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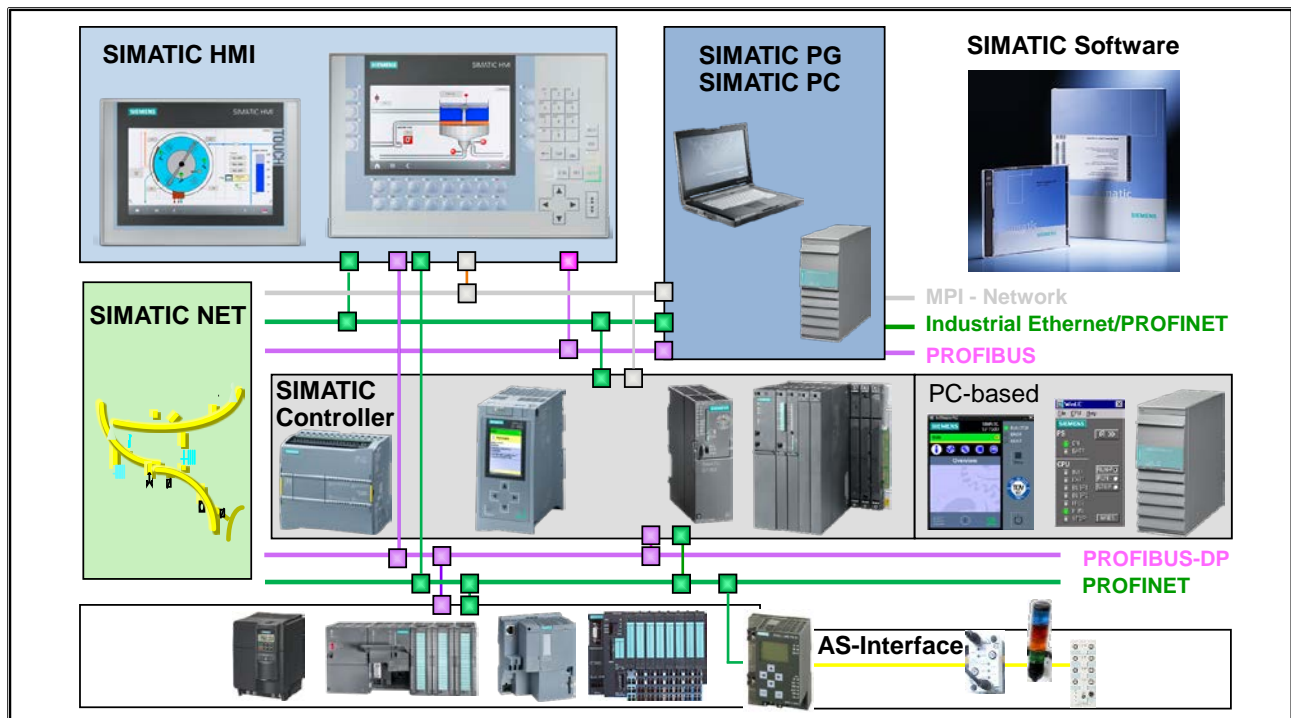
2. System Overview

At the end of the chapter the participant will ...



- ... be familiar with the concept of “Totally Integrated Automation” (T.I.A.)
- ... be familiar with the TIA Portal Information Center
- ... have an overview of the available modules
- ... have an overview of the new SIMATIC S7-1200/1500 system family
- ... be familiar with the SIMATIC Memory Card as well as the S7-1500 Display
- ... know the S7-300 and S7-400 automation systems

2.1. SIMATIC S7 Overview



Introduction

For the operation of machines, equipment and processes in almost all areas of manufacturing you require control elements in addition to energy supply. It must be possible to initiate, control, monitor and end the operation of any given machine or process.

Hard-wired Programmed Controller → PLC

In the hard-wired controllers of the past, the program logic was governed by the task-specific wiring of contactors and relays.

Today, programmable logic controllers are used to solve automation tasks. The logic stored in the program memory of an automation system does not depend on equipment design and wiring and can be modified at any time with the help of a programming device.

Totally Integrated Automation

Production processes are no longer seen as individual partial processes, but rather as integral components of an entire production process. The total integration of the entire automation environment is today achieved with the help of:

- one common software environment that integrates all components and tasks into one uniform easy to use system
- a common data management (central database)
- a common communication between all participating automation components.

2.2. TIA Portal Information Center

<https://support.industry.siemens.com>

Entry ID 65601780

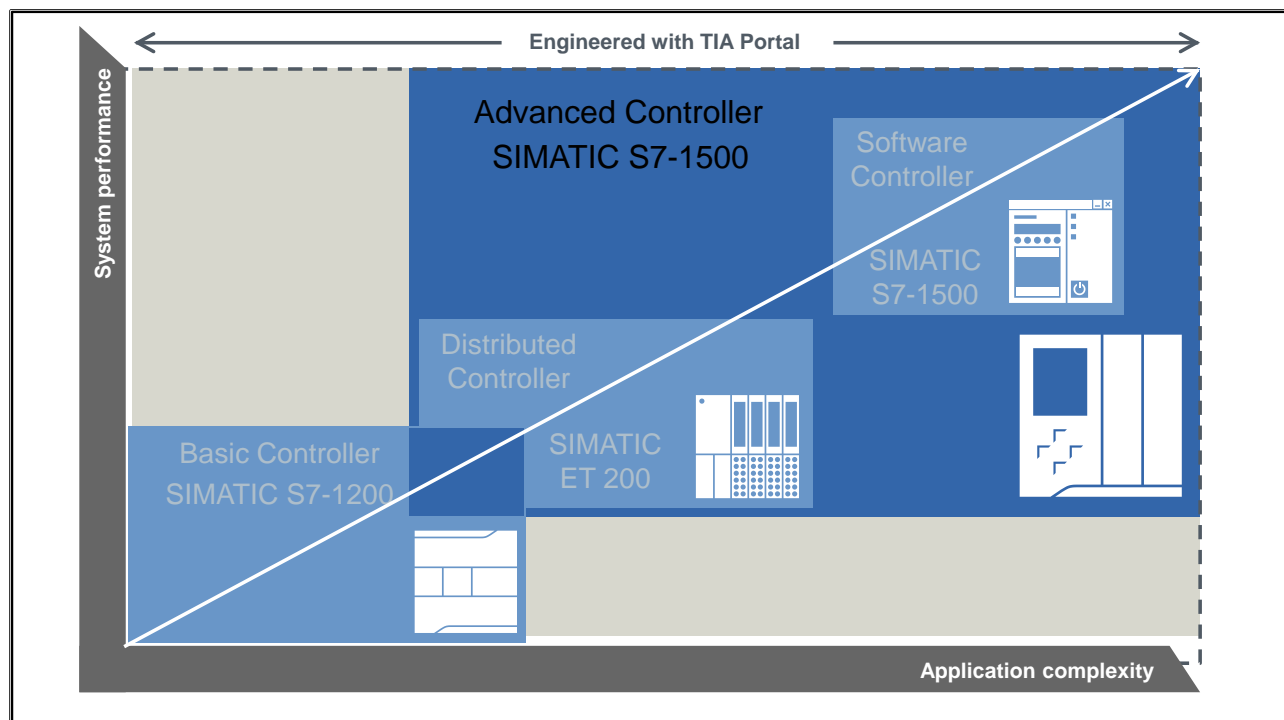


By entering the Product/Article No. (Entry ID) 65601780, you arrive at the start page "TIA Portal - An Overview of the Most Important Documents and Links".

Here you will find all important documents and links about the TIA Portal as well as the controllers S7-1200 and S7-1500.

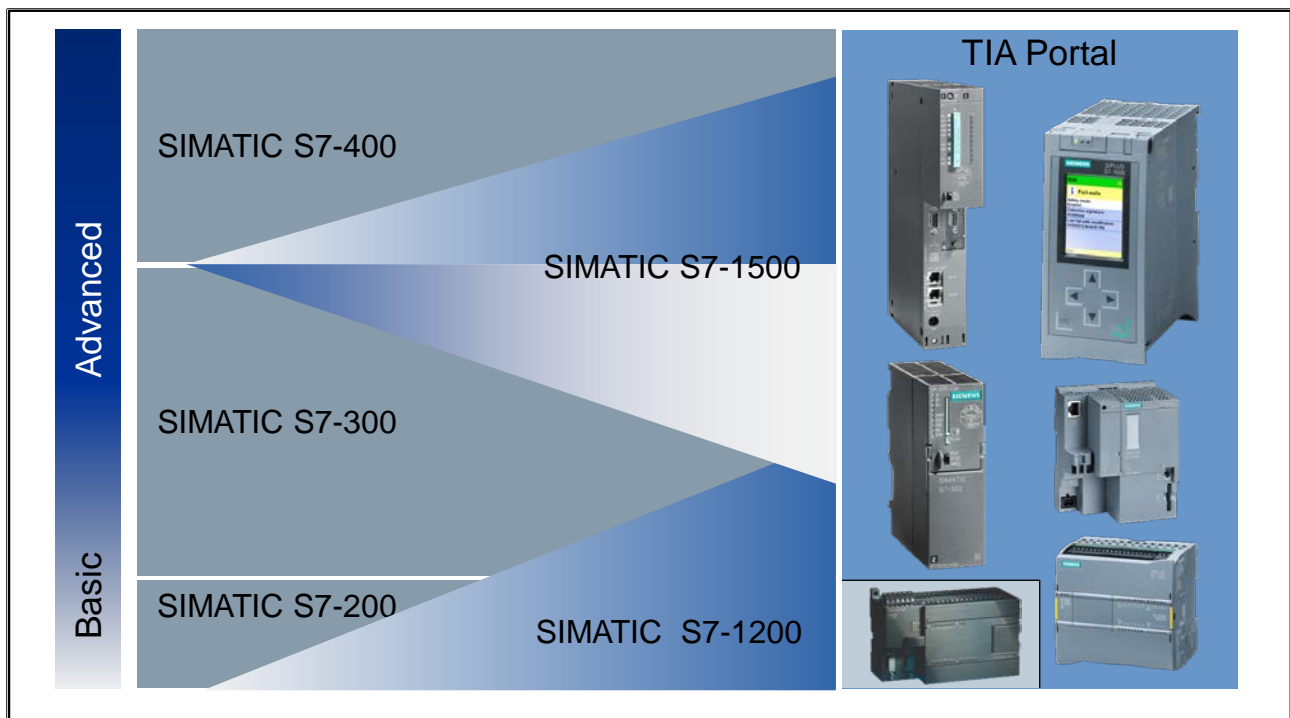
In addition, you can get to the "TIA Portal Information Center". Through it you can also get to all important links and information.

2.3. Overview Controller



Depending on the complexity, different controllers from S7-1200 to S7-1500 can be used.

2.3.1. Positioning the Modular S7 Controllers



SIMATIC S7

The programmable logic controllers can be divided into the performance ranges Basic (S7-1200) and Advanced (S7-1500).

The product range of the S7-1200 and S7-1500 will be expanded in the next few years such that the S7-200, S7-300 and even the S7-400 can be completely replaced.

2.4. Overview: Available Modules

2.4.1. Central Modules

	S7-1200	S7-1500	S7-300	S7-400
Standard	✗	✓	✓	✓
Fail-safe	✓	✓	✓	✓
Compact	✓	✓	✓	✗
High availability	✗		✗	✓
Technology	✓ Different functions	Different functions ✓ T-CPU ✓	✓ T-CPU	✗

More Information under the Link:

TIA Portal Information Center > Product information > Controllers

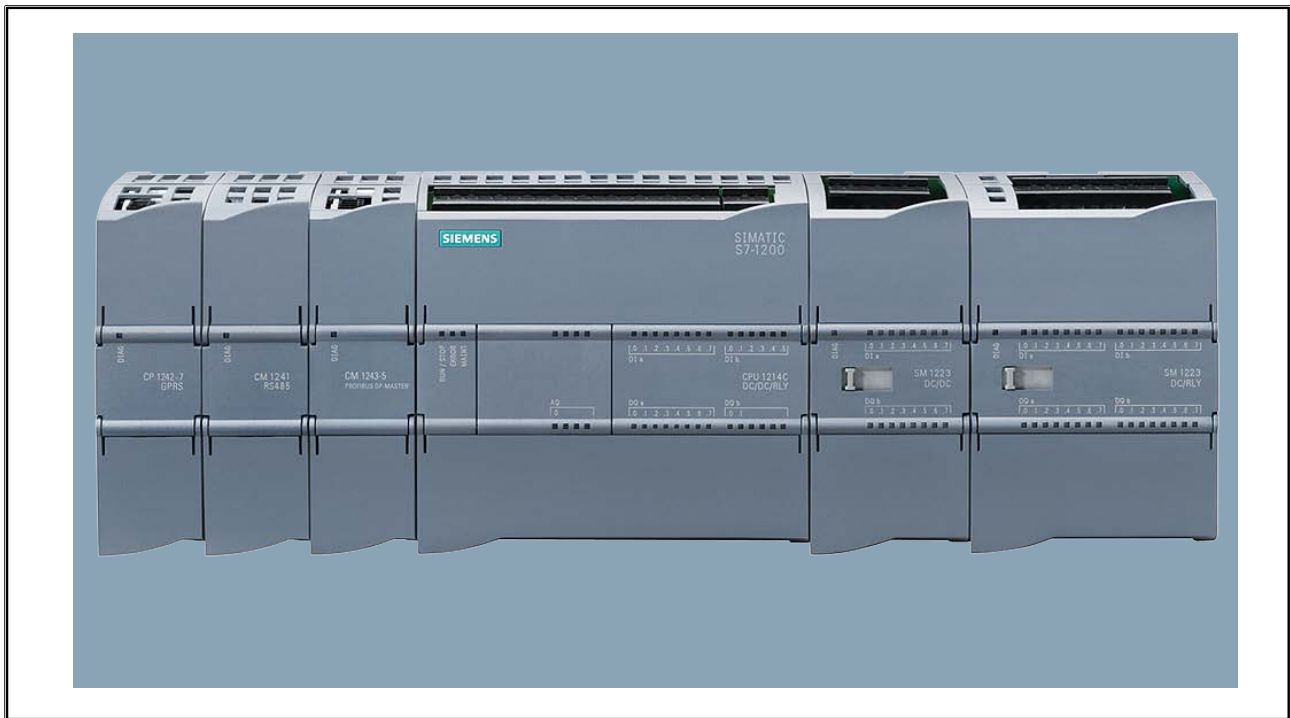
2.4.2. Signal Modules (Central)

	S7-1200	S7-1500	S7-300	S7-400
DI/DQ	✓	✓	✓	✓
AI/AQ	✓	✓	✓	✓
F-DI/F-DQ	✓	✓	✓	✗
F-AI			✓	✗

More Information under the Link:

[TIA Portal Information Center > Product information > Controllers](#)

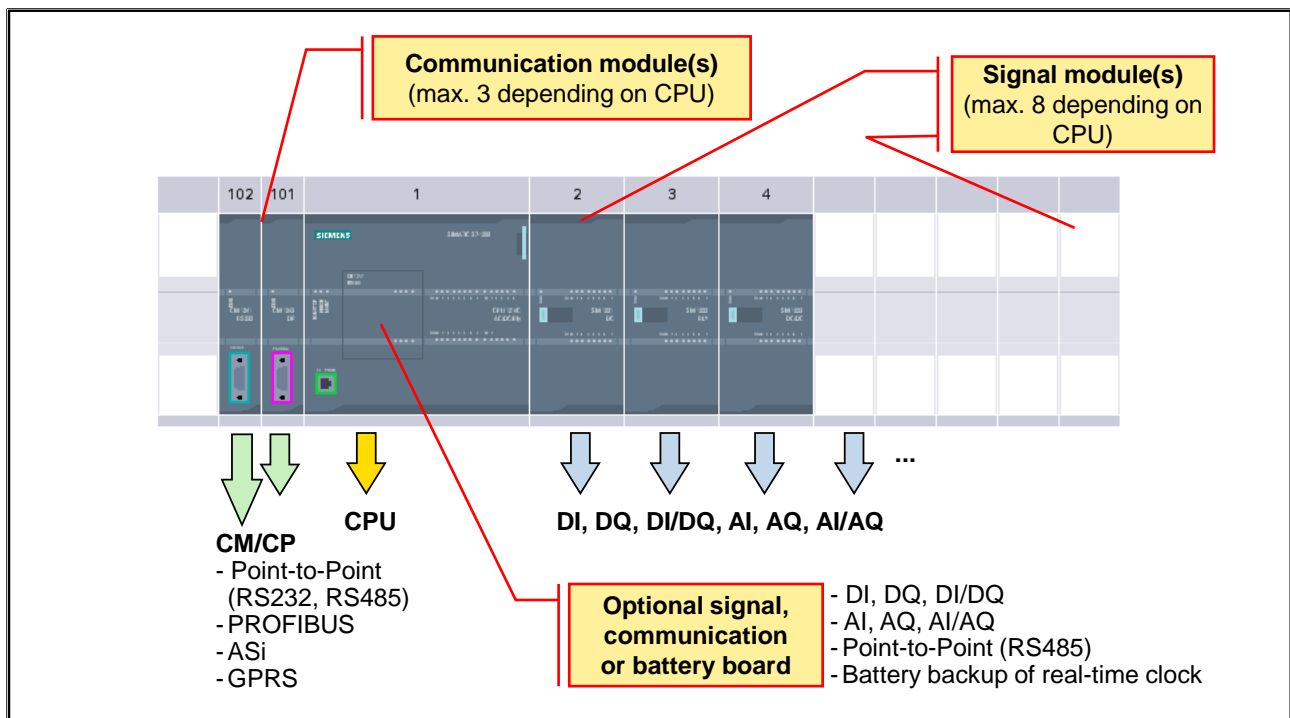
2.5. SIMATIC S7-1200: The Modular Mini-PLC



Features

- Modular compact control system for the low-end performance range
- Scaled CPU range
- Extensive range of modules
- Can be expanded to up to 11 modules (depends on the CPU)
- Can be networked with PROFIBUS or PROFINET
- Slot rules
 - CM left of the CPU (number depends on the CPU)
 - SM right of the CPU (number depends on the CPU)
 - "Total package" with CPU and I/O in one device
 - integrated digital and analog I/O
 - an expansion with signal board
 - "Micro PLC" with integrated functions

2.5.1. SIMATIC S7-1200: Modules



Slot Rules

- CM left of the CPU (number depends on the CPU)
- Signal modules (digital, analog) right of the CPU (number depends on the CPU)

Signal Modules

- Digital input, output or mixed modules (24VDC, relay)
- Analog input, output or mixed modules (voltage, current, resistance, thermocouple)

Communication Modules (CM - Communication Module, CP - Communication Processor)

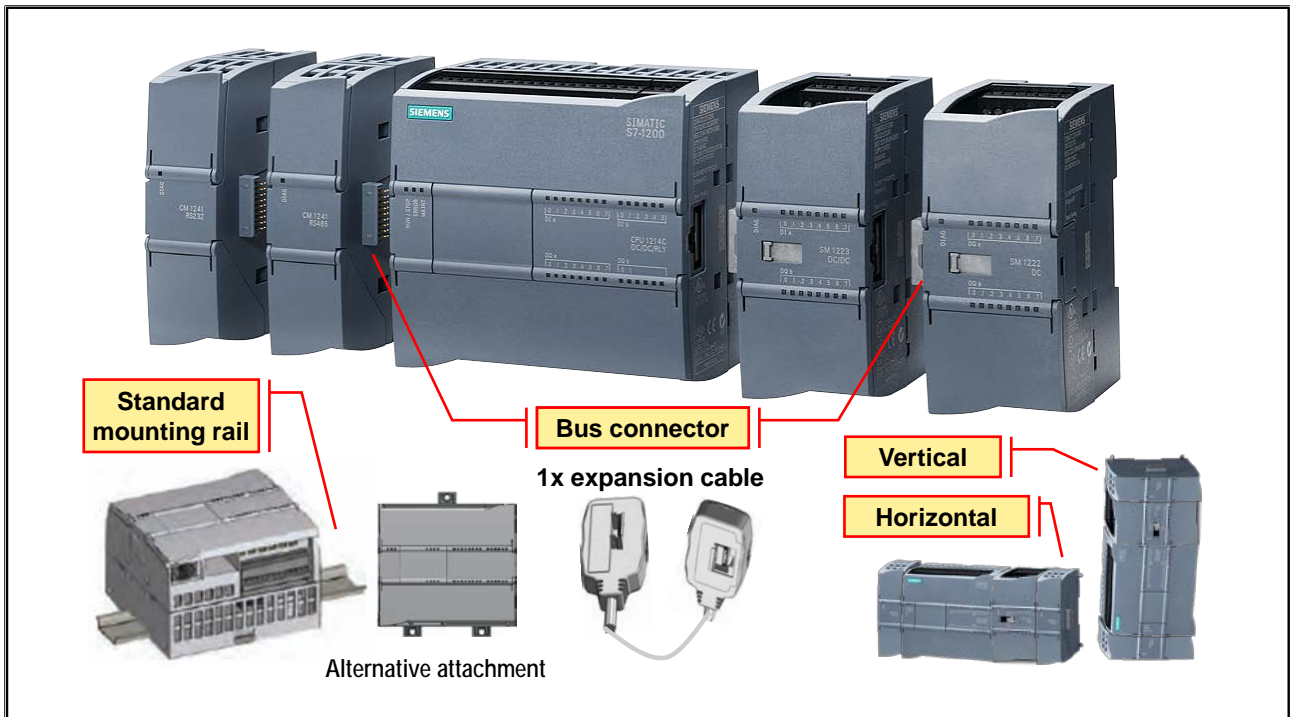
- Point-to-point connection (RS232, RS485)
- PROFIBUS
- ASi-Master
- Telecontrol (GPRS functionality)

Expansion Board

With this, the CPU can be expanded by onboard I/O or an interface.

A battery board ensures the long-term battery backup (buffering) of the real-time clock.

2.5.2. SIMATIC S7-1200: Installation and Mounting Positions



Installation

The modules are mounted on a standard mounting rail or alternatively screwed into the control cabinet.

S7-1200 Expansion Cable

It offers additional flexibility in configuring the S7-1200 system. One expansion cable can be used for each CPU system.

- Either between the CPU and the first SM or between two SMs

Bus Connector

It is located as a mechanical slide on the left side of the SM modules.

It is mechanically attached on the right side of the CMs/CPs.

Mounting Positions

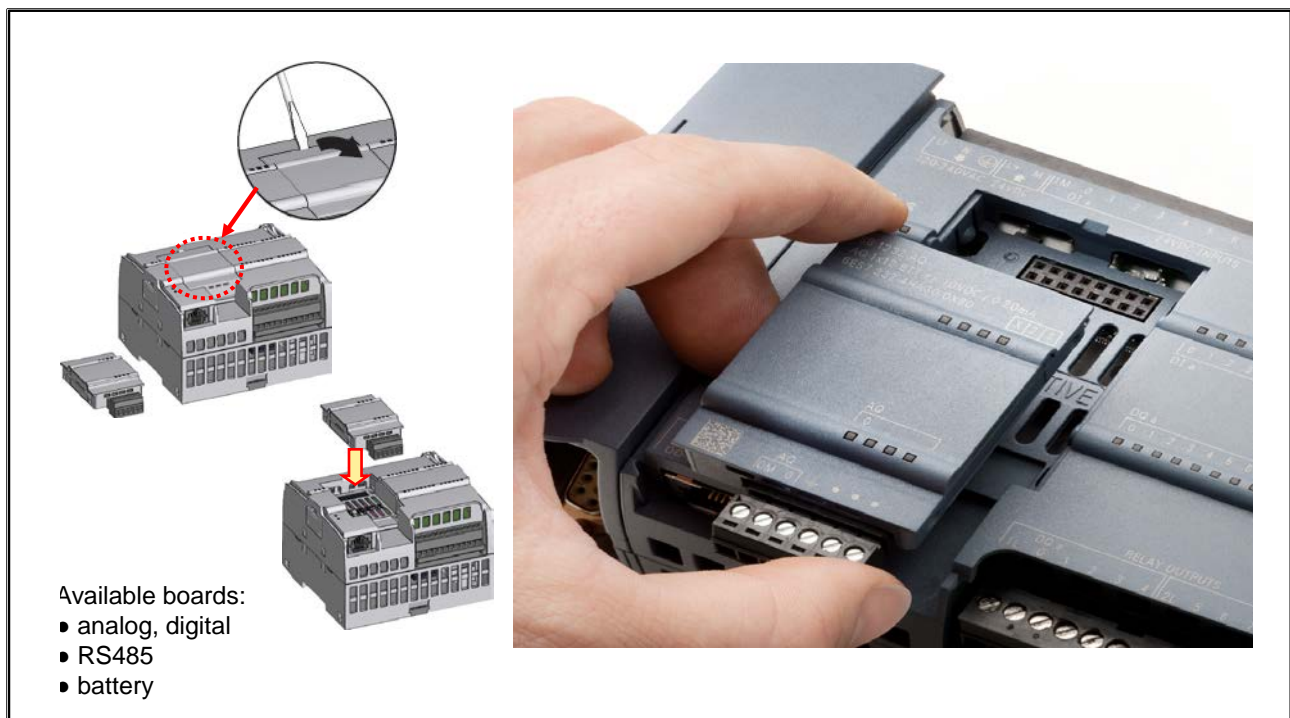
A horizontal or vertical mounting is possible.



Caution!

With a vertical mounting, the maximum allowed ambient temperature is 10 °C lower.

2.5.3. SIMATIC S7-1200: Signal, Communication or Battery Board



Application

These boards are used for application-specific adaptation of the CPU to the requirements of the plant. The physical size of the CPU remains unchanged.

Signal Board (SB)

- Digital signal board
 - only inputs
 - only outputs
 - inputs and outputs
- Analog signal board
 - only inputs
 - only outputs

Communication Board (CB)

- RS485 interface

Battery Board (BB)

A battery board (housing for CR1025 battery) ensures the long-term battery backup (buffering) of the real-time clock.

- Buffering time without battery board typically 20 days / minimum 12 days at 40°C
- Buffering time with battery board approximately 1 year

2.6. SIMATIC S7-1500: Modular Controller for the Mid to Upper Performance Range

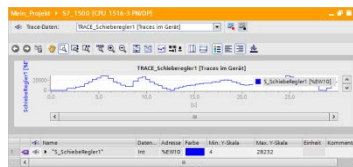


Highlights of the SIMATIC S7-1500 System

- Highest performance of the entire system (terminal-terminal)
 - High performance program execution in the CPU
 - High performance backplane bus
 - PROFINET interface with PROFINET IO IRT on every CPU
 - Automatically activated system diagnostics, right down to the IO channel



- Trace for all CPU tags



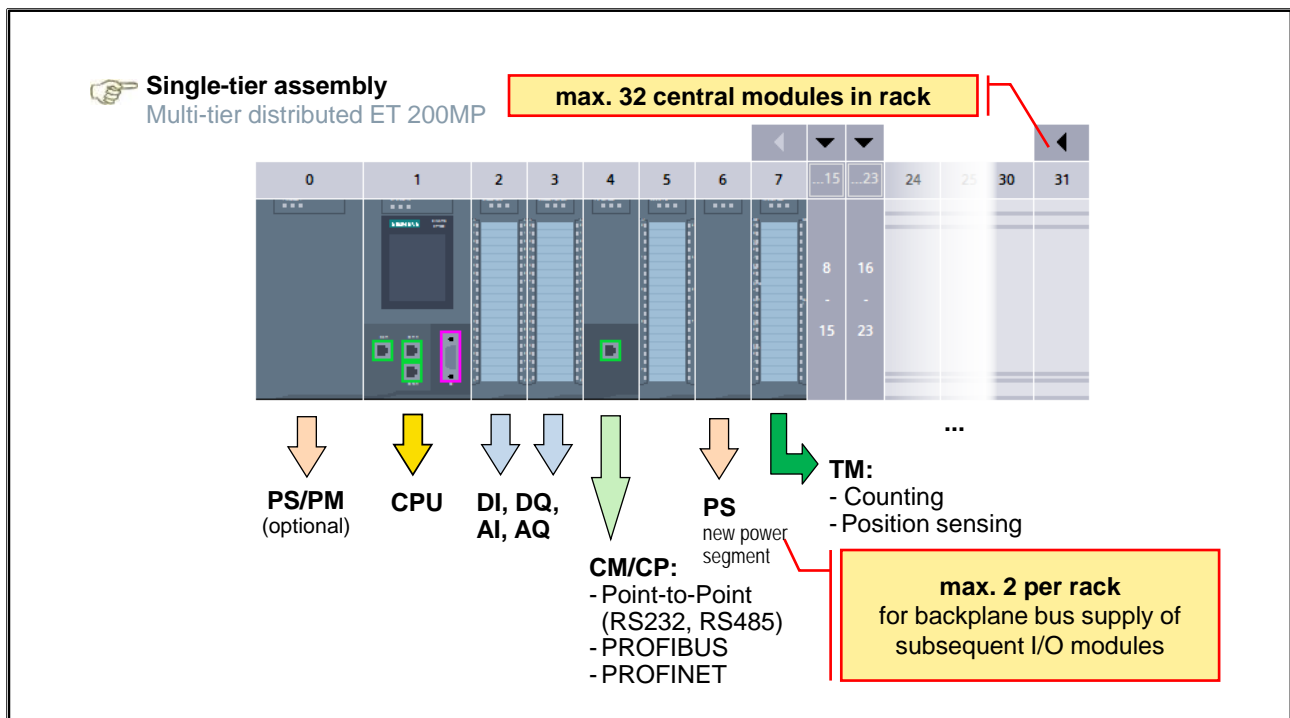
- CPU - Display for:
 - Access to MLFB, FW version and serial number
 - Commissioning (e.g. Setting the IP address, station name)
 - Backup/Restore
 - Diagnostics



- Simplified programming through user-friendly new instructions in LAD/FBD/STL



2.6.1. SIMATIC S7-1500: Modules



Slot Rules

- 1x PS/PM Slot 0
- 1x CPU in Slot 1
- As of Slot 2 any

Signal Modules

- Digital input modules: 24VDC, 230VAC
- Digital output modules: 24VDC, 230VAC
- Analog input modules: voltage, current, resistance, thermocouple
- Analog output modules: voltage, current

Communication Modules (CP - Communication Processor, CM - Communication Module)

- Point-to-Point connection
- PROFIBUS
- PROFINET



CPs and CMs are both communication modules. CPs have, as a rule, somewhat more functionality than CMs (e.g. own web server, firewall, or the like).

Technology Modules (TM - Technology Module)

- Counting
- Position sensing

Power Supply

I/O modules in the central rack of the S7-1500 require a system power supply via the backplane bus (communication connection to the CPU) and a load power supply (input or output circuits for sensors/encoders and actuators).

- **PM - Power Module → Load Power Supply**

supplies modules with 24VDC for input and output circuits as well as sensors/encoders and actuators



If the CPU is supplied 24V via a load power supply (PM), it supplies the system power supply of 12W for the first inserted I/O modules.

- **PS - Power System → System Power Supply**

supplies S7-1500 modules in the central rack via the backplane bus



Each CPU offers a system power supply of 12W for the first inserted I/O modules. Depending on the I/O modules used, further power segments have to be set up, as required.



A system power supply (PS) can also supply the load circuit for 24VDC modules in addition to the CPU.

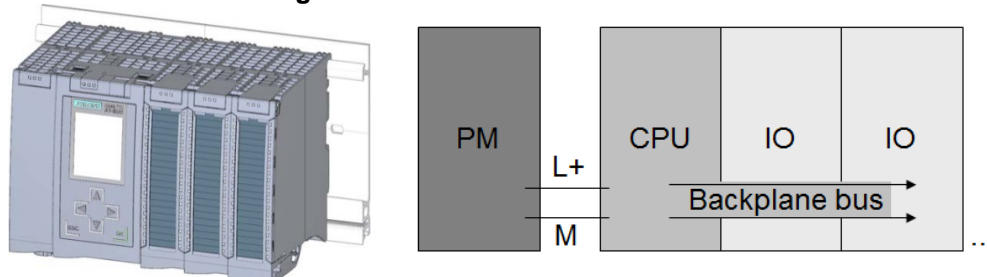
Power Supply and Power Segments of the I/O Modules

It is necessary to set up power segments in the central rack for larger configurations or configurations with greater I/O module power requirements (as a rule, when using CP, CM, TM).

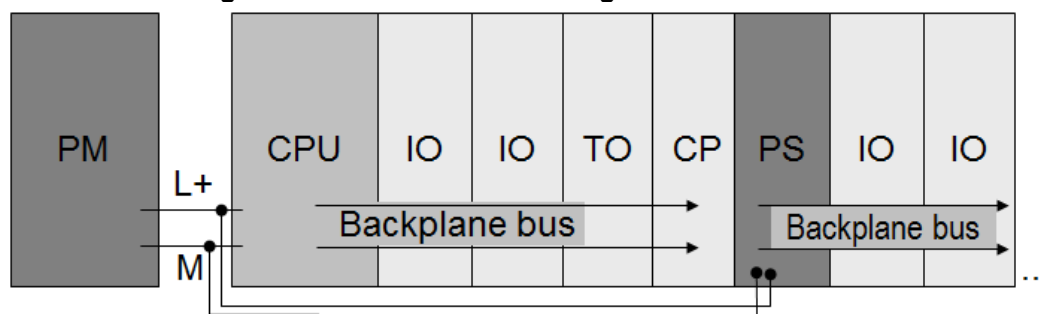
A maximum of 3 power segments can be set up per rack (1xCPU segment plus 2 more).

If the configuration includes additional power segments, additional system power supply modules (PS) are inserted to the right next to the CPU. The CPU continues to control all modules of the rack. Only the system power supply of the I/O modules is subdivided here.

Example of a Small S7-1500 Configuration



Example of an S7-1500 Configuration with a 2nd. Power Segment



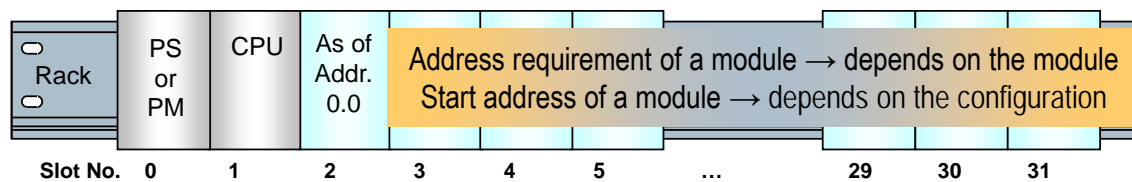
Interface Modules for Expansion Rack

There are no plans for a central multi-tier assembly. An expansion can be realized using the distributed ET 200MP I/O system.

2.6.2. I/O Addressing of the S7-1500

Default addresses of the I/O modules:

- Address assignment does not depend on the slot
- Begin as of I/O address = 0
- Addresses are assigned consecutively in the order in which the manual configuration of the I/O modules occurs

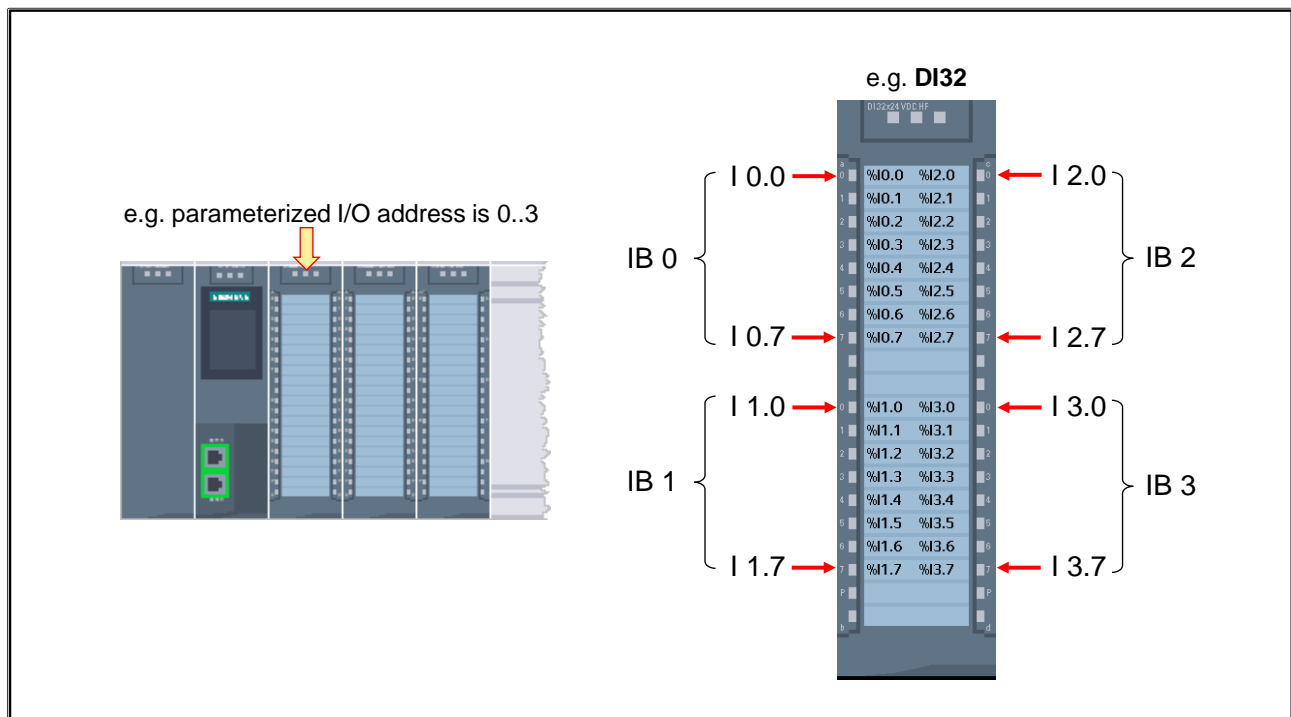


In order to be used by the user program, each I/O module is assigned "Module Address(es)" for the status/modify data area of its channels. By reading and writing the address areas, the user program can work with the process peripherals which are connected to the modules.

Default Addressing

During the device configuration, the address assignment for an added module is suggested as a **consecutive allocation of the I/O address area** as of byte-address 0. This address can be changed during the configuration of the hardware.

2.6.2.1. Channel Addressing of Digital S7-1500 Modules



Each digital channel has an assigned Status LED next to the terminal connection.

The address of the binary process signal results from...

- the terminal used
- the I/O address of the module

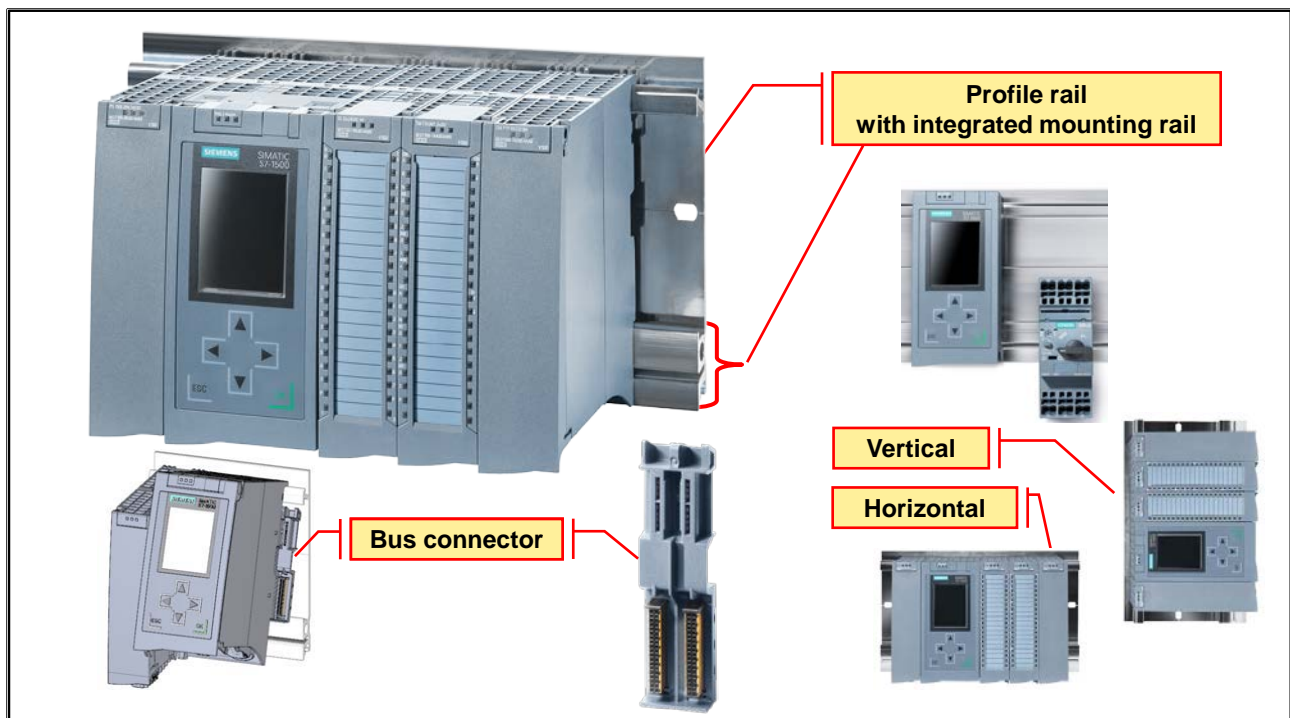
Address Assignment of the Byte Addresses

From top to bottom and (for > 16 channels) from left to right

Address Assignment of the Bit Addresses

From top to bottom

2.6.3. SIMATIC S7-1500: Installation and Mounting Positions



Installation

The modules are mounted on an S7-1500 profile rail.

Bus Connector

If the installation is made on the profile rail, the modules are then connected with the U-connector.

The U-connector establishes the mechanical and electrical connection between the modules and is included with every I/O module.

Mounting Positions

A horizontal or vertical mounting is possible.



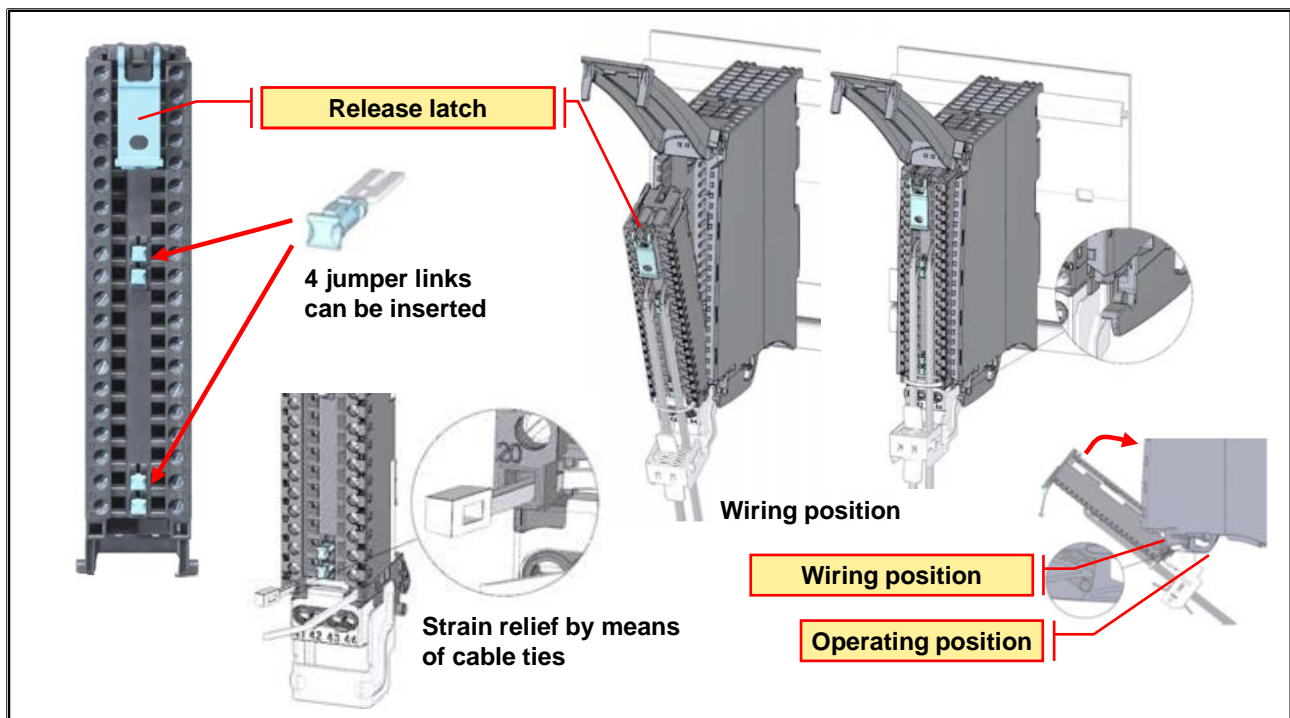
Caution!

With a vertical mounting, the maximum allowed ambient temperature is 20 °C lower (ambient temperature 0 to 40 °C).

Integrated Mounting Rail

For the S7-1500 CPU, there is a profile rail on which components can also be mounted according to EN 60715. With that, even terminals, miniature circuit breakers, small contactors or similar components can be mounted in addition to the S7-1500.

2.6.4. SIMATIC S7-1500: Connection Technology / Front Connector



Properties of the Front Connector

- In each case 40 terminals
 - Clamping techniques:
 - Screw-type terminal
 - SIMATIC TOP connect
- System wiring for the connection of sensors/encoders and actuators
 → S7-1500 front connector wired with 20 or 40 single conductors (prefabricated)



Prewiring Position

The front connector latches up in the front cover. In this position, the front connector still juts out of the module, but the front connector and the module are not yet electrically connected.

Jumper Links

The jumper links can be inserted in the front connector in four places for easier set up of load groups. That is, looping the supply voltage to several potential groups.
Only one connection from left to right exists!

Automatic Coding of the I/O Modules

This enables a faster and safer exchange of the front connector.

Two Front Door Latching Positions

At the bottom of the front cover there are 2 different latching positions for different space requirements of the conductor bundle.

- Cable storage space that grows with the need (AWG cabling)
 American Wire Gauge (AWG) is an American standard measure for copper wires which defines the wire strength and the allowed damping, whereby a lower AWG value represents a thicker wire. By swinging up the release latch, you can pull the front connector and remove it from the module.

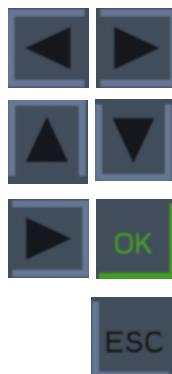
2.6.5. SIMATIC S7-1500: CPU-Display → Overview

- Every S7-1500 CPU is delivered with a Display
- Two sizes depending on the CPU type
1.36" up to CPU1513
2.4" as of CPU1516
- Has its own MLFB
→ can be ordered as replacement part
- CPU can be operated without the Display
(different front cover)
- Removal and insertion possible during running operation
→ CPU stays in RUN
- Multi-lingual display (menu)
- Message/Alarm texts and comments can be loaded in 3 languages
- Language can be switched during running operation
- Alarm acknowledgement
- Backup/Restore
- Format SMC



The available Display languages are the available user-interface languages of STEP 7.

Operation



Selecting the main menu item

Shifting the selection of the submenu item

Choosing the selected submenu item

Go back one menu item



Current main menu item

Selected submenu item

Editable submenu item








After choosing the menu item
Edit setting

Accept change

Discard change

2.6.6. SIMATIC S7-1500: CPU-Display → Menu and Colors

Main menu items and their meaning:

-  **Overview** (Info on: CPU, program protection, memory card, fail-safe (operation)...)
-  **Diagnostics** (alarms, diagnostic buffer, message display, watch tables, cycle time, current memory)
-  **Settings** (addresses, date & time, operating mode, CPU Reset, unlock Display, Backup, FW update ...)
-  **Modules** (status, MLFBs, version, information,... of individual modules)
-  **Display** (setting: brightness, language Display/diagnostic message, standby,..., Display infos: MLFB, version, ...)

Colors of status information and their meaning:

- green** RUN of CPU,
- yellow** STOP or CPU HOLD
- red** Error
- white** Connection setup or connection to CPU lost



Additional Symbols in the Status Information



Password is configured but not entered



Password is configured and entered



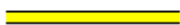
An Alarm exists



A Force job is active on the CPU



F-ability activated. Safety operation active (for fail-safe CPUs)
With deactivated safety operation, the icon is greyed out.

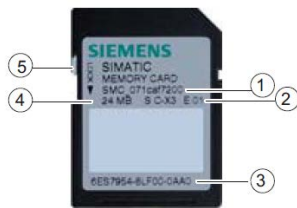


Fail-safe CPU (for fail-safe CPU)

S7-1500 Display Simulator

Under the link "TIA Portal Information Center" > First steps > Getting Started > SIMATIC S7-1500 and STEP 7 - Getting Started > Displays of the SIMATIC S7-1500 controller family" you can test the S7-1500 display simulator as an online version or you can download it and test it offline.

2.7. SIMATIC S7-1200/1500: Memory Card(s)



- ① Serial number of the SMC card
- ② Product version
- ③ Order number
- ④ Card size
- ⑤ Slide switch for write-protect (must not be write-protected)

Written with:

- Commercially available SD card reader
- Field PG

SIMATIC Memory Card in the S7-1200:

- External load memory
- Distribution of programs
- Firmware update
- Documentation
- Memory Card Binding
- Unlinked DBs
- Module exchange without PG

SIMATIC Memory Card in the S7-1500:

- Load memory
- Firmware update
- Documentation
- Memory Card Binding
- Unlinked DBs
- Archiving of data
- Module exchange without PG

Memory Card Binding – Copy Protection

The executability of the program can be bound to the serial number of the card.

Load Memory

- S7-1500
This has no integrated load memory and therefore it is imperative that a card is inserted.
- S7-1200
This has an integrated load memory. Here, an inserted memory card can replace (expand) the integrated load memory or the card can be used for program updates (distribution of programs).

Distribution of Programs ← only S7-1200

The use as Transfer card (card mode = "Transfer") is only supported by the S7-1200. Here, a program can be downloaded into the CPU without a PG if a card is inserted.

Archiving of Data ← only S7-1500

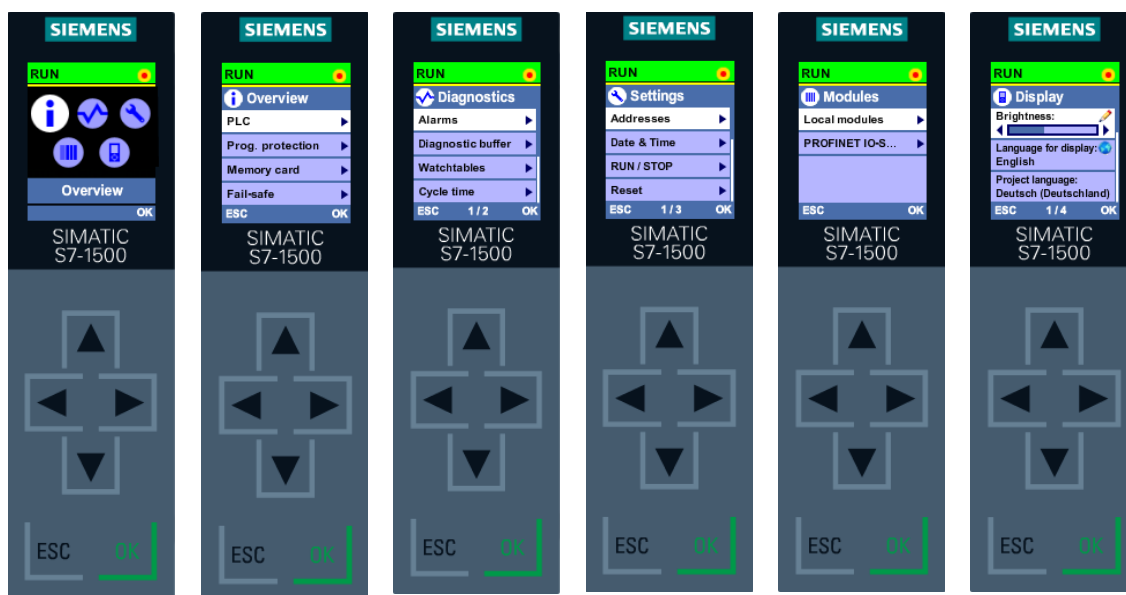
It is possible to archive process values on the card.



The use of this functionality influences the operating life of the Memory Card

2.8. Exercise 1: Display

Familiarize yourself with the Display!



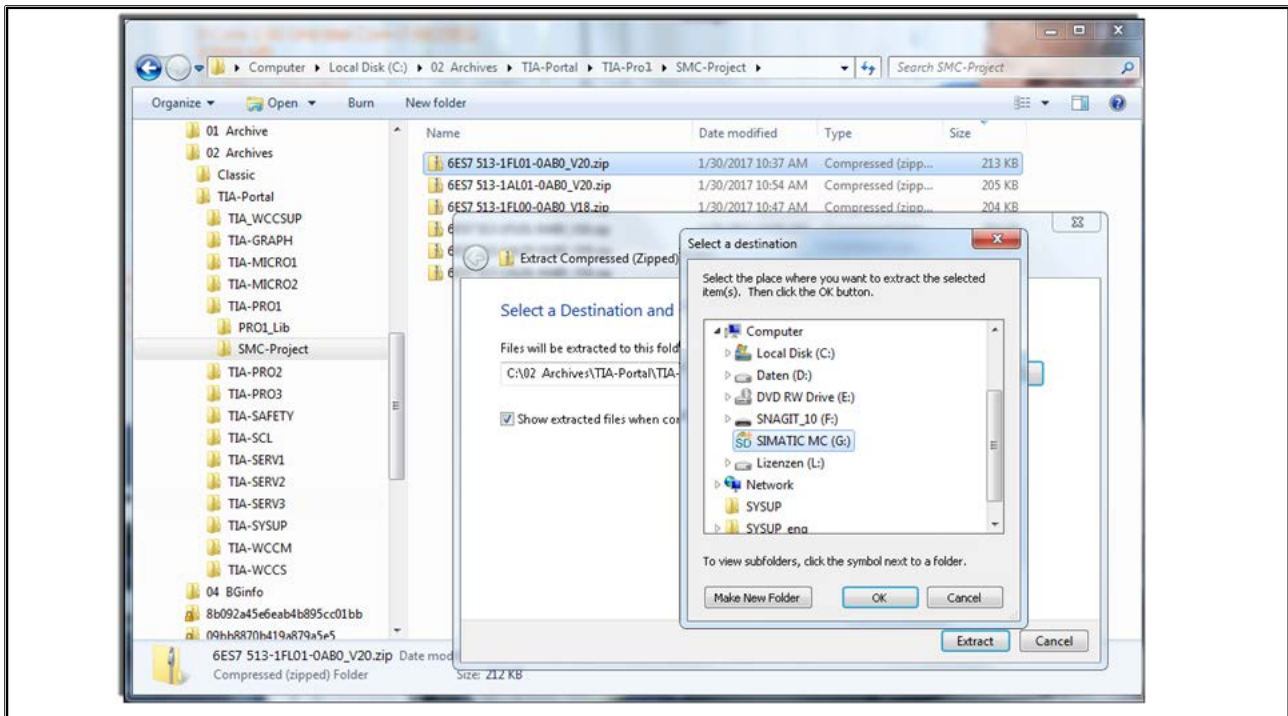
What to Do:

1. Change the language and the brightness on the Display.
2. Read-out the memory card type and how much memory still exists.
3. Take a look at the diagnostic buffer.
4. Make a note of the MLFB (order number) and the Firmware of the CPU and all central modules.

Module	MLFB (order number)	Firmware
CPU		
DI		
DO		
AI		

5. Change the time (of day) of the CPU, the IP address of the Interface X1, and format the memory card.

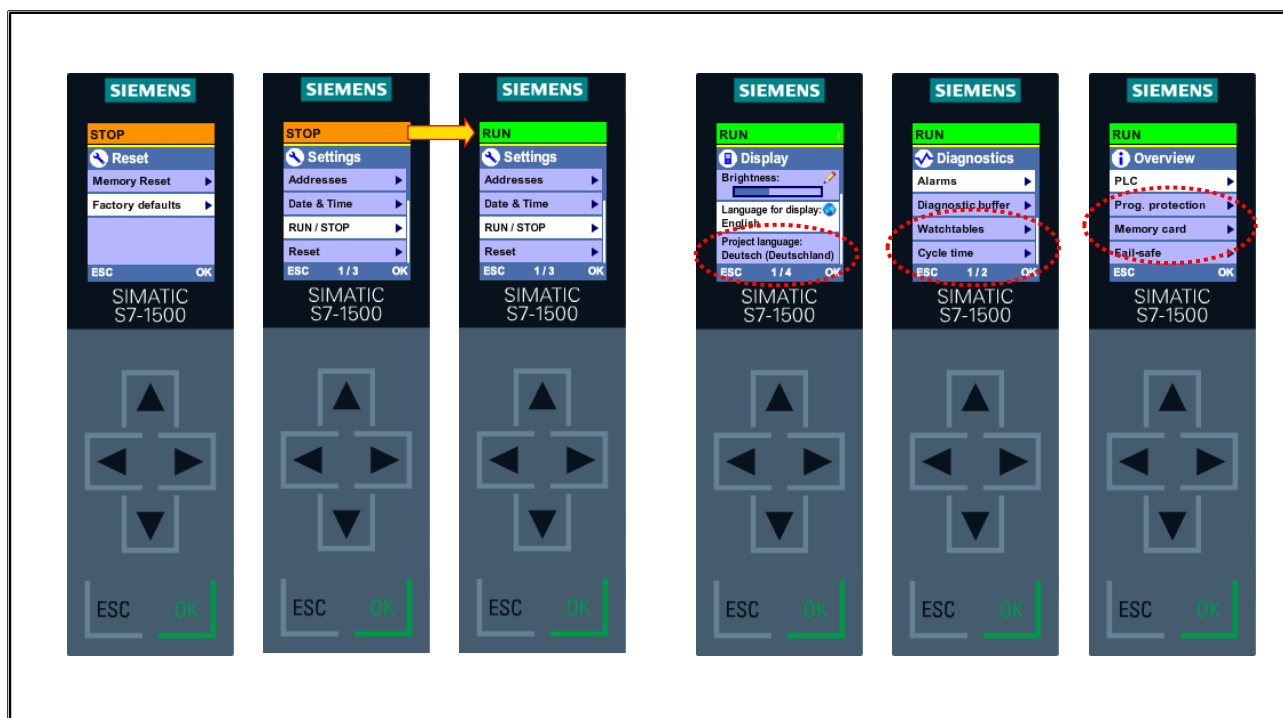
2.9. Exercise 2: Loading the Program onto the SMC



What to Do:

1. Set the CPU to STOP using the Display.
2. Remove the SIMATIC Memory Card.
3. Insert the SMC in the SD card reader of the programming device (PC).
4. Erase the card using Windows Explorer.
5. Open the folder "C:\02_Archives\TIA_Portal\TIA-Pro1\SMC-Project".
6. Extract (unzip) the ZIP file (Name according to the MLFB and the firmware of the CPU) onto the SIMATIC Memory Card.

2.9.1. Exercise 3: Diagnostics and Program Test



What to Do:

1. Insert the SIMATIC Memory Card in the CPU and wait until the MAIN-LED no longer flashes.
2. Reset the CPU to factory defaults using the Display, (delete all data since there could still be an old program on the CPU)
3. Switch the CPU to Run.
4. Set the language.
5. Diagnostics using the Display: Check the Watchtables, Cycle time and Memory.
6. Check whether the broadband cable of your conveyor model is connected to the "S7-1500 DI/DO" socket on the back of your training case.
7. Switch on your conveyor model (green button).
8. Carry out a program test.

Function Description

The distribution conveyor is used to transport parts and can be operated in two different operating modes. (Manual and Automatic)

These can be set using the control panel buttons "Operation ON" and "Operation OFF".

Manual Mode "Operation" = off

Now, the conveyor motor can be jogged to the right "Jog right" and to the left "Jog left".

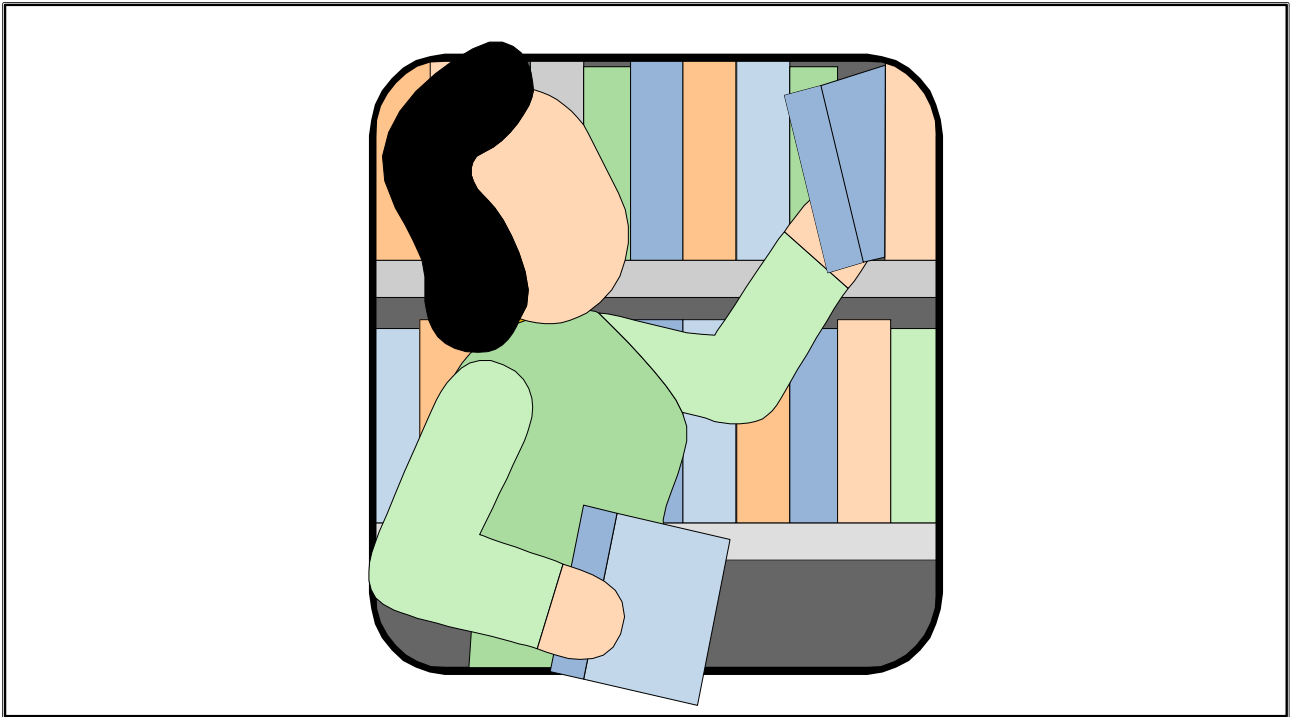
Automatic Mode "Operation" = on

On the conveyor model, parts can be transported from Bay 1, 2 or 3 to the right, right up to the light barrier, using the appropriate button at the respective Bay. Only one Bay may be occupied (at a time).

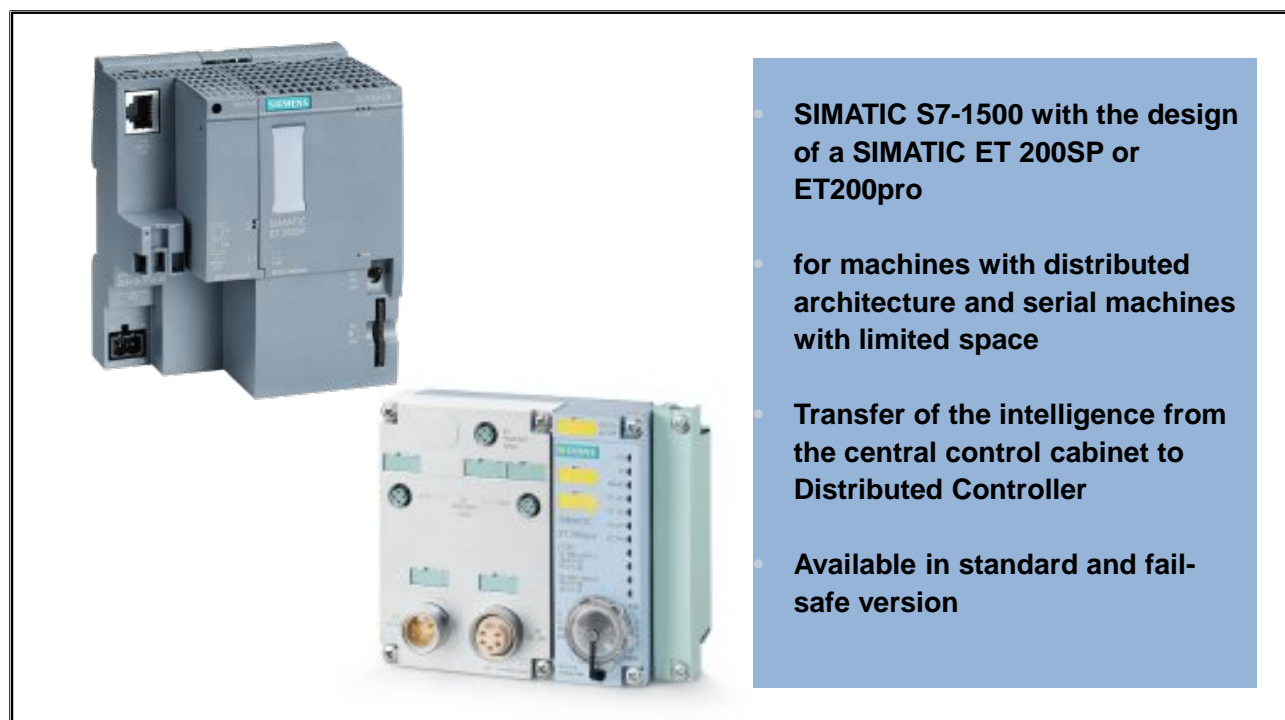
The indicator lights at Bays 1, 2 and 3 show...

- A continuous light at the bay at which the associated sensor detects a part, however only as long as the conveyor has not yet been started.
- A 2Hz flashing light as long as the conveyor motor is running.

2.10. Additional Information



2.10.1. ET 200SP and ET 200pro Controller



Further Information under the Link:

[TIA Portal Information Center > Product information > Controllers > SIMATIC controllers in general > Distributed Controllers](#)

2.10.2. Software Controller

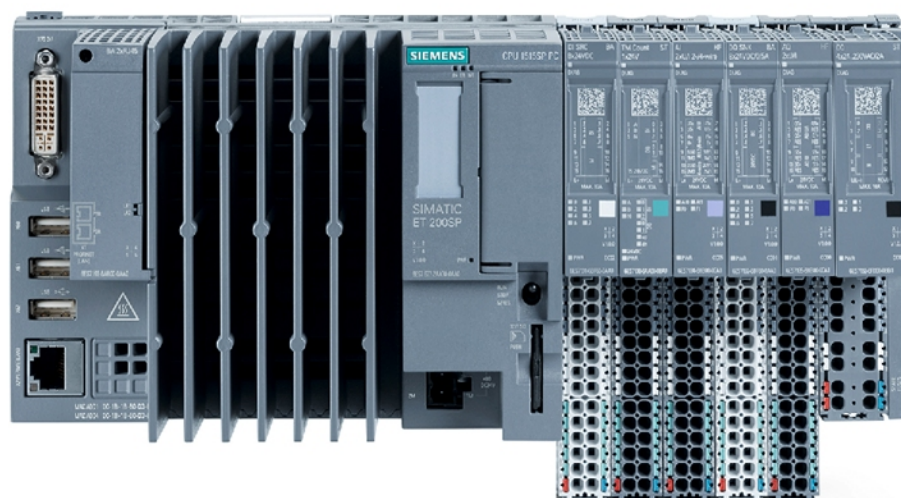
- Use with industry-suitable SIMATIC IPCs
- Runs completely independently of the Windows system (even with restart or failure of Windows)
- Flexible controller for special-purpose machines with high performance and functional requirements
- Integration of user-specific functions via open interfaces (for example C++ / Matlab)



Further Information under the Link:

TIA Portal Information Center > Product information > PC-Based Automation > SIMATIC Software Controller

2.10.3. ET 200SP Open Controller "All in one"



- - Controller with central, modular I/Os
- - Visualization and Windows applications
- - PC interfaces for monitor, mouse and keyboard
- - Gigabit Ethernet

Further Information under the Link:

TIA Portal Information Center > First steps > Getting Started > SIMATIC Open Controller - Getting Started

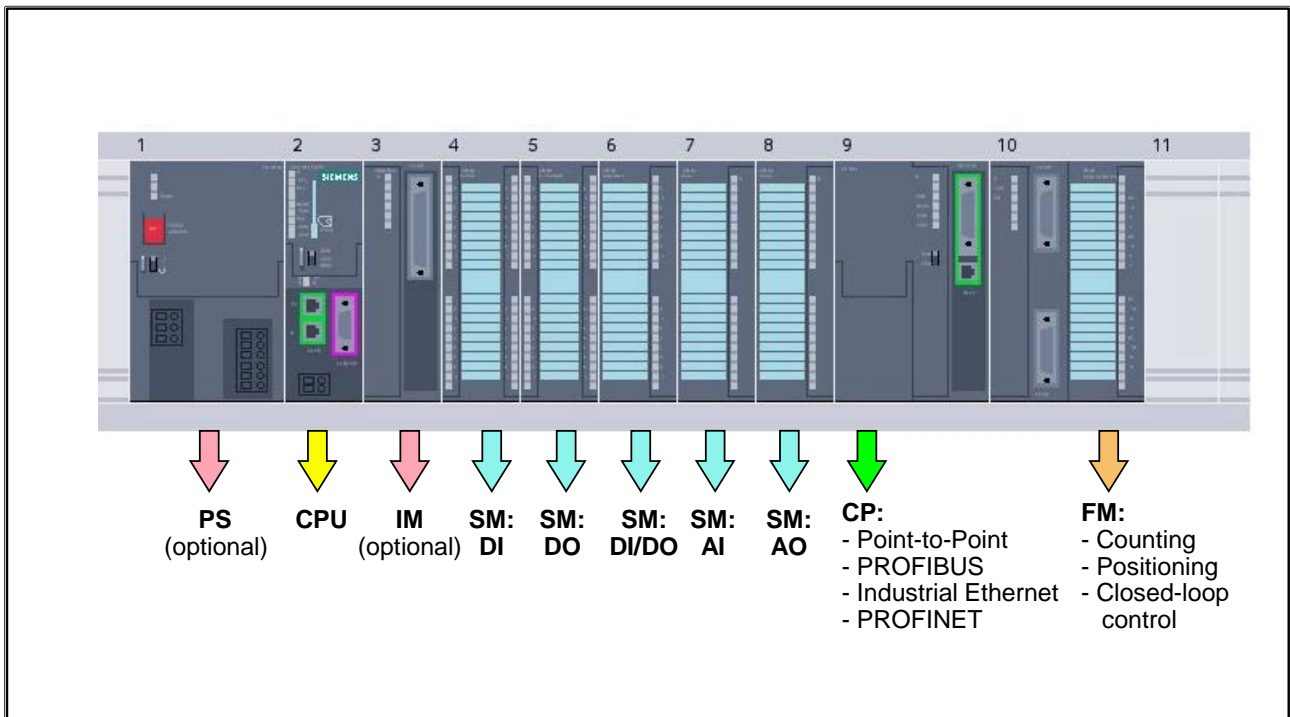
2.10.4. SIMATIC S7-300: Modular Automation System



Features

- Modular compact control system for the lower and middle performance range
- Scaled CPU range
- Extensive range of modules
- Can be expanded to up to 32 modules
- Backplane bus integrated in the modules
- Can be networked with
Multipoint Interface (MPI),
PROFIBUS or
Industrial Ethernet or
PROFINET
- Central PG/PC connection with access to all modules
- No slot rules for I/O modules.

2.10.4.1. SIMATIC S7-300: Modules



Signal Modules (SM)

- Digital input modules: 24VDC, 120/230V AC
- Digital output modules: 24VDC, Relay
- Analog input modules: Voltage, Current, Resistance, Thermocouple
- Analog output modules: Voltage, Current

Interface Modules (IM)

The IM360/IM361 and IM365 make multi-tier configurations possible. The interface modules loop the bus from one tier to the next.

Dummy Modules (DM)

The DM 370 dummy module reserves a slot for a signal module whose parameters have not yet been assigned. A dummy module can also be used to reserve a slot for installation of an interface module at a later date.

Function Modules (FM)

- Counting
- Positioning
- Closed-loop control.

Communication Processors (CP)

- Point-to-Point connections
- PROFIBUS
- Industrial Ethernet
- PROFINET.

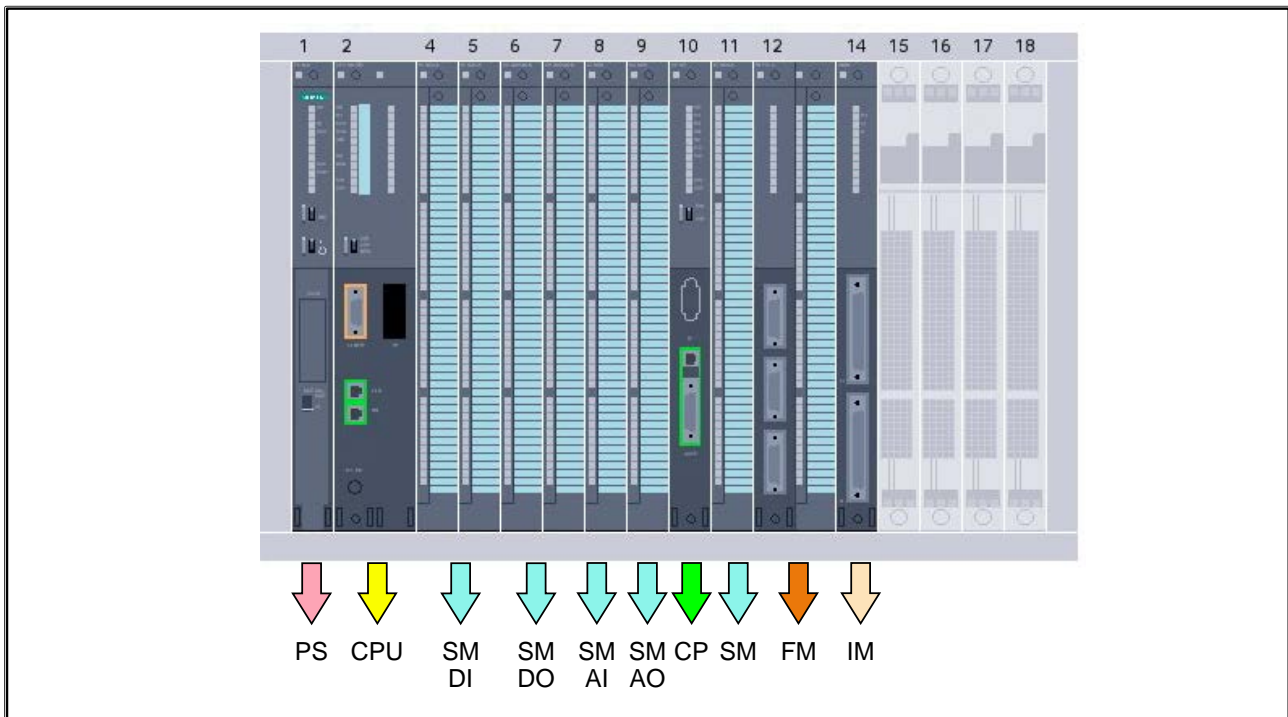
2.10.5. SIMATIC S7-400: Modular Automation System



Features

- The power PLC for the mid to upper performance range,
- Scaled CPU range
- Extensive range of modules
- Can be expanded to over 300 modules,
- Backplane bus integrated in the mounting rack
- can be networked with
Multipoint Interface (MPI),
PROFIBUS or
Industrial Ethernet or
PROFINET
- Central PG/PC connection with access to all modules,
- Only a few slot rules,
- Multicomputing (up to four CPUs can be used in the central rack).

2.10.5.1. SIMATIC S7-400: Modules



Signal Modules (SM)

- Digital input modules: 24VDC, 120/230VAC
- Digital output modules: 24VDC, Relay
- Analog input modules: Voltage, Current, Resistance, Thermocouple
- Analog output modules: Voltage, Current.

Interface Modules (IM)

The IM460, IM461, IM463, IM467 interface modules provide the connection between various racks:

- UR1 (Universal Rack) with up to 18 modules
- UR2 (Universal Rack) with up to 9 modules
- ER1 (Extension Rack) with up to 18 modules
- ER2 (Extension Rack) with up to 9 modules.

Function Modules (FM)

- Counting
- Positioning
- Closed-loop control.

Communication Processors (CP)

- Point-to-Point connections
- PROFIBUS
- Industrial Ethernet
- PROFINET.