure
- Signaling the “maintenance required” in a group display, in symbol displays of the affected components/devices, and in an alarm log
- Navigation to component/device requiring maintenance, and information on specific data such as measuring-point number, mounting location and device type
- Display of detailed diagnostic information (depending on device type and vendor), e.g.
  - Error description
  - Error cause
  - Trend statement
  - Operating instruction
- Evaluation, commenting and, if applicable, changing the priority of the maintenance requirement
- Initiation of a maintenance measure per maintenance request and tracking of execution; symbolic visualization of current status of maintenance measure
- Conclusion of maintenance measure; all status displays are reset to their normal state

All activities are documented on the maintenance station without gaps – automatically and without additional configuration overhead.
Architecture

For asset management, the Maintenance Station uses hardware and software components of the Engineering System (ES) and Operator System (OS). As a result of the close interlacing, ES, OS, and Asset Management functions execute on common hardware. Such a multi-functional station cannot only be used for asset management, but also for system engineering or HMI.

Depending on the project-specific SIMATIC PCS 7 architecture, the Maintenance Station can be implemented on the basis of a SIMATIC PCS 7 BOX, a Microbox (as stand-alone maintenance station), a SIMATIC PCS 7 Single Station, or a client/server combination. In client/server combinations, the Maintenance Station server can also have a redundant design. In this case, they must be configured like redundant OS servers.

Message system, GUI, picture hierarchy and operator prompting are oriented according to the HMI philosophy of the operator system. The diagnostics data of all assets are displayed on uniform faceplates whose functions and information depend on the components. This means that working with the Maintenance Station is simple and intuitive, complex familiarization is not required.

The diagnostics screens structured according to the process cell hierarchy with the operating states of the SIMATIC PCS 7 components can be displayed on the Maintenance Station and also on the OS clients. More detailed diagnostic information determined by SIMATIC PDM is also displayed on the faceplates of these stations. Enhanced online diagnostics functions in conjunction with HW Config can also be called from the Maintenance Station.

The user management and access control for the Maintenance Station is handled by SIMATIC Logon integrated in SIMATIC PCS 7.

Configuration

For asset management, the Maintenance Station uses the relevant data from the hardware and software project of the application which is generated during the standard configuration with the Engineering System. Simply by pressing a button, these data are derived with system support from the project data of the application, and the diagnostics screens are generated. The procedure is simple, and no additional overhead is required for configuration of the asset management:

- Generation of the hardware and software project of the application
- Configuring/parameter assignment of specific Maintenance Station functions and connections (optional)
- System-supported generation of the diagnostics screens with all components present in the project, including the picture hierarchy according to the project's hardware structure
- Compilation of the configuration data, and downloading to the operator station and Maintenance Station with subsequent test and commissioning phase.

The names of imported images, symbols, etc. can be permanently changed for further use in the maintenance project.

Conformity to international standards, specifications, and recommendations

Asset Management with the SIMATIC PCS 7 Maintenance Station conforms to international standards, specifications, and recommendations. It takes into account the NAMUR requirements (standardization association for measurement and control in chemical industries) defined for systems for asset management at plant level and for status messages from field devices:

- NAMUR recommendation NE91 (requirements for systems for Asset Management at plant level)
- NAMUR recommendation NE105 (requirements for the integration of fieldbus devices in engineering tools)
- NAMUR recommendation NE107 (status messages from field devices): "Device failure", "Maintenance required", "Function check"

In addition, it follows the IEC 61804-2 for describing devices by means of the Electronic Device Description Language (EDDL) and specifications made by the PROFIBUS & PROFINET International (PI) organization, e.g.:

- PROFIBUS Profile Guidelines Identification & Maintenance Functions
- PROFIBUS PA Profile for Process Control Devices
Asset Management function characteristics

As the system interface to the maintenance engineer, the Maintenance Station provides integrated maintenance functions and information.

Standard diagnostics functions
Starting from the overview display, the maintenance engineer can navigate to the diagnostics screens of the subordinate hardware levels in order to obtain information on the diagnostics status of individual plant areas or components. If a fault is signaled in the overview display, the "loop in alarm" function permits rapid switching to the diagnostics faceplate of the associated component. The information is filtered according to the area of responsibility of the user.

The following information can be displayed if applicable:

- Diagnostics status determined by the system
- Information on the component, such as process tag name, manufacturer or serial number
- Diagnostics messages of a component
- Detailed diagnostics information of a component
- Enabling of maintenance measure by the process operator
- Type and current status of initiated maintenance measure

Information on mechanical assets
A function block acting as a proxy for mechanical assets without self-diagnostics (pumps, motors, etc.) can determine impermissible operating states from different measured values and their deviations from a defined normal status. These are then displayed as a maintenance alarm. This function block is also suitable for implementing individual diagnostics structures, project-specific diagnostics rules, and condition monitoring functions.

In addition to this, individual asset management blocks are available with which maintenance engineers can monitor plant components such as pumps, heat exchangers or control valves. An example of this is the PumpMon function block with faceplates for monitoring and analysis of centrifugal pumps. The Premium Service "Asset Management" additionally provides comprehensive consulting for maintenance engineers and support during commissioning.

Extended information for assets according to IEC 61804-2
Additional information can be called for assets described by the electronic device description (EDD) according to IEC 61804-2. This information is automatically read out of the components and made available by SIMATIC PDM in the background.

- Detailed diagnostics information
  - Device-specific information from the vendor
  - Information on fault diagnostics and troubleshooting
  - Additional documentation
- Results of internal condition monitoring functions
- Status information (e.g. local operation, local configuration changes)
- Display of modification logbook (audit trail) of the component with all entries on the persons, times and types of operator intervention on the component
- Parameter view of the assets (display of parameters saved in the component and in the project; if required, also differences between them)
Visualization of the maintenance information

The hierarchical structuring of information and the uniform symbols support the overview, facilitate orientation, and permit the maintenance engineer to rapidly access detailed information starting from the plant overview. The symbol set defined for asset management with the SIMATIC PCS 7 Maintenance Station contains symbols which identify the diagnostics status of the devices/components, the relevance of the maintenance request, and the status of the maintenance measure. Group displays in the plant overview visualize the diagnostics status of the subordinate structures/components according to a type of traffic light with red, yellow or green.

Diagnostics screens represent the status of components and subordinate devices/components through standardized symbols. These contain the following elements:

- Bitmap of component
- Tag identification of component
- Maintenance state display
- Group display for diagnostics status of subordinate components

Clicking an element in the symbol display either opens the subordinate hierarchy level or a component faceplate. The component faceplate offers various views of the associated component with additional device-specific information, e.g. an identification, message or maintenance view.

Information management

With the following functions, the maintenance engineer can forward classified information quickly and simply, access project-specific information databases, or request maintenance measures:

- Export of identity data (electronic rating plate) and associated diagnostics status for devices/components determined by filter (total export)
- Export of all the relevant information of a component (including the action defined in the project for the maintenance measure) to defined destinations, e.g. mail system, printer or pager (single export)

Asset Management highlights

- Instrument for minimization of the total cost of ownership for the complete lifecycle of the plant
- Diagnostics and maintenance management for the components of the process control system and for mechanical assets such as pumps, motors or heat exchangers
- Maintenance station as system interface for maintenance engineer
- Uniform display of diagnostics and maintenance status throughout the plant
- Automatically generated overview of ID data with firmware and software versions for planning upgrades
- Function block for mechanical assets, individual diagnostics, and condition monitoring functions
- Additive blocks for plant components (pumps, heat exchangers, control valves, etc.) as well as Premium Service for consulting and maintenance support
- Recording of changes in configurations and parameters of EDD-based devices in the change log
- Generation of overviews on diagnostics statuses
- Integration of internal and external applications for special diagnostics and additional information
- Consideration of international standards and directives
Automation systems
Scalable performance for every requirement

The SIMATIC PCS 7 process control system offers a wide range of automation systems whose performances are finely matched to one another within wide limits. The range encompasses the three different designs shown above.

SIMATIC PCS 7 AS RTX Microbox
automation system with software controller

The SIMATIC PCS 7 AS RTX represents the starter system for the low to mid-performance range of SIMATIC PCS 7. As a result of its exceptional physical properties and small dimensions, it is particularly suitable for small applications and for use at the plant level.

The compact and rugged automation system based on the SIMATIC Microbox PC 427C has been designed for maintenance-free 24-hour continuous operation at ambient temperatures up to 55 °C. Since there are no fans or rotating storage media, it is resistant to vibration and shock.

The SIMATIC PCS 7 AS RTX is supplied with an AS Runtime license for 100 POs (expandable up to 2 000 POs). The Windows XP Embedded 2009 operating system, the WinAC RTX controller software, and the SIMATIC IPC DiagMonitor diagnostics software are pre-installed on a 4 GB CompactFlash card. The system is configured using the SIMATIC PCS 7 Engineering System.

ET 200 remote I/O systems with connected sensors/actuators and field devices/process devices on PROFIBUS DP/PA can be connected over a PROFIBUS DP interface which also supports routing. Two 10/100/1000 Mbit/s Ethernet RJ45 interfaces allow integration into a SIMATIC PCS 7 plant bus.

Parameterizable monitoring functions for program execution/watchdog, processor and board temperatures, as well as enhanced diagnostics/alarms (e.g. runtime meter, system status) can be recorded and evaluated via SIMATIC IPC DiagMonitor and PCS 7 Maintenance Station or signaled by LED.

SIMATIC PCS 7 AS mEC RTX Embedded automation system with software controller

The SIMATIC PCS 7 AS mEC RTX is a rugged, fan-free automation system in S7-300 format. Its special feature is centralized expandability by means of adding up to 8 I/O modules from the S7-300 I/O range on the same mounting rail. This merges the controller and I/Os into a low-cost compact unit that can be used preferably in small applications and as an OEM product, e.g. in package units.

The SIMATIC PCS 7 AS mEC RTX can be connected to the SIMATIC PCS 7 plant bus via a 10/100/1000 Mbit/s Ethernet interface.

The SIMATIC PCS 7 AS mEC RTX can be fully integrated into SIMATIC PCS 7 and is configured using the SIMATIC PCS 7 Engineering System. It includes an AS Runtime license for 100 POs that can be expanded with additional cumulative AS Runtime licenses up to a maximum of 2 000 POs. The Windows XP Embedded 2009 operating system and the WinAC RTX controller software are pre-installed on a CompactFlash card. Since SIMATIC PCS 7 AS mEC RTX and SIMATIC PCS 7 AS RTX use the same controller software, and both have a similar performance level.

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Modular automation systems of the SIMATIC S7-400 range with hardware controller

The automation systems are extremely rugged, and are characterized by high processing and communications performance. With consideration of the price/performance ratio, selected components of the SIMATIC S7-400 are combined in bundles depending on the task. These “AS bundles” are available in two versions:

- Individual components bundled per system in one delivery
- Preassembled and tested all-in-one systems (no extra charge compared to delivery of individual components)

They are configured by selecting predefined ordering units. Depending on the configuration as Single Station or Redundant Station, an AS bundle is equipped with the following components:

- Rack with 9 or 18 slots
- SIMATIC S7-400 CPUs, RAM from 1 to 32 MB
- 24 V DC or 120/230 V AC power supplies
- Memory cards with 1 to 64 MB RAM
- Industrial Ethernet and PROFINET interfaces for plant bus
- Additive PROFIBUS communications modules
- Sync modules for a range up to 10 m or 10 km, and 2 fiber-optic Sync cables

Each AS bundle is combined with a SIMATIC PCS 7 AS Runtime license for 100 process objects (PO). The number of POs can be extended with cumulative Runtime licenses for 100, 1000 or 10000 POs.

Up to 8 PROFIBUS interfaces (single or redundant) can be configured for an automation system. By default the CPU of the automation systems comes with an onboard PROFBUS DP fieldbus connection. Depending on the type of CPU, 1 or 2 further PROFIBUS DP interfaces are possible using additive IF 964 DP interface modules. PROFIBUS communications cards can be additionally fitted if required.

The AS firmware can be updated by means of a Flash EPROM memory card or from the central Engineering System via the plant bus.

The following characteristics make the SIMATIC S7-400 predestined for use as a SIMATIC PCS 7 automation system:

- Modular, fan-free design
- Extremely rugged and expandable
- Single and redundant versions
- Comprehensive communication facilities
- Integrated system functions
- Integratable safety functions (Safety Integrated)
- Simple linking of central or distributed I/O
- PROFINET support

In accordance with their functionalities, the modular automation systems of the S7-400 range can be classified into

- Standard automation systems
- Fault-tolerant automation systems
- Safety-related automation systems

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Typical mixed configuration limits for SIMATIC PCS 7 automation systems, based on the SIMATIC PCS 7 Advanced Library
Standard automation systems
The AS 414 automation systems are low-cost, modular and scalable systems for applications with relatively small configuration demands.

Larger configuration limits are possible with the AS 416 and AS 417 automation systems, and are mainly used with medium and larger plant sizes.

In the AS 414-3IE and AS 416-3IE automation systems, the Industrial Ethernet interface is integrated in the CPU. They differ from the AS 414-3 and AS 416-3 with Industrial Ethernet CP 443-1 in terms of time synchronization (NTP instead of S7 synchronization).

If two separate power supply systems are used for supplying the plant, the availability of the standard automation systems can be increased by using two redundant power supplies.

Fault-tolerant automation systems
Fault-tolerant automation systems are used to reduce the risk of production failures. The higher investment costs are frequently negligible compared to the costs resulting from production failures. The higher the costs of a production failure, the more worthwhile it is to use a fault-tolerant system.

The innovated V6.0 controllers offer higher achievable configuration limits, as well as increased computing power and communications resources. Integrated Ethernet interfaces also help to improve the price-performance ratio. In addition, expansion of the range with the AS 416H also results in more favorable performance grading within the fault-tolerant automation systems.

Fault-tolerant SIMATIC PCS 7 automation systems can be used on their own or together with standard and safety-related automation systems. In accordance with their basic design, they can be distinguished as:

• Single Stations with only one CPU
• Redundancy Stations with two redundant CPUs
The two redundant and electrically isolated subsystems of the Redundancy Station can be mounted on one compact rack with divided backplane bus or on two separate racks. The design with two racks allows physical separation of the redundant subsystems over a distance of up to 10 km, e.g. separated by a fireproof partition. As a result of the electrical isolation, the system is insensitive to electromagnetic interferences.

The use of a fault-tolerant single station instead of a standard automation system provides the option for a redundant configuration at a later date.

A particular characteristic of the fault-tolerant SIMATIC PCS 7 automation systems is the flexible and scalable availability of various modules.

When planning a system, it is even possible with a Single Station to increase the availability at a specific point by means of redundant configuration of the power supply, or for the Industrial Ethernet communication module, and to combine these measures.

The Redundancy Station with its two redundant CPUs already offers a higher level of availability. It operates according to the 1-out-of-2 principle, where a switchover is made from the active subsystem to the standby subsystem in the event of a fault. Based on this, as with the Single Station the power supply or the Industrial Ethernet communication module can be doubled for each subsystem, and these measures can be combined.

Safety-related automation systems
Safety-related automation systems are used for critical applications in which an incident can cause danger to personnel, plant damage, or environmental pollution. These F/FH systems collaborate with safety-related F modules of the ET 200 distributed I/O systems or fail-safe transmitters connected directly via the fieldbus to detect not only faults in the process, but also their own, internal faults. They automatically bring the plant into a safe state in the event of a fault.
The safety-related automation systems are TÜV-certified and comply with the safety requirements up to SIL 3 in accordance with IEC 61508. They are based on the hardware of the redundancy stations that has been expanded by safety functions by means of S7 F systems.

Analogous to the basic systems, two versions can be distinguished:

- Single stations with one CPU, safety-related
- Redundancy stations with two redundant CPUs, safety-related and fault-tolerant

As a result of a redundant design of the power supply or of the Industrial Ethernet interfaces, the availability of the safety-related Single/Redundancy Stations can be increased flexibly as with the fault-tolerant automation systems on which they are based.

In the multitasking systems, several programs can run simultaneously in one CPU, Basic Process Control System (BPCS) applications as well as safety-related applications. The programs are reaction-free, this means that faults in BPCS applications have no effect on safety-related applications, and vice versa. Special tasks with very short response times can also be implemented.

With parallel processing of BPCS and safety functions in one CPU, mutual interference is prevented by ensuring the BPCS programs and the safety-related programs are kept strictly separate and the data exchange is by means of special conversion function blocks. The safety functions are processed twice in different processor sections of the CPU by means of redundant, diverse instruction processing. Potential errors are detected by the system during the subsequent comparison of results.

Safety programs executed on different F/FH systems of a plant are also able to carry out safety-related communication with one another over the Industrial Ethernet plant bus.

The redundancy of the FH systems is only used to increase the availability. It is not relevant for processing the safety functions or for the fault detection associated with this.

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### Highlights of the automation systems

**SIMATIC PCS 7 AS RTX Microbox automation system with software controller**
- Compact and rugged system for use at plant level
- Resistant to vibration and shock since there are no fans or rotating storage media
- Maintenance-free 24/7 operation at ambient temperatures up to 55 °C

**SIMATIC PCS 7 AS mEC RTX embedded automation system with software controller**
- Compact system in S7-300 format for small applications and package units
- Centrally expandable thanks to the direct addition of up to 8 S7-300 I/O modules

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**Modular automation systems of the SIMATIC S7-400 range with hardware controller**

- Individually configurable AS bundles, available as:
  - Individual components bundled per station in one delivery
  - Pre-assembled and tested systems

- Flexible and scalable availability:
  - Standard systems as Single Station, optionally with redundant power supply
  - Fault-tolerant systems as Single/Redundancy Station, optionally with redundant power supply and/or redundant Industrial Ethernet communication for each system/subsystem
  - Safety-related systems as Single/Redundancy Station, optionally with redundant power supply and/or redundant Industrial Ethernet communication for each system/subsystem

- Redundancy Station with two electrically isolated sub-systems:
  - One or two racks separated by up to 10 km
  - Simultaneous (synchronous) processing of identical user programs in the two CPUs
  - Bumpless switchover

- Changes to the configuration during operation
Communication

Fast and reliable communication with Industrial Ethernet for plant bus and terminal bus

SIMATIC NET

Through application of SIMATIC NET network components based on globally established standards, SIMATIC PCS 7 is provided with a powerful and rugged range of products for implementing integrated communications networks for reliable data exchange between the system components in different levels of a plant.

The SIMATIC NET products specially developed for industrial applications provide optimum suitability for plants in all sectors. They are matched to one another and meet the highest standards, especially in areas where they are subject to extreme influences, such as:

- Electromagnetic interference fields
- Corrosive liquids and atmospheres
- Explosion hazards
- High mechanical loads

The SIMATIC NET products ensure expandability and the protection of investments due to compatible further developments, as well as integration from inbound logistics to outbound logistics and from field devices up to the management information system.

Industrial Ethernet

The plant bus and the terminal bus for multiple station systems with client/server architecture are implemented with Industrial Ethernet, a powerful area and cell network for industrial applications in line with the international IEEE 802.3 standard (Ethernet).

In the various SIMATIC PCS 7 subsystems (ES, OS, AS, etc.), onboard interface modules, simple network cards or special communications processors (CP 1613 A2/CP 1623) are used as communication interfaces. For small systems, the "Basic Communication Ethernet" integrated in the SIMATIC PCS 7 Industrial Workstations permits economical operation of single stations and servers on the plant bus with simple network cards.

In medium and large plants characterized by high requirements, SIMATIC PCS 7 relies on powerful CP 1613 A2/CP 1623 communication modules as well as modern Gigabit and FastEthernet technology which combines the high security provided by optical rings with the scalable performance provided by switching technology and high transmission rates up to 1 Gbit/s.

<table>
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<tr>
<th>Technical specifications for Industrial Ethernet</th>
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<tbody>
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<td>Number of switches</td>
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<td>Length of the network</td>
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<td>- Local network</td>
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<td>- WAN</td>
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<tr>
<td>Topology</td>
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Industrial Ethernet Switches / Industrial Wireless LAN

Industrial Ethernet switches

The communication nodes are integrated into the bus using Industrial Ethernet switches. The Industrial Ethernet switches from the SCALANCE X family are particularly suitable for this and offer scalable performance at an attractive price while supporting versatile configuration possibilities.

A multi-faceted range of products from the SCALANCE X product lines SCALANCE X-200, X-200 IRT, X-300 and X-400 is authorized for SIMATIC PCS 7. The number of ports, and levels of modularity, flexibility and functionality increase with ascending type number. While the switches of the SCALANCE X-200 and X-200 IRT product lines are only equipped with Fast Ethernet ports for data rates up to 100 Mbit/s, switches from the SCALANCE X-300 and X-400 product lines are mainly equipped with Gigabit Ethernet ports. The designs vary even within one product line: Compact and flat design on X-200/ X-200 IRT, as well as compact and rack design on X-300.

Ring topologies are preferred for the plant bus and terminal bus thanks to their high availability. An additional benefit of optical rings is their electromagnetic compatibility.

Redundant ring topology

If availability requirements are particularly high, it is possible to distribute the communication on two redundant rings:

- With the terminal bus, the two rings are connected together by 2 pairs of SCALANCE X switches. Switches from the SCALANCE X-400, X-300 and X-200 IRT product lines have the "standby functionality" necessary for this. Each of the redundant servers and clients can be connected to both rings via two separate interface modules (redundant terminal bus adapter package).
- With the plant bus, the two rings are physically separate. One switch in each case takes over the function of the redundancy manager for each ring. The current switches from the SCALANCE X-400, X-300, X-200 IRT and X-200 product lines (except X208PRO) can be used as redundancy manager. The link partners connected to the two rings by means of two CPs per AS CPU and OS server are linked together logically when configuring with NetPro by using a fault-tolerant S7 connection (4-way redundancy).

Industrial Wireless LAN (IWLAN)

SIMATIC PCS 7 offers the option of integrating mobile or stationary remote clients into the terminal bus. This is handled via Industrial Wireless LAN (IWLAN) access points, SCALANCE W784 (in the control cabinet), W786 (outdoors), or W788 (indoors).

Mobile remote clients (e.g. notebooks) can communicate with the IWLAN access point using a WLAN interface module, and stationary remote clients in a desktop/tower housing (SIMATIC PCS 7 Industrial Workstations) can communicate using a SCALANCE W740 IWLAN client module.

The following applications can then be implemented:

- Use of additional remote OS clients (1 or 2 on IWLAN)
- Linking of web clients to a PCS 7 Web Server (up to 2 on IWLAN)
- Remote access to an engineering station using the "RealVNC" software (Enterprise Edition), e.g. during commissioning.

All components used are very rugged, apply state-of-the-art authentication and encryption procedures, and guarantee high reliability of the radio channel.

SCALANCE W740 Ethernet client module for indoor use
PROFINET – The Industrial Ethernet standard for automation

PROFINET, based on the international standards IEC 61158 and IEC 61784, is being introduced to the process control system with SIMATIC PCS 7 V8.0. PROFINET unites the benefits of the Ethernet open network standard with the PROFIBUS fieldbus system. It stands for maximum transparency, open IT communication, network security and real-time communication down to the field level. This makes PROFINET the ideal basis for a uniform automation network in the plant, into which existing fieldbuses implemented with PROFIBUS can be easily integrated.

When configuring PROFINET communication, it is generally recommended that the field communication should be separated from the plant communication. In the context of the SIMATIC PCS 7 process control system, the application of PROFINET mainly focuses on the field communication between the automation systems (controllers) and the process I/O.

The modular automation systems of the S7-400 series and the ET200M remote I/O stations can be networked simply and effectively via PROFINET. A wide variety of network configurations can be implemented in the field, based on line, star, tree and ring topologies. Design versions with ring topology achieve maximum availability. It is insignificant here whether networking is carried out via SCALANCE X switches or direct via the PROFINET interfaces of the automation system and remote I/O station. Media redundancy of the ring means that bus interruptions or failure of a node will not result in failure of the entire segment.

The automation systems can be integrated into the CPU via a PROFINET interface, or into PROFINET via a CP 443-1 communications processor. The ET 200M remote I/O stations can be integrated via an IM153-4PN High Feature interface module. Different Industrial Ethernet products such as SCALANCE X switches and media converters, FastConnect connection elements, electrical and optical transmission media can be used as network components.

The fieldbuses PROFIBUS DP/PA or FOUNDATION Fieldbus H1 can be integrated into the CPU automation system via a CP 443-5 communications processor or a PROFINIBUS DP interface, and moreover the fieldbuses PROFIBUS DP/PA can also be integrated via IE/PB Link PN IO.
Typical PROFINET configurations with AS single station

Networking the PROFINET stations via SCALANCE X switches

Direct networking of the PROFINET stations via integrated interfaces

Typical PROFINET configurations with AS redundancy station

PROFINET ring configuration with AS redundancy station
Fast and rugged fieldbus communication

Distributed peripherals such as remote I/O stations with their I/O modules, transmitters, drives, valves or operator terminals communicate with the automation systems at field level through a powerful real-time bus system. This field communication is characterized by:

- Cyclic transmission of process data
- Acyclic transfer of alarms, parameters and diagnostics data

The universal PROFIBUS has proven itself as a rugged and reliable communication medium at field level. Based on the IEC 61158 and IEC 61784 standards, it can cover all requirements of the production and process industries using complementary transmission technologies, a uniform communication profile, and additive application profiles for typical device functions, e.g. PA Devices, PROFIdrive, PROFIsafe or PROFIenergy.

PROFIBUS DP

PROFIBUS DP is designed to provide high data transmission rates (up to 12 Mbit/s) and short response times (up to 1 ms) and is at the same time:

- Communication medium for data transmission between automation systems (controllers) and distributed I/O devices of the ET 200 series (remote I/Os), as well as field/process devices, drives, analyzers, CPUs/CPs, operator panels etc. that have a PROFIBUS DP interface.
- Integrator for the PROFIBUS PA fieldbus and FOUNDATION Fieldbus H1 which are typical in the process industry

Since PROFIBUS DP supports the HART protocol, it is also possible to integrate HART field devices into the PROFIBUS DP communication via HART remote I/Os.

The PROFIBUS DP is available for electrical or optical transmission:

- RS 485
  Simple and low-cost electrical transmission technology based on shielded two-wire cable
- Fiber-optic
  Optical transmission system with glass or plastic fiber-optic cables, for fast transmission of large quantities of data in environments with high interferences or for covering long distances

With the aid of the fieldbus isolating transformer (RS 485-iS coupler) and the RS 485-iS electrical transmission technology, PROFIBUS DP can also be run as an intrinsically-safe fieldbus in all environments up to hazardous zone 1 or 21.
PROFIBUS PA and FOUNDATION Fieldbus H1

The direct connection of transmitters and actuators including power supply via the communication medium, as well as detailed diagnostics, are particularly relevant to the automation of industrial processes that frequently take place in corrosive, harmful, and hazardous environments.

Both the PROFIBUS PA fieldbus and the FOUNDATION Fieldbus H1 (FF H1) meet these requirements. Both fieldbuses are optimally suitable for directing integrating actuators and sensors in operating environments up to hazardous zone 1/21 or 0 into the process system. The intrinsically-safe transmission technology MBP (Manchester Coded; Bus Powered) provides the power supply to the field devices as well as digital data transmission with a constant transfer rate of 31.25 kbit/s over a two-wire cable.

The physical bus systems of PROFIBUS PA and FF H1 are largely identical in accordance with IEC 61158. Both can be integrated seamlessly in the SIMATIC PCS 7 process control system using PROFIBUS DP as link. PROFIBUS PA and FOUNDATION Fieldbus H1 thus profit equally from the higher-level PROFIBUS DP architecture. SIMATIC PCS 7 customers are therefore not limited to a specific fieldbus but can select this freely matching the optimum field instrumentation.

### Technical data

<table>
<thead>
<tr>
<th></th>
<th>PROFIBUS DP</th>
<th>FOUNDATION Fieldbus H1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data transmission</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RS 485</td>
<td>RS 485-iS</td>
<td>Fiber-optic</td>
</tr>
<tr>
<td>Transfer rate</td>
<td>9.6 kbit/s... 12 Mbit/s</td>
<td>9.6 kbit/s... 1.5 Mbit/s</td>
</tr>
<tr>
<td></td>
<td>Two-wire shielded</td>
<td>Two-wire shielded</td>
</tr>
<tr>
<td>Type of protection</td>
<td>EEx(ib)</td>
<td></td>
</tr>
<tr>
<td>Topology</td>
<td>Line, tree</td>
<td>Line, Ring, star, linear</td>
</tr>
<tr>
<td>Nodes per segment</td>
<td>32</td>
<td>32 1)</td>
</tr>
<tr>
<td></td>
<td>126</td>
<td></td>
</tr>
<tr>
<td></td>
<td>126</td>
<td></td>
</tr>
<tr>
<td></td>
<td>126</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 m at 12 Mbit/s</td>
<td>200 m at 1.5 Mbit/s 1)</td>
</tr>
<tr>
<td></td>
<td>1000 m at 500 kbit/s 1)</td>
<td>400 m at 1.5 Mbit/s 1)</td>
</tr>
<tr>
<td>Repeater for signal boosting with RS 485 networks</td>
<td>Max. 9</td>
<td>Max. 9 1)</td>
</tr>
</tbody>
</table>

1) Conforming to PROFIBUS installation guideline 2.262

<table>
<thead>
<tr>
<th></th>
<th>PROFIBUS PA</th>
<th>FOUNDATION Fieldbus H1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data transmission</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MBP</td>
<td>MBP</td>
<td></td>
</tr>
<tr>
<td>Transfer rate</td>
<td>31.25 kbit/s</td>
<td>31.25 kbit/s</td>
</tr>
<tr>
<td>Cable</td>
<td>Two-wire shielded</td>
<td>Two-wire shielded</td>
</tr>
<tr>
<td>Type of protection</td>
<td>EEx(ia/ib)</td>
<td>EEx(ia/ib)</td>
</tr>
<tr>
<td>Topology</td>
<td>Linear, tree, ring</td>
<td>Linear, tree, ring</td>
</tr>
<tr>
<td>Safety Integrated</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Control in the field</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Interoperability</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Field devices per segment/coupler</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>Field devices per link</td>
<td>64</td>
<td>31</td>
</tr>
<tr>
<td>Active field distributor per segment/coupler</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>- AFD</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>- AFDiS or AFDiSs combined</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. total current consumption of all field devices</td>
<td>1 A</td>
<td>1 A</td>
</tr>
<tr>
<td>Cable length per segment depending on transfer rate</td>
<td>1 900 m: standard</td>
<td>1 900 m: EEx(ib)</td>
</tr>
<tr>
<td></td>
<td>1 000 m: EEx(ia)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 900 m</td>
<td></td>
</tr>
</tbody>
</table>
Fieldbus architectures

With the displayed fieldbus architectures, the network transition from PROFIBUS PA or FF H1 to PROFIBUS DP is via a link (PA link/FF link) which is equipped with one or two couplers.

A maximum of 5 bus segments can be operated via individual couplers on a PA link which can be equipped with up to 5 couplers (max. 3 for mixed configurations with ring or with coupler redundancy). Only 1 bus segment can be operated on the FF link which can be equipped with 2 couplers, independent of the configuration.

As a result of the identical physical bus systems, the same active field distributors can be used for PROFIBUS PA and FF H1: AFS (active field splitter), AFD (active field distributor) for Ex-Zone 2/22 and AFDiS (active field distributor intrinsically safe) for Ex-Zone 1/21 and 2/22.

Linear architectures with single couplers
The field devices are integrated in a line segment via up to 8/5 active field distributors AFD/AFDiS. Connection to these field distributors is made via short-circuit-proof spur lines. In contrast to AFD, the spur line lengths with AFDiS are independent of the total number of spur lines in the bus segment and need not be taken into account for the total length of the bus segment. The line segment can be connected to a single or redundant PROFIBUS DP via a link. The last AFD/AFDiS at the end of the line leading away from the link automatically activates its bus terminating resistor.

Linear architectures with redundant couplers
The active field splitter AFS is connected with a redundant coupler pair (2 x FDC 157) in the link. It interconnects a line segment with the respective active coupler. A coupler can be replaced during operation. The field devices are integrated in the line segment as described in the section "Line architecture with single coupler".

Ring architecture with coupler and media redundancy
Maximum availability can be achieved with a ring segment that is created by means of a redundant coupler pair (2 x FDC 157) in the link. Up to 8/5 active field distributors AFD/AFDiS integrate the FF field devices into this ring segment via short-circuit-proof spur lines. The bus is terminated automatically and is immediately adapted in the event of changes or faults on the bus. An extension on the fieldbus or replacement of a coupler during operation is possible.

Advantages of the ring architecture
- Maximum availability avoids unplanned plant downtimes
- Simple and safe installation
- Automatic termination
- Automatic, bumpless isolation of faulty subsegments
- Topology can be repaired or expanded during ongoing operation

<table>
<thead>
<tr>
<th>Max. spur line length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of spur lines per bus segment (1 device per spur line)</td>
</tr>
<tr>
<td>Non-intrinsically-safe devices</td>
</tr>
<tr>
<td>1 through 31</td>
</tr>
<tr>
<td>13 ... 14</td>
</tr>
<tr>
<td>15 ... 18</td>
</tr>
<tr>
<td>19 ... 24</td>
</tr>
<tr>
<td>25 ... 31</td>
</tr>
</tbody>
</table>
SIMATIC PCS 7 offers a variety of options for detecting and outputting process signals via sensors and actuators as well as for connecting process I/O to the automation systems:

- ET 200 remote I/O stations with an extensive range of cost-effective signal and function modules on PROFIBUS DP
- ET 200M remote I/O stations on PROFINET
- Intelligent, distributed field/process devices and operator terminals direct on PROFIBUS DP, PROFIBUS PA or FOUNDATION Fieldbus H1, also redundant or in hazardous areas of Zones 0, 1, 2 or 20, 21, 22
- Analog and digital I/O modules of the SIMATIC S7-400 operated centrally in the automation system

In practice, automation in the field area is largely characterized by distributed process I/Os:

- ET 200 remote I/Os in conjunction with classic field/process devices and HART field devices
- Intelligent field/process devices for direct fieldbus connection

In addition to the wide technical bandwidth, the following properties characterize the distributed process I/Os:

- Modularity and uniformity
- Flexible adaptability to the plant structure
- Minimum cabling and engineering requirements
- Low commissioning, servicing and lifecycle costs

S7-400 signal modules that can be operated centrally in the automation system are an alternative to distributed I/Os for small applications or plants with limited distributed expansion.

Standard process I/Os for SIMATIC PCS 7

The following standard process I/Os are recommended for the SIMATIC PCS 7 process control system for automation in the field area:

- ET 200M distributed I/O system
- ET 200iSP distributed I/O system
- ET 200S distributed I/O system
- ET 200pro distributed I/O system
- PROFIBUS PA devices with PA profile 3.0 or later

Further process I/O can be integrated into SIMATIC PCS 7 with standard blocks from the Advanced Process Library or special add-on blocks. Examples of this are devices of drive and weighing systems such as:

- SIMOCODE pro motor management system
- SINAMICS G120 frequency inverter
- SIWAREX U/FTA/FTC weighing systems

MTA terminal modules

Field devices, sensors and actuators can be connected simply, rapidly and reliably to I/O modules of the ET 200M remote I/O stations using MTA terminal modules (Marshalled Termination Assemblies). MTA versions are available for standard I/O modules as well as for redundant and safety-related I/O modules. The use of the MTA achieves a significant reduction in costs for cabling and commissioning and avoids wiring errors.
Use of the process I/Os for SIMATIC PCS 7

The graphic above shows the possibilities for connecting distributed SIMATIC PCS 7 process I/Os with consideration of different environmental conditions.

Sensors/actuators, analyzers as well as weighing and dosing systems

Siemens Sensors and Communication offers a comprehensive range of devices for operation with the SIMATIC PCS 7 process control system. These include, for example:

- Devices for measurement of pressure, flow, temperature or level
- Positioners
- Gas analyzers
- SIWAREX weighing systems

These devices are available in versions with PROFIBUS DP/PA interface and for HART communication. The majority of devices is already included in the device catalog of the SIMATIC PDM process device manager.

An overview of the current range of devices with additional information, technical specifications and ordering data is available at the following Internet site:

www.siemens.com/processinstrumentation
## Distributed I/O systems

**Recommended devices for field automation**

<table>
<thead>
<tr>
<th>I/O system</th>
<th>ET 200M</th>
<th>ET 200iSP</th>
<th>ET 200S</th>
<th>ET 200pro</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of protection</td>
<td>IP20</td>
<td>IP30</td>
<td>IP20</td>
<td>IP65/IP66/IP67</td>
</tr>
<tr>
<td>Design</td>
<td>Modular</td>
<td>Modular</td>
<td>Bit modular, expandable block</td>
<td>Modular</td>
</tr>
<tr>
<td>Mounting</td>
<td>Mounting rail</td>
<td>Mounting rail</td>
<td>Standard sectional rail</td>
<td>Mounting rail</td>
</tr>
<tr>
<td>Connection system for sensors/actuators</td>
<td>Single-wire connection, Cage-clamp/screw-type connection, FastConnect, TopConnect</td>
<td>Multi-wire connection, Cage-clamp/screw-type connection</td>
<td>Multi-wire connection, Cage-clamp/screw-type connection, FastConnect</td>
<td>M8, M12, M23</td>
</tr>
<tr>
<td><strong>Special applications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>For use in hazardous areas</td>
<td>Zones 2, 22</td>
<td>Zones 1, 21</td>
<td>Zones 2, 22</td>
<td>–</td>
</tr>
<tr>
<td>Increased availability</td>
<td>Switched, redundant</td>
<td>Switched, redundant</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Temperature range</td>
<td>0 ... +60 °C</td>
<td>-20 ... +70 °C</td>
<td>0 ... +60 °C</td>
<td>-25 ... +55 °C</td>
</tr>
<tr>
<td>Vibration resistance (continuous)</td>
<td>1 g</td>
<td>1 g</td>
<td>2 g</td>
<td>5 g (module-dependent)</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROFIBUS (copper/fiber-optic)</td>
<td>● / – (12 Mbit/s)</td>
<td>● / – (1.5 Mbit/s)</td>
<td>● / ● (12 Mbit/s)</td>
<td>● / ● (12 Mbit/s)</td>
</tr>
<tr>
<td><strong>System functions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent wiring</td>
<td>● (plugging and removal)</td>
<td>●</td>
<td>●</td>
<td>–</td>
</tr>
<tr>
<td>Hot swapping</td>
<td>● (with active backplane bus)</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Expansion/configuration during ongoing operation</td>
<td>● / ●</td>
<td>● / ●</td>
<td>● / –</td>
<td>– / –</td>
</tr>
<tr>
<td>Diagnostics (module-dependent)</td>
<td>Channel-discrete</td>
<td>Channel-discrete</td>
<td>Channel-discrete</td>
<td>Channel-discrete</td>
</tr>
<tr>
<td><strong>Functions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital channels</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Analog channels</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>incl. HART</td>
<td>●</td>
<td>●</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Motor starter</td>
<td>–</td>
<td>–</td>
<td>●</td>
<td>–</td>
</tr>
<tr>
<td>Pneumatic interface</td>
<td>–</td>
<td>●</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Technological functions</td>
<td>Counting/measuring, controlling, weighing</td>
<td>Counting, frequency measuring</td>
<td>Counting/measuring</td>
<td>–</td>
</tr>
</tbody>
</table>

1) Also available as SIPLUS component for expanded temperature range -25 ... +60/70 °C and corrosive atmosphere/condensation (exact details at www.siemens.com/siplus)
# Drives

## Recommended devices

<table>
<thead>
<tr>
<th>Drives</th>
<th>SIMOCODE pro</th>
<th>SINAMICS G120</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Motor management system for constant-speed motors in the low-voltage range</td>
<td>Frequency converter for three-phase asynchronous and synchronous motors</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>SIMOCODE pro</th>
<th>SINAMICS G120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of protection</td>
<td>IP20 (module-dependent)</td>
<td>IP20</td>
</tr>
<tr>
<td>Design</td>
<td>Modular</td>
<td>Modular (control unit, power unit)</td>
</tr>
<tr>
<td>Performance range</td>
<td>0.1 ... 700 kW</td>
<td>0.37 ... 250 kW</td>
</tr>
<tr>
<td>Voltages</td>
<td>Up to 690 V AC</td>
<td>380 ... 480 V or 660 ... 690 V AC ± 10 %</td>
</tr>
<tr>
<td>Rated motor currents</td>
<td>Up to 820 A</td>
<td>–</td>
</tr>
<tr>
<td>PROFIBUS communications</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Block library for integration in SIMATIC PCS 7</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

**Application**

- Protection and control of motors
  - In hazardous areas for types of protection EEx e/d corresponding to ATEX directive 94/9/EC
  - With heavy-duty starting (paper, cement, metal and water industries)
  - In high-availability plants (chemical, oil, raw material processing industry, power plants)

For universal use in all industrial and trade sectors
Batch automation with SIMATIC BATCH
Modular, flexible, scalable and fully integrated in SIMATIC PCS 7

SIMATIC BATCH’s recipe-driven control strategies enable efficient and flexible execution of simple and complex batch processes with changing control sequences. SIMATIC BATCH meets all the associated high requirements without exception:

- Optimum capacity utilization of production plants
- Uniform product quality
- Traceability
- Compliance with statutory standards and directives
- Fast response to changing market conditions

Modular architecture
SIMATIC BATCH is configured as a single station system or as a client/server system and can be used in plants of any size due to its modular architecture and scalability in cumulative SIMATIC BATCH UNITS (sets of 1, 10 and 50 plant unit instances).

With small batch applications, a SIMATIC PCS 7 BOX can be combined with a separate controller, e.g. a SIMATIC PCS 7 AS RTX or SIMATIC PCS 7 AS mEC RTX.

However, characteristic for the automation of batch processes using SIMATIC BATCH are client/server architectures with which one batch server and several Batch Clients process a plant project together. The batch server can also be configured with redundancy in order to increase availability.

In addition to the SIMATIC PCS 7 Industrial Workstations, the more compact SIMATIC PCS 7 OS clients 627C and 427C are also suitable for use as batch clients.

Integration in SIMATIC PCS 7
SIMATIC BATCH is completely integrated in SIMATIC PCS 7. Connection to the production control level is supported by direct communication with SIMATIC IT or by an open interface to any manufacturing execution system (MES).

The plant data can be configured entirely using the Engineering System. This passes all data required for recipe creation to the batch server, making recipe processing possible separate from the Engineering System. Changes to the configuration which are made on the Engineering System are available to the batch server using an update function.

The SIMATIC BATCH server software usually runs on an autonomous server hardware (batch server), separate from the OS servers. Depending on the capacity utilization of the operator system, OS and batch server software can also be operated on shared server hardware (OS/batch server). SIMATIC BATCH clients and OS clients can run on separate or common basic hardware.

SIMATIC BATCH uses SIMATIC Logon integrated in the process control system for central user administration and authentication, as well as for the "electronic signature" to release master recipes, formulas, and library objects through enabled Windows users/user groups. Individual configuration settings of the Batch Control Center and recipe editor are saved as a user-specific profile when logging off. This means that you can work in a familiar environment as soon as you log on again at any client in the plant.
Communication with the automation systems

Depending on the operating mode, SIMATIC BATCH communicates with the automation systems (AS) via the PCS 7 operator system (OS) or direct via S7 DOS.

SIMATIC BATCH provides special faceplates for controlling and monitoring units and equipment phases. As a rule, instances of an SFC type are used as the interface to the lower automation level.

Operating modes for recipe processing

- **PC mode**: execution of complete recipe logic in the batch server
- **AS mode**: execution of unit recipe logic in the automation system:
  - Very fast step changing times
  - Improved determinism during batch processing
  - Enhanced availability
- **Mixed mode**: parallel application of PC and AS modes in one batch

SIMATIC BATCH highlights

- **Modular architecture with flexible scalability (hardware and software)**
  - Optimum scaling to plant size and individual requirements
  - Grows with the plant configuration; no expensive spare capacities

- **High availability thanks to redundant batch servers**
  - No loss of batch data
  - Automatic synchronization of batch data

- **PC and AS modes**

- **Homogenous integration of SIMATIC BATCH into the HMI strategy and the engineering of SIMATIC PCS 7 via system interface**
  - No customized interfaces
  - No double configuring for batch-specific engineering data
  - OS Controls for integration in process displays

- **Recipes independent of unit**
  - Considerable simplification in recipe management and validation
  - Flexible control strategy and optimum plant utilization through modification of occupation strategy and assignment of units during batch runtime

- **Flat and hierarchical recipes according to ISA-88.01**
  - Creation of recipes oriented according to process engineering
  - Quick, easy and fault-minimized creation

- **Importing and exporting of master recipes, formulas and library objects**

- **Saving and archiving in XML format as well as comprehensive reporting of batch data**
  - Production becomes transparent and comprehensible
  - Reliable operator prompting, safe response to process faults
  - Viewer for archived batches

- **Reduction in engineering and validation overhead through**:
  - Type/instance concept of SFC
  - Separation of procedure and formula
  - ROP library and configuration independent of unit
  - Multiple usage, central modification

- **Validation support according to 21 CFR Part 11 through**:
  - Audit Trail (change log)
  - Free and system-aided versioning
  - Libraries with recipe operations and formulas
  - User administration with access protection and electronic signature

- **Interfacing an SIMATIC IT or any other MES systems**
Batch client functionality

Batch Control Center

The Batch Control Center (BatchCC) is the "command center" for monitoring and controlling batch processes with SIMATIC BATCH. The data relevant to SIMATIC BATCH are managed using a GUI. BatchCC offers powerful functions for the following tasks:

- Reading in and updating the process cell data of the basic automation
- Definition of user privileges for all functions, for clients, or for units of SIMATIC BATCH
- Definition of material names and codes
- Management of master recipes
- Management of libraries with recipe elements (library operations)
- Editing of formula categories and management of associated formulas (parameter sets)
- Creation of master recipe from control recipe
- Exporting and importing of master recipes, formulas and library objects
- Creation of batches with master recipes
- Starting of batch processing and controlling of batches
- Monitoring and diagnostics of batch processing
- Changing assignment strategy and unit assignment online during batch runtime
- Modification/deletion/insertion of objects and structure elements (loops, transitions etc.) of the recipe online
- Recording and archiving of recipes and batch data
- Calling of SFC visualization directly from the control recipe

Batch Planning

BatchCC can be used to create production orders and batches individually. However, Batch Planning offers significantly more planning functions. The batches for a large number of production orders can then be planned in advance. In addition to planning, the scope of functions include the modification, cancellation, deletion and release of batches.

Batch OS Control

Batch OS Controls output in the process display permit operation and monitoring of batch processes.
Recipe system, archiving and logging

Recipe Editor

The Recipe Editor is used for easy, intuitive creation and modification of master recipes and library operations. It possesses a GUI, processing functions for individual and grouped objects, and a structural syntax check. The basis for recipe creation are the batch objects created from the plant configuration using the SIMATIC PCS 7 Engineering System, e.g. units and equipment phases. The Recipe Editor can be called from BatchCC, or it can be started individually.

The following tasks can be performed with the Recipe Editor:

- Creation of new master recipes and library operations
- Modification of existing master recipes and library operations (changes to structures or parameters)
- Querying of statuses of the recipe objects and of process values in transition conditions
- Assignment of route control locations to the transport phases as transfer parameters (source, target, via), in order to direct products of one batch into other units (local or external plants)
- Configuring arithmetic expressions for calculating setpoints for transitions and recipe parameters from recipe variables and constants
- Documentation of master recipes and library operations
- Validation under inclusion of user-specific plausibility checks
- Selection of unit candidates through limitation of equipment properties
- Releasing master recipes and library operations for test or production

Recipe elements for handling of exceptions

Monitoring of process states is possible during runtime by marking freely selectable recipe sections. It is possible to react to evaluated events or faults using a command block or jump function in a special container.

Batch reports

Batch reports comprise all data required for the reproduction of batch process, for proof of the quality, and for compliance with statutory directives, including

- Identification data
- Control recipe data
- Effective production data
- Time sequence of steps
- Status messages, fault messages and alarms
- Operator interventions
- Process values

Recipe reports

The recipe reports contain the production data, e.g.

- Recipe header data
- Recipe topology
- Input material, output material and parameter lists
- Procedure rules

Viewer for archived batches

The batch data which is only accessible to authorized persons or systems can be saved in XML format – locally, on a network drive, or on a central archive server. It is insignificant whether the connected batches originate from a single SIMATIC BATCH plant or from several plants. The batches archived in this manner can be displayed again as a control recipe in the Batch Control Center using a Viewer.
Hierarchical and recipes not specific to the unit

Flat recipes

Flat recipes are suitable for simple applications with only a few units. With these recipes, the units are directly assigned to the recipe functions within the recipe procedure.

Hierarchical recipes according to ISA-88.01

SIMATIC BATCH and SIMATIC PCS 7 form a functional unit that fully covers the models described in the ISA-88.01 standard. The hierarchical recipe structure is mapped on the plant model as follows:

- Recipe procedure for controlling the process or production in a process cell
- Recipe unit procedure for controlling a process step in a unit
- Recipe operation/recipe phase to implement the process engineering task/function in an equipment module facility

Non-specificity and assignment of units

Creation of recipes that are not bound to a specific unit minimizes the engineering overhead and provides significant advantages for validation. During creation of the recipe, the recipe unit procedures are only assigned unit classes. The final assignment of the units is only carried out during runtime. In the cases of batches which run for a longer period and where the units are not to be already determined and occupied at the start of a batch, the assignment is only carried out at the time of use. Conflicts in the unit allocation are detected by the system, and displayed.

The following occupation strategies for unit assignments permit optimum orientation according to the specific plant situation:

- "Manual selection of unit" when the units are occupied
- "Preferred unit" for preselection at time of recipe creation
- Determination of "Unit unused for longest time" to achieve uniform utilization
- Assignment of unit to be used by means of "Process parameters" from external module (e.g. scheduler)

The occupation strategy can also be modified during the batch runtime, just like the unit assignment.
Rationalization of recipe creation and supporting of validation

Library with recipe operations (ROP)

Recipe operations managed in a user library (ROP library) can be installed in the recipe procedures of hierarchical recipes as a reference and thus modified centrally. With flat recipes, referencing is possible in an analogous manner to so-called substructures in the user library.

This reduces the requirements for engineering and validation. If the reference link is broken, the recipe operation or the substructure becomes a fixed component of the recipe procedure, and is thus independent of further central modifications.

Separation of procedure and formula

The flexibility achieved by recipes which are independent of specific units can be increased even further if the procedure and parameter sets (formulas) are separated from one another. Various master recipes can be created by linking several formulas using a recipe procedure. This enables central modification of procedures. The formula structure is determined by the formula category defined by the user.

Application Programming Interface (API)

The SIMATIC BATCH API Application Programming Interface is an open interface for customer-specific extensions. To program special industry-specific or project-specific applications it offers the user access to data and the functions of SIMATIC BATCH.

Validation according to 21 CFR Part 11

As a manufacturer of process control systems, Siemens has specially trained personnel, as well as many years of experience in quality management and plant validation. SIMATIC BATCH particularly supports validation according to 21 CFR Part 11 through:

- Consistent standardization, e.g. with:
  - Type/instance concept of SFC
  - Recipe creation independent of a specific unit
  - Separation of procedure and formula
  - Library recipe operations
- Audit Trail (change log):
  - Recording of changes in recipes and recipe operations (saved with modified object)
  - Recording of changes during production (in the batch report), including the operations of the individual control level belonging to the corresponding batch
- Free and system-aided versioning of recipes, formulas, and library elements
- Central user administration with access control through SIMATIC Logon
- Electronic signature for release of master recipes, formulas and library objects based on SIMATIC Logon

For additional information, see: www.siemens.com/simatic-batch
SIMATIC Route Control (RC) expands the SIMATIC PCS 7 process control system with a sector-independent tool for the configuration, control, monitoring and diagnostics of material transport in pipeline networks or on conveyor belts.

With SIMATIC Route Control, users of SIMATIC PCS 7 are capable of automating not only their production processes and associated warehouses but also the material transport linking both areas.

SIMATIC Route Control is suitable for small plants with simple, static transport routes or also for plants in the medium and top performance ranges possessing comprehensive, complex routes and pipeline networks.

SIMATIC Route Control is particularly predestined for the following requirements:

- Frequent conversions and extensions of the transport network including actuators and sensors
- Transport routes with high flexibility, characterized by:
  - Regularly changing materials
  - Dynamic selection of the origin and destination of the material transport (including reversal of direction on bidirectional transport routes)
- Numerous simultaneous material transports
- Dynamic occupation of units using SIMATIC BATCH

This requirement profile particularly applies to plants with numerous branched pipelines or comprehensive tank farms typical for the chemical, petrochemical or food and beverage industries.

SIMATIC PCS 7 multiple station system with SIMATIC Route Control

When transporting solid materials on conveyor belts, the sequence for switching actuators on and off can be cascaded using WAIT elements. When transporting liquids in pipelines, the valves can be cleaned by means of pulses, with the sequence and time intervals being set using WAIT elements.

Modular architecture

Thanks to its modularity and discrete scalability with cumulative SIMATIC Route Control (10, and 50 quantity options for simultaneously active material transports), SIMATIC Route Control can be flexibly adapted to different plant sizes and architectures (single-user/multi-user systems) up to the project upper limit of 300 routes.

Integration in SIMATIC PCS 7

The Route Control Engineering software, consisting of engineering tool, wizard and block library, is concentrated together with the other engineering tools in the central SIMATIC PCS 7 engineering system.

For small plants, SIMATIC Route Control can be installed either alone or together with the OS software on a single station system. Distributed multiple station systems with client/server architecture, expandable with up to 32 clients per server, are typical for the automation of material transports with SIMATIC Route Control.

For additional information, see:
www.siemens.com/simatic-pcs7/routecontrol
**SIMATIC Route Control engineering**

SIMATIC PCS 7 supports a Route Control server or pair of Route Control servers in the multiuser system which is limited to 12 servers/pairs of servers. In the case of multiple station systems with small quantity frameworks it is also possible to operate the Route Control Server, Batch Server and OS Server on shared basic hardware. However, availability will be higher and performance better if the subsystems are installed on separate servers or redundant pairs of servers.

A synonym for the Route Control client is the Route Control Center (RCC). It can be installed on an OS client, a batch client or separate client hardware.

SIMATIC Route Control can work together with the following SIMATIC PCS 7 automation systems:

<table>
<thead>
<tr>
<th>SIMATIC PCS 7 automation systems</th>
<th>Max. number of simultaneous material transports</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS 416-3</td>
<td>up to 30</td>
</tr>
<tr>
<td>AS 417, AS 417H, AS 417F/FH</td>
<td>up to 300</td>
</tr>
</tbody>
</table>

In the mimic diagram of the SIMATIC PCS 7 operator system, each route block is represented by an RC block symbol and an RC faceplate. The selection of locations (synonyms: nodes, plant points) for partial routes and routes is facilitated by dropdown list boxes. Locations are parameters for requesting a material transport (source, destination, intermediate points). They mark the start and end of each partial route and thus also the source and destination of a material transport.

For access control and for managing the graded user rights for engineering, operating and maintenance personnel, SIMATIC Route Control uses the SIMATIC Logon integrated in the process control system.

**Route Control Engineering**

Route Control configuring supplements basic configuring with blocks from the SIMATIC PCS 7 library. Even existing SIMATIC PCS 7 plants are therefore easy to expand with SIMATIC Route Control.

Technological elements of relevance to control of material transport (RC elements) are adapted in the CFC editor using uniform interface blocks from the Route Control library. The RC elements include:

- Control elements (actuators)
- Sensor elements (sensors)
- Parameter elements (setpoints)
- Connection elements (material information related to partial route)
- WAIT elements

Locations of partial or complete routes are configured in the SIMATIC Manager as "Equipment properties of units" and transferred to the RC project together with the other RC-relevant basic data of the SIMATIC PCS 7 project.

**Route Control library**

The Route Control library contains blocks for RC and transport route configuration and interface blocks for RC elements. It is provided in the catalog of the CFC editor.

**Route Control wizard**

The Route Control wizard constitutes the interface between the SIMATIC PCS 7 basic configuration supplemented with RC interface blocks and the actual RC configuration in the RC engineering tool. The wizard, which can be called up from the SIMATIC Manager menu, accepts the RC-specific configuration data of the SIMATIC PCS 7 project into the Route Control engineering. In doing so, it carries out a plausibility check, defines the AS-OS and AS-AS communication connections (NetPro and CFC), and configures the RC server signals.

**Route Control Engineering tool**

Once the RC-relevant basic data of the PCS 7 project has been transferred to the RC project, the next step is to configure the RC-specific objects with the Route Control engineering tool:

- Subdivision of the transport routes into flexible partial routes; parameters "bidirectional" and "priority"
- Interconnection of the RC elements by means of installing in a partial route and thus transfer of type-specific additional properties to these RC elements, e.g. in the base position "Close valve"
- Assignment of the partial routes to mode tables, e.g. "cleaning" or "product transport", that operate as as a criterion in the route search to restrict the resulting quantity
• Assignment of up to 32 technological sequence functions (function stages) that determine the sequence of material transport by means of the RC elements interconnected in the partial routes, e.g. base position of the control elements, open transport valves, open origin valve, switch on pump

Configuration of the partial routes and assignment of the RC elements to the partial routes are performed in a matrix of the Route Control engineering tool. With the aid of generic elements, objects or blocks generated on a user-specific basis can be integrated into the RC project and handled like RC elements.

Similarly to a navigation system, the graphically visualized offline route search determines all possible route combinations. Errors in the route network or undesired routes can be detected in advance. A preferred route can be selected from the results of the offline route search, and saved as a static route. An active route can also be saved for re-use via the Route Control Center. A saved route takes priority in a route request.

Special configuration functions make it easier to perform repetitive routine work and extend the range of options for controlling material transport, e.g.:

• Exporting configuration data in the form of CSV files to Microsoft Excel, copying and editing the data there, and then re-importing the files into Route Control
• Controlling the joint use of partial routes by configurable function IDs
• Checking of material compatibilities by evaluating the partial route material IDs and interlocking of partial routes in the case of incompatible material sequences
• Injection of setpoints coming from the process at runtime into the route block (e.g. weighed quantity)

Route Control Center (RCC)

The RCC can be called from the RC faceplate of the route block or from the keyset on the operator station. It displays all route data and error information relevant to material transport in several coordinated views. Key functional features are:

• Overview of all RC elements and request details
• Selection of manual/automatic mode
• Operation of the selected material transport in manual mode:
  - Request, start, stop, continue and terminate material transport
  - Set/modify requirement parameters (locations, origin, destination, intermediate points)
  - Set/modify general properties (mode table, function ID, material ID and "ignore error")
  - Enable/disable sequence functions
• Diagnostics of material transport request errors caused by locked RC elements, locked partial routes, inconsistent actuations or prohibited sequential material
• Diagnostics of currently running material transports:
  - Transport route status display shown in color and text in the route view of the RCC
  - Detailed analysis of feedbacks from RC elements
• Server functions: select RC server, display RC server status, update view
• Display of operator who has logged on
• Definition of route parameters (source, destination, material, function ID etc.), and saving and loading these settings with names
• Switchover between "AS in maintenance" and "AS in operation"
Route Control Server

After the transport network has been configured and the variants of a material transport tested, the Route Control project engineering data are transferred to the Route Control Server where they can then be activated at a suitable time. The new data are then considered when searching for a route.

The Route Control Server (RC Server) supplies the Route Control Clients (Route Control Centers) with the necessary data and transfers their operations to the automation systems.

If a material transport is waiting, a route is requested either via the controller or by the operator at the Route Control Center (RCC). Apart from specifying the source, destination and up to 10 optional locations, this also includes creating a start signal on the route control block of the automation system. If no saved route is available, the RC Server starts the route search and, if possible, combines the statically defined partial routes into one complete transport route. From there on, Route Control takes over the control and monitoring of all RC elements involved in the transport route. The process cell control only has to switch the individual technological functions. When errors occur, the operator receives detailed diagnostics information about the cause, e.g. why the search for a transport route failed.

For maintenance purposes, an automation system can be specifically set to "in maintenance" (out of service). The material transports operating via this automation system are then completed, but no more new ones are permitted.

SIMATIC Route Control highlights

- Flexible, modular architecture with scalable hardware and software components for single-user and multiple station systems
  - Optimum adaptability to plant size and individual requirements
  - No expensive reserve capacities
- High availability thanks to redundant Route Control Servers
- Homogenous integration into the HMI strategy and the engineering of SIMATIC PCS 7
  - No customized interfaces
  - No double configuring
  - Subsequent integration into existing projects
- Can be combined with SIMATIC BATCH – Material transports can be started automatically from the batch control recipe.
- Plant transparency
  - Identical mapping of route network of the plant through partial routes
  - Simple assignment of RC elements to the partial routes using plant plans
- Fast response to plant modifications (e.g. additional valves) during configuration, commissioning or runtime
- Exclusive assignment of RC elements and partial routes involved in material transport
- Recording of route reports with filter functions, screen output and printer output
- Reduction in configuration overhead and commissioning times
  - Configuring partial routes by means of repeated application
  - Export of configuration data to Microsoft Excel, re-importation of edited data from Excel
  - Reduction in complex, repeated tasks through RC wizard
  - Encapsulation of functionality from viewpoint of user program, control as entity
  - Graphical offline route search determines all route combinations in advance and finds undesired routes as well as errors in the route network
- Material transport using common partial routes (several origins or destinations with bumpless switchover facility)
- Consideration of material compatibilities to avoid undesired mixing or material sequences
- Offline testing for completeness during configuration, as well as for inconsistencies and undesired combinations
- Detailed diagnostics of material transport requirement faults and current material transport
- Saved static route (e.g. for cleaning) is executed with priority when a route is requested.
- Definition of on/off switching sequences using cascaded control of actuators with WAIT elements, e.g. for conveyor belts
The process industry frequently features complex production sequences where materials and mixtures which are explosive or dangerous to health are produced or processed. A fault or failure could have disastrous consequences.

Therefore the objective of Siemens safety technology is to minimize potential hazards for personnel, plant and environment by means of technical measures, without adversely affecting the production process. A reliable Safety Instrumented System (SIS) is therefore required which is able to automatically place the plant into a safe state should critical events occur, to continue operating it safely under defined conditions, and to limit any negative effects in the event of a safety-related event.

Safety Integrated for Process Automation provides a comprehensive range of products and services for safe, fault-tolerant applications in the process industry – based on the Siemens safety-related system. It offers complete safety-related functionality – extending from safe instrumentation for signal recording and conversion, to safe and fault-tolerant control, up to the actuator (e.g. positioner, valve, or pump). The enormous potential of Safety Integrated for Process Automation can best be exploited in conjunction with SIMATIC PCS 7. Thanks to the modularity and the flexibility of the safety-related products this combination is extremely variable. It is not just the degree of integration of safety-related systems that can be individually defined in the process control system, it is also the degree of redundancy for controllers, fieldbus and process I/O (Flexible Modular Redundancy). Thanks to the reduced spatial requirements, the scope of hardware and wiring, as well as reduced mounting, installation and engineering overhead, complete (common) integration of the safety-relevant systems in SIMATIC PCS 7 offers the greatest cost advantages viewed over the entire life-cycle of a plant.

Both the safety technology and the safety applications implemented with it are characterized by great efficiency and comply with both national and international standards, such as:

- IEC 61508 – basic standard for specifications, as well as for the design and operation of safety-related systems
- IEC 61511 – application-specific standard for the process industry

For additional information, see:
www.siemens.com/simatic-pcs7/process-safety
## Product range

### Safety Integrated for Process Automation – Product spectrum for SIMATIC PCS 7

<table>
<thead>
<tr>
<th>Engineering</th>
<th>Configuration of safety functions (up to SIL 3) using TÜV-certified function blocks and Continuous Function Chart (CFC) or SIMATIC Safety Matrix (Cause&amp;Effect matrix)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automation systems</td>
<td>Fail-safe, fault-tolerant controllers with a redundant or non-redundant design (SIL 3) for the bottom, mid and top performance ranges</td>
</tr>
<tr>
<td>PROFIsafe with PROFIBUS PROFIsafe with PROFINET</td>
<td>For standard and safety-related communication on just one bus cable, certified according to IEC 61508 (SIL 3)</td>
</tr>
</tbody>
</table>
| SIMATIC ET 200 | ET 200M: Modular I/O for multi-channel applications with safety-related signal modules (F-DI, F-DO, F-AI), SIL 2/SIL 3; IP20 degree of protection  
ET 200ISP: Modular, intrinsically-safe I/O with safety-related electronic modules (F-DI Ex, F-DO Ex, F-AI Ex), SIL 3, IP30 degree of protection  
ET 200S: Bit-modular I/O with safety-related electronic modules (F-DI, F-DO) and safety-related motor starters, SIL 2/SIL 3; IP20 degree of protection  
ET 200pro: Modular, very compact I/O with safety-related electronic modules (F-DI, F-DI/F-DO), SIL 2/SIL 3; F-switch for switch-off of standard I/O and control of motor switches; IP65/66/67 degree of protection |
| Process instruments/process devices | Safe process instruments/devices on PROFIBUS: SITRANS P DS III PA pressure transmitters (proven in use SIL 2) with PROFIsafe, SIPART PS2 PA (SIL 2), SIMOCODE pro with DM-F local/PROFiSafe (SIL 3)  
Safe process instruments/devices for connection to ET 200M remote I/Os: SITRANS P DS III analog/HART (SIL 2/SIL 3), SITRANS TW series (SIL 1), SITRANS TH200/300 (SIL 2/SIL 3), SITRANS TR200/300 (SIL 2/SIL 3), SITRANS LR250 HART (SIL 2), SIPART PS2 2/4-wire (SIL 2) |
| Applications | Partial Stroke Test  
Predefined function blocks and faceplates for online valve test to enable preventive valve diagnostics without affecting production  
Burner libraries Libraries for SIMATIC S7-400FH controllers with TÜV-certified function blocks for burner management systems |
Safety-related design versions

Safety-related design versions with PROFIBUS communication

The PROFIsafe profile allows safety-related communication for between the controller and the process I/O via the open standard buses PROFIBUS and PROFINET. The decision between these two standard buses seriously influences the architecture of the safety-related system.

Safety-related design versions with PROFIBUS

In the case of a safety-related system with PROFIBUS communication integrated into SIMATIC PCS 7, a distinction is made across all architecture levels between two design versions:

- Single-channel, non-redundant design
- Redundant, fault-tolerant design

Both alternatives are extremely variable and offer generous scope for design. At the individual architectural levels (controller, fieldbus, distributed I/O), the configuration options shown in the diagram are available depending on the process I/O used.

Standard (basic process control) and safety-related functions can be combined flexibly, not only in the area of the distributed I/O. Even at the controller level, they can combined in one system or separate. In addition, there are numerous possibilities arising from the use of flexible modular redundancy.
Flexible Modular Redundancy (FMR)

Depending on the automation task and the associated safety requirements, the degree of redundancy may be defined separately for the controller, fieldbus and distributed I/O level, and coordinated with the field instrumentation. In this way, individual fault-tolerant architectures which are precisely tailored to the individual tasks can be implemented, and tolerate several faults occurring at once. As FMR provides redundancy only where it is actually required, comparatively more attractive and cost-effective applications are possible than with conventional redundancy architectures.

As shown in the example of a process cell with ET 200M distributed I/O, the total of the tasks can produce a mix of different degrees of redundancy within one architecture level (1oo1, 1oo2, 2oo3).

Safety-related design versions with PROFINET

PROFINET supports safety-related systems on the basis of safety-related SIMATIC PCS 7 automation systems (F/FH) and ET 200M remote I/Os. With a safety-related system with PROFINET communication, the ring is the topology of choice from the point of view of availability. The media redundancy of the ring means that bus interruptions or failure of a node will not result in failure of the entire segment. The maximum availability level is achieved when the PROFINET ring is operated on a redundant controller (AS Redundancy Station).
Engineering tools for safety functions

The F-block library in S7 F Systems and the SIMATIC Safety Matrix are available for configuring and programming safety-related controllers.

S7 F Systems with F-block library

The S7 F Systems engineering tool permits parameterization of safety-related controllers as well as safety-related F-modules of the ET 200 series. It supports configuration by means of functions for:

- Comparison of safety-related F-programs
- Recognition of changes in the F-program using the checksum
- Separation of safety-related and standard functions.

Access to the F-functions can be password-protected. The F block library integrated in S7 F Systems contains predefined function blocks for generation of safety-related applications with the CFC or the Safety Matrix based on it. The certified F-blocks are extremely rugged and intercept programming errors such as division by zero or out-of-range values. Diverse programming tasks for detecting and reacting to errors can thus be omitted.

Safety Matrix: assignment of exactly defined reactions (effects) to occurring events (causes)

SIMATIC Safety Matrix

The SIMATIC Safety Matrix which can be used in addition to S7 F Systems is an innovative safety lifecycle tool from Siemens, that can be used not only for the user-friendly configuration of safety applications, but also for their operation and service. The tool, which is based on the proven principle of a cause & effect matrix, is ideally suited to processes where defined statuses require specific safety reactions.

The Safety Matrix not only means that programming of the safety logic is significantly simpler and more convenient, but also much faster than in the conventional manner.

During the risk analysis of a plant, the configuration engineer can assign exactly defined reactions (effects) to events (causes) which may occur during a process. The possible process events (inputs) are initially entered in the horizontal lines of a matrix table comparable to a spreadsheet program, and then their type and quantity, logic operations, any delays and interlocks as well as any tolerable faults are configured. The reactions (outputs) to a particular event are then defined in the vertical columns.

The events and reactions are linked by simply clicking the cell at the intersection point of line and column. Using this procedure, the Safety Matrix automatically generates complex, safety-related CFC programs. Special programming knowledge is not required, and the configuration engineer can concentrate fully on the safety requirements of his plant.
Safety-related controllers and process I/O

Safety-related automation systems

The safety-related SIMATIC PCS 7 automation systems are available in two design versions:

- **AS Single Station**
  - of the type AS 412F, AS 414F, AS 416F, AS 417F
  - with only one CPU, safety-related

- **AS Redundancy Station**
  - of the type AS 412FH, AS 414FH, AS 416FH, AS 417FH
  - with two redundant CPUs, safety-related and fault-tolerant

All these systems have multitasking capability, i.e. several programs can be executed simultaneously in one CPU, both basic process control applications and safety-related applications. Working together with the safety-related signal modules of the ET 200 distributed I/O systems or directly via fail-safe transmitters connected via the fieldbus, they detect faults both in the process and their own internal faults and automatically set the process cell to a safe state in the event of a fault. Safety programs executed on different automation systems of a plant are able to carry out safety-related communication with one another over the Industrial Ethernet plant bus.

The standard PROFIBUS or PROFINET is used together with the PROFIsafe profile for safety-related communication between the CPU of the automation system and the safety-related process I/O. In both cases, operation of standard and safety-related components on the same bus is possible. This makes a separate and expensive safety bus unnecessary.

The PROFIsafe profile is implemented as an additional software layer within the devices/systems without modifying the communication mechanisms of the standard PROFIBUS. PROFIsafe expands the frames by additional information with which the PROFIsafe communications partners can recognize and compensate transmission errors such as delays, incorrect sequences, repetitions, losses, addressing errors, or data falsification.

Safety-related F-modules

The safety functions of the F/FH automation systems are perfectly matched to the following safety-related F-modules of the ET200 range:

- **ET 200M:**
  - F-DI 12/24 x 24 V DC
  - F-DI 4/8 x NAMUR [EEx ib]
  - F-DO 10 x 24 V DC/2 A
  - F-DO 8 x 24 V DC/2 A;
  - F-AI 3/6 x 0 ... 20 mA or 4 ... 20 mA (HART)

- **ET 200iSP:**
  - F-DI Ex 4/8 x NAMUR
  - F-DO Ex 4 x 17.4 V DC/40 mA
  - F-AI Ex HART 4 x 0 ... 20 mA or 4 ... 20 mA

- **ET 200S:**
  - F-DO 4 x 24 V DC/2 A
  - F-DI 4/8 x 24 V DC

- **ET 200pro:**
  - F-DI 8/16 x 24 V DC
  - F-DI/DO 4/8 x 24 V DC (DI) and 4 x 24 V DC/2 A (DO)

Safety-related F-motor starter for ET 200S

Safety-related motor starters up to 7.5 kW, can be expanded by brake control module:

- F-DS1e-x direct-on-line starter
- F-RS1e-x reversing starter

Initiated by a switch-off signal, safety-related ET 200S motor starters can be selectively switched off by the series-connected PM-D F PROFIsafe power module. In addition to a circuit-breaker/contactor combination, the safety-related motor starters have a safe electronic evaluation circuit for fault detection.

If the contactor to be switched in the case of an emergency stop fails, the evaluation electronics detects a fault and deactivates the circuit-breaker in the motor starter in a safety-related manner.
PROFIBUS PA devices for safety shutdowns

The SITRANS P DSIII digital pressure transmitter which can be used on the PROFIBUS PA fieldbus is suitable for SIL 2 safety shutdowns conforming to IEC 61508/ IEC 61511-1. For this reason, Siemens has extended its standard instrument for measuring pressure, absolute pressure and differential pressure to include a PROFIsafe driver.

In a safety application, the pressure transmitter can be interconnected via PROFIBUS PA with a safety-related automation system (F/FH). The digital input of the PROFIBUS PA SIPART PS2 electropneumatic positioner can be used for the safe shutdown.

Process safety highlights

- Safety Integrated for Process Automation – the comprehensive product and service offering for safe, fault tolerant, and high-availability applications in the process industry
  - Easy implementation, operation, and maintenance of safety applications
  - Innovation safe thanks to high-level adaptability to changed conditions
  - Reliable elimination of dangers and risks
- Homogenous integration of safety technology in the SIMATIC PCS 7 Process Control System
  - Processing of basic process control functions and safety functions in one controller: Safety integrity level SIL 3 possible with only one CPU
  - Standard and safety-related communication between controller and I/O via a common fieldbus PROFIBUS/PROFINET with PROFIsafe; no separate safety bus
  - Mixed operation of standard and safety-related F-modules in ET 200 stations
  - Uniform data management for basic process control and safety-related automation, including process visualization and diagnostics; no complex data management
- Integration of safety-related applications in the convenient process visualization on the SIMATIC PCS 7 operator station

- Configuration of safety functions is part of the uniform system configuration with the PCS 7 Engineering System
  - S7 F systems, CFC, and SIMATIC Safety Matrix are anchored in the engineering toolset
  - Configuration of basic process control functions and safety functions with one engineering tool, the CFC
  - Safety Matrix for creation of safety functions without special programming know-how: even faster, simpler and more user-friendly than with CFC
- Automatic consideration of safety-related fault messages in the process visualization, with identical time tagging
- Uniform diagnostics and maintenance from sensor/actuator via automation system up to the operator system
- Integration of safety-related technology in diagnostics and maintenance with the SIMATIC PCS 7 Maintenance Station
- Minimization of total lifecycle costs
  - Reduction of costs for hardware, mounting, wiring, installation, engineering, and commissioning as the level of integration increases
  - Low acquaintance and training requirements as result of uniform system/tool landscape
  - Cost-effective stocking of spare parts through reduction of types and parts
Optimization with Advanced Process Control

With complex processes, control concepts based on PID controllers often reach their limits quickly. Advanced Process Control (APC) functions which enable a mathematical description even of complicated relationships between process parameters are integrated in the SIMATIC PCS 7 process control system and provide significantly more options. The application of these advanced control functions permits the following:

- Drastic reduction of undesirable variations in critical process variables
- Noticeable reduction in use of raw materials and consumption of energy
- Increase in throughput and product quality
- Reduction in demands placed on operating personnel

Integrated Advanced Process Control functions

In addition to numerous basic control functions, e.g. PID control, cascade control, split range control and ratio control, the I&C libraries of SIMATIC PCS 7 provide function blocks and templates at no extra cost for the advanced control functions described below.

Using these model solutions already included in the standard, complex APC applications can be implemented simply and cost-effectively for small and medium-sized plants. A standardized APC process tag type selected from the library in accordance with the control requirement can be modified in a simple manner to allow problem-oriented determination of optimized solutions for special tasks.

Override control

With override control, the outputs of two or more controllers are connected to a common final controlling element. The decision concerning which controller actually has access to the final controlling element is made depending on the evaluation of the current process state.

- Two or more controllers share a final controlling element
- Decision for the active controller based on:
  - Measurable output variables, e.g. one of the controlled variables
  - Manipulated variables of the controllers
- Application examples:
  - Primary controlled variable: flow
  - Secondary controlled variable: pressure limiting (for safety reasons)
  - Primary controlled variable: steam pressure
  - Secondary controlled variable: level

Gain scheduling

Gain scheduling enables infinite adjustment of the controller settings in non-linear processes depending on the operating point.

Similar to the polygon block, the GainSched block derives control parameters for a connected control block at three operating points from a continuously measurable input variable (measured variable X) which describes the process status. Linear interpolation effects soft, bumpless transitions between the operating points so that the parameters of the combined PID controller can be infinitely modified dependent on the course of the measured variable X.

- Suitable for non-linear processes
- Three complete parameter sets for three operating points
- Application examples:
  - Control of pH value (neutralization) with non-linear titration trend
  - Temperature control of boilers
  - Batch processes with chemical reactions (non-linear reaction kinetics)

Dynamic feedforward control

Feed-forward control can compensate a strong, measurable interference in advance so that the control is limited to model uncertainties and non-measurable interferences.

- Compensation of strong, measurable interferences
- Eliminating faults before the appearance of negative effects
- Application examples:
  - Temperature control on an industrial furnace (disturbance variable: flow rate)
  - Concentration control in a stirring vat reactor (disturbance variable: inlet concentration)
Monitoring of the control performance

The ConPerMon block determines the control performance of the control block, e.g. the PID controller, from its setpoint, actual value and manipulated variable. Depending on the deviation from the comparison value, e.g. the control performance during commissioning, it triggers a warning or an alarm. The faceplates of all control performance monitoring actions of a process cell or unit can be combined clearly on OS screens. In this way, problems can be detected, analyzed and specifically corrected at an early stage.

- Online monitoring of the control performance
- Identification of control loops according to the criteria:
  - Maximum urgency for optimization
  - Imminent fault
- Configurable alarm limits for standard deviation and over-shoots
- Graphic evaluation
- Application example: large plants with many control loops, e.g. refineries

Smith Predictor

As an alternative to a model-based predictive controller, the Smith predictor can significantly improve the control performance of processes with long and relatively constant dead times. By eliminating the dead time component using a process model running parallel to the actual process, the controller can be designed for a process free of dead time, and set more effectively.

- Can be used on processes with long, known and relatively constant dead times:
  - Process model runs parallel to the actual process
  - Feedback of virtual controlled variable free of dead time from the process model to the controller
  - Feedback of deviation between the measured actual value and the virtual value of the controlled variable with dead time at the model output
- Draft PI(D) controller:
  - Based on component of process model that is free of dead time
  - Allows significantly more precise controller setting
- Application examples:
  - Polymerization
  - Control of analyzed values (as result of dead time associated with analyses)
  - Temperature control through supply of water or heating steam as well as via external heat exchangers

PID tuning

Using experimental trial and error, a model of the process is initially generated using the PID Tuner integrated into the engineering system. Based on this, the most favorable controller settings can be determined by means of value optimization, while differentiating between the optimum response to disturbance variable changes, and the optimum response to setpoint changes.

- Optimization of PID control loops
- Can be used for standard PID controllers and blocks from user-specific libraries
- Simulation of closed control loops
- Application example: Optimization of PID controller settings in any applications
Model-based predictive multi-variable control

The model-based predictive multi-variable controller (MPC) separately analyses the behavior of up to four interdependent variables for complex processes over a longer period. The parameter matrix calculated from the results is then used by the MPC for optimum control of these variables, and thus eliminates the disadvantageous interactions which occur with separate control of the interdependent variables.

In a tolerance range specified instead of the precise setpoint, the integral static operating point optimization can calculate the economically optimal operating point. Prediction mode predicts future process behavior within the entire prediction horizon, assuming the current values of the manipulated variables are frozen.

Advanced Process Control with SIMATIC PCS 7 add-ons

The previously described range of advanced control functions can be expanded with further such functions. In contrast to the usual interface connection, they can be seamlessly integrated into the process control system in the form of SIMATIC PCS 7 add-on products, e.g.

- Fuzzy Control++
- Soft sensors (Presto)
- Model-predictive multi-variable controller (INCA)
- Adaptive controller (ADCO)

For additional information, see:
www.siemens.com/simatic-pcs7/apc
Plants often extend over huge areas, especially in the water & wastewater and oil & gas industries. In such cases it is necessary to integrate outstations for monitoring and controlling highly remote units (usually with a small or medium degree of automation) into the control system of the complete plant. This is carried out by means of telecontrol protocols over a WAN (Wide Area Network).

The telecontrol center for the outer stations (consisting usually of simpler remote terminal units (RTUs)) can be integrated directly into the process control system using SIMATIC PCS 7 TeleControl. This results in significant advantages compared to conventional solutions in which central and remote plant areas are configured as separate units and then combined in a higher-level network control system. Benefits include:

- Uniform process control
- Simple and user-friendly data management
- Integrated engineering for central and remote plant units
- Lower service and training costs

The telecontrol center is integrated into the SIMATIC PCS 7 process control in the form of an operator station in single station or server design (also redundant as option). This PCS 7 TeleControl Operator Station (single station/server) is dedicated to telecontrol operation. However with smaller configurations, it can also control SIMATIC PCS 7 automation systems in central plant areas in parallel with telecontrol systems (dual-channel operation).

There are no differences between central and remote automation with regard to operating philosophy and alarm response. Data from the RTUs of the telecontrol system can be displayed in one process picture together with data from SIMATIC PCS 7 automation systems.
To enable engineering of the TeleControl Operator Station (single station/server), the functions of the central Engineering Station of the SIMATIC PCS 7 process control system are expanded by DBA technology (DBA) and the object library “SIMATIC PCS 7 TeleControl”.

In addition to technological objects for processing and displaying process data, the library also contains diagnostics objects for communication diagnostics and control. These blocks support SIMATIC PCS 7 compliant operator control by means of symbols and faceplates, as well as the hierarchy of SIMATIC PCS 7 fault messages. If necessary, the DBA Type Editor can be used to expand the library project-specifically with new script-based object types.

For additional information, see: www.siemens.com/simatic-pcs7/telecontrol

Hierarchical system configurations

SIMATIC PCS 7 TeleControl also supports hierarchical system configurations. These are especially significant in the oil and gas sector. Monitoring and control of the technical process is possible here via one or more (redundant) control centers, as well as lower-level control stations (subsystems).

The RTUs only have to send their data to one of the lower-level control stations, e.g. the control station of a pump station in an oil pipeline. Replication functions automatically synchronize the higher-level main control center and, if applicable, an additional disaster recovery control center with this data.

The replication functions for data matching must also be capable of ensuring data consistency in the overall system even when special events occur such as a communication failure or a system startup.

<table>
<thead>
<tr>
<th>RTU category</th>
<th>RTU type2)</th>
<th>Possible telecontrol protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small with 30 ... 200 I/Os1) for small, cost-sensitive applications</td>
<td>controller integrated in SIMATIC ET 200S</td>
<td>Modbus, IEC 870-5-101, IEC 870-5-104</td>
</tr>
<tr>
<td>Medium with 100 ... 2 000 I/Os1) for medium-sized applications</td>
<td>SIMATIC S7-300/S7-300F controller</td>
<td>SINAUT ST7, DNP3, Modbus, IEC 870-5-101, IEC 870-5-104</td>
</tr>
<tr>
<td>Large with 500 ... 5 000 I/Os1) for larger applications requiring higher performance</td>
<td>SIMATIC S7-400/S7-400F controller</td>
<td>SINAUT ST7, DNP3, Modbus, IEC 870-5-101, IEC 870-5-104</td>
</tr>
<tr>
<td></td>
<td>SIMATIC S7-400H/S7-400FH controller</td>
<td>DNP3, IEC 870-5-101, IEC 870-5-104</td>
</tr>
</tbody>
</table>

1) Dependent on CPU size, protocol type and application
2) Also in SIPLUS extreme version, e.g. for environments with temperature from -25 °C to +70 °C, condensation, or medial loading
Historically, systems for automating a process and systems for automating the power supply to this process were always strictly segregated. With SIMATIC PCS 7 PowerControl, it is now possible to combine process automation and the automation of electrical switchgears for medium voltages ranging from 4 to 30 kV in one control system. This results in a host of benefits that provide huge cost savings over the entire life cycle of the plant, by means, for example, of:

- Simpler plant structures with more transparency in the technological dependencies
- Further increase in the level of integration of the plant
- Uniform process control and further expansion of the operator’s task area
- Long-term investment security thanks to globally valid standard IEC 61850
- Rational, integrated engineering and fast commissioning
- Lower administration, service and training costs thanks to uniform holistic view
- Effective energy management (load management, consumption optimization)

These are gaining even more in importance given the increasing decentralization resulting from greater use of renewable energies. One example of this is provided by wind farms.

An electrical switchgear distributes or transforms electrical energy, bundling loads/consumers into load groups. With the help of switching devices, network nodes implemented as busbars connect incoming and outgoing cables known as feeders. When the substation is dimensioned, account is taken of changes to the network topology in the event of faults, and the isolation and grounding of equipment for maintenance work.

**Integration of intelligent electronic devices into SIMATIC PCS 7**

Electronic devices (IEDs) such as SIPROTEC protective devices or interoperable third-party devices are used for automating switchgears, that is, for protection, control, measuring and monitoring functions in electrical energy transmission and distribution. IEDs can be integrated into the SIMATIC PCS 7 process control system via Ethernet TCP/IP communication with the IEC 61850 transmission protocol for protection and control technology in electrical switchgears.
Integration options for automating medium voltage switchgears

IEDs can be integrated in two ways:

- Direct on the plant bus
- Via a station controller (PCS 7 AS) on the plant bus

IEC 61850 provides the Manufacturing Messaging Specification (MMS) for data exchange between the process control system and IEDs, and Generic Object Oriented Substation Events (GOOSE) for high-speed real-time communication between the IEDs.

Performance features of SIMATIC PCS 7 PowerControl for integrating switchgear automation into

SIMATIC PCS 7 Engineering
- Object library with function blocks, symbols and faceplates
- Object-oriented type-instance concept
- Automatic generation of the objects for the operator station
- Integration of new IEDs by importing their IEC 61850 Device Description (ICD)

SIMATIC PCS 7 process control
- Faceplates for SIPROTEC protective devices in the SIMATIC PCS 7 APL style (look&feel)
- Standardized behavior in the case of alarms, messages, and operator control and monitoring
- Diagnostics functionality for every IED
Energy management with SIMATIC PCS 7

Resources which are becoming scarcer, increasing energy prices, an increased sensitivity for environmental matters, and tighter statutory constraints significantly emphasize the importance of efficient energy management. All aspects concerning the generation, procurement, distribution, and consumption of energy must be considered.

Companies operating in the process industry must be able to plan, monitor and record their energy consumptions, to define and implement possible energy saving measures, and to prove the efficiency through regular evaluation of indicators.

Identification and evaluation of energy data

Transparency is a basic prerequisite for improving the energy balance, i.e. the measurement and recording of consumption data and the presentation of the flows of energy and media within the company. It is only possible to define potential savings and the required efforts when the consumption of each type of energy is known.

This is supported in the context of the SIMATIC PCS 7 process control system by:

- Basic power monitoring with SIMATIC PCS 7 standard functionality:
  - Data of process-related energies measured using process instruments, such as steam, cooling media or gas
  - Data provided directly by electric components such as circuit-breakers (SENTRON), frequency converters (SINAMICS), motor starters (ET 200S) etc.
  - Data of other energy consumers measured using power monitoring devices of the SENTRON PAC range

- SIMATIC powerrate for analysis and evaluation of the flows of energy with automatic reporting
  - Recording of energy and performance data from the field using additional function blocks
  - Data preparation, data visualization per faceplate, and data archiving
  - Automatic assignment of energy consumptions/costs to cost centers, units or batches
  - Monitoring of performance limits according to process/user-specific definitions

- B.Data software for optimization of operational energy management with division and transfer to the accounting system in accordance with the causer
  - Company-wide transparency thanks to gap-free energy and material balancing of power generation and consumption plants
  - Generation of key performance indicators (KPIs) for reliable statements on raising the efficiency of energy generation, distribution, and consumption systems
  - Distribution of energy costs and revenues based on causer, and transfer of such to ERP systems (e.g. SAP R/3)
  - Production-based prediction of loads and requirements to improve planning security
  - Support of cost-effective purchasing of energy
Optimization of energy utilization

SIMATIC PCS 7 and SIMATIC powerrate can be used to optimize the energy utilization such that previously unused resources can be accessed, and consumption peaks avoided. SIMATIC powerrate with the integrated load management function permits active monitoring of performance limits. SIMATIC PCS 7 standard blocks use the current consumption to calculate a prediction for the running 15-minute average, and compare this with defined limits. Consumers can be specifically switched off or on, for example, in order to smoothen larger peaks or to observe limits agreed by contract with the energy supplier. In the case of unstable power supplies, loads can also be rapidly disconnected in order to guarantee the operation of critical plant components using the remaining infeed capacity.

Furthermore, the optimization of processes using Advanced Process Control (APC) as well as plant-level asset management with the PCS 7 Maintenance Station provide a significant contribution to energy-efficient plant operation.

Energy saving with innovative technology

The application of low-energy motors or frequency converters is a further large potential for savings, especially with energy-intensive production processes, e.g. in the chemical or pharmaceutical industry.

Energy-saving motors
Energy-efficient motors have a power loss reduced by up to 42%. Since the share of energy costs in the total costs of a motor over its complete lifecycle is approximately 98%, enormous cost savings can be achieved for new plants or when modernizing existing plants.

Energy saving potential through frequency converters

Frequency converters with braking energy recovery
Frequency converters make it possible for the equipment in plants, such as pumps, fans or compressors, to always operate within the optimum working range. Energy savings of up to 50% can then be achieved compared to conventional control procedures.

Consulting

With its modular Premium Service "Energy study", Siemens offers holistic solutions for energy saving with associated process optimization options for reducing operating costs. The range of services covers evaluation of the plant’s energy requirements, the preparation of a feasibility study for effective energy-saving measures, up to specific implementation of the determined measures in the plant.

For additional information, see: www.siemens.com/simatic-pcs7/energy-management
Industrial security
Comprehensive protective measures for I&C plants

Progressive standardization, opening and networking of control systems has been accompanied by an enormous increase in security risks for a process control plant. The potential dangers arising from destructive programs and access by unauthorized personnel range from network overloads or failures, theft of passwords and data, to unauthorized access to process automation. Apart from material damage, specifically targeted sabotage can also have dangerous consequences for personnel and the environment.

SIMATIC PCS 7 security concept

SIMATIC PCS 7 offers comprehensive solutions for safeguarding a process engineering plant that are based on a hierarchical security architecture. What is special about this concept is its holistic approach. It is not restricted to use of individual security methods (e.g. encryption) or devices (e.g. firewalls). Rather its strengths are the interaction of a host of security measures in the plant network.

The SIMATIC PCS 7 security concept comprises advice and recommendations (best practices) on the following topics:

- Design of a network architecture with graded security levels (defense in depth), combined with segmenting of the plant into security cells
- Network management, network segmentation
- Operation of process cells in Windows domains (Active Directory)
- Administration of Windows operator privileges and SIMATIC PCS 7 operator privileges; integration of SIMATIC PCS 7 operator privileges into the Windows administration
- Reliable control of time synchronization
- Management of security patches for Microsoft products
- Use of virus scanners and firewalls
- Establishment and operation of support and remote access (VPN, IPSec)
The security aspects and the recommendations for safeguarding the automation plant are described in detail in the manual "PCS 7 & WinCC Security Concept basic document" and the further detailed documents.

**System support for the security concept**

On the system side, SIMATIC PCS 7 supports implementation of guidelines and recommendations of the security concept by means of:

- Compatibility with the current versions of virus scanners
  - Trend Micro OfficeScan Client-Server Suite
  - McAfee VirusScan Enterprise
  - Symantec Endpoint Protection
- Use of the local Windows firewall
- Automatic setting of security-relevant parameters such as DCOM, registry and Windows firewall already during setup
- User administration and authentication using SIMATIC Logon
- Integration of Industrial Security Modules SCALANCE S602, S612, S613
- Automation firewall
- Application whitelisting with McAfee Application Control

**SCALANCE S industrial security modules**

The SCALANCE S602, S612 and S613 industrial security modules offer scalable security functions such as port filter, NAT, DHCP server, data encryption (IPSec), and VPN in a rugged, industrial-compatible design. They can be used, for example, to safeguard the cross-cell data exchange between components of automation and process control systems.

**Automation firewall**

The automation firewall is based on the Forefront Threat Management Gateway 2010 from Microsoft, and it is provided with stateful inspection packet filters, application layer firewall, VPN gateway functionality, URL filtering, Web proxy, virus scan, and intrusion prevention. It thus protects the access point to the production environment e.g. from the office or intranet/Internet networks. It can be used as follows, depending on plant size:

- Access point firewall for small plants and secure remote access
- Three-homed firewall for small to medium-sized plants with minimal perimeter network
- Front and back firewall for maximum protection in larger plants with extensive perimeter network

The automation firewall is supplied preinstalled. A user-friendly configuration wizard is provided for setup.

**Application whitelisting**

Application whitelisting protection mechanisms guarantee that only trustworthy applications and programs are executed on a station of the SIMATIC PCS 7 process control system. They prevent the execution of illegal software and the modification of installed applications, and thus add to the existing protection against malware (malicious software).

**Industrial security services**

Siemens Industry Automation not only offers products and systems but also professional services and solutions for protection of industrial plants against the manifold threats to IT security. These industrial security services are not only oriented according to individual phases but are provided for the complete lifecycle of the plant.

The "Awareness Workshop" and "Assessment" services can be used to identify spheres of activity for an holistic security program. Specific consulting concerning secure plant configurations and concepts support customers in the individual planning of their I&C plant. Services for implementation and acceptance test support the protective measures. These also include the service for setting up and updating the automation firewall as well as for implementation of the application whitelisting concept.

For additional information, see: www.siemens.com/industrial-security
Interfacing to IT systems
Evaluating and managing process data with OpenPCS 7

The OpenPCS 7 server collects data for the OPC clients. Depending on the system configuration, these data may be distributed across different SIMATIC PCS 7 stations (OS server, archive server). It covers the distribution of data with respect to:

- Period (OS1 / OS2 / ... / archive server)
- Location (OS1 / OS2 / ...)
- Redundancy (OS1 master / OS1 standby...)

The OpenPCS 7 interface is based on the OPC specifications (Openness, Productivity, Collaboration) that mainly make use of Microsoft’s DCOM technology (Distributed Component Object Model) for communication between the applications. It supports the following standardized access options:

**OPC DA (data access server)**

For read and write access to process values according to OPC specification OPC DA V2.05a and V3.0.

As an OPC DA server, the OpenPCS 7 server provides other applications with current data from the OS data management. The OPC client can log itself on to ongoing changes or also write values.

**OPC HDA (historical data access server)**

For read-only access to archived process values according to OPC Specification OPC HDA V1.2

As an OPC HDA server, the OpenPCS 7 server provides other applications with historical data from the OS archive system. The OPC client, e.g. a reporting tool, can specifically request the required data by defining the start and end of a time interval. Numerous functions, e.g. variance, mean value or integral, already permit preprocessing by the HDA server and thus contribute to reduction of the communications load.

**OPC A&E (alarm & events server)**

For read-only access to messages, alarms and events according to OPC Specification OPC A&E V1.1

As an OPC A&E server, the OpenPCS 7 server passes on OS messages together with all accompanying process values to the subscribers at the production and corporate management levels. They can of course also be acknowledged there. Filter mechanisms and subscriptions ensure that only selected, modified data are transmitted.

**OPC "H" A&E (Historical Alarm & Events Server)**

For read access to archived alarms and messages

Thanks to a Siemens extension of the OPC standard interface, the OpenPCS 7 server is able to transmit historic alarms and messages from the archive to subscribers in the production control and corporate control level.

**OLE-DB**

Simple, standardized direct access to the archive data in the Microsoft SQL server database of the operator system is possible with the OLE-DB. Through this, all OS archive data are accessible with the accompanying process values, message texts and user texts.
The competitiveness of a company depends on a quick response to market requirements and optimization of the supply chain. At the interface between production and management, Manufacturing Execution Systems (MES) ensure uniform optimization of corporate processes - and therefore greater efficiency, integrated transparency and consistent quality.

With SIMATIC IT, Siemens has one of the most powerful and flexible MES systems on the market. As a component of Totally Integrated Automation, SIMATIC IT is based on consistent standardization of interfaces and clear ISA-95-compatible structuring and works homogeneously with all commonly available ERP and process control systems. Modeling of the entire product manufacturing know-how, precise definition of the operating processes, and real-time data acquisition from the ERP and the production level enable SIMATIC IT to control operating processes more effectively, to minimize downtimes, production waste and reworking, and to optimize stockholding.

With three SIMATIC IT suites, independent components, and SIMATIC IT libraries (reusable MES applications), SIMATIC IT can be quickly and flexibly aligned to the specific requirements of companies in different sectors of the process and life sciences industry.

As well as normal technical support, the range of services also encompasses predictive and preventive service and support. It supports the customer in optimizing the availability of IT resources in the production plant, whether by automatic management of software updates or by predicting potential server problems.

SIMATIC IT Suites

**SIMATIC IT Production Suite**

is a manufacturing execution system in accordance with ISA-95 that combines ERP systems with process control technology, and visualizes production performance in real time at the corporate management level.

**SIMATIC IT R&D Suite**

combines research and development with the production plant for system-wide optimization of research and development processes, and for reducing product launch times.

**SIMATIC IT Intelligence Suite**

analyzes the production data acquired in real time in combination with the business data, and thus derives improvement measures.

SIMATIC IT Components

The following SIMATIC IT components provide MES basic functionality in accordance with ISA-95 for specific task areas such as order management, materials management, personnel management or report management:

- SIMATIC IT Product Definition Manager
- SIMATIC IT Production Order Manager
- SIMATIC IT Material Manager
- SIMATIC IT Personnel Manager
- SIMATIC IT Messaging Manager
- SIMATIC IT Data Integration Service
- SIMATIC IT Client Application Builder (CAB)
- SIMATIC IT Report Manager

Other SIMATIC IT components can be used in stand-alone mode and can also be combined with other MES functionalities:

- SIMATIC IT Historian - PIMS (Plant Information Management System)
- SIMATIC IT Unilab - LIMS (Lab Information Management System)
- SIMATIC IT Interspec - Product specification management
- SIMATIC IT Unicam - Solution for manufacturers of electronic components

SIMATIC IT libraries

**Sector-specific SIMATIC IT function packages**

SIMATIC IT also offers specific function packages for life sciences and different sectors of the process industry. Pre-configured best-practice applications in SIMATIC IT libraries already cover 80% of sector-specific customer requirements as standard.
Compact systems
SIMATIC PCS 7 BOX – complete control system in compact design

SIMATIC PCS 7 BOX enhances the SIMATIC PCS 7 range with low-price, rugged and space-saving industrial PC systems with versatile application options, e.g. as:

- Client in an operator system or in SIMATIC BATCH
- Compact process control system with system functionality for engineering (ES), automation (AS), HMI (OS)
- Runtime system with system functionality as above, but without engineering

SIMATIC PCS 7 BOX systems are compact systems and are reduced to the last two applications listed above.

With the SIMATIC PCS 7 OS Runtime software limited to 2,000 process objects (POs), excellent physical properties, and small dimensions, they are designed for automation at plant level for:

- Small applications/units in production processes
- Package units (enclosed subprocesses)
- Laboratories or institutes

They are also highly suitable as training systems for operators and service engineers.

The application of standard SIMATIC PCS 7 components ensures scalability and unlimited expansion without a change in compatibility. With increasing requirements, e.g. if a test system is subsequently to be operated as a productive system of larger scale, expansion with SIMATIC PCS 7 system components is possible without problem, as is integration into the production plant.

The product range is differentiated primarily via the automation functionality, that is, via the controller type:

- **SIMATIC PCS 7 BOX RTX**
  - with integrated WinAC RTX software controller
- **SIMATIC PCS 7 BOX**
  - in combination with a separate external controller:
    - PCS 7 AS RTX Microbox automation system
    - Modular automation system of the S7-400 series as single or redundancy station

The selection depends on the price/performance ratio and on the supported hardware and software functionalities.

The two basic types can be differentiated further depending on whether the engineering is concentrated in a central engineering system or integrated in the compact system:

- **SIMATIC PCS 7 BOX RTX**
  - ES/OS system with ES + OS + AS functionality
  - OS Runtime system with OS + AS functionality
- **SIMATIC PCS 7 BOX**
  - ES/OS system with ES + OS functionality
  - OS Runtime system with OS functionality

A complete process control system for small applications can be implemented by expanding with distributed process I/Os on the PROFIBUS fieldbus or the FOUNDATION Fieldbus H1 (only in combination with modular automation systems from the S7-400 range). The ET 200M, ET 200iSP, ET 200S and ET 200pro remote I/O stations are supported by a comprehensive range of low-cost signal/function modules, but also by field/process devices connected direct over the fieldbus.

The compact systems can be incorporated into the PCS 7 asset management using the integrated SIMATIC PC DiagMonitor diagnostic software. Equipped as an ES/OS system with additional software licenses for SIMATIC PDM and SIMATIC PCS 7 Maintenance Station, a compact system can also be operated as a maintenance station.
Design versions

The compact systems are operated and monitored as standard using separate control units (mouse, keyboard, process Monitor).

An alternative design version with panel (photo on right) also permits operation and monitoring using a 19” TFT Touch Panel with a resolution of 1280 x 1024 pixels.
Migration of own and third-party systems

An investment for the future

Migration strategy

Globalization and the intensified competition that accompanies it are forcing companies to continuously increase productivity and shorten product launch times. To achieve this, it is necessary to continuously optimize the engineering and process, with simultaneous consideration of new industrial requirements and regulations.

Existing systems and plants have to be repeatedly expanded and modernized to ensure that companies can also satisfy tomorrow’s market requirements. However, since the installed basis of hardware, application software and know-how of the operating and maintenance engineers represents an enormous value, the safeguarding of investments for companies operating the plants is always assigned a high priority during all modernization plans.

Experience has shown that the success of a migration process greatly depends on a technical solution optimally matched to customer requirements and the respective plant. Minimization of the technical and financial risks together with safeguarding of investments for as long a period as possible are always fundamental aspects. The different life cycles of the various system components must also be considered, which currently vary from 5 years for PC-based workstations, 15 years for controllers, up to 25 years or more for input/output components and wiring.

For this reason, Siemens sees its task in the case of migration to be not simply the complete replacement of an existing system, but also, in close collaboration with customers and their system integrators, the production of an individual, future-oriented solution based on the state-of-the-art SIMATIC PCS 7 process control system – always under the directives:

- Step-by-step system innovation
- Adaptable to the special conditions of the plant
- Flexible according to production demands

Flexible migration solutions

The reasons for modernizing process control systems are as diverse as the available systems, their communication networks, the quality of the engineering, and the documentation or spare parts supply. The aims of modernization are also diverse:

- Guaranteeing automation functionality in aging components
- More up-to-date closed-loop and open-loop control strategies
- Rising requirements for networking and documentation
- Capacity expansion
- Enhanced production flexibility
The first and most important task of an optimal migration concept for a plant is to analyze the starting point, and from this to derive the goals of the modernization.

With very old systems, complete replacement by the new process control system is usually the preferred method. However, it is often possible to continue using components such as controllers or I/O modules. If these still correspond to functional and performance requirements, and if sufficient spare parts are available or still supported by the supplier, a complete replacement of the system is not mandatory. By integrating components that are worth keeping into the migration concept, significant investment savings can be achieved and conversion times shortened.

Even if the hardware is largely obsolete, the available controller engineering can still represent significant value. The entire process automation know-how, often optimized over a period of years, is concentrated here. Intelligent tools help to analyze this data, and in certain circumstances, they can significantly reduce costs for re-engineering the new system thanks to function-based conversion of the existing engineering.

But migration is more than just a matter of porting field-proven functions to a new system platform. Modern process control systems such as SIMATIC PCS 7 offer significantly more performance, flexibility and functionality than the systems of the 1980s and 90s. For this reason, it is certainly worthwhile to also revise and optimize the closed-loop and open-loop control functions, as well as the operator input and alarm concepts, during or following a migration.
Experts with experience of migration

In view of the complexity of many migration projects, decisive prerequisites for migration success include the analysis and design of the correct procedure, including a realistic assessment of the opportunities and risks. The migration experts at Siemens have already acquired relevant experience in migrating the most diverse systems. This know-how is concentrated in Migration Support Centers that support migration projects worldwide by means of analyses, concepts and powerful tools.

If desired, Siemens works closely with the customer’s system integrators when implementing migration projects, for they have the know-how gained over many years, coupled with precise knowledge of the plant and the customer's requirements. For the plant operator, this partnership is the guarantee for an optimal migration outcome.

For additional information, see: www.siemens.com/simatic pcs7/migration

Migration spectrum

Siemens recognized the significance of migration for process automation at an early stage, and has for many years offered a wide range of innovative migration products and solutions for its own globally proven systems, such as APACS+ or TELEPERM M.

Migration of old systems from other manufacturers such as ABB, Honeywell, Emerson or Invensys has since become firmly established. Here too, various products and solutions support the step-by-step transition to SIMATIC PCS 7. Increasingly, the universal, OPC-linked SIMATIC PCS 7/Open OS is used here. This allows any systems to be incorporated into the integrated operational concept of SIMATIC PCS 7. Engineering tools such as DBA (Data Base Automation), or the powerful migration platform for controller engineering, accelerate the change-over from old systems to SIMATIC PCS 7. This is all supplemented by further solutions including those for communication between the old and new system, or for fast switch-over of field wiring in migration projects, e.g. specific gateways, connectors, cables, and field termination assemblies (FTAs).

With the future-oriented SIMATIC PCS 7 process control system, innovative migration solutions and services, many years of expertise in process automation and migration, as well as continuous worldwide servicing, Siemens demonstrates its expertise and offers the security of a reliable partner.
Services
Global service & support

Siemens Industry Automation and Drive Technologies offers comprehensive service and support to its customers worldwide for its products and systems. An experienced team of specialists directly on site will support you with bundled know-how for planning and implementation, commissioning, maintenance and modernization in more than 100 countries. Regular training courses and intensive contact among our employees – even across continents – guarantee a high quality for our services.

Online support
By using a Service & Support portal on the Internet, the very latest expert knowledge can be called from any country and at any time. The information is extremely versatile and, in addition to product support, also includes details on the services offered and on regional partners.

www.siemens.com/automation/support

Technical support
The competent technical support provides help for technical questions concerning products and systems by means of a wide range of adequate consulting services. Regional technical support is supported when handling technical inquiries by central technical support in Europe, the USA and Asia. Observation of the different times on the continents enables 24/7 consulting.

Service personnel can access all the available request-related information worldwide via an IT-supported network.

www.siemens.com/automation/support-request

Technical consulting
Experts provide support during planning and design of a project – covering detailed analysis of the current situation, definition of objectives, advice on products and systems, and design of the automation solution.
Field service

Specialists for commissioning and maintenance guarantee a trouble-free production startup as well as the availability of machines and plants. The assignments are coordinated by regional control centers which can be reached round-the-clock.

Spare parts and repairs

Since downtimes resulting from technical problems are associated with losses in revenue and additional costs, everything is done to avoid or minimize these.

Supported by a powerful logistics system, a global network of regional warehouses enables fast delivery of spare parts, in many countries also in combination with a spare parts emergency service.

If a repair is possible, this can be carried out in a Repair Center or by a mobile repair service – fast, reliably and with a high quality.

Optimization and modernization

Advancements during the operating phase frequently generate a new potential for optimization and modernization. Local Siemens experts provide expert, competent advice on new possibilities for increasing productivity and saving costs.

Training

Participation in professional training oriented according to target groups in more than 60 countries worldwide enables the acquisition of profound Simatic PCS 7 system knowledge as well as the expansion of existing know-how. In practice-oriented courses, participants receive excellent training directly from the manufacturer, and this enables them to efficiently use the process control system within the shortest possible time. The range of courses also includes special hands-on training direct on site at the customer plant.

www.siemens.com/sitrain
Service programs

As well as global service and support, the range of services of Siemens Industry Automation and Drive Technologies also includes special service programs for the process industry that can be used independently of each other and flexibly adapted.

SIMATIC PCS 7 Life Cycle Services

When making decisions concerning investments in new or innovative control technology, the associated costs must always be evaluated in relation to the total cost of ownership (TCO) of the plant. Support, maintenance, servicing, and modernization make a significant contribution to these costs. The short innovation cycles associated with the introduction of PC technology to process automation must also be taken into consideration. It is all the more important to keep servicing costs transparent and plannable. Indispensable in this regard is a cost-optimized life cycle service which guarantees the functionality of the control technology for a defined time period. By using active obsolescence management, Siemens takes into account the aging process of the I&C plants and supports its control system customers in designing specific substitute solutions as well as appropriate maintenance and spare parts strategies.

Based on many years of experience, the service specialists from Siemens have identified four fundamental requirement profiles and developed appropriate service modules which build upon each other: Standard Service, Maintenance Service, Basis Life Cycle Service and Extended Life Cycle Service (see graphic).

The scope of services agreed individually on the basis of service modules and additive supplementary services is stipulated in a contract. The contracts are flexible enough to allow adaptation in the event of plant modifications. The service contract management includes documentation, planning of measures, and performance controlling.

Safety Life Cycle Services

The safety life cycle is divided into analysis, implementation and operation, and it follows the life cycle of the I&C systems. Operators of safety-related I&C systems, e.g. chemical plants, refineries, and distilleries, who use safety-related systems and equipment to reduce the risk and effects of a safety event are obliged in accordance with IEC 61511 to verify the effectiveness of their protection measures in the safety life cycle.

In addition to the correct hardware and software, applied planning, operating, and modification processes are decisive in ensuring that the safety engineering effectively maintains its intended function throughout the complete life cycle of the plant. With Safety Life Cycle Services, Siemens provides not only the necessary expert know-how for safety verification, but also progressive tools and methods that exclude systemic errors in all project phases. This is all the more important since errors in an early project phase are often costly and time-consuming to correct at a later date. In addition, plant operators do not have to acquire the expert know-how themselves and permanently adapt to the latest guidelines and technologies.

SIMATIC Remote Support Services

Using modern IT structures and secure Internet connections, SIMATIC Remote Support Services offer preventive, system-specific support, which is highly efficient, flexible and profitable. The SIMATIC Remote Support Services are based on the high-performance Siemens Remote Service (SRS) platform, that enables secure remote access to the automation system - both by Siemens experts as well as by your own system specialists or system integrators.
The information provided in this brochure contains descriptions or characteristics of performance which in case of actual use do not always apply as described or which may change as a result of further development of the products. An obligation to provide the respective characteristics shall only exist if expressly agreed in the terms of contract. Availability and technical specifications are subject to change without notice.

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