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 operating system 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.

Licensing of the standard engineering software depends on use of the engineering station as:

- Classical, exclusive engineering station (2-hour OS test mode, but no OS productive operation possible)
- Combined engineering/operator station for small applications

# 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.

The project data for engineering of the operator systems is also organized with the SIMATIC Manager. All the data relevant to operation and monitoring of a process tag are generated automatically during definition of the automation function.

A powerful Graphics Designer supports generation of the process displays. The basis for generating process displays is provided by static symbols and dynamic block icons and faceplates that are managed in libraries and linked to the parameters of the function blocks.

Component view: hardware configuration with HW-Config

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.

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
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. This is also 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 used for configuration of the continuous automation functions. In addition to convenient editing functions, its scope of functions also includes powerful test and commissioning functions as well as individually configurable documentation functions.

Instances of function block types can be positioned, assigned parameters, and interconnected on CFCs. Access privileges can already be assigned at the block level per block attribute, thus enabling finely graded privileges.

When creating a new CFC, a runtime group with the same name is created and automatically assigned to all blocks of this chart. Each block is therefore immediately assigned runtime properties which the configuration engineer can change or optimize using algorithms.
Continuous Function Chart

Sequential Function Chart

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**
  Function block types supplied with I&C libraries are used for I&C modeling of engineering equipment such as valves or motors. The smallest standardized software modules for multiple usage have connections for actuating and control signals and for parameter assignment and monitoring functions. Some also contain interlocking functions for automatic transition to defined safety settings.

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

- **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.

### 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 is 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 blocks
  - 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, split-range) etc. extend the scope of library elements.

Advanced Process Library

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

Proven functions 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 of local control options
  - "Out of service" for deactivating a measuring point for maintenance
- 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 technological blocks
- 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
- Integration of any compact drives and switch/starter objects via standard PROFIBUS profiles
- Coordination of multiple access operations, e.g. of SFC/SIMATIC BATCH, to the equipment such as valves, pumps etc.
- 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. This includes:

- 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 appear in the design of 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 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, thus controlling the access to data. Access rights for stations of the process control system and operator privileges for blocks can both be set up. Configurable modification protocols can record 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 when. Such verifications are often the object of special 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, CFCs/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

When used together with SIMATIC Logon, SIMATIC Version Trail permits 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 can also be performed independent 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.

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.

The user is supported in carrying out tasks by integrated workflow management. The sequence and progress of execution are displayed in a header.
The AdvES rationalizes mass data engineering by means of multiplying standardized software modules. Both the individual control module types (CMTs) and the classic process tag types are supported. AdvES is optimized for working with the control module types.

A CMT library of the PCS 7 Basic Control Modules (BCMs) is integrated into AdvES. With system support, any user libraries with process tag types can be converted into control module types.

Blocks, links, connections or messages can be added later to a CMT or removed from it, even if instances (individual control modules (CMs)) already exist. In this way, versions of process tag types can be defined very easily for multiple use. The instances can be checked for deviations from CMT, and adapted if necessary.

Summary of basic AdvES functions

- Import of system planning data and SIMATIC PCS 7 engineering data
- Processing functions for the manual completion of imported data
- Simple interconnection of several process tags
- Generating of process tags from signal and process tag lists
- Generation of hardware configurations from signal lists
- Batch processing of process tags, signals, and parameters
- Automatic plausibility and consistency check
- Transfer of data into the SIMATIC PCS 7 Engineering System
- Reports for updates and tests
Engineering System highlights

- Central hardware and software configuration which is uniform throughout the system through use of one engineering system
  - User-friendly GUI
  - Low-effort parameterization of communication
  - Same configuration for redundant plants
  - Integrated configuration for field devices and safety-related applications
- Technology-oriented configuration
  - Functional hierarchy organized according to plants, units, and technical equipment
  - Hardware-independent engineering: AS assignment and I/O modules can be subsequently selected
  - Expandable on industry-specific basis using standard data exchange interfaces
- Integral user administration with access control
- Central dialog for compilation and loading of AS, OS, and SIMATIC BATCH modifications
  - Optimization of sequence and control by dialog with sequence control
  - Compilation and loading in one operation: minimum turnaround times
  - Online loading of selective changes in configuration
- Process object view for display and processing of all aspects of process tags/objects
  - Convenient editing in tables
  - Process library with import/export functions
  - Online mode for testing and commissioning
- Shared configuration tasks: Concurrent Engineering or Multiproject Engineering with Branch & Merge
- Configuration-dependent hiding of alarms for specific operating states
- Special SFC functionalities:
  - SFC type: sequential control for multiple use, instances as block in the CFC
  - SFC: sequential control for single use, also with chart I/Os
  - Separate sequences for statuses such as HOLD, ABORT or SAFE STATE, conforming to ISA-88
- Lower engineering/validation overhead:
  - Advanced Process Library (function blocks, faceplates, icons, process tag types)
  - 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 of a multiproject
  - Many automatic configuration steps (auto engineering)
  - Simple duplication of units by copying, renaming and compilation
- High-performance version management with version comparison and version history
- Automatic generation of diagnostics displays for the maintenance station on the basis of the project data
- Integrated engineering workflow with COMOS planning tools