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SIMATIC S5

S5-100U
Programmable Controller

System Manual

CPU 100/102/103

EWA 4NEB 812 6120-02b

Edition 04

1 The SIMATIC S5 System Family

The programmable controllers (PLCs) in the SIMATIC S5 family offer economical solutions to simple control tasks and to complex computer functions.

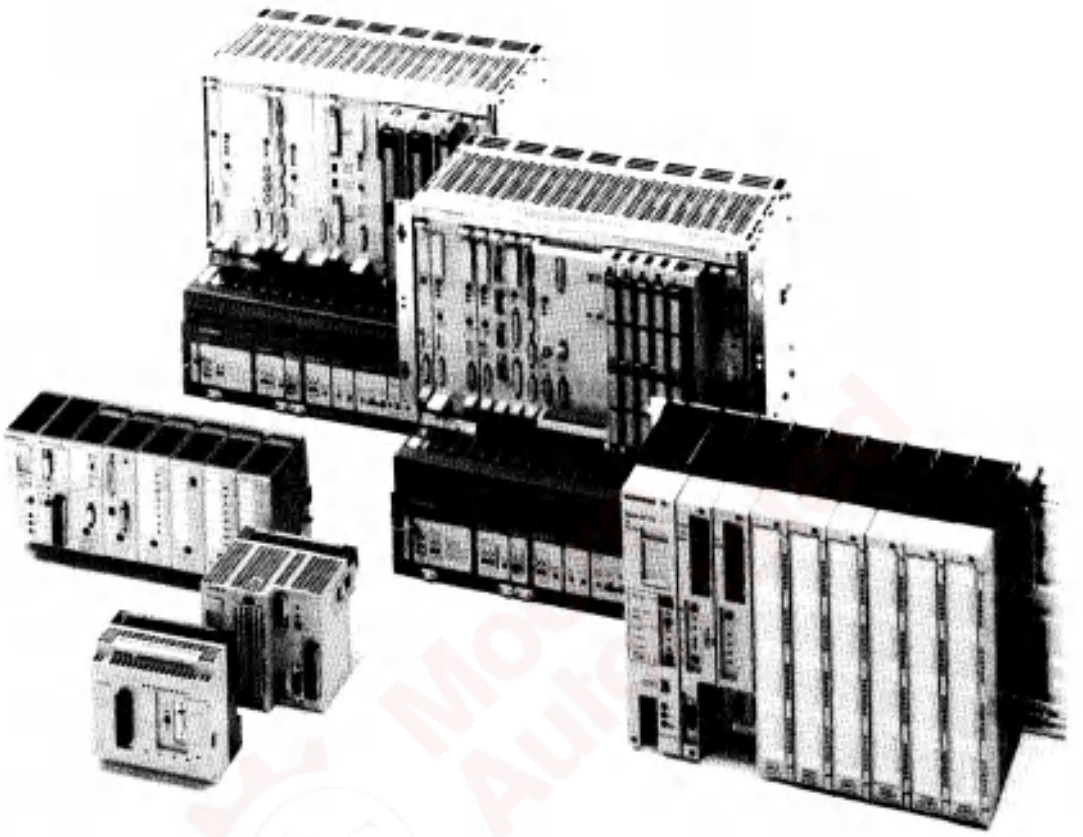


Figure 1-1. Members of the SIMATIC S5 System Family

The S5-100U programmable controller is one of the smallest and most economical of the programmable controllers in the SIMATIC S5 family. The S5-100U is especially suited for small automation tasks. It is economical to use these programmable controllers if you want to replace more than five control relays.

2 Technical Description

This chapter describes the design and principle of operation for the S5-100U programmable controller and its accessories.

2.1 Programmable Controller Design

The S5-100U belongs to the SIMATIC S5 range of programmable controllers. The S5-100U consists of various functional units (modules) that you can combine according to the task you want to perform.

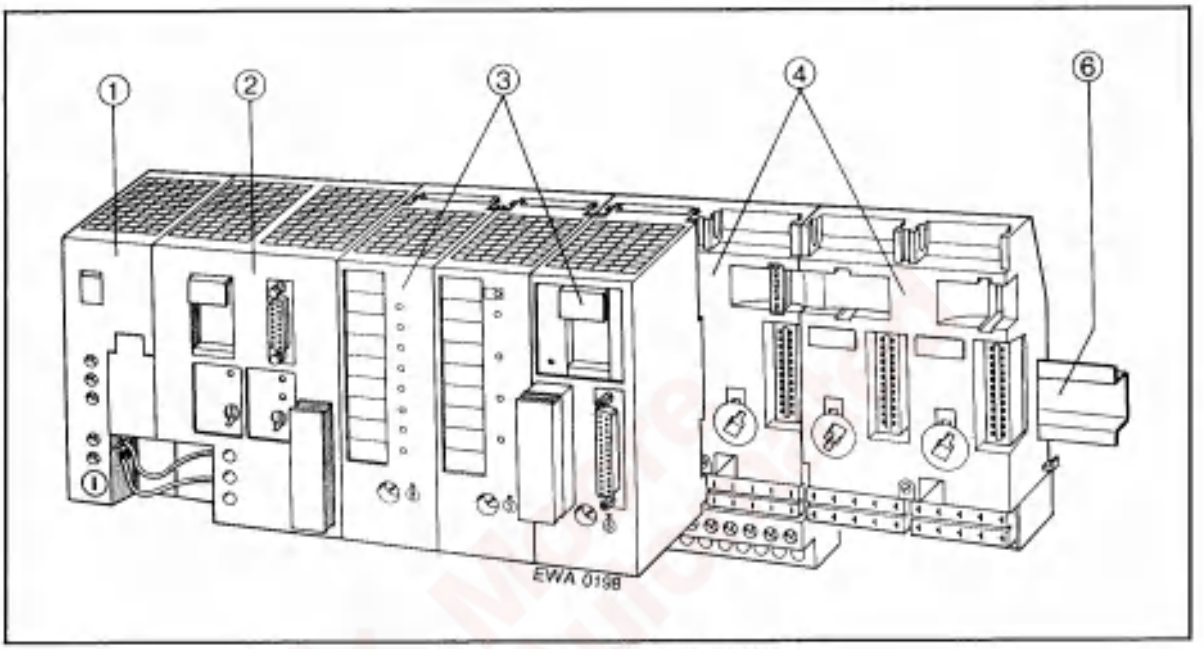


Figure 2-1. The S5-100U

① **Power supply module (PS 930)**

This module is required if 24 V DC is not available for the CPU.

② **Central processing unit (CPU)**

The CPU scans the control program. In the event of a power failure, a backup battery located in the battery compartment saves the memory contents (9).
The control program can be stored in a memory submodule.
The CPU has a serial port, and you can connect a programmer, an operator panel, or a SINEC L1 bus to it.

Input/output modules

Input/output modules transfer information between the CPU and such process peripherals as sensors, actuators, and transducers. You can use the following types of input/output modules with your S5-100U:

- Digital input modules and digital output modules (4, 8, and 16/16 channel)
  - Use these modules for simple control tasks involving signal states “0” and “1” only.
- Analog input modules and analog output modules
  - Use these modules to record and generate such variable quantities as currents and voltages.
- Timer module
  - Use this module to set various times without having to change the program.
- Counter module
  - Use this module to count pulses up to 500 Hz. You can input comparison values without having to change the program.
- High-speed counter/position detection module
  - Use the high-speed counter to record high-speed counter pulses of 25/500 kHz. You can use this module for position detection in a positioning task.
- Comparator module
  - This module makes it possible for you to monitor preset comparison values, such as for current and voltage.
- Simulator module
  - Use this module to generate digital input signals or to display digital output signals.
- Diagnostic module
  - Use this module to check the function of the I/O bus.
- Communications module (CP)
  - Use this module to output message texts with the date and clock time to a connected printer. You can also use this module to connect to external systems.
- Intelligent I/O module (IP)
  - Use these intelligent input/output modules for such special tasks as temperature control and positioning tasks.

Bus units with terminal blocks (Crimp-snap-in or SIGUT, screw type)

Use bus units to connect the CPU to input/output modules. You can plug two input/output modules into a single bus unit.

Interface modules (IM)

Use these modules to assemble your S5-100U in a multi-tier configuration.

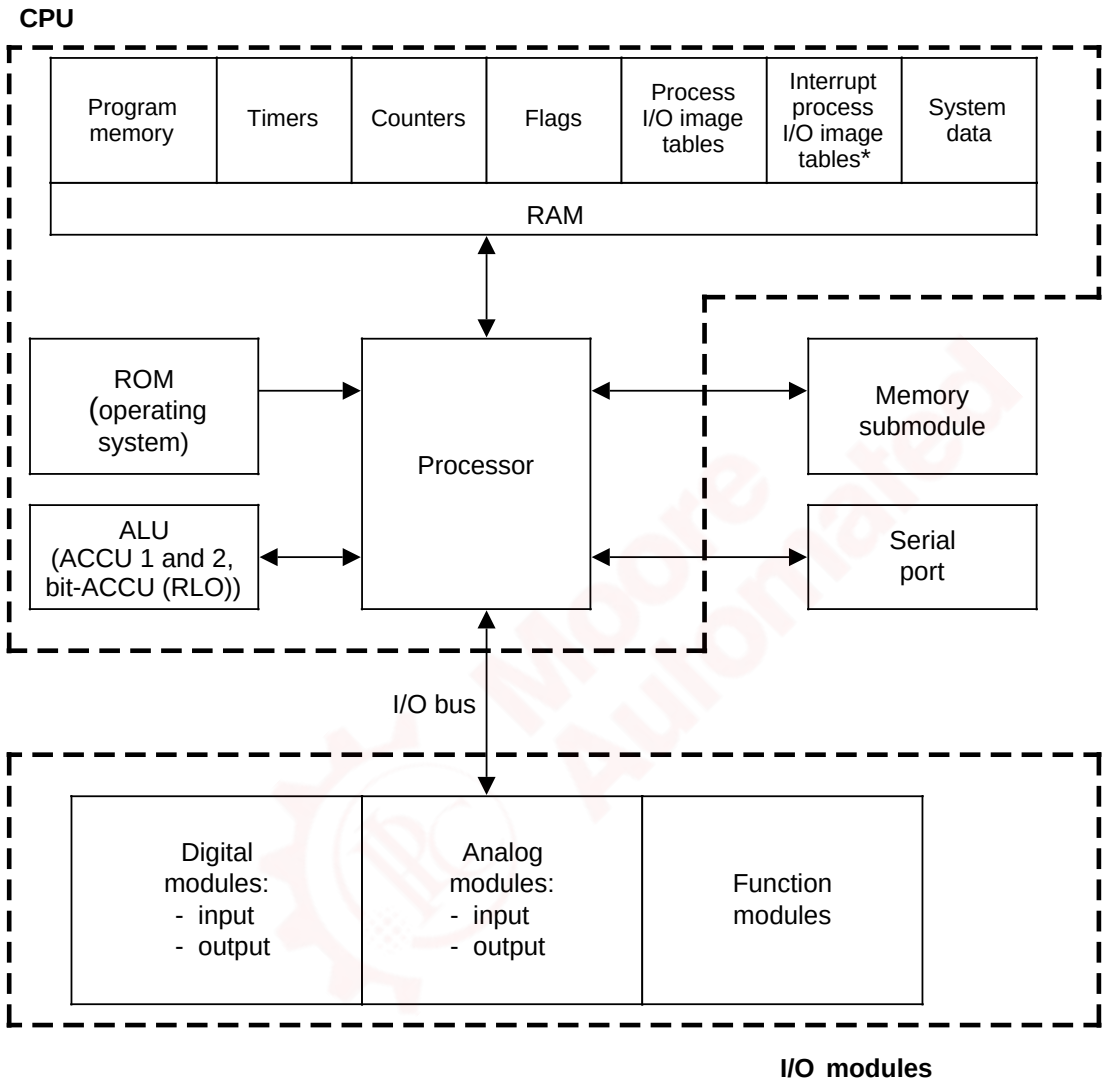
Standard mounting rail

Mount your programmable controller on the standard mounting rail.

2.2 Principle of Operation for the Programmable Controller

The remainder of this chapter explains how your S5-100U processes your program.

2.2.1 Functional Units



* Beginning with CPU 103, version 8MA02

Figure 2-2. Functional Units of the S5-100U

Program Memory (EPROM/EEPROM)

In order to safely store the control program outside of your S5-100U, you must store it on an EPROM or EEPROM memory submodule (see section 4.4).
Programs that are available on a memory submodule (EPROM or EEPROM) can be copied to the internal program memory (see section 4.3). This internal program memory is a reserved area of the CPU's internal RAM memory.

The internal RAM memory has the following characteristics:

- The memory contents can be changed quickly.
- Memory contents are lost when there is a supply voltage failure and there is no battery backup.

Operating System (ROM)

The operating system contains system programs that determine how the user program is executed, how inputs and outputs are managed, how the memory is divided, and how data is managed.
The operating system is fixed and cannot be changed.

Process Image Tables (PII, PIQ)

Signal states of input and output modules are stored in the CPU in “process image tables”. Process image tables are reserved areas in the RAM of the CPU.

Input and output modules have the following separate image tables:

- Process image input table (PII)
- Process image output table (PIQ)

Serial Interface

You can connect programmers, operator panels, and monitors to the serial port (cable connector). You can use the serial port to connect your S5-100U as a slave to the SINEC L1 local area network.

Timers, Counters, Flags

The CPU has timers, counters, and flags available internally that the control program can use.
The program can set, delete, start, and stop the timers and counters. The time and count values are stored in reserved areas of the RAM memory.

There is another area in the RAM memory where information such as intermediate results can be stored as flags. You can address the flags by bits, bytes, or words.

If battery backup is available, then some of the flags and counters remain in the internal RAM memory even if the supply voltage fails or your S5-100U is switched off. These flags and counters are retentive.

Table 2-1 gives information about the number and retentive characteristics (the internal memory contents are retained/are not retained) of these timers, counters, and flags.

Table 2-1. Retentive and Non-Retentive Operands

Operand	Retentive	Non-Retentive		
	CPU 100 to 103	CPU 100	CPU 102	CPU 103
Flags	0.0 to 63.7	64.0 to 127.7	64.0 to 127.7	64.0 to 255.7
Counters	0 to 7	8 to 15	8 to 31	8 to 127
Timers	_____	0 to 15	0 to 31	0 to 127

Arithmetic Unit

The arithmetic unit (ALU) consists of two accumulators, ACCU 1 and 2. The accumulators can process byte and word operations.

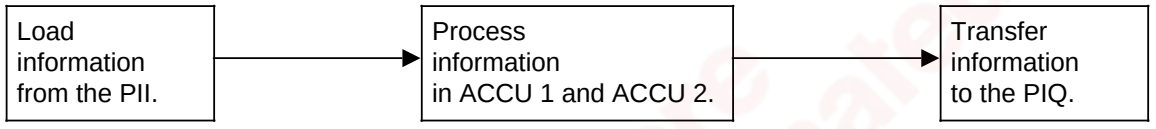


Figure 2-3. Example of an Arithmetic Logic Unit's Mode of Operation

Accumulator Design

Figure 2-4. Accumulator Design

Processor

According to the control program, the processor calls statements in the program memory in sequence and executes them. It processes the information from the PII and takes into consideration the values of internal timers and counters as well as the signal states of internal flags.

External I/O Bus

The I/O bus is the electrical connection for all signals that are exchanged between the CPU and the S5-100U modules in a programmable controller.

2.2.2 Mode of Operation for the External I/O Bus

The S5-100U has a serial bus for the transfer of data between the CPU and the I/O modules. This serial bus has the following characteristics:

- The modular design permits optimal adaptation to the particular control task.
- No addresses have to be set on the I/O modules.
- A terminating resistor connector is not required.
- Direct access to individual modules is not possible.

A number of shift registers moves the data (Figure 2-5).

Four data bits and one check bit for bus monitoring are assigned to each slot in the bus unit. All modules requiring more than four data bits have their own shift register and therefore do not have to use the shift register of the particular slot.

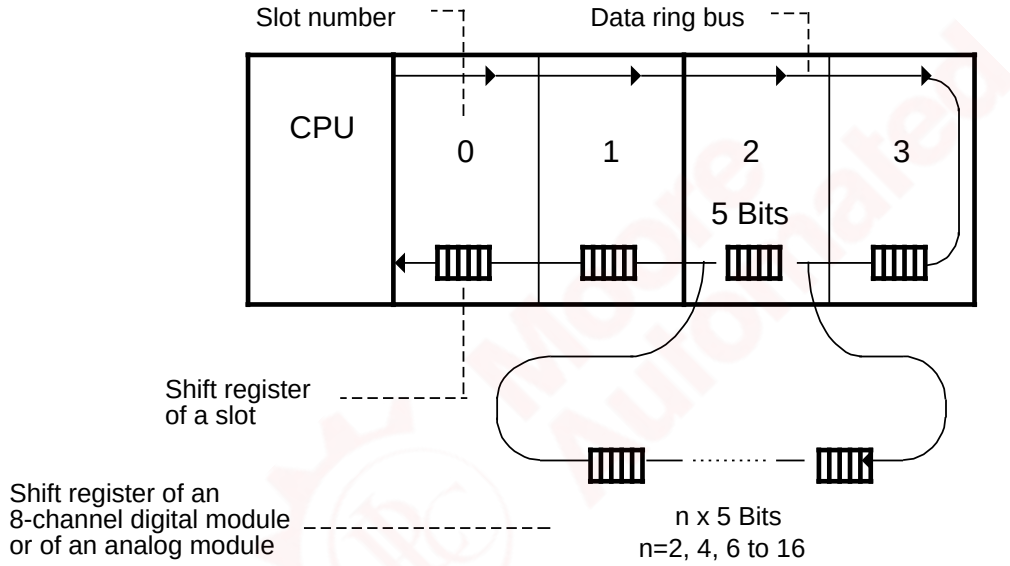


Figure 2-5. Structure of the External I/O Bus

Data Cycle

Prior to a program scan, the external I/O bus transfers current information from the input modules to the process image input table (PII). At the same time, information contained in the process image output table (PIQ) is transferred to the output modules.

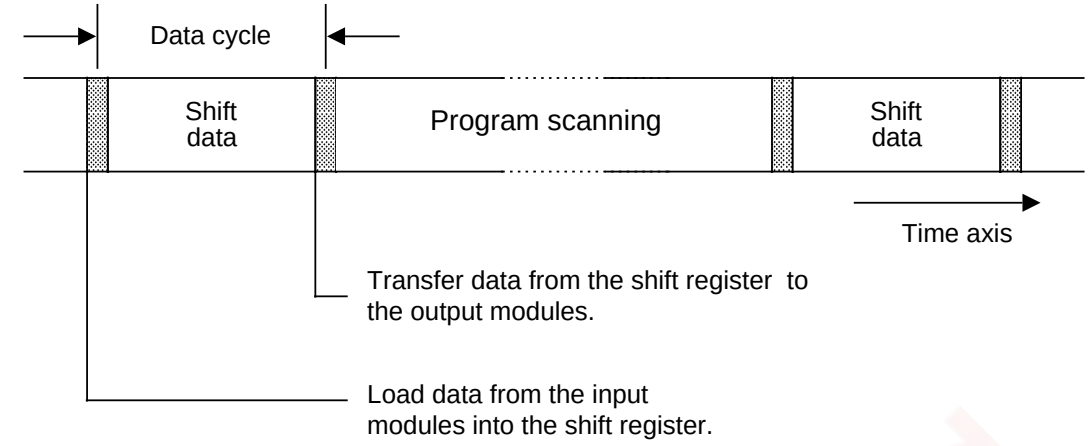


Figure 2-6. Data Cycle

Interrupt Data Cycle, for CPU 103 version 8MA02 and higher

There is an interrupt input data cycle prior to each time-controlled or interrupt-driven program scan.

Before a time-controlled program scan, current information about the input modules is read into the interrupt PII. Before an interrupt-driven program scan, interrupt inputs on slots 0 and 1 only are read into the interrupt PII.

Following a time-controlled program scan, there is not an interrupt output data cycle until data has been moved into the interrupt PIQ via a transfer operation (see section 6.6.2).
Information is output from the interrupt PIQ to the output modules during an interrupt output data cycle. The PIQ is updated.

3 Installation Guidelines

3.1 Installing S5-100U Components

Except for the I/O module, all of the S5-100U components are mounted on standard mounting rails in accordance with DIN EN 50022-35x15. Mount the rails on a metal plate to obtain the same reference potential.
Bus units with a SIGUT/screw-type, or crimp snap-in connection method have different heights.

If you install, remove, or change any parts of your S5-100U system, your system must be in the state indicated in Table 3-1.

Table 3-1. Installing, Removing, and Changing S5-100U Components

Installing, Removing, and Changing:	S5-100U Power Status	S5-100U Operating Mode	Load Voltage
I/O modules	X	STOP	OFF
Bus units Interface modules	Power OFF	X	X
CPU power supply	Power supply voltage OFF	X	X

X=not relevant

3.1.1 Assembling a Tier

You need the following components to configure the S5-100U:

- Power supply module
- Central processing unit
- Bus units
- I/O modules

If you do not have a 24 V DC power supply, you must have a power supply module.

Mount the first module on the extreme left end of the standard mounting rail. Add other modules to the right of the first module.

Mounting the PS 930 Power Supply Module

The backplane design makes it easy to attach this module to the standard mounting rail.

1. Hook the module onto the standard mounting rail.
2. Swing the module back until the slide snaps into place (see Figure 3-1).

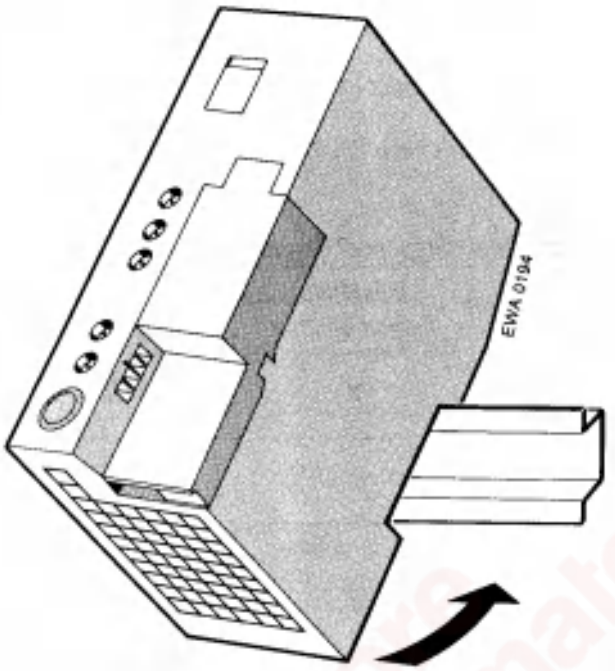


Figure 3-1. Mounting the PS 930 Power Supply Module

Removing the PS 930 Power Supply Module

1. Turn off the 115 V/230 V AC power supply.
2. Remove the connections between the CPU and the power supply module.
3. Use a screwdriver to press down on the slide on the bottom of the module.
4. Swing the module up and out of the standard mounting rail.

Mounting the Central Processing Unit

Follow the same procedure you used to mount the PS 930 power supply module (see Figure 3-1).

1. Hook the CPU onto the rail and to the right of the power supply module.
2. Swing the CPU back until the slide snaps into place.

Removing the CPU

1. Remove the I/O module located at slot "0".
2. Pull the connection (ribbon cable) between the CPU and the first bus unit.
3. Pull the connections between the CPU and the power supply module.
4. Use a screwdriver to press down on the slide on the bottom of the module.
5. Swing the module up and out of the standard mounting rail.

Mounting Bus Units

Use the same procedures to mount the bus unit that you used to mount both the power supply module and the CPU. Hooks are located on the sides of each bus unit. These hooks are used to connect bus units to each other and to connect bus units to the CPU.

Connecting Bus Units to Each Other or to the CPU

1. Pull the ribbon cable connector located on the top left of the bus unit out of its holder.
2. Plug the connector either into the receptacle located on the right side of the CPU or into the receptacle of the adjacent bus unit located on the left (see Figure 3-2).

Removing Bus Units

1. Pull the connections to the neighboring bus units or to the CPU.
2. Use a screwdriver to press down on the slide.
3. Swing the module up and out of the standard mounting rail.

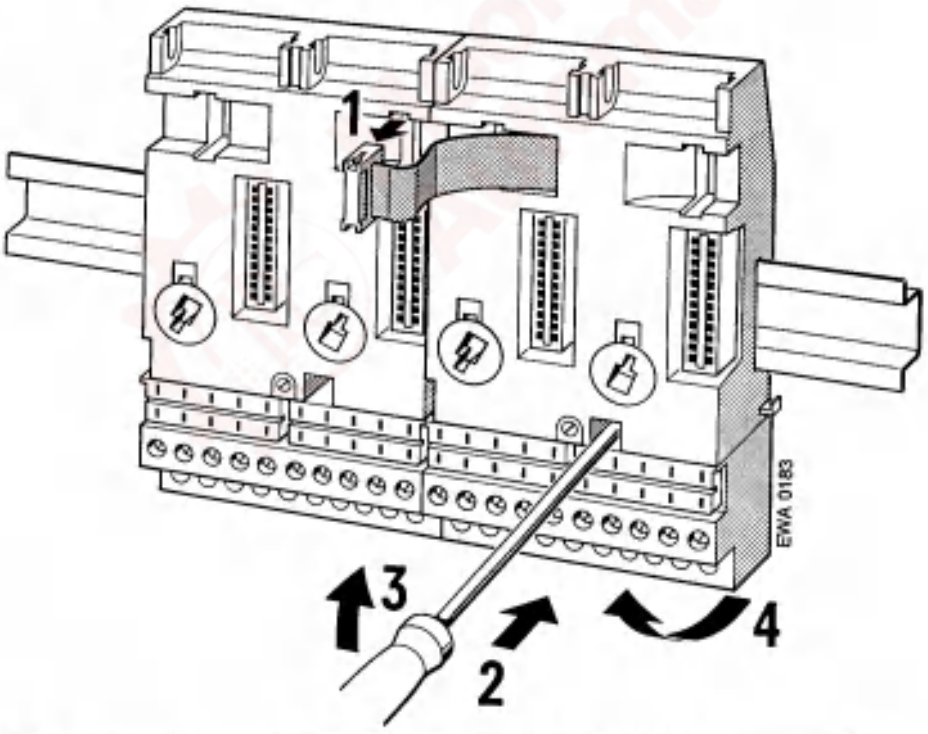


Figure 3-2. Removing Bus Units

Plugging Input and Output Modules into the Bus Units

Before you plug in an input or output module, you must set the bus unit's coding element to match the module type.

Setting the Coding Element

An identification number is printed on the front plate of every I/O module. Depending on the particular module type, the number is between two and eight. There is a white mechanical coding key located on the back of each module. The position of the coding key is determined by the module type and cannot be changed. The bus unit has a mating component for each key, a white rotating coding element or "lock" (see Figure 3-3).

Use a screwdriver to set the "lock" on the bus unit to the corresponding I/O module code number.

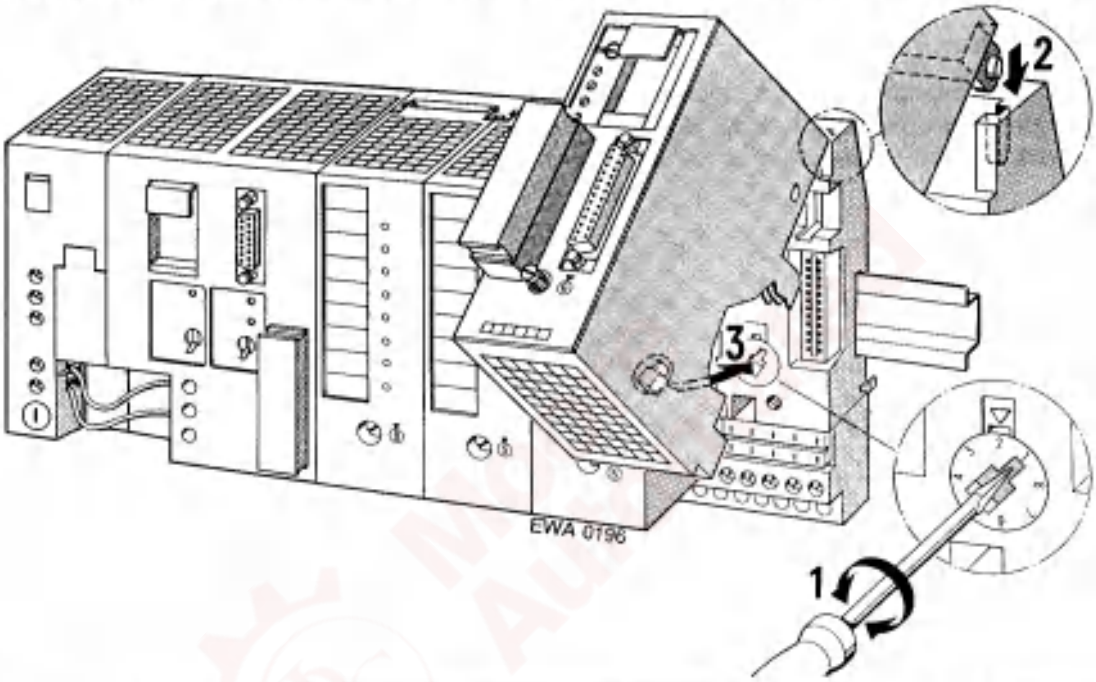


Figure 3-3. Coding System to Prevent an Inadvertent Interchange of Modules

The 6ES5 788-8MA11 simulator module does not have a coding key. You can plug in this simulator module in place of any module.

Attaching I/O Modules

1. Hook the module onto the top of the bus unit.
2. Swing the module down onto the bus unit.
3. Press the module down firmly.
4. Tighten the hold-down screw on the front of the module to attach the module to the bus unit.

Removing I/O Modules

Remove the hold-down screw and swing the module up and out of the bus unit.

3.1.2 Multi-Tier Expansion

If it is not possible to have all of the modules located on one tier, you can expand the configuration up to four tiers. You may use a maximum of 16 bus units. It does not matter how many bus units are mounted on a tier. You need one interface module per tier to interconnect the tiers.

Install an interface module as you would install a bus unit. You must connect each interface module to the last bus unit via the ribbon cable.

Use the IM 315 interface module for two-tier configurations. The IM 315 consists of two modules permanently connected to each other via a 0.5-m (20-in.) cable.

Use the IM 316 interface modules for multi-tier configurations. Use the 712-8 connecting cable to connect the IM 316 interface modules (Order No. 6ES5 712-8...).

The standard mounting rails must have a common reference potential if they are mounted in different cabinets.

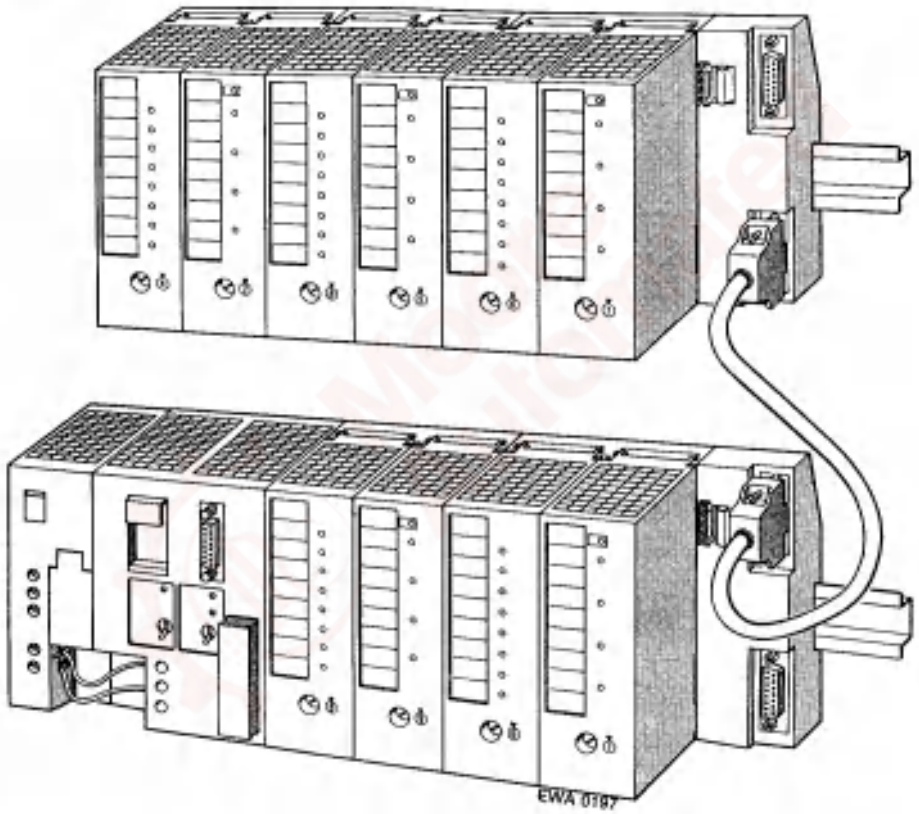


Figure 3-4. Interconnecting Tiers with Interface Modules (6ES5 316-8MA12)

Installing an Interface Module

1. Hook the interface module to the standard mounting rail.
2. Swing the interface module back until the slide on the bottom snaps into place on the rail.
3. Use the ribbon cable to connect the module to the last bus unit.
4. Use connecting cable 712-8 to join the two interface modules.
5. Connect the cable to the “out” socket on the programmable controller tier and to the “in” socket on the expansion tier.
6. Securely screw the connecting cable plugs in place. Use two screws for each connecting cable plug.

Removing an Interface Module

1. Only for the IM 316: Remove the hold-down screws from the plugs and remove the connecting cable.
2. Remove the connecting ribbon cable from the adjacent bus unit.
3. Use a screwdriver to press down on the slide located on the bottom of the interface module.
4. Swing the module up and out of the standard mounting rail.

3.1.3 Cabinet Mounting

Make sure that the S5-100U, the power supply, and all modules are well grounded. Mount the S5-100U on a metal plate to help prevent noise. There should be electrical continuity between the grounded enclosure and the mounting rails. Make sure that the system is bonded to earth.

You can use the 8LW system or the 8LX system mounting plates (see Catalog NV 21).

Adequate ventilation and heat dissipation are important to the proper operation of the system. You must have at least 210 mm (8.3 in.) between each mounting rail (see Figures in Appendix B) for proper ventilation.

Always locate the power supply and the CPU on the lowest tier to ensure better heat dissipation. To measure cabinet ventilation, define the total heat loss by calculating the sum of all typical heat losses (see Catalog ST 52.1).

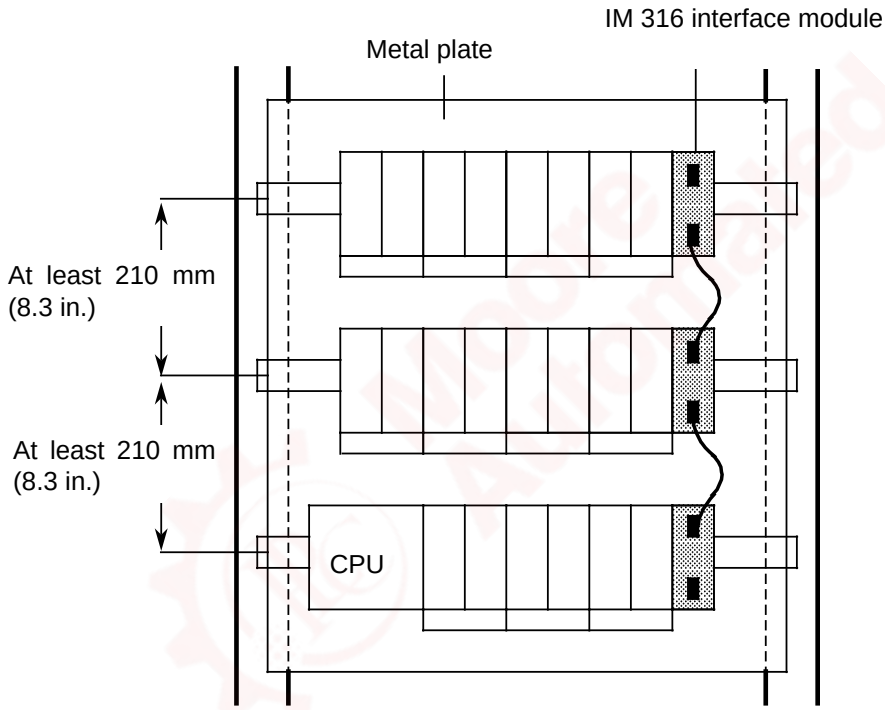


Figure 3-5. Multi-Tier Configuration in a Cabinet with the IM 316 Interface Module (6ES5 316-8MA12)

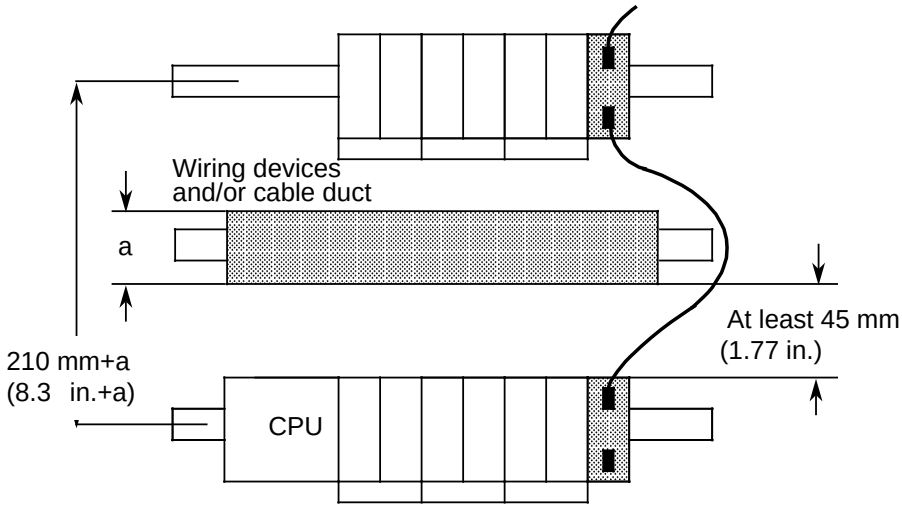


Figure 3-6. Cabinet Mounting with a Series of Devices

3.1.4 Vertical Mounting

You can also mount the standard mounting rails vertically and then attach the modules one over the other. Because heat dissipation by convection is less effective in this case, the maximum ambient temperature allowed is 40 °C (104 °F).

Use the same minimum clearances for a vertical configuration as for a horizontal configuration.

You must install a clamp (see Catalog SA 2) on the lower end of the programmable controller tier to hold the modules mechanically in position.

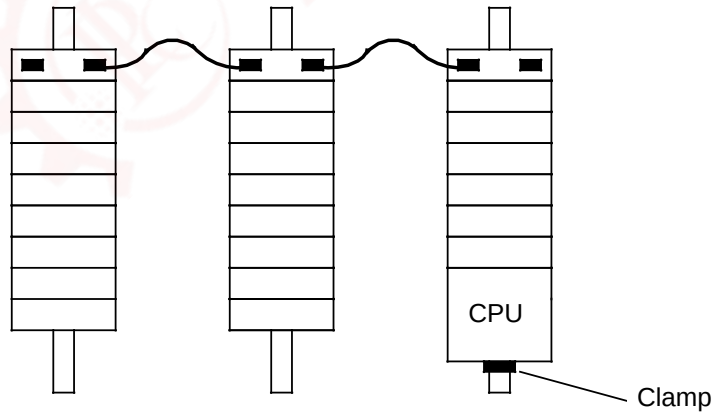


Figure 3-7. Vertically Mounting a Programmable Controller

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