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 427D 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 on 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 and OS controls 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 occupation strategies 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 the Process Historian and 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. 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
- Occupation strategy during creation of the recipe, and assignment of units 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.

Special list representations for order categories, production orders, batch planning, batch status or batch result support and simplify batch planning and batch control. Creation and distribution of the batches for a production order are possible manually, but can also be carried out automatically depending on the definition of the batch number or production quantity. All batches including their unit allocation can be clearly presented in a combination of Gantt diagram and table. Time conflicts or those resulting from multiple allocation of units are identified by symbols. Time conflicts can be eliminated simply by shifting the associated batches in the Gantt diagram. The following batch properties can be set and changed:

- Quantity
- Start mode (immediately, following operator input, or time-driven)
- Unit allocation
- Formula (parameter set)
- Run sequence (chaining to previous or subsequent batch)
- Display of planned runtime for a batch
- Definition of minimum time interval for batch chaining

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 appropriate units using static equipment properties and dynamic attributes
- 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

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

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 selection criteria. The final assignment of the units following evaluation of the static and dynamic properties (e.g. vessel size and cleaning status) is then 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)
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 on SIMATIC BATCH, see: www.siemens.com/simatic-batch