



Andhra Pradesh State Skill Development Corporation







Basics of PLC

Scan cycle and accessories of PLC



Scan cycle of PLC

A PLC program is generally executed repeatedly as long as the controlled system is running. The status of physical input points is copied to an area of memory accessible to the processor, sometimes called the "I/O Image Table". The program is then run from its first instruction rung down to the last rung. It takes some time for the processor of the PLC to evaluate all the rungs and update the I/O image table with the status of outputs. This scan time may be a few milliseconds for a small program or on a fast processor, but older PLCs running very large programs could take much longer (say, up to 100 ms) to execute the program. If the scan time were too long, the response of the PLC to process conditions would be too slow to be useful.

Special-purpose I/O modules may be used where the scan time of the PLC is too long to allow predictable performance. Precision timing modules, or counter modules for use with shaft encoders, are used where the scan time would be too long to reliably count pulses or detect the sense of rotation of an encoder. The relatively slow PLC can still interpret the counted values to control a machine, but the accumulation of pulses is done by a dedicated module that is unaffected by the speed of the program execution.

System overview

SIMATIC S7 overview

SIMATIC is a core part of Totally Integrated Automation and its range includes numerous standardized products and systems - such as the SIMATIC Controllers presented in this brochure. Whether you prefer a conventional PLC, an embedded or a PC based automation solution: The complete range of SIMATIC Controllers covers solutions for all application areas

– and offers the performance capability and flexibility you need.

Positioning of Modular S7 Controllers

The Modular Controllers have been optimized for control tasks and specially designed for ruggedness and long-term availability. They can be flexibly expanded at any time using plug-in I/O modules, function modules, and communication modules. Depending on the size of the application, the right controller can be selected from a wide range according to performance, quantity frameworks, and communication interfaces. The modular controllers can also be used as fault-tolerant or fail-safe systems.

Your benefits

1. Flexible in use
2. Openness in hardware and software configuration
3. Use of existing PC resources
4. Participation in the continuous PC innovation process
5. Multifunctional
6. Customized PC variants



7. Embedded bundles:

- a. Ready to use
- b. Rugged
- c. Maintenance-free

Fields of application

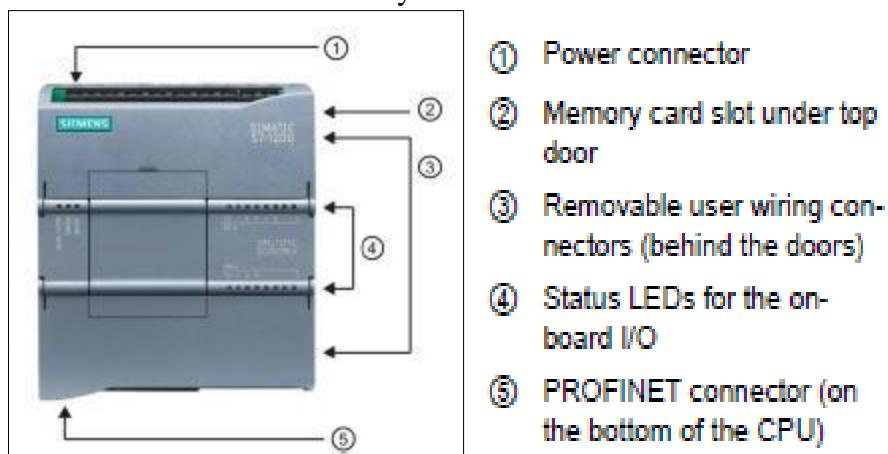
1. Control, operator control and monitoring
2. Technological tasks
3. Data acquisition and archiving
4. Link to PC hardware and software
5. Integration of C/C++/C# programs
6. Data exchange via OPC
7. Fail-safe control

SIMATIC S7-1200: The Modular Mini-PLC

- Compact controllers for the low to mid-performance ranges
- Large-scale integration, space-saving, powerful
- With exceptional real-time performance and powerful communication options:
 - Controller with integrated PROFINET IO controller interface for communication between SIMATIC controllers, HMI, programming device or other automation components
- All CPUs can be used in stand-alone mode, in networks and within distributed structures
- Extremely simple installation, programming and operation
- Integrated web server with standard and user-specific web pages
- Data logging functionality for archiving of data at runtime from the user program
- Powerful, integrated technology functions such as counting, measuring, closed-loop control, and motion control
- Integrated digital and analog inputs/outputs
- Flexible expansion facilities
 - Signal boards for direct use in a controller
 - Signal modules for expansion of controllers by input/output channels



- Accessories, e.g. power supply, switch module or SIMATIC Memory Card



SIMATIC S7-1500: Modular Controller for mid to upper range Performance

- Modular, scalable, and universally usable system in IP20 level of protection
- The system solution for a variety of automation applications in discrete automation
- Highest performance with excellent usability
- Configurable exclusively in the Totally Integrated Automation Portal with STEP 7 Professional V12 or higher

Performance

- Increase in performance through
 - Faster command execution
 - Language extensions
 - New data types
 - Faster backplane bus
 - Optimized code generation
- Powerful communication:

PROFINET IO (2-port switch) as standard interface

From CPU 1515-2 PN, one or more additional integrated PROFINET interfaces,
e.g. for network separation

- Expandable with communication modules for bus systems and point-to-point connection



Integrated technology

- Motion Control integrated without additional modules:
 - Standardized blocks (PLC open) for connection of analog and PROFI drive- capable drives
 - The Motion Control functionality supports speed-controlled and positioning axes as well as external encoders
 - Position wise precise gearing between axes
- Comprehensive trace functions for all CPU tags for real-time diagnosis and sporadic error detection;
For effective commissioning and quick optimization of drives and controls
- Comprehensive control functionalities:
E.g. easily configurable blocks for automatic optimization of the control parameters for optimum control quality
- Additional functions through available technology modules:
E.g. high-speed counting, position detection, or measurement functions for signals up to 1 MHz

Safety Integrated

Protection of personnel and machinery – within the framework of an integrated complete system

- Failsafe SIMATIC S7-1500F controllers for processing standard and safety programs on the same controller.
Generation of the failsafe and standard user program is carried out in the TIA Portal with the same editors; this enables failsafe data to be evaluated like standard data in the standard user program, for example. Due to this integration the system benefits and the comprehensive functionality of SIMATIC are also available for failsafe applications.

Security Integrated

- Password-based know-how protection against unauthorized reading and modification of program blocks
- Copy protection for greater protection against unauthorized copying of program blocks:

With copy protection, individual blocks on the SIMATIC memory card can be tied to its serial number so that the block can only be run if the configured memory card is inserted into the CPU.



- Rights concept with four different authorization levels:

Different access rights can be assigned to various user groups. The new protection level 4 makes it possible to also restrict communication to HMI devices.

- Improved manipulation protection:

Changed or unauthorized transfers of engineering data are detected by the controller.

- For use of an Ethernet CP (CP 1543-1):

- Additional access protection by means of a firewall
- Setup of secure VPN connections (V12 SP1 or higher)

Design and handling

- CPUs with display for plain text information:

- Information about article numbers, firmware version, and the serial number of all connected modules can be displayed
- Setting the IP address of the CPU and additional network settings directly on site, without programming device
- Display of occurring error messages directly as plain text message, meaning reduction in downtime

- Uniform front connectors for all modules and integrated potential bridges for flexible potential group formation simplify stock keeping and reduce wiring costs

- Integrated DIN rail in the S7-1500 mounting rail:

Quick and easy installation of additional components such as miniature circuit breakers, relays, etc.

- Central expansion with

signal modules: For
flexible adaptation to any
application

- System cabling for digital signal modules:

For fast and clearly arranged connecting to sensors and actuators in the field and simple wiring inside the control cabinet

- Power supply:



- Load power supply modules (PMs) for supplying the module with 24 V
- Power supply modules to supply power to the internal module electronics via the backplane bus
- Distributed expansion:
 - Use of up to 30 signal modules, communication modules, and technology modules via the PROFINET interface module IM 155-5 for the ET 200MP I/O system
 - No difference in terms of handling and system functions in central and distributed operation

Integrated system diagnostics

- Integrated system diagnostics for CPUs, activated by default:
 - Consistent plain text display of system diagnostic information in the display, TIA Portal, HMI, and web server, even for drive messages. Messages are updated even if the CPU is in STOP state.
 - System diagnostics integrated in the CPU firmware. Configuration by user not required. The diagnostics is automatically updated on configuration changes.

Data log (archives) and recipes

- SIMATIC memory card:
- Plug-in load memory
- Permits firmware updates
- Storage option for STEP 7 projects (including comments and symbols), additional documentation, or csv files (for recipes and archives)
- Easy access to plant-relevant operating data and configuration data with Office tools via the SD Card reader (two-way data exchange from and to the controller)
- Integrated web server:
- Easy access to plant-relevant operating data and configuration data via a Web browser

Approvals

The SIMATIC S7-1500 complies with the following national and international standards:

- cULus approval
- cULus HazLoc approval



- FM approval
- ATEX approval (only for 24 V; not for 230 V)
- CE
- C-TICK
- KCC
- IECEx (24 V only; not for 230 V)
- EN 61000-6-4
- EN 60068-2-1/ -2/ -6/ -14/ -27/ -30/ -32
- EN 61131-2

SIMATIC S7-1200/1500: Technology Functions

S7-1200 Functions

The S7-1200 is characterized by:

- Easy getting started:
Special starter packages including simulators and documentation facilitate familiarization.
- Uncomplicated operation:
Powerful standard commands which are simple to use, together with the user-friendly programming software, reduce the programming overhead to a minimum.
- Real-time properties:
Special interrupt functions, fast counters, and pulse outputs permit use even with time-critical processes.

The SIMATIC S7-1200 meets national and international standards:

- UL 508
- CSA C22.2 No. 142
- FM Class I, Div. 2, Groups A, B, C, D; T4A Class I, Zone 2, IIC, T4
- VDE 0160
- EN 61131-2
- Requirements of the EMC directive in accordance with EN 50081-1, 50081-2 and 50082-2

S7-1500 functions

A host of features support users in programming, commissioning, and servicing the S7-1500.



- Performance
- Faster command processing, depending on the CPU type, language extensions and new data types
- Significantly shorter response times through optimized code generation
- Integrated technology
- Simple, fast programming of motion sequences via standard PLC open Motion blocks
- Position wise precise gearing between axes
- Convenient diagnostic and commissioning tools provide support in commissioning drives
- Automatic alarm messages to engineering system and HMI: Simplified troubleshooting saves time and effort in commissioning.
- Isochronous mode
- Synchronous coupling of distributed signal acquisition, signal transmission and program execution to the cycle of the PROFIBUS and PROFINET with constant bus cycle time:
- The input signals are acquired and processed and output signals are output at fixed intervals (constant bus cycle time). A consistent process image partition is created at the same time.
- Precisely reproducible and defined process response times due to synchronous signal processing with constant bus cycle times by the distributed I/O
- In distributed automation solutions, the SIMATIC S7-1500 thus also permits high- speed processing operations and enables the achievement of maximum precision and reproducibility. This means increased production with optimal and constant quality.
- Comprehensive range of components for complex tasks such as motion control, measured value acquisition, high-speed control, etc.
- Security Integrated
- Password-based know-how protection against unauthorized readout and modification of program blocks (in combination with STEP 7)
- Copy protection:

Protection against unauthorized copying of program blocks. With copy protection, individual blocks on the SIMATIC memory card can be tied to its serial number so that the block can only be run if the configured memory card is inserted into the CPU.

- 4-stage authorization concept

Different access rights can be assigned to user groups. The new protection level 4 makes it possible to also restrict



communication to HMI devices. Improved manipulation protection allows changed or unauthorized transfers of engineering data to be detected by the controller.

- Design and handling
- CPUs with integrated display

For convenient evaluation of module states for central and distributed modules or to set or change IP address (es) without programming device. System diagnostics and user alarms are shown in plain text on the display and help to respond to occurring error messages quickly and efficiently. The menu and message texts are available in multiple languages on the display.

- Integrated system diagnostics
- System diagnostics information is displayed consistently and in plain text on the display, TIA Portal, HMI device and web server, including for messages from the drives, and are even possible in the CPU's STOP state. This functionality is integrated in the CPU firmware as a system feature and does not have to be configured separately by the user. If new hardware components are configured, the diagnostic information is updated automatically.
- Simple and rapid diagnostics directly in the user program through the quality information:
- By activating the quality information (QI) of a module, the validity of the supplied process value can be queried and evaluated directly in the user program. Here, access is via the process image using simple binary or load commands. The prerequisite is that the module can be diagnosed and the quality information can be configured in the TIA Portal.
- Configuration by means of the SIMATIC STEP 7 Professional engineering software, V12 and higher
- The SIMATIC S7-1500 controller family is programmed in the Totally Integrated Automation Portal using STEP 7 Professional V12 or higher. SIMATIC STEP 7 Professional, V12 and higher, is the intuitively operated engineering system for the SIMATIC S7-1500.
- Compatibility
- Migration:

A migration tool integrated in SIMATIC STEP 7 Professional V12 or higher provides support in switching from the S7-300/S7-400 to the S7-1500 controller and converts the program code automatically. Program code that cannot be



converted automatically is logged and can be adapted manually. The migration tool is also made available as a standalone tool in the download area of Customer Support. STEP 7 V11 projects can continue to be used with STEP 7 V12 in compatibility mode. S7-1200 programs can also be transferred to the S7-1500 by means of copy paste.

- SIMATIC memory card (required for operation of the CPU)
- The SIMATIC memory card is used as plug-in load memory or for updating the firmware. STEP 7 projects including comments and symbols, additional documentation or csv files (for recipes and archives) can also be stored on the SIMATIC memory card. Data blocks can be created and data stored or read via SFCs on the SIMATIC memory card with the user program.
- Safety Integrated (option for S7-1500F controller)
- "STEP 7 Safety Advanced" option package; required for programming the safety- related program sections of the S7-1500F controller.
- The package contains all the functions and blocks required to create an F program. STEP 7 Safety Advanced V12 can run under SIMATIC STEP 7 Professional V12 SP1.

SIMATIC S7-1200/1500: Memory Cards

In a free analogy, comparing a S7-1500 and a PC, the Work memory represents the PC's RAM and the Load memory represents the PS's hard disc drive / pen drives.

Code Work memory (inside CPU – volatile - not expandable): Where stay the programs blocks when the CPU is running

Data Work memory (inside CPU – volatile - not expandable): Where stays the DBs when the CPU is running

Load Memory (inside the SIMATIC SD card – nonvolatile - different sizes could be used):

Where stays the program blocks, DB, HW configuration, etc. when the CPU stay turned off.

Highlights:

S7-1500/1200 (like S7-300 modern CPU) need necessarily a memory card (each this respective type, SD / MMC).

- Just SIMATIC Memory Card should be used (no “Standard” SD-Cards could be used).



- S7-1500 can use the same Memory Card types as S7-1200. But can't be used of S7-300 or S7-400.

- If you "format" the SIMATIC Memory Card by Window, the card will be damage, and could not be "restored" by the user.

- Commentaries are stored in Load memory (each character takes one byte).

Distributed I/O systems

SIMATIC ET 200S – the all-rounder with a comprehensive range of functions

- Bit-modular design with multi-conductor connection
- Multifunctional thanks to a wide range of modules: motor starters, frequency converters, safety technology, distributed intelligence, IO-link modules.
- Use in hazardous areas (Zone 2)
- Also available as expandable block version with integral DI/DO:
SIMATIC ET 200S COMPACT



SIMATIC ET 200M – the multi-channel S7-300

- Modular design using standard SIMATIC S7-300 modules; redundant design also possible
- Fail-safe I/O modules
- For use in hazardous areas up to Zone 2, sensors and actuators up to Zone 1.
- High plant availability thanks to redundancy, hot swapping, and configuration changes during operation



SIMATIC ET 200L – digital block I/O

- Low-cost digital block I/O
- Digital electronic blocks of up to 32 channels



SIMATIC ET 200ISP – the intrinsically-safe version for hazardous areas

- Modular design, also available with redundancy
- Rugged, intrinsically-safe design
- Use in hazardous areas up to Zone 1/21, sensors and actuators may even be located in Zone 0/20
- High plant availability thanks to redundancy, hot swapping, and configuration changes during operation



SIMATIC S7-300: Modular Automation System



S7-300

- The modular mini PLC system for the low and mid-performance ranges
- With comprehensive range of modules for optimum adaptation to the automation task
- Flexible use through simple implementation of distributed structures and versatile networking
- User-friendly handling and uncomplicated design without a fan
- Can be expanded without problems when the tasks increase
- Powerful thanks to a range of integrated functions

S7-300F

- Failsafe automation system for plants with increased safety requirements for production technology
- Based on S7-300
- Additional ET 200S and ET 200M distributed I/O stations complete with safety-related modules can be connected
- Safety-related communication via PROFIBUS DP with PROFI safe profile
- Standard modules can be used in addition for non-safety-relevant applications

SIMATIC S7-300: Modules

The S7-300 automation system is modular in design. It has a comprehensive range of modules that can be combined individually.

A system includes the following:

- A CPU:
Different CPUs are available for different performance ranges, including CPUs with integral inputs/outputs and the corresponding functions, as well as CPUs with integral PROFIBUS DP, PROFINET and point-to-point interfaces.
- Signal modules (SMs) for digital and analog inputs/outputs.
- Communications processors (CPs) for bus connection and point-to-point connections.
- Function modules (FMs) for high-speed counting, positioning (open-loop/closed-loop) and PID control.

The following can also be used depending on requirements:



- Load power supply (PS) for connecting the SIMATIC S7-300 to a supply voltage of 120/230 V AC.
- Interface modules (IMs) for connecting the central controller (CC) and expansion units (EUs) in multi-tier configurations. The SIMATIC S7-300 can be operated with up to 32 modules distributed across the CC and 3 EUs. All modules can be operated in enclosures and without fans.
- SIPLUS modules for extended environmental conditions:
 - Suitable for temperature range -25 to +60 °C, and higher humidity, condensation and frost loads. Can be used direct on vehicles or outside building in an IP20 cabinet protected against direct sunlight and rainwater/spray water. Air-conditioned cabinet and IP65 housing not required.