4.2 Starting Up a System

The following section contains suggestions for configuring and starting up a system containing programmable controllers.

4.2.1 Suggestions for Configuring and Installing the Programmable Controller

A programmable controller is often used as a component in a larger system. The suggestions contained in the following warning are intended to help you safely install your programmable controller.

Warning

- Adhere to any safety and accident-prevention regulations applicable to your situation and system.
- If your system has a permanent power connection (stationary equipment) that is not equipped with an isolating switch and/or fuses that disconnect all poles, install either a suitable isolating switch or fuses in the building wiring system. Connect your system to a ground conductor.
- Before start-up, if you have units that operate using the main power supply, make sure that the voltage range setting on the equipment matches the local main power voltage.
- When using a 24-V supply, make sure to provide proper electric isolation between the main supply and the 24-V supply. Use only power supplies manufactured according to IEC 364-4-41 or HD 384.04.41 (VDE 0100, part 410).
- Fluctuations or deviations of the supply voltage from the rated value may not exceed the tolerance limit specified in the technical data. If they do, functional failures or dangerous conditions can occur in the electronic modules or equipment.
- Take suitable measures to make sure that programs that are interrupted by a voltage dip or power failure resume proper operation when the power is restored. Make sure that dangerous operating conditions do not occur even momentarily. If necessary, force an EMERGENCY OFF.
- EMERGENCY OFF devices must be in accordance with EN 60204/IEC 204 (VDE 0113) and be effective in all operating modes of the equipment. Make certain to prevent any uncontrolled or undefined restart when the EMERGENCY OFF devices are released.
- Install power supply and signal cables so that inductive and capacitive interference can not affect the automation functions.
- Install your automation system and its operative components so as to prevent unintentional operation.
- Automation equipment can assume an undefined state in the case of a wire break in the signal lines. To prevent this, take the proper hardware and software safety measures when linking the inputs and outputs of the automation equipment.

4.2.2 Steps for Starting Up the Programmable Controller

Steps for Starting Up the S5-90U without External I/Os

Table 4-1. Starting Up the S5-90U without External I/Os

Prerequisites Procedures	Comments	Displays
System and PLC are off-load. • Check the mechanical configuration and the wiring. (see sections 3.2 and 3.3)	Adhere to the installation guidelines contained in VDE 0100 and VDE 0160.	
Put the operating mode switch in the "STOP" position. • Connect the PLC to the power supply. • Connect the programmer to the PLC. • Perform an overall reset on the PLC (see section 4.1.3). • Put the operating mode switch in the "RUN" position. • Turn on the power supply for the sensors.		• The green LED on the programmable controller lights up.
• Activate all sensors in sequence.	You can observe the input signals in the PII if you use the "STATUS VAR" programmer function.	• The LEDs for the connected onboard inputs light up.
• Turn on the power supply for the actuators. • Force outputs using the "FORCE VAR" programmer function.	The circuit states of the respective actuators change.	
When the program is on a memory submodule: • No battery is connected. • Remove the PLC from the power supply. • Plug in the memory submodule. • Connect the PLC to the power supply.	The program is being loaded.	• The red LED on the programmable controller is flickering.
• Test the program and correct it if necessary. • Put the operating mode switch in the "STOP" position. • Turn on the load circuit. • Put the operating mode switch in the "RUN" position.	The system is operative.	• The green LED on the programmable controller lights up.
• **Save the program.**		

MONITOR PANEL

± 10 Volts

DC VOLTS

MONITOR

LOCAL

EXTEND

INPUTS

OUTPUTS

AL MONITOR PANEL

INPUTS

JW32

OUTPUTS

QW32

PETRA

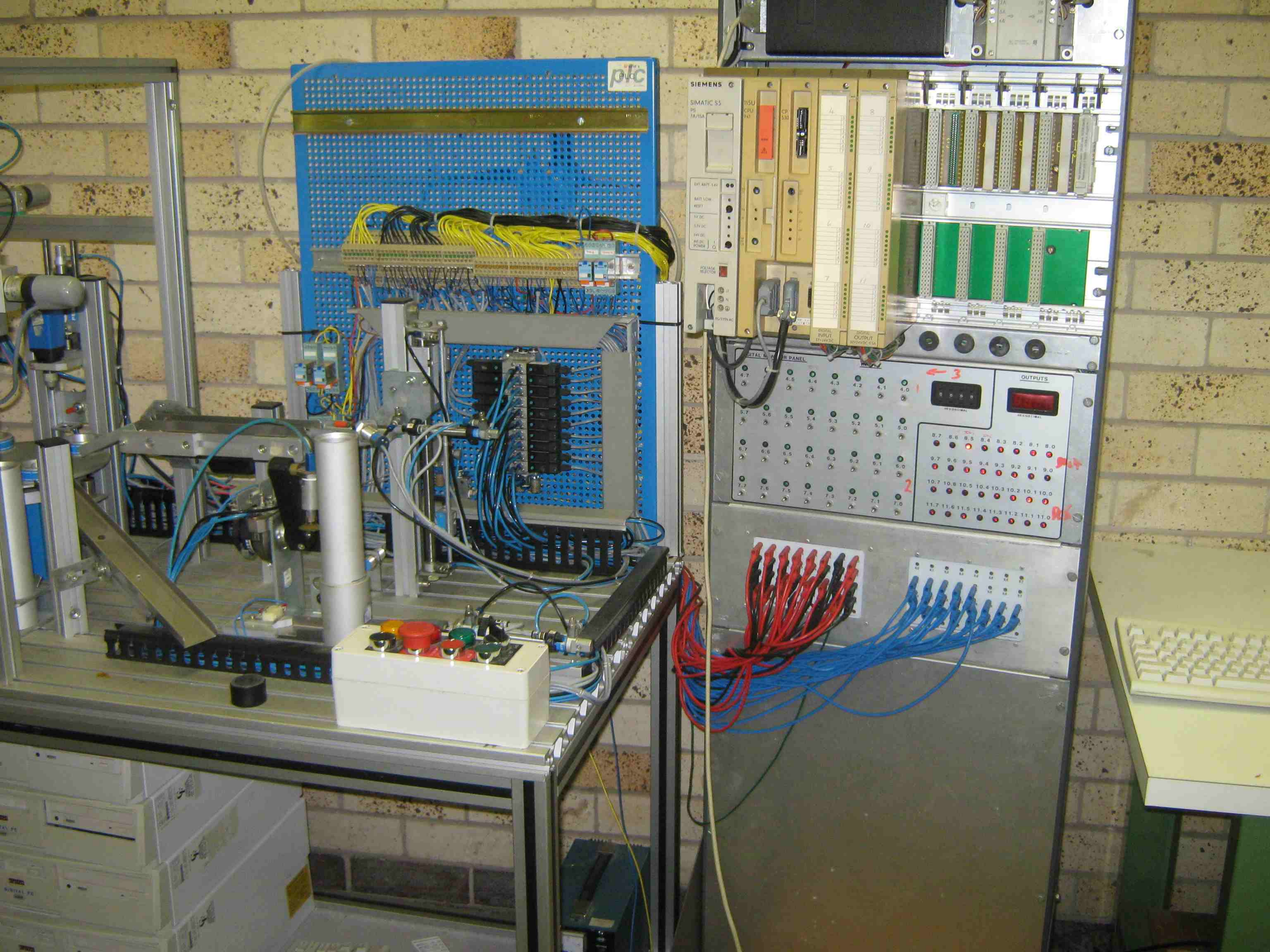
Cylinder C

Maximum Input to Pressure Regulator - 6 Bar (90 PSI)

Cylinder D

PLC - PETRA INTERFACE
SYDNEY INSTITUTE OF TECHNOLOGY
ELECTROTECHNOLOGY - CAMS
VII - 1990

GND


SIEMENS
SIMATIC S5
OUTPUTS

SIEMENS
SIMATIC S5-100U
CPU 102
BATTERY OFF/ LOW
RUN
STOP
RUN STOP COPY
L+
24VDC
M
INPUTS
I/O PATCHING
THE KW SUPER CONVEYOR
STOP
START
LPA
RPA
JOG
SIEMENS
SIMATIC S5
6ES5 700-8MA11
MADE IN GERMANY
0000
IW 64
DIGITAL INPUTS
3.7 3.6 3.5 3.4 3.3 3.2 3.1 3.0
4.7 4.6 4.5 4.4 4.3 4.2 4.1 4.0
DIGITAL OUTPUTS

RUN
STOP
L+
24VDC
M
6ES5 102-8MA02
INPUTS
I/O PATCHING
0.7
0.6
0.5
0.4
0.3
1.7
1.6
1.5
1.4
DIGITAL OUTPUT
SIEMENS
SIMATIC S5-100U
PS 930
VOLTAGE SELECTOR

THE KW SUPER CONVEYOR

STOP

START

RPA

LPA

JOG

SIEMENS
SIMATIC S5
BUS MODULE
6ES5 700-8MA11
MADE IN GERMANY

Contents

Appendices

How to Use This System Manual

The S5-90U and S5-95U are programmable controllers for lower and intermediate performance ranges. They meet all the requirements for a modern programmable controller. To use these controllers optimally, you need detailed information.

In this system manual we have attempted to present this information as completely and as well organized as possible. Certain information is repeated in various chapters so that you do not have to leaf through the manual to find what you need.

This How to Use This System Manual section gives you information that will make it easier for you to find what you need. This section explains how the manual is organized.

Contents of This System Manual

- Hardware Description (Chapters 1, 2, and 3)
  These chapters describe the controllers: how they fit into the SIMATIC® S5 family of programmable controllers, how they function, and how you install them.

- Start-Up Information (Chapters 4, 5, and 6)
  These chapters summarize the information you need to start up your programmable controller. These chapters describe how the hardware and software influence each other.

- The Programming Language of the Programmable Controllers (Chapters 7, 8, and 9)
  These chapters describe the structure, operations, and structuring aids of the STEP® 5 programming language.

- Functions of the Programmable Controllers (Chapters 10, 11, 12, 13, and 14)
  Each of these chapters contains a complete description of a particular function, from wiring to programming. Subjects include analog value processing, counter and interrupt inputs, integral clock, and the programmable controller as a SINEC® L1 slave.

- Module Spectrum (Chapters 15 and 16)
  These chapters contain information about all the currently available S5-100U modules that you can use to expand your controller. Chapter 16, Function Modules, includes the modules that require an extensive description (i. e., more than just technical specifications).

- Overviews (Appendices)
  In these chapters you will find not only a complete list of operations but also dimension drawings, a description of errors that may occur during operation of the programmable controller, maintenance and repair procedures, a list of accessories, and reference literature about programmable controllers.

You will find correction pages at the end of the system manual. Use them to indicate any corrections, additions, or suggestions for improvement you might have. Send these suggestions to us. They will help us to improve the next edition of this system manual.

Conventions

This system manual is organized in menu form to make it easier for you to find information. This means the following:

- Each chapter is marked with printed tabs.
- At the front of the system manual is an overview page that lists the title of each chapter. Following this page, you will find a table of contents.
- At the beginning of each chapter is a table of contents for that chapter. Each chapter has three level headings that are numbered. The fourth level heading is not numbered but appears in **boldface type**.
- Pages, figures, and tables are numbered separately for each chapter. On the back of the table of contents for each chapter you will find a list of the figures and tables that appear in that chapter.

This system manual employs the following specific structuring devices:

- Specific terms have characteristic abbreviations (e. g., programmer is PG). Appendix A contains a list of abbreviations.
- Footnotes are marked with a raised number (e. g., "1") or a raised asterisk ("*"). You will find the corresponding explanations in the lower margin of the page or under a figure or table if the footnote appears in one of these.
- Lists are designated with bullets (• as in this particular listing) or with hyphens (-).
- Procedures are marked with black triangles (‣) and must be performed in the sequence presented.
- Cross references are indicated as follows: (see section 7.3.2). There are no references to specific page numbers.
- Dimensions in drawings are indicated in millimeters and inches.
- Value ranges are indicated as follows: 17 through 21.
- Especially important information appears in framed boxes such as the following:

> **Warning**
>
>

You will find definitions for the terms "Warning," "Danger," "Caution," and "Note" in the Safety-Related Guidelines for the User at the end of the introduction.

Changes Made to the Second Edition of the S5-90U/S5-95U System Manual (Order Number: 6ES5 998-8MA21)

Several functions have been added to the S5-95U programmable controller (order number 6ES5 095-8MA01). These functions are described in the following new chapters and sections.

- Section 8.2.8: DO Operations
- Chapter 13: Integral Real-Time Clock

Improvements to the S5-95U programmable controller (6ES5 095-8MA01, Release 2)

- If you want to reset the hardware counter to 0, you must enter a new comparison value (se section 11.3).

An additional I/O module has been added to the S5-90U/S5-95U system. This module, the "CP 5 BASIC communications module", is described in section 16.10.2.

Training

Siemens offers a wide range of training courses for SIMATIC S5 users.
Contact your Siemens representative for more information.

Safety-Related Guidelines for the User

This document provides the information required for the intended use of the particular product. The documentation is written for technically qualified personnel.

Qualified personnel as referred to in the safety guidelines in this document as well as on the product itself are defined as follows.

- System planning and design engineers who are familiar with the safety concepts of automation equipment.
- Operating personnel who have been trained to work with automation equipment and are conversant with the contents of the document in as far as it is connected with the actual operation of the plant.
- Commissioning and service personnel who are trained to repair such automation equipment and who are authorized to energize, de-energize, clear, ground, and tag circuits, equipment, and systems in accordance with established safety practice.

Danger Notices

The notices and guidelines that follow are intended to ensure personal safety, as well as protect the products and connected equipment against damage.

The safety notices and warnings for protection against loss of life (the users or service personnel) or for protection against damage to property are highlighted in this document by the terms and pictograms defined here. The terms used in this document and marked on the equipment itself have the following significance.

Danger

indicates that death, severe personal injury or substantial property damage will result if proper precautions are not taken.

Warning

indicates that death, severe personal injury or substantial property damage can result if proper precautions are not taken.

Caution

indicates that minor personal injury or property damage can result if proper precautions are not taken.

Note

contains important information about the product, its operation or a part of the document to which special attention is drawn.

Proper Usage

Warning

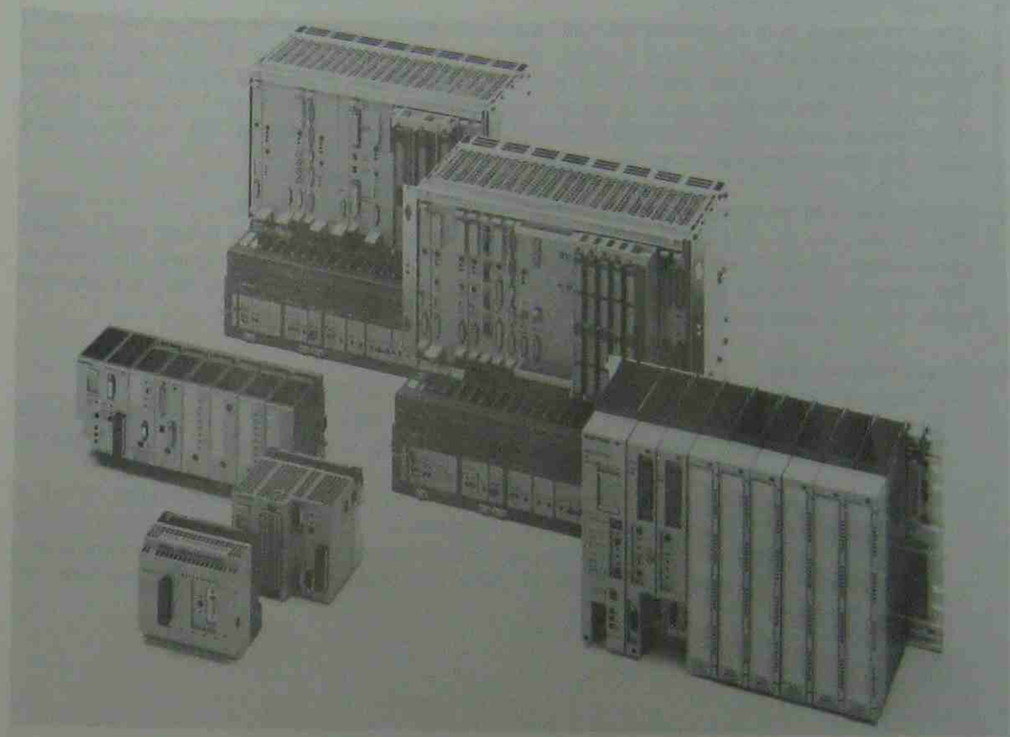
- The equipment/system or the system components may only be used for the applications described in the catalog or the technical description, and only in combination with the equipment, components, and devices of other manufacturers as far as this is recommended or permitted by Siemens.
- The product will function correctly and safely only if it is transported, stored, set up, and installed as intended, and operated and maintained with care.

1 The SIMATIC S5 System Family

Figures

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.



EWA AUT 91 FE 1016

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

The S5-90U and S5-95U SIMATIC programmable controllers are the most compact and economical control systems of the S5 family. Especially suited for small and simple automation tasks, they are highly efficient and very flexible. It is economical to use these programmable controllers if you just need to replace five control relays, for example. The following characteristics distinguish these compact programmable controllers.

- S5-90U
  The S5-90U is small and easy to use. Its size makes it possible for you to use it when there is little space available. This compact PLC has eight digital inputs, six relay outputs, one processor, one interrupt input, and one counter input. When connected to the SINEC L1 bus system via an interface, the S5-90U can communicate with other PLCs. The S5-90U is pre-wired for 115-V or 230-V AC supply voltage. The S5-90U has a 24-V DC power supply for the sensors.

- S5-95U
  The S5-95U is an efficient and flexible PLC for solving complex tasks such as analog value processing. When connected to the SINEC L1 bus system via an interface, the S5-95U can communicate with other PLCs. In addition to the processor and interface, the S5-95U has 16 digital inputs, 16 digital outputs, 8 analog inputs, 1 analog output, 4 interrupt inputs, and 2 counter inputs.

- Modular Expansion Capability
  You can expand both PLCs with S5-100U modules. You expand the S5-90U with the S5-100U modules via the IM 90 interface module. For the S5-95U, you connect the S5-100U modules directly to the PLC. Both the S5-90U and the S5-95U have a modular design. This design allows the S5-90U to have up to 48 digital inputs and outputs and the S5-95U to have up to 256 digital inputs and outputs. The S5-100U series modules make it possible for you to optimally adapt the S5-90U and the S5-95U to your control tasks.

- Robust and Light-Weight Design
  The S5-90U, the S5-95U, and all of the expansion modules are small, easy to use, and ruggedly constructed. They do not need fans and are not susceptible to electromagnetic interference. The expansion modules are plugged into bus units and screwed tightly so that they are vibration-proof. The bus units snap onto a standard mounting rail.

- Simple Programming
  The following software packages are available to program your S5-90U and S5-95U.
  - The STEP 5 software allows you to display in ladder logic, control system flowchart, and statement lists. With STEP 5, you can program using any programmer in the SIMATIC family.
  - The STEP 5 LAD 90 software is particularly effective for programming simple tasks. STEP 5 LAD 90 allows you to display in ladder logic and statement lists. You can run STEP 5 LAD 90 under MS-DOS. Using this software, you can write programs on an IBM-compatible computer. You can also use the wide range of SIMATIC programmers that are available for programming.

Figures

Tables

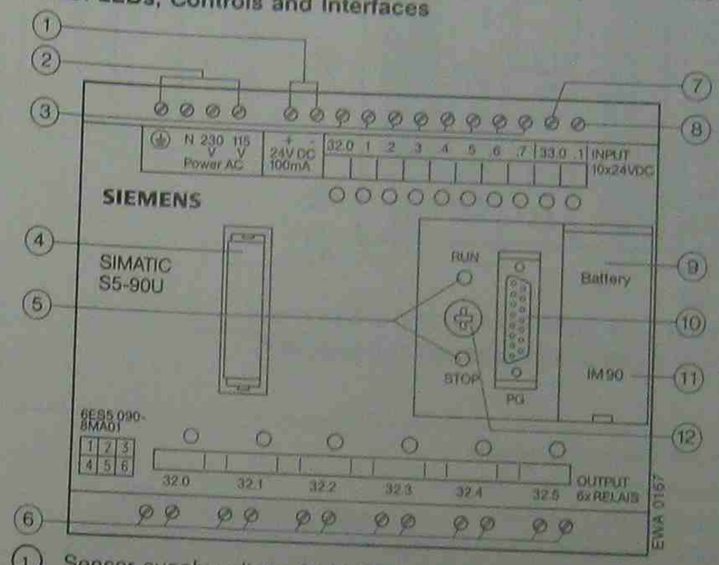
2 Technical Description

This chapter describes the design and principle of operation for the S5-90U/95U programmable controllers (PLCs) and their accessories.

2.1 Programmable Controller Design - without External I/Os

The following section discusses programmable controllers but does not discuss expansion devices. Both controllers have a limited number of inputs and outputs available on board.

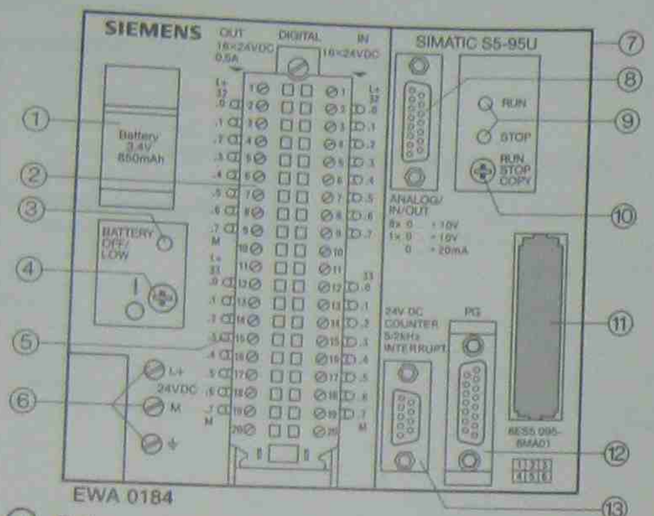
S5-90U: LEDs, Controls and Interfaces



(1) Sensor supply voltage 24-V DC/0.1 A
(2) Terminals for connecting the power supply
(3) Terminals for connecting the digital inputs (I 32.0 to I 32.7)
(4) Receptacle for an EPROM or EEPROM memory submodule
(5) RUN/STOP LEDs: The green LED indicates the "RUN" mode, the red LED indicates the "STOP" mode.
(6) Terminals for connecting the digital outputs (Q 32.0 to Q 32.5)
(7) Terminal for connecting the interrupt input (I 33.0)
(8) Terminal for connecting the counter input (I 33.1, IW 36)
(9) Battery compartment
(10) Interface for a programmer (PG), a personal computer (PC), an operator panel (OP), or the SINEC L1 bus
(11) Interface for an IM 90 interface module for expansion with S5-100U modules
(12) RUN/STOP switch

Figure 2-1. S5-90U LEDs, Controls and Interfaces

S5-95U: LEDs, Controls and Interfaces



(1) Battery compartment
(2) Front panel connector for digital inputs (I 32.0 to I 33.7) and for digital outputs (Q 32.0 to Q 33.7)
(3) Battery low LED
(4) ON/OFF switch
(5) LED display for digital inputs and outputs
(6) Terminals for connecting the power supply
(7) Cable connector for S5-100U modules
(8) Interface for analog inputs (IW 40 to IW 54) and for analog outputs (QW 40)
(9) RUN/STOP LEDs: The green LED indicates the "RUN" mode, the red LED indicates the "STOP" mode.
(10) RUN/STOP/COPY switch
(11) Receptacle for an EPROM or EEPROM memory submodule
(12) Interface for a PG, PC, OP or SINEC L1 bus
(13) Interface for interrupt inputs (I 34.0 to 34.3) and for counter inputs (IW 36, IW 38)

Figure 2-2. S5-95U LEDs, Controls and Interfaces

2.2 Programmable Controller Design - with External I/Os

You can expand the programmable controller by using S5-100U external I/O modules. This external peripheral consists of functional units (modules) that you can combine according to the task you want to perform.

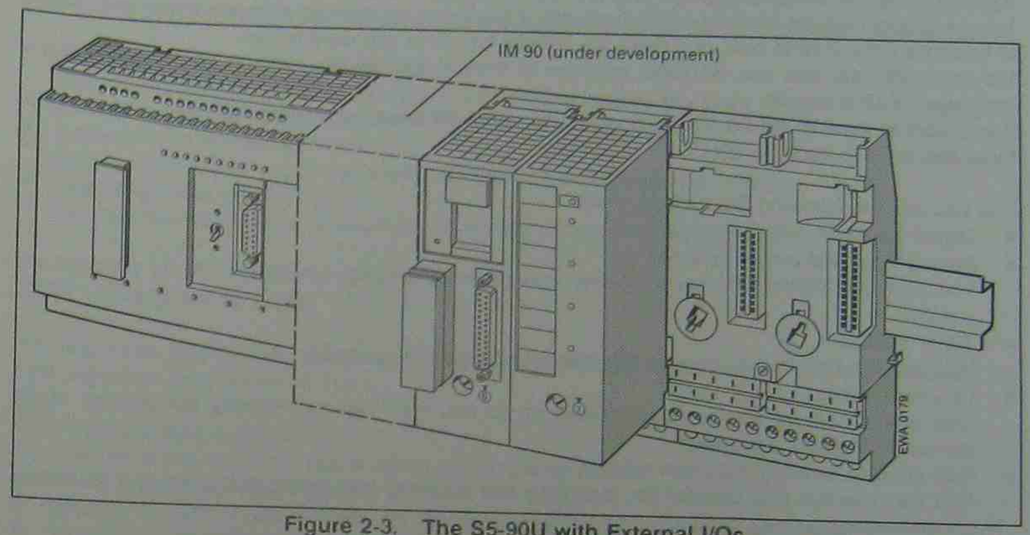


Figure 2-3. The S5-90U with External I/Os

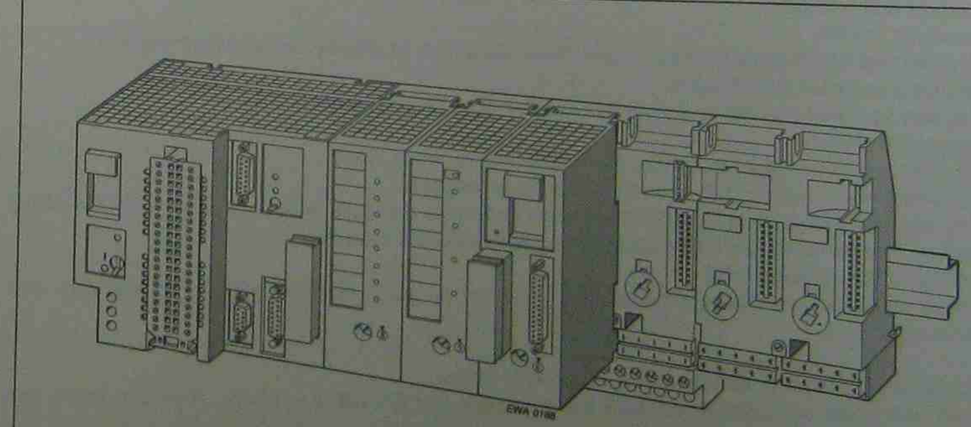


Figure 2-4. The S5-95U with External I/Os

Power Supply Module
The S5-95U requires this module to use the 115-V/230-V AC from the supply voltage to generate the operating voltage for the controller.

External I/Os (S5-100U Modules)
You must use external I/Os (S5-100U modules) if there are not enough onboard inputs and outputs to implement the control task, or if there are special functions you want to use.
Via bus units, you can use S5-100U modules to expand the S5-95U directly. You can connect a maximum of 16 bus units.
If you want to expand the S5-90U, you must use an IM 90 interface module. You can connect up to three bus units to each S5-90U.

You can use the following S5-100U modules:
- Digital input and output modules
- Analog input and output modules
  You can use these modules to create and record changing variables such as currents and voltages.
- Timer module
  You can use this module to set times without changing the program.
- Counter module
  This module allows you to count pulses up to 500 Hz. You can specify comparison values without changing the program.
- Fast counter, position detection module
  You can use the fast counter for recording fast counting pulses (25/500 kHz) and for simple positioning tasks.
- Comparator module
  You can use this module to monitor a set comparison value.
  (current and voltage)
- Simulator module
  You can use this module to create digital input signals or to display digital output signals.
- Simulator (only for the S5-90U)
  You can use the simulator to create and display digital input signals.
- Diagnostic module
  You can use this module to control the functioning of the I/O bus.
- Communication module (CP - communications processor)
  You can use this module to output message texts with the date and clock time to a connected printer. You can also use this module to interface external systems.
- Intelligent I/O modules (IPs)
  These signal preprocessing modules are available for such special tasks as temperature and drive regulation.

Bus Units with Terminal Blocks (crimp snap-in or screw)
You can use these bus units to connect the controller and S5-100U modules. You can insert two I/O modules per bus unit.

Interface Modules (IMs)
S5-90U: The IM 90 interface module (under development) allows a configuration with external I/Os.
The IM 315 and IM 316 interface modules allow the controller to be configured with external I/Os in several tiers.

2.3 Internal Functions

2.3.1 Integral Real-Time Clock (currently under development for the S5-95U)

The integral real-time clock enables you to manipulate the process sequence on a time-dependent basis and to control the process sequence by offering the following possibilities (see Chapter 13):

- Clock-time function and calendar function
  This function allows you, for example, to determine exactly the point in time at which an error caused the PLC to go into the "STOP" mode.
- Interrupt or time interrupt function
  This function allows you, for example, to monitor the duration of a process.
- Operating hours counter
  This function allows you, for example, to monitor inspection intervals.

2.3.2 Diagnostic Byte

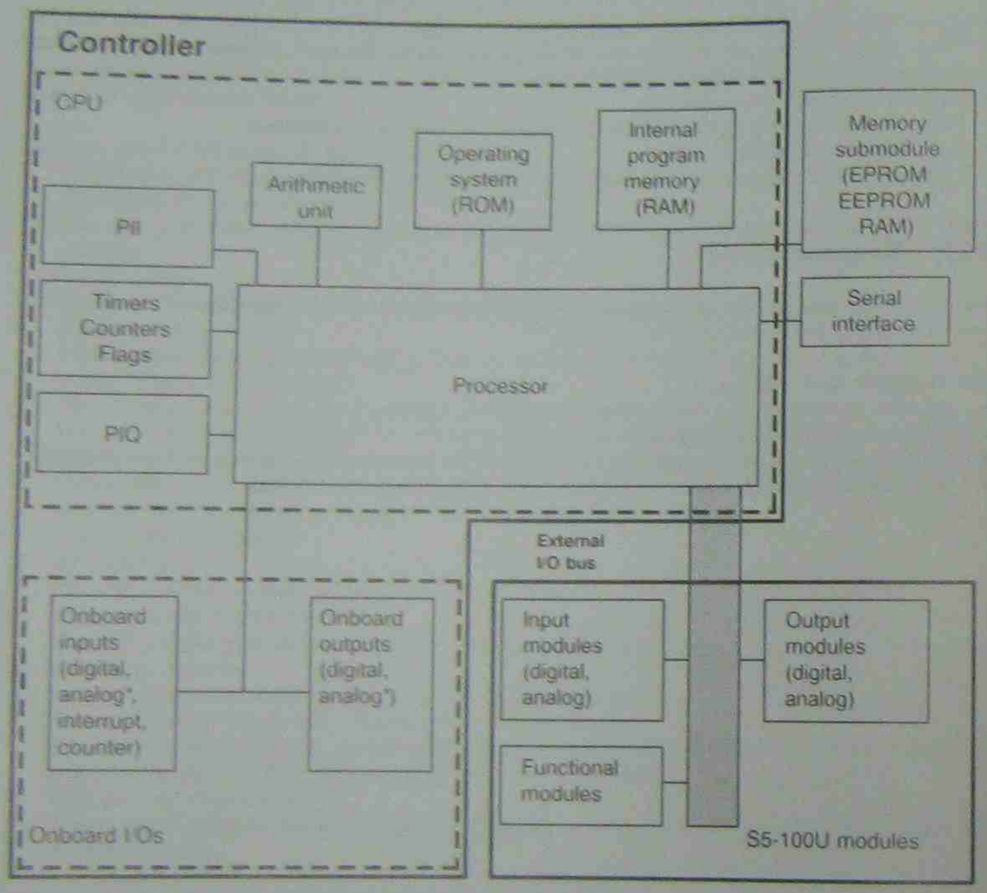
The diagnostic byte (IB 35) gives you an additional possibility to control the process sequence for both controllers (see section 5.1).

The diagnostic byte displays:
- Whether or not a counter has reached its comparison value
- Where an interrupt was triggered
- Whether or not the power supply for the onboard I/Os has failed (only applicable to the S5-95U)
- Whether or not battery backup is available (only applicable to the S5-95U)

2.4 The Programmable Controller's Principle of Operation

This section describes how the controller processes your program.

2.4.1 Functional Units



*for the S5-95U

Figure 2-5. Functional Units for the Programmable Controller

Program Memory (RAM, EPROM/EEPROM)

In order to safely store the control program outside of the PLC, 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 Images (PII, PIQ)

Signal states of onboard inputs, onboard outputs, and output modules are stored in the CPU in "process images". Process images are reserved areas in the CPU RAM.

Input and output modules have the following separate images:
- Process image input table (PII)
- Process image output table (PIQ)

Serial Interface

You can connect programmers, operator panels and monitors at the serial interface (cable connector). Via the serial interface, you can connect both controllers as slaves 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 the 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 the controller is switched off. These flags and counters are called retentive ones.

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	S5-90U		S5-95U	
	Retentive	Non-Retentive	Retentive	Non-Retentive
Flags	0.0 to 63.7	64.0 to 127.7	0.0 to 63.7	64.0 to 255.7
Counters	0 to 7	8 to 31	0 to 7	8 to 127
Timers	___	0 to 31	___	0 to 127

Arithmetic Unit

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

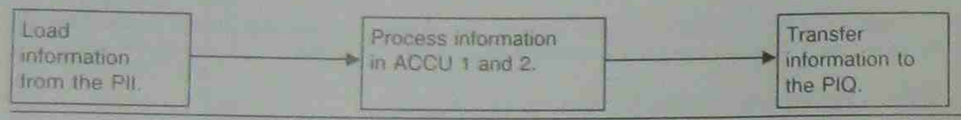


Figure 2-6. Example of an Arithmetic Logic Unit's Mode of Operation

Accumulator Design

Figure 2-7. 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

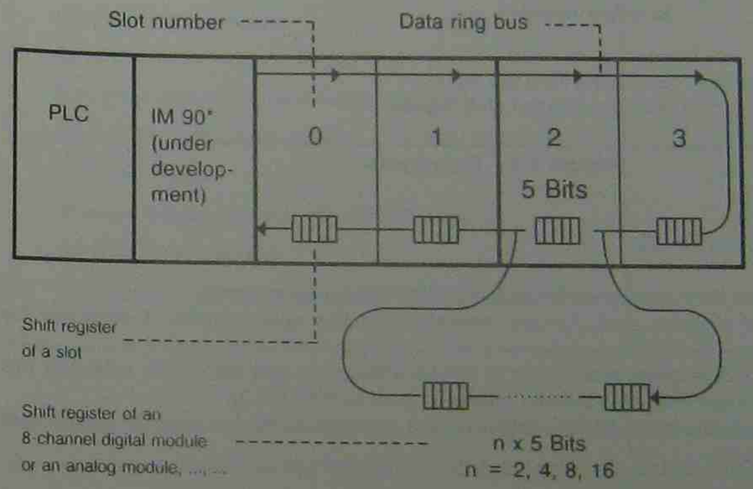
The I/O bus is the electrical connection for all signals that are exchanged between the CPU and the S5-100U modules in a programmable controller.

2.4.2 Mode of Operation for the External I/O Bus

The programmable controllers have a serial bus for the transfer of data between the CPU and the S5-100U 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.

The data is moved via a number of shift registers (Figure 2-8).
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.



* Module required only for expanding the S5-90U (currently under development)

Figure 2-8. Structure of the External I/O Bus

Note

If you want to make certain that the controller starts up only with external I/Os connected to it, you must set parameters in DB1. (Change the "SDP" parameter block, see section 9.1). With the S5-90U, the IM 90 recognizes this situation automatically.

Data Cycle

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

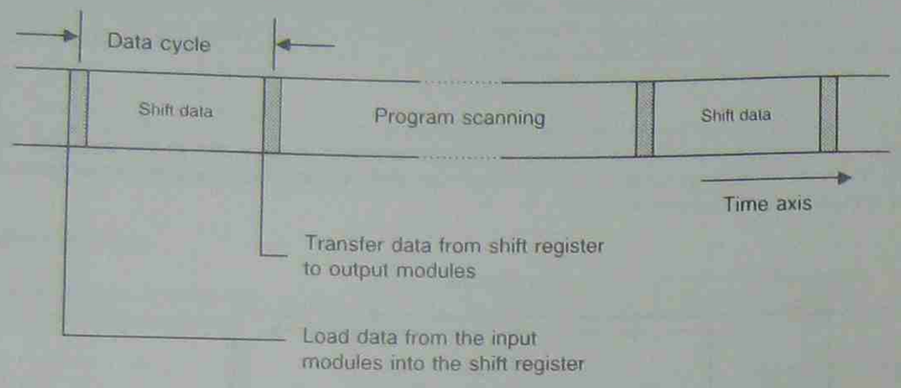


Figure 2-9. Data Cycle

Interrupt Data Cycle (for the S5-95U)

There is an interrupt input data cycle prior to each time-controlled program scan.
Before a time-controlled program scan, current information of the input modules is 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 8.1.3).
Information is output from the interrupt PIQ to the output modules during an interrupt output data cycle. The PIQ is updated.

Length of the Shift Register

The total length of the shift register is obtained from the sum of the data bits of all plugged in modules and of the empty slots. The check bit is not counted.
You must know the length of the shift register to be able to determine the data cycle time. Data cycle time is 25 µs x number of data bits.

Table 2-2. Number of Bits per Module in the Shift Register

Plugged in module	Number of data bits
Diagnostic module or vacant slot	4
4-channel digital input and output modules	4
500 Hz comparator module, 500 Hz timer module, 500 Hz counter module	4
25 KHz counter module, IP 267	32
8-channel digital input and output modules	8
Digital input and output module, 16 inputs/16 outputs	16
Simulator module	8
Analog modules for each activated channel	16
CP 521, IP 262, IP 266	64
Refer to the individual manuals for information on other modules.	

The maximum expansion for the S5-90U is 48 digital channels and/or 8 analog channels.

The maximum expansion for the S5-95U is 256 digital channels and 16 analog channels.

Note

If the maximum expansion allowed is exceeded, then the controllers go into the STOP mode. The "PEU" bit (I/O not ready) is set in the ISTACK.

3 Installation Guidelines

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Figures

Figures

Tables

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3 Installation Guidelines

3.1 Mechanical Installation of the Programmable Controller

How to Mount the S5-90U with Wall Brackets

If you use the S5-90U without external I/O modules, then you can mount the controller directly on walls or mounting plates. You need one set of wall brackets (Order No. 6ES5 981-8MB11) to mount the controller.

- Push the wall brackets into the appropriate openings on the controller until the brackets snap into place.
- Use four screws (size M5) to tighten the mounted controller.

Figure 3-1 shows you how to mount the S5-90U on a wall.

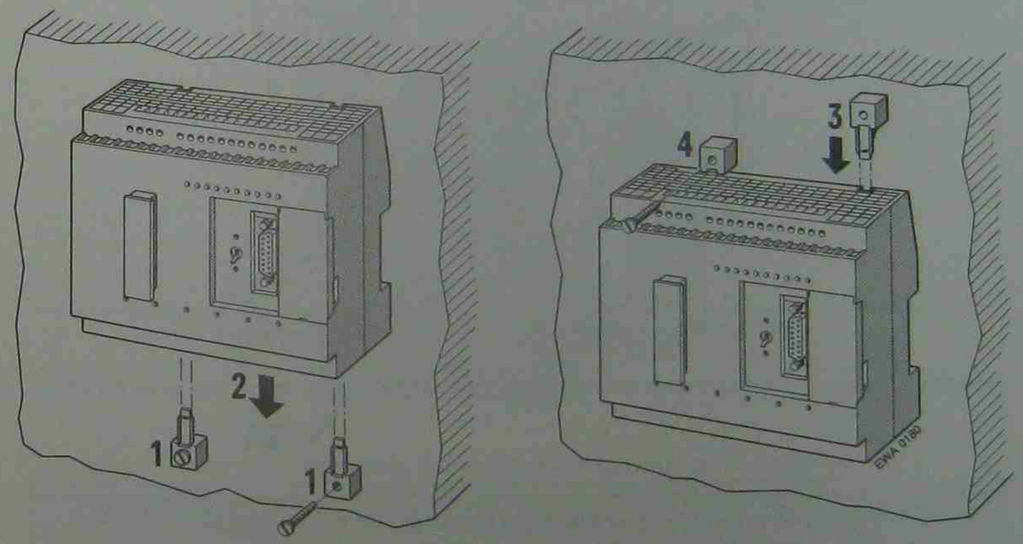

Figure 3-1. Mounting the S5-90U on a Wall

To remove the S5-90U, perform the following steps.

- Remove all connected supply cables and signal cables.
- Loosen the four hold-down screws.

How to Mount the S5-90U on Standard Mounting Rails

Both the S5-90U and the S5-95U can be mounted on 35-mm standard mounting rails.

To install the programmable controller on a standard mounting rail, proceed as follows:
- Hook the controller onto the standard mounting rail.
- Swing the controller back until the slide on the bottom of the controller audibly snaps into place.

Figure 3-2 shows the installation of the S5-95U.

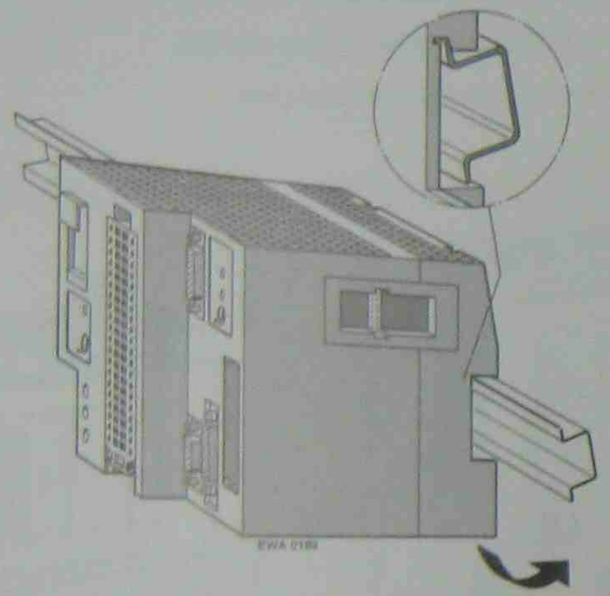

Figure 3-2. Mounting the Programmable Controller on a Standard Mounting Rail

To remove the programmable controller from a standard mounting rail, proceed as follows:
- Remove all connected supply cables and signal cables.
- Using a screwdriver, press down on the slide on the bottom of the controller.
- Swing the controller up and out of the standard mounting rail.

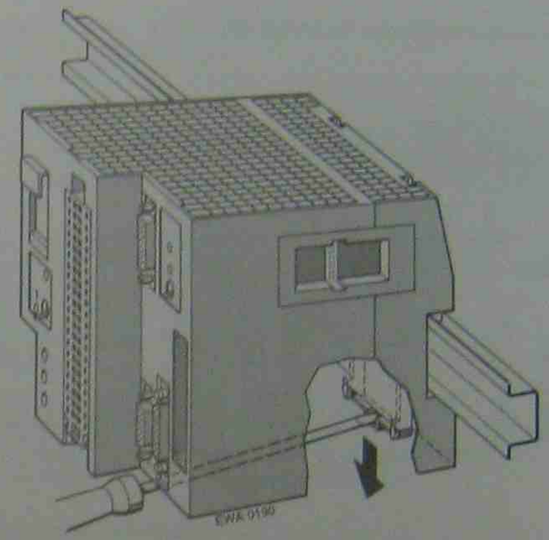

Figure 3-3. Removing the Programmable Controller

Use the following table when you install, remove, or change the programmable controller installation.

Table 3-1. Mounting, Removing and Exchanging the Hardware

Mounting, Removing, and Modifying:	Status of PLC Power Supply	PLC Operating Mode	Load Voltage
I/O modules	X	STOP	OFF
Bus units Interface modules	Power OFF	X	X
S5-90U, S5-95U Power supply	Supply voltage OFF	X	X

X = not relevant

3.2 Mechanical Installation with External I/Os

You can expand the programmable controllers by using S5-100U external I/O modules. If you install S5-100U external I/O modules, mount the controller, bus units, and interface module on a 35-mm standard mounting rail and connect them to each other. Each bus unit has room available for two I/O modules.

Figure 3-4 shows an expanded installation for an S5-95U.

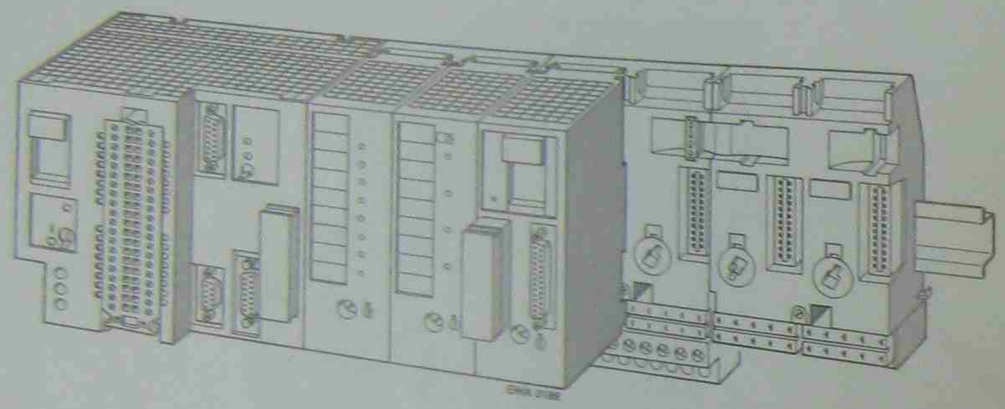

Figure 3-4. Expanded Installation for an S5-95U

3.2.1 Assembling a Tier

To assemble a tier with the S5-90U, you need the following parts:
- An S5-90U
- IM 90 interface module
- Bus units (maximum of three)
- I/O modules
- Standard mounting rail

To assemble a tier with the S5-95U, you need the following parts:
- An S5-95U
- A power supply module (such as the PS 931) - if you do not have a 24-V DC power supply available
- Bus units (maximum of 16)
- I/O modules
- Standard mounting rail

Mount the first module on the far left end of the standard mounting rail and then add the other modules to the right of the first module.

How to Mount the PS 931 Power Supply Module

The design of the backplane makes it easy to attach the power supply module to the standard mounting rail.
- Hook the power supply module onto the standard mounting rail.
- Press the module down firmly until the slide snaps onto the rail.

To remove the power supply module, proceed as follows:
- Turn off the 115-V/230-V AC power supply.
- Loosen the connections between the controller and the power supply module.
- Using a screwdriver, press down on the slide on the bottom of the module.
- Swing the module up and out of the standard mounting rail.

How to Mount the Programmable Controller

To install the programmable controller on a standard mounting rail, proceed as follows:
- Hook the controller onto the standard mounting rail to the right of the power supply module.
- Swing the controller back until the slide snaps onto the rail.

To remove the S5-90U, proceed as follows:
- Turn off the 115-V/230-V AC power supply.
- Remove all connected signal cables and supply cables.
- Loosen the connection (flat ribbon cable) between the controller and IM 90 interface module.
- Using a screwdriver, press down on the slide located on the bottom of the controller.
- Swing the controller up and out of the standard mounting rail.

To remove the S5-95U, proceed as follows:
- Turn off the 24-V DC power supply.
- Remove all connected signal cables and supply cables.
- Remove the I/O module that is in slot 0.
- Loosen the connection (flat ribbon cable) between the controller and the first bus unit.
- Using a screwdriver, press down on the slide located on the bottom of the controller.
- Swing the controller up and out of the standard mounting rail.

How to Connect the S5-90U to the IM 90

- Open the cover on the front of the S5-90U (plug connector will be visible).
- Pull the plug with the flat ribbon cable out of the IM 90 mount.
- Connect the plug to the S5-90U's plug connector.
- Close the cover.

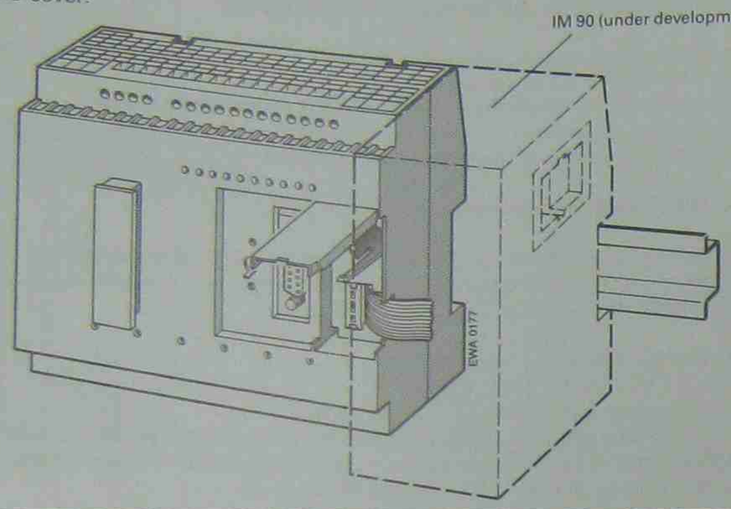

Figure 3-5. Connecting the S5-90U and the IM 90

How to Connect the IM 90 to the Bus Unit

- Pull the plug with the flat ribbon cable out of the bus unit mount.
- Connect the plug to the plug connector on the right side of the IM 90.

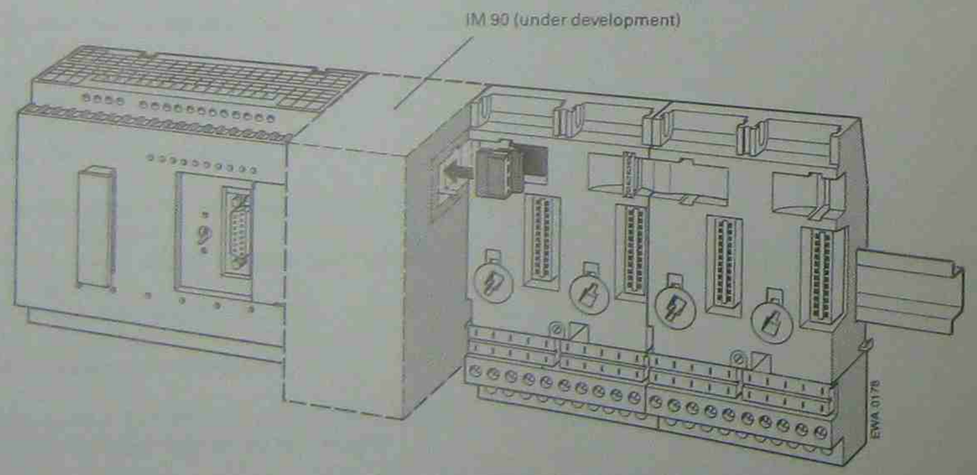

Figure 3-6. Connecting the IM 90 to the Bus Unit

How to Mount the Bus Units

Bus units are also mounted on a standard mounting rail. Mount the bus units in the same way you mounted the controller or a power supply module.
There are small hooks on the sides of the bus units that interlock them.

- Hook the bus unit onto the top of the standard mounting rail beside the programmable controller.
- Press the bus unit down firmly until the slide audibly snaps into place.

To remove bus units, proceed as follows:

- Loosen the connections (flat ribbon cable) to the adjoining devices.
- Using a screwdriver, press down on the slide.
- Swing the bus unit up and out of the standard mounting rail.

How to Connect Bus Units to the S5-95U or Interlocking Bus Units

- Pull the flat ribbon cable connector (top left on the bus unit) out of its holder.
- Plug the connector into the receptacle on the right side of the controller or into the adjacent receptacle of the bus unit on the left side (see Figure 3-7).

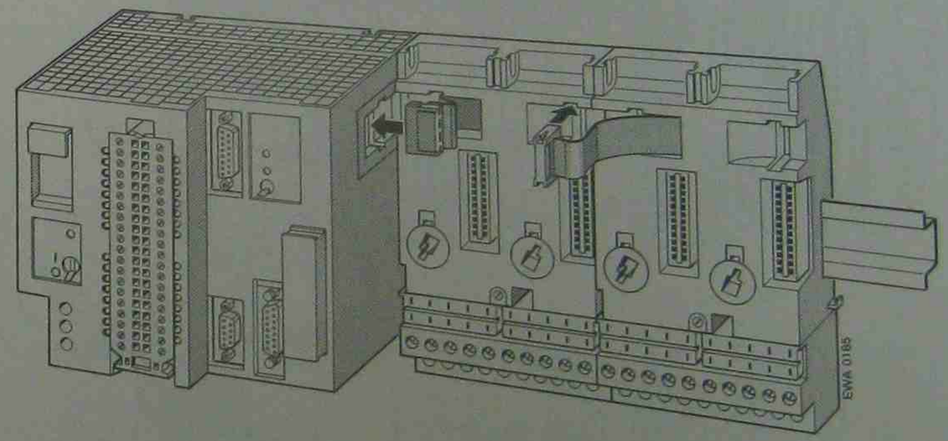

Figure 3-7. Connecting the Bus Units

How to Plug Input and Output (I/O) Modules into the Bus Units

Before you mount an input or output module, you must set the coding element on the bus unit to match the module type. The coding element keeps you from confusing module types when exchanging modules.

Use the following information to set the coding element.
A code number is printed on the frontplate of every I/O module. The number is between two and eight, depending on the particular module type. 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 3-8).

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

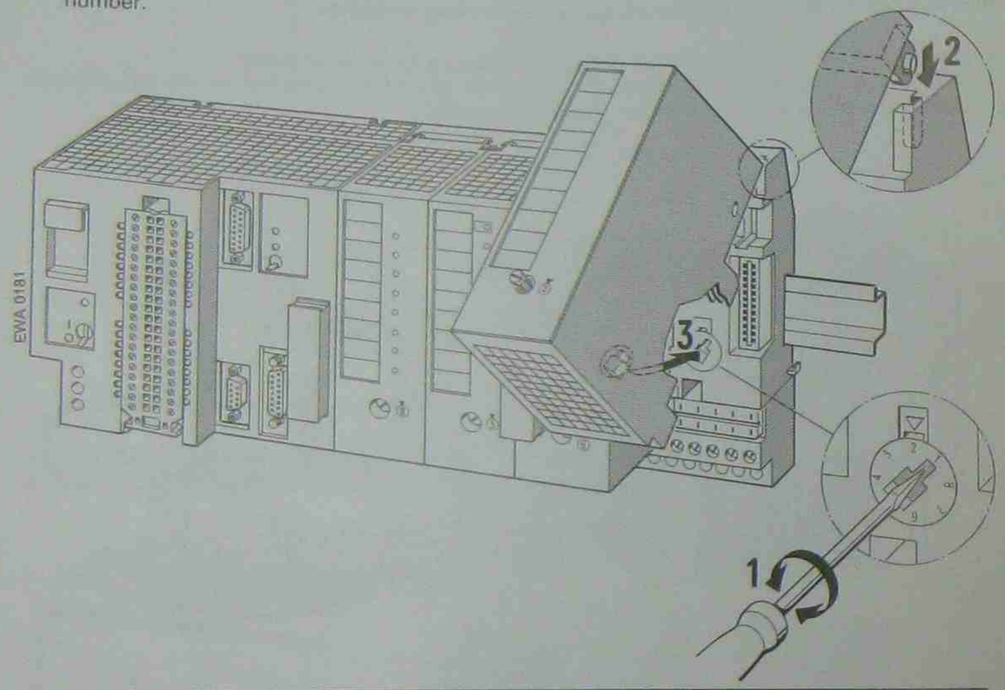

Figure 3-8. Coding System to Prevent an Inadvertent Interchange of Modules

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

To attach the module, proceed as follows:
- Hook the module onto the top of the bus unit.
- Swing the module down onto the bus unit.
- Press the module down firmly.
- Tighten the hold-down screw on the front of the module to attach the module to the bus unit.

To detach I/O modules:
- Loosen the hold-down screw and swing the module up and out of the bus unit.

3.2.2 Multi-Tier Expansion

If it is not possible to have all of the modules located on one tier, then you can expand the configuration up to four tiers. You may use a maximum of 16 bus units for the S5-95U and a maximum of three bus units for the S5-90U. It does not matter how many bus units are mounted on a tier. You need one interface module per tier to connect the tiers one to the other.

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

Use the IM 315 interface module for two-tier configurations. The IM 315 consists of two modules permanently connected 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.

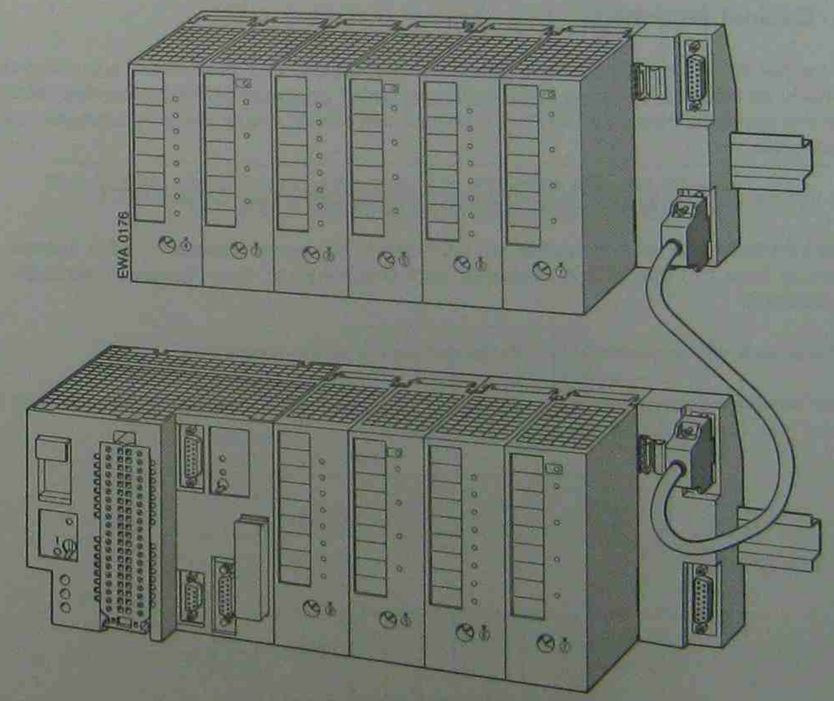

Figure 3-9. Interconnecting Tiers with Interface Modules (6ES5 316-8MA12)

How to Install the Interface Module

- Hook the interface module to the standard mounting rail.
- Swing the interface module back until the slide on the bottom snaps into place on the rail.
- Use the flat ribbon cable to connect the module to the last bus unit.
- Use connecting cable 712-8 to join the two IM 316 interface modules.
- Connect the cable to the "out" socket on the PLC tier and to the "in" socket on the expansion tier.
- Securely screw the connecting cable plugs in place.

How to Remove the Interface Module

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

3.2.3 Cabinet Mounting

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

You can use the 8LW system or the 8LX system mounting plates (see Catalog NV21).

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.

Locate the programmable controller and the power supply on the lowest tier.

To provide adequate cabinet ventilation, define the total heat loss by calculating the sum of all typical heat losses (see Catalog ST 52.1).

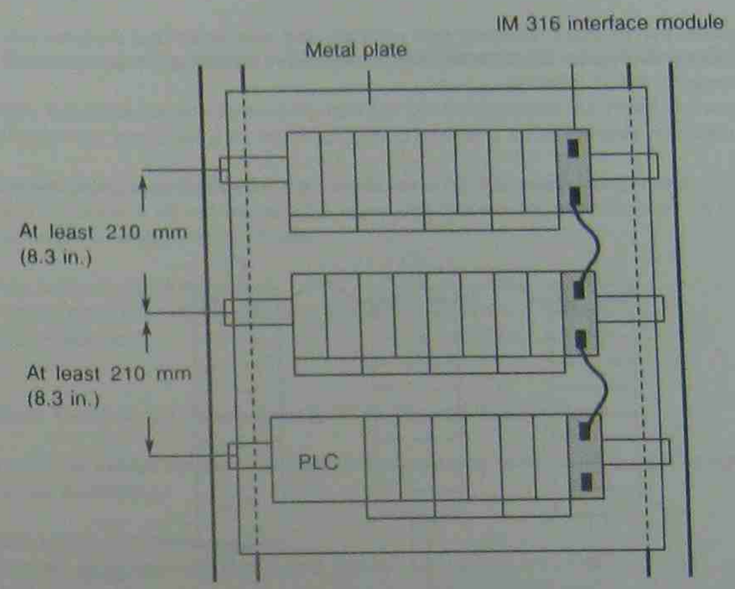

Figure 3-10. Multi-Tier Configuration in a Cabinet with the S5-95U and the IM 316 Interface Module (6ES5 316-8MA12)

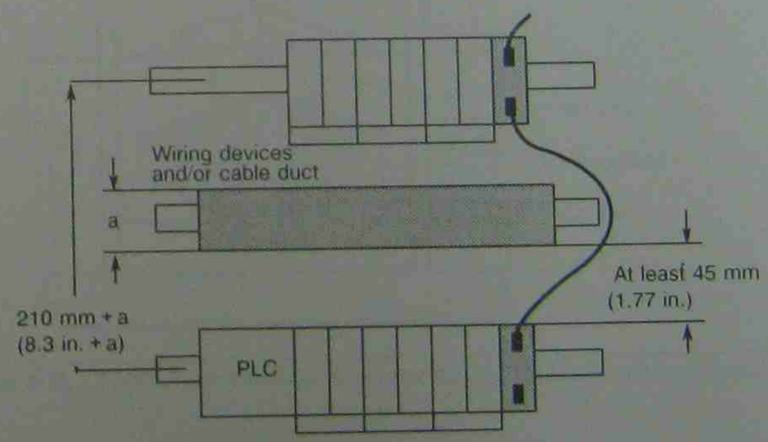

Figure 3-11. Cabinet Mounting with a Series of Devices

3.2.4 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 PLC tier to hold the modules in position.

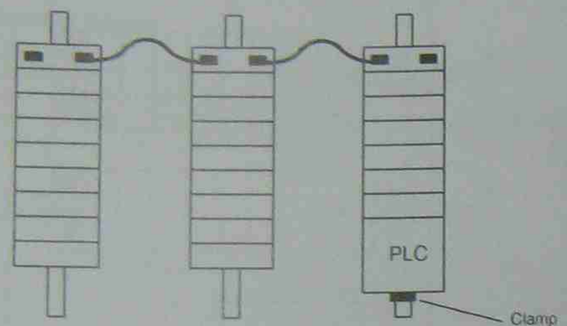

Figure 3-12. Vertically Mounting a PLC

3.3 Wiring

3.3.1 Connection Methods: Screw-Type Terminals and Crimp Snap-In

Screw-Type Terminal (Screw-Type Terminal for the S5-90U and the Front Connector for the S5-95U)

When using screw-type terminals for the S5-90U and for the front connector of the S5-95U, you can connect cables that do not exceed the maximum cross-section of 1.5 mm². It is best to use a 3.5-mm screwdriver to tighten the screws.

Permissible cable cross-sections are:
- A stranded conductor with a core end sleeve: 1 x 0.25 to 1.5 mm²
- A solid conductor: 1 x 0.25 to 1.5 mm²

Screw-Type Terminal for Power Supply Modules and Bus Modules

You can wire two cables per terminal using this screw-type terminal. It is best to tighten the screws using a 5-mm screwdriver.

Permissible cable cross-sections are:
- A stranded conductor with a core end sleeve: 2 x 0.5 to 1.5 mm²
- A solid conductor: 2 x 0.5 to 2.5 mm²

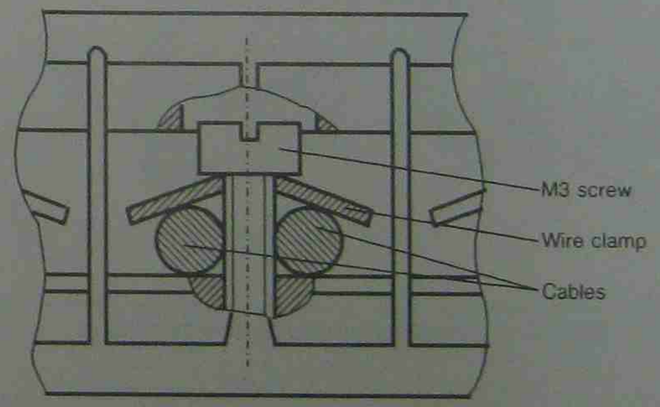

Figure 3-13. Screw-Type Terminal for Power Supply Modules and Bus Modules

Crimp Snap-In Terminals

Bus units using the crimp snap-in connection method have the exact same height as the S5-90U and the S5-95U. You can connect stranded conductors with a cross-section of between 0.5 to 1.5 mm² to these terminals.

How to Connect the Contact to the Terminal Block (see Figure 3-14)

- Remove the module that is plugged into the bus unit.
- Use a screwdriver to press down on the terminal block (1).
- Swing the terminal block up. The rear side is now visible (2).
- Push the contact into the desired opening until the locating spring engages.
  Caution: The spring must point into the slot!
- Pull lightly on the cable to make certain that the contact is properly engaged.
- Swing the terminal block back into its original position. Press up on the terminal block until it snaps into position.

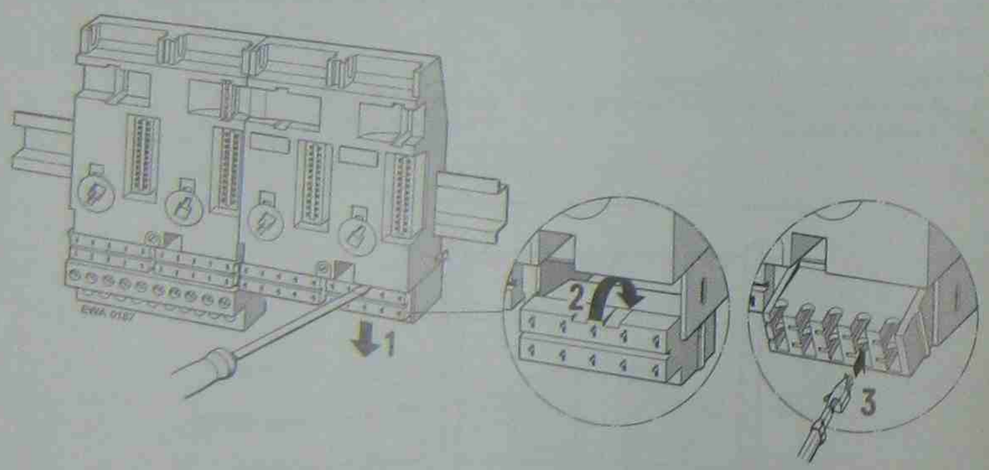

Figure 3-14. Installing a Crimp Snap-In Terminal

How to Disconnect the Terminal Block

- Position the terminal block as is shown in Figure 3-15.
- Insert the extraction tool into the slot beside the terminal so that you can compress the barb.
- Position the cable in the groove on the extraction tool and pull out both the tool and the cable.
- Realign the deformed barb so that you can use the terminal again.

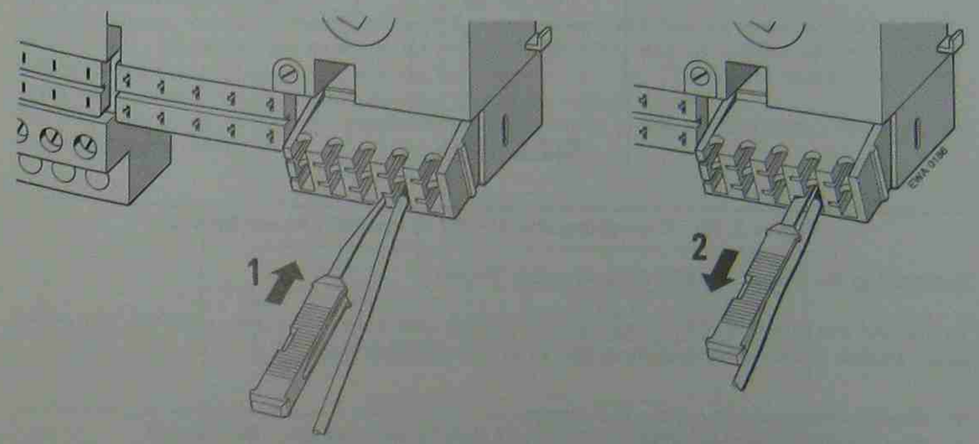

Figure 3-15. Disconnecting a Terminal

3.3.2 Connecting the Power Supply to the Programmmable Controller

Connecting the Power Supply Voltage to the S5-90U

The S5-90U is directly connected to the 115-V or 230-V AC power supply.

Figure 3-16. Connecting the S5-90U to the Main Power Source

Connecting the Power Supply Voltage to the S5-90U

To connect the power supply voltage to the S5-95U, you must first connect the PS 931 power supply module to the supply system by performing the following steps.

- Set the voltage selector to the line voltage.
- Swing up the protective cover.
- Connect the supply cable to the L1, N and ⏚ terminals (see Figure 3-17).
- Close the protective cover.

To connect the S5-95U to the PS 931, perform the following steps.

- Connect the L+ and M terminals of the PS 931 power supply module to the corresponding terminals of the PLC (see Figure 3-17).
- Connect the PLC's ⏚ terminal to the standard mounting rail.

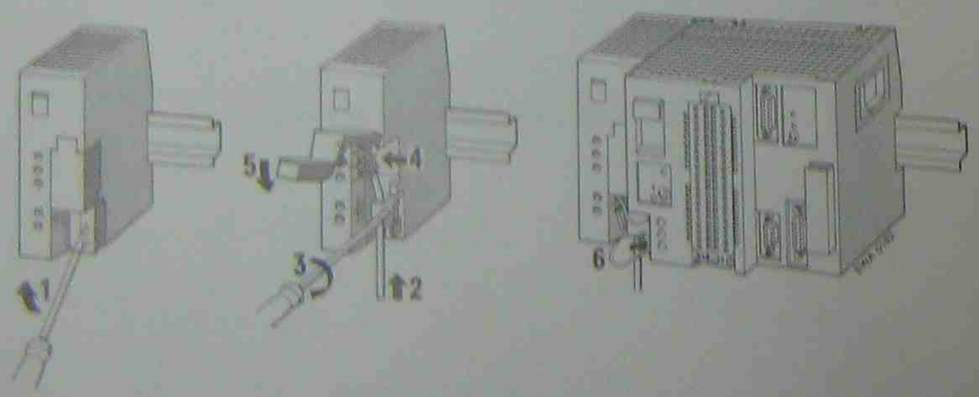

Figure 3-17. Connecting the S5-95U and the PS 931 Power Supply Module

3.3.3 Connecting Onboard I/Os

How to Connect the Onboard I/Os for the S5-90U

You connect the signal cables for the onboard I/Os directly to the screws on the PLC. All of the onboard I/Os are isolated from the potential of the control circuit.

How to connect digital inputs
The digital inputs, located on the top of the PLC, are numbered with fixed bit addresses ranging from 32.0 to 33.1. The inputs are designed for 24-V DC. The PLC has an isolated 24-V DC 100-mA voltage source that is short-circuit protected and supplies the I/Os. The ground connections for the inputs are internally connected to the negative pole of the voltage source.
The maximum length of the signal cables to the digital inputs is 100 m (328 feet). You may use unshielded signal cables.

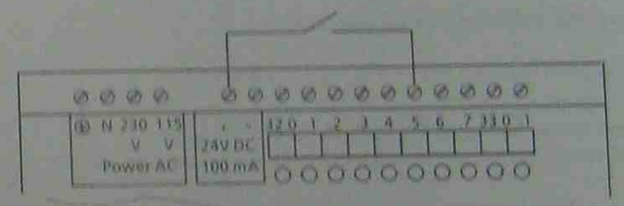

Figure 3-18. An Example of How Digital Inputs Can Be Connected

How to connect the interrupt input
You can use input I 33.0 as an interrupt input if you set the OBI parameter in DB1 (see Chapter 10). The maximum length of the signal cable to the interrupt input is 50 meters (164 feet). You may use unshielded signal cables.

How to connect the counter input
You can use input I 33.1 as a counter (IW 36) if you set the OBC parameter in DB1 (see Chapter 11).
The maximum length of the signal cable to the counter input is 50 meters (164 feet). You may use unshielded signal cables.

How to connect digital outputs
The digital outputs are located on the lower front of the PLC. Their fixed bit addresses are numbered from 32.0 to 32.5.
The maximum length of the signal cables to the digital outputs is 100 meters (328 feet). You may use unshielded signal cables.

Note

The sensor voltage for the S5-90U or the IM 90 is available when the first process image is read in.

Example: A signal lamp is connected to output Q 32.0.

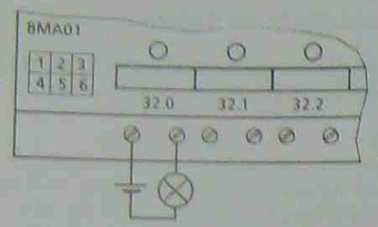

Figure 3-19. An Example of How Digital Outputs Can Be Connected

How to Connect the Onboard I/Os for the S5-95U

Use the following parts to mount onboard I/Os for the S5-95U.

- 40-pin front wiring connector for digital inputs and outputs
- 15-pin D-type female connector for analog inputs and outputs
- 9-pin D-type female connector for interrupt inputs and counter inputs (can also be used as digital inputs)

How to connect digital inputs and outputs

The signal cables for the digital I/Os must be connected to a 40-terminal front wiring connector. The front connector is available in two versions.

- Front connector with screw-type terminals
- Front connector with the crimp snap-in terminals

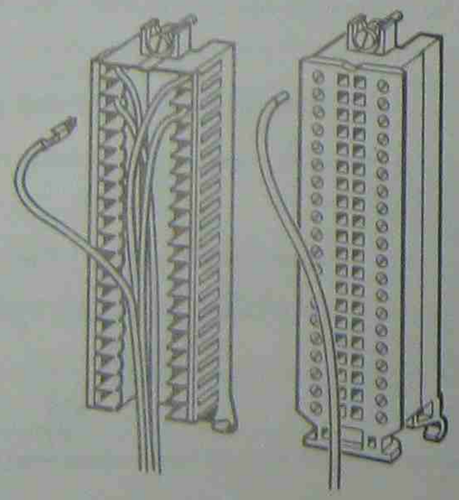

Figure 3-20. Front Connector with a Crimp Terminal and a Screw-Type Terminal

Every input and output (port) has a terminal assigned to it on the front connector. The 16 inputs (IN) and the 16 outputs (OUT) are numbered from 32.0 to 33.7. Use a 24-V DC power supply for all digital inputs and outputs.

Example: A field device is connected to input I 32.4. A lamp is connected to output Q 33.3.

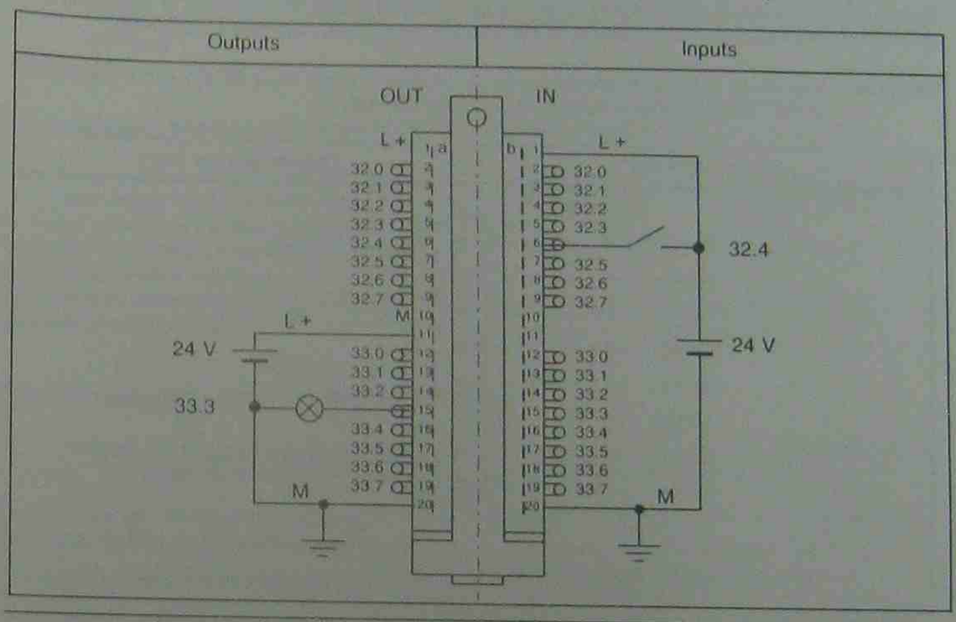

Figure 3-21. Frontal View of the Front Connector for Digital Inputs and Outputs

How to connect analog inputs and outputs
Attach the analog I/O signal cables to the PLC using a D-type female connector. There are eight analog inputs and one analog output available. Depending on the terminal assignment, the analog output is either a "current" output or a "voltage" output.

Before you connect the analog inputs, make certain that you assign the channels in ascending order for multi-channel operation and make sure that you isolate the channels (see Chapter 12).

Example: You are to connect a voltage sensor to channel 0 (input word IW 40) and a load resistor to the "voltage" analog output (output word QW 40).

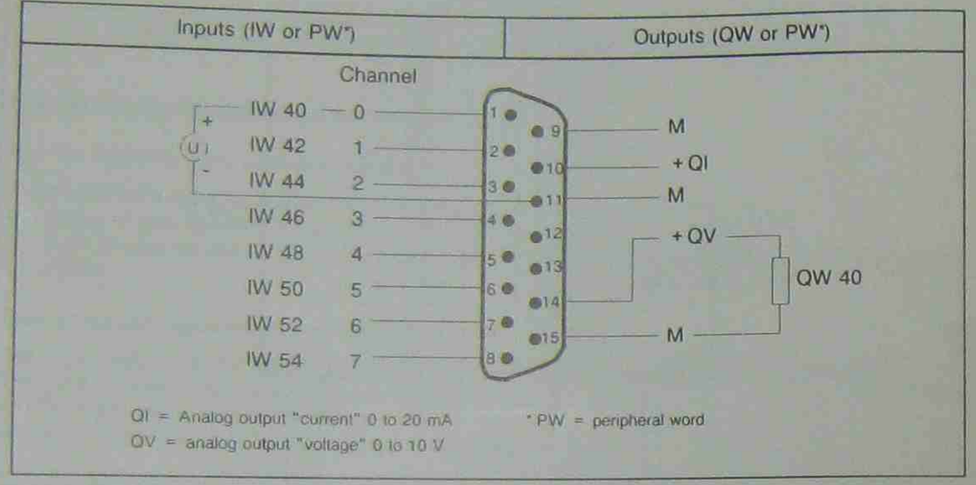

Figure 3-22. An Example of an Analog Input and an Analog Output Connection

Note

You may not assign terminals 12 and 13. These assignments are used for internal processes.

You can find a detailed description of the analog I/Os in Chapter 12.

The maximum cable length to the analog I/Os is 100 m (328 feet). You must use shielded cables.

Note

Do not mount the cable shield to the PLC's D-type female connector. To provide high interference immunity, connect the shield at the other end of the cable to a ground reference.

How to Establish Interrupt Connections and Counter Connections

There are four interrupt inputs and two counter inputs available in the S5-95U. The interrupt inputs and counter inputs have the same internal grounding point as the PLC. Use a 9-pin D-type female connector to connect the signal cables for these inputs to the PLC.
Chapter 10 contains a comprehensive description of the usage of interrupt inputs and Chapter 11 of the usage of counter inputs.
The maximum cable length to the interrupt inputs and counter inputs is 100 meters (328 feet). You must use shielded cables.

3.3.4 Connecting External Digital Modules

All I/O modules are plugged into bus units. Connect the I/O modules to the terminal blocks of the bus units. The connections illustrated in this section are of the screw terminal type.

You can also use crimp snap-in connections (see section 3.3.1). In both cases, the terminal assignments are marked on the terminal blocks.

The following assignments always apply for the connection of the load voltage.

Table 3-2. Connecting the Load Voltage

Load Voltage	Terminal 1	Terminal 2
24-V DC	L +	M
115/230-V AC	L1	N

Note

For digital outputs, energy is temporarily stored in an internal capacitor for about 100 ms after the L + supply is switched off.
Please note that this energy may be sufficient to activate low-rating loads (e.g., pulse valves) for a triggered output.

How to Connect Four-Channel Digital Modules

All of these modules are designed for a two-wire connection. You can therefore wire directly to the sensor or output field device. An external distribution block is not required.

The four channels of a module are numbered from .0 through .3. (Numbers .4 through .7 are only significant for the ET 100 distributed I/O system. Each channel has a pair of terminals on the terminal block.

The terminal assignments and the connection diagram are printed on the front plate of the module.

Connecting Four-Channel Input Modules

Example: Connecting a sensor to channel 2 (address I 3.2) on the input module in slot 3 (see Figure 3-23)

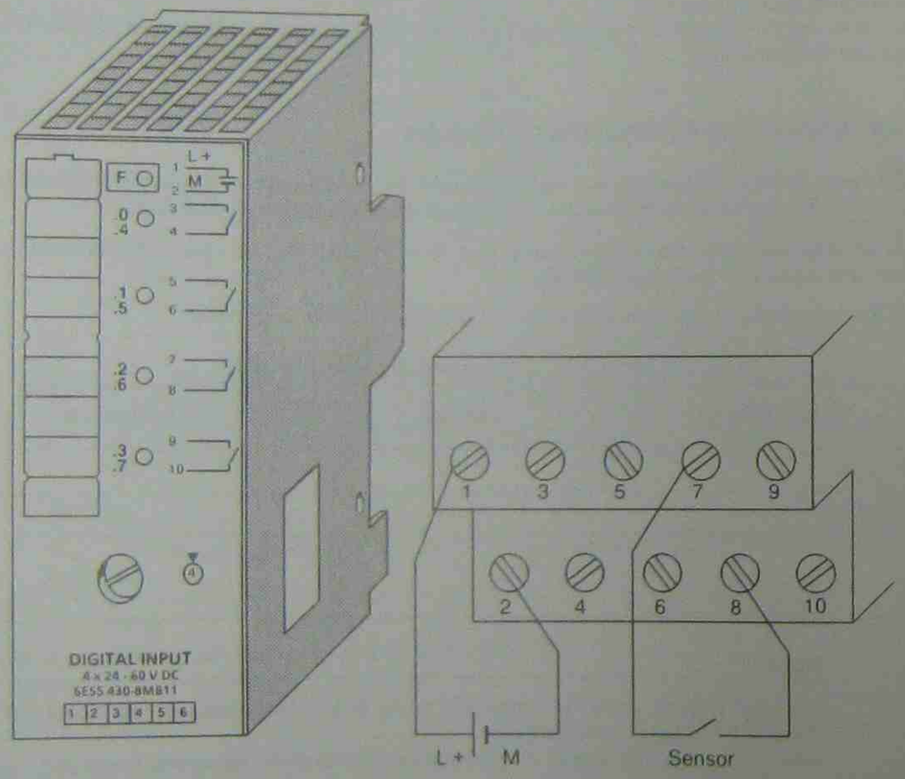

Figure 3-23. Two-Wire Connection of a Sensor to Channel 2

Connecting Four-Channel Output Modules

Example: Connecting a lamp to channel 3 (address Q 1.3) on the output module in slot 1 (see Figure 3-24)

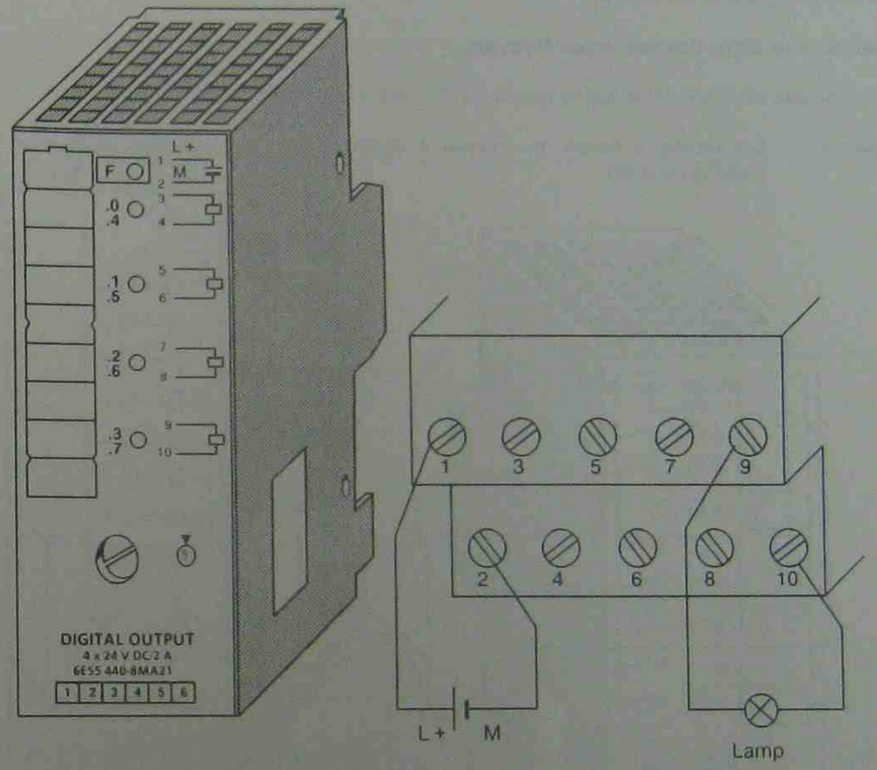

Figure 3-24. Two-Wire Connection of a Lamp to Channel 3

Connecting Eight-Channel Digital Modules

These modules do not have a two-wire connection. You therefore need an external distribution block.

The eight channels of a module are numbered from .0 through .7. One terminal on the terminal block is assigned to each channel. The terminal assignment and the connection diagram are printed on the front plate of the module.

Connecting Eight-Channel Input Modules

The sensors must be connected to terminal 1 via the L+ terminal block.

Example: Connecting a sensor to channel 4 (address I 3.4) on an input module in slot 3 (see Figure 3-25).

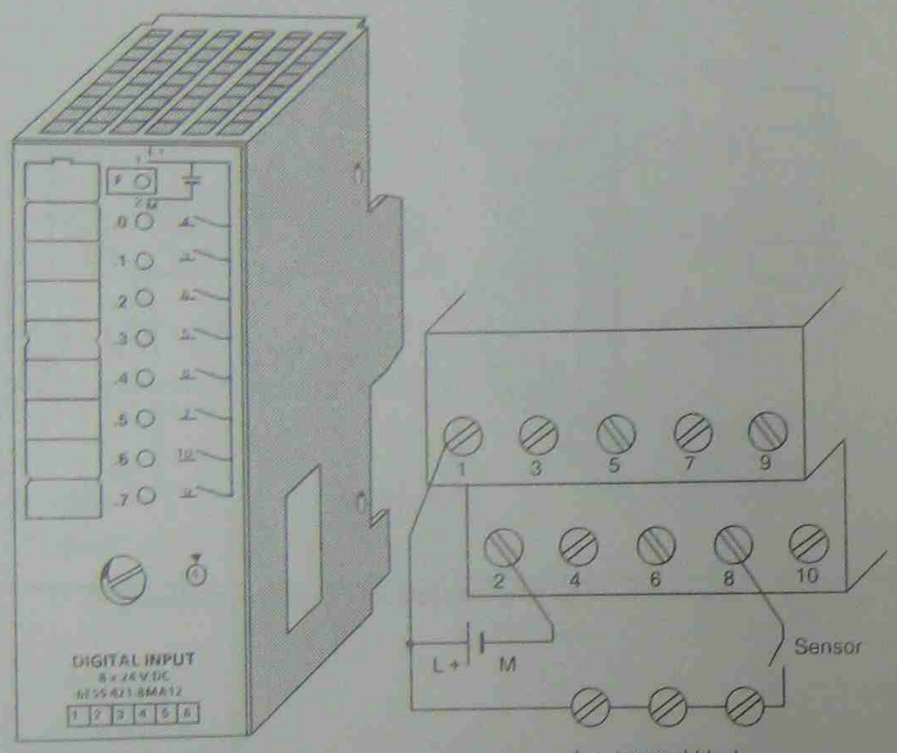

Figure 3-25. Connecting a Sensor to Channel 4

Connecting Eight-Channel Output Modules

The actuators must be connected to terminal 2 via the M (negative) terminal block. This does not apply to the digital output module 8 × 5 to 24-V DC/0.1 A (see section 15.6.2).

Example: Connecting a lamp to channel 6 (address Q 5.6) on an output module in slot 5 (see Figure 3-26).

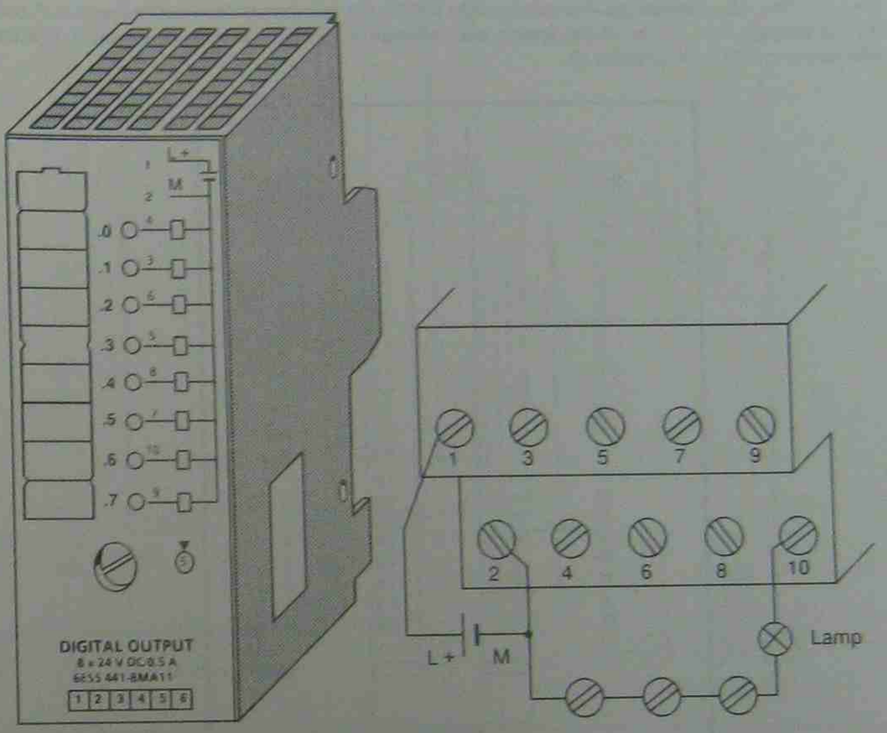

Figure 3-26. Connecting a Lamp to Channel 6

3.3.5 Connecting the Digital Input/Output Module

Use only slots 0 through 7 (S5-90U: 0 through 5) when you plug the module into the bus unit. Use a 40-pin cable connector with a screw-type connection or crimp snap-in connection for wiring. The module does not have a two-wire connection. You must therefore use an external distribution block.

Every channel is assigned a terminal on the 40-pin connector. The channel numbers are printed on the front plate.

The 16 channels on the input side (IN) are numbered from n.0 through n.7 and from n + 1.0 through n + 1.7. The 16 channels on the output side (OUT) are numbered from n.0 through n.7 and from n + 1.0 through n + 1.7. "n" is the analog start address of the slot. Slot 0, for example, has the start address of n = 64 (see Chapter 6).

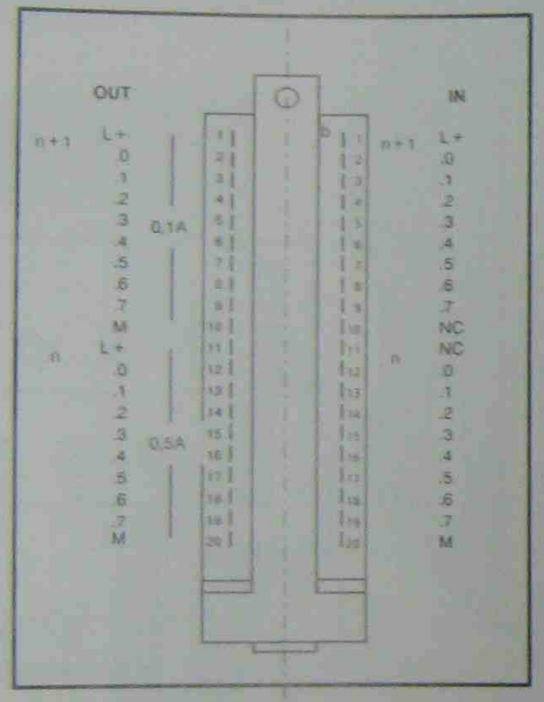

Figure 3-27. Front View of the Digital I/O Module with a Crimp Snap-In Connector (simplified view and not true to scale)

Example
The module is plugged into slot 0, its start address is 64.0.
Inputs and outputs have the same address. A sensor is to be connected to input I64.4 and a lamp to output Q65.3.
Figure 3-28 illustrates the wiring on the front connector.

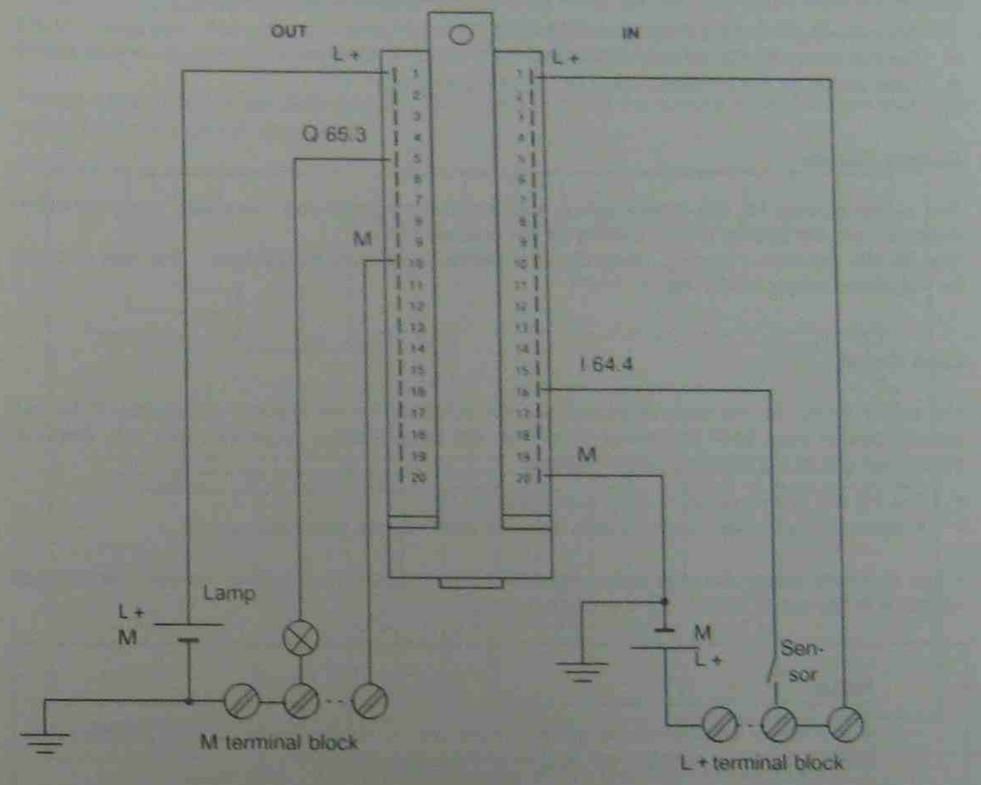

Figure 3-28. Connecting a Sensor and a Lamp to Digital Input/Output Module 482

3.4 Electrical Configuration

3.4.1 Electrical Configuration for the S5-90U

Power Supply

The control for the S5-90U consists of the following separate electrical circuits.

- Control circuit for the S5-90U (115-/230-V AC)
- Control circuit for the sensors (24-V DC)
- Load circuit for the actuators (24-V DC or 115-/230-V AC)

Control Circuits

The power source for the control circuit supplies the programmable controller, the programmer interface, and the internal control circuits for the onboard I/Os.
The S5-90U provides a floating, short-circuit-protected voltage for the sensors . The load capability for the power supply is 100 mA.

Load Circuit

The power source for the load circuit supplies the actuators for the process peripherals. If the total current load of your 24-V DC power supply for the peripherals is more than 100 mA, then you should use one of the following power supplies.

- The PS 931 power supply module (see Appendix D)
- A Siemens load power supply module from the 6EW1 series (see Appendix D)

If you use load power supplies other than the recommended ones, make certain that the load voltage is in the range of 20 to 30 V (including ripple).

> **Note**
>
> If you use a switched-mode power supply unit to supply floating analog modules and BEROs, then this supply must be filtered through a network.

3.4.2 Onboard I/Os for the S5-90U

Several separate load circuits can be configured next to each other on a PLC. If the load circuits and the control circuit of the PLC are galvanically isolated, then this is a floating configuration. If there is a common chassis ground between the load circuit and the control circuit, then this is a non-floating configuration. You can have a non-floating configuration only with 24-V DC load circuits.

The S5-90U's onboard I/Os allow a floating configuration. The ten onboard inputs have a common ground connection. The ground connection is attached to the negative pole of the PLC's 24-V DC voltage source. Optocouplers separate all inputs from the control circuit's ground.

The six onboard outputs are relay outputs. The connections for the contact assemblies are separate and do not have a mutual connection.

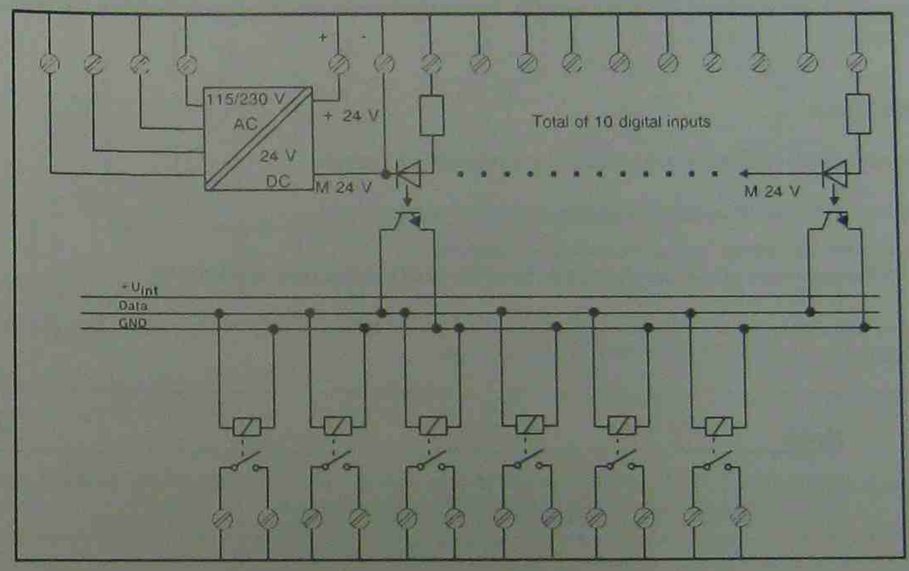

Figure 3-29. A Simplified Display of the Floating Onboard I/Os

3.4.3 Electrical Configuration for the S5-95U

Power Supply

The control for the S5-95U consists of the following separate electrical circuits.

- Control circuit for the PLC (24-V DC)
- Control circuit for the sensors (24-V DC for onboard I/Os)
- Load circuit for the actuators (24-V DC for onboard I/Os)

Control Circuits

The control circuit for the PLC supplies the programmable controller, the programmer interface, the bus units, and the control circuit for the I/Os. The control circuit for the sensors supplies the onboard I/O sensors .

Load Circuit

The load circuit supplies the actuators of the process peripherals.

Use one of the following power supplies to power the peripherals.

- The PS 931 power supply module (see Appendix D)
- A Siemens load power supply module from the 6EW1 series (see Appendix D)

If you use load power supplies other than the recommended ones, make certain that the load voltage is in the range of 20 to 30 V (including ripple).

Note

If you use a switched-mode power supply unit to supply floating analog modules and BEROs, then this supply must be filtered through a network.

3.4.4 Onboard I/Os for the S5-95U

The digital onboard I/Os for the S5-95U are galvanically isolated from the control circuit by optocouplers and allow a floating configuration.

The digital onboard I/Os are divided into three groups: two groups that each have eight outputs and one group that has 16 inputs. Each group has its own 24-V DC connection.

Analog inputs and outputs, counter inputs, and interrupt inputs are connected to the chassis ground of the control circuit and are used only for non-floating configurations.

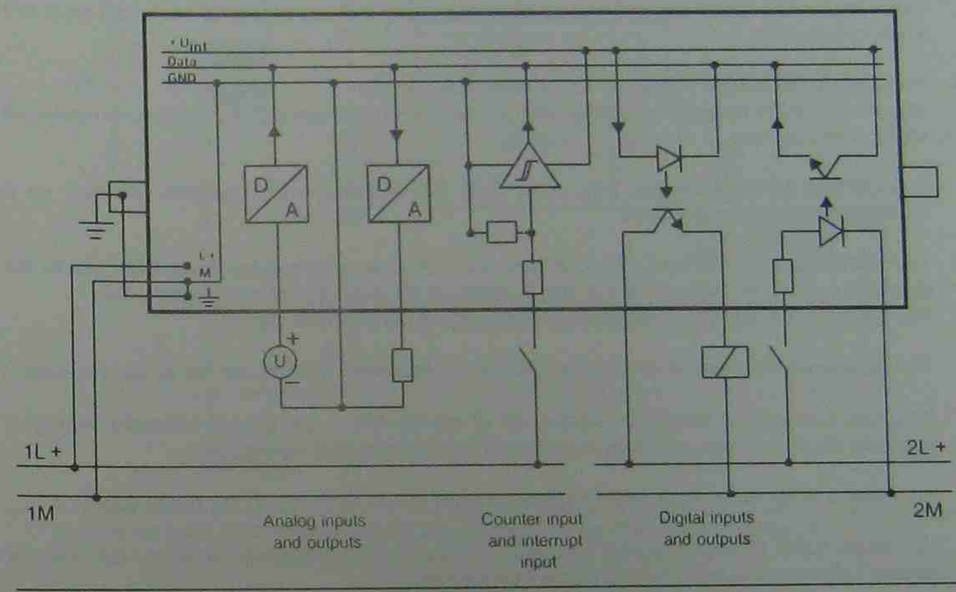

Figure 3-30. A Simplified Display of the S5-95U with Non-Floating and Floating Onboard I/Os

3.4.5 Electrical Configuration with External I/Os

Figures 3-31, 3-32, and 3-33 display different configuration possibilities. Pay attention to the following points when you design your configuration. The numbers appearing in parentheses in the following points refer to the numbers in the three figures.

- You must have a main switch (**1**) in accordance with VDE 0100 for your PLC, the sensors, and the actuators.
- You do not need an additional fuse (**2**) to connect your PLC and the load circuit to power if your radial lines are a maximum of 3 meters (9.84 feet) long and are inherently earth-fault-proof and short-circuit-proof.
- You need a load power supply (**3**) for 24-V DC load circuits.
  You need a back-up capacitor (rating: 200 µF per 1 A of load current) if you have non-stabilized load power supplies.
- If you have AC load circuits with more than five actuating coils, galvanic isolation via a transformer (**4**) is recommended.
- You should ground the load circuit at one end. Provide a removable connection (**5**) to the ground conductor on the load power supply (terminal M) or on the isolating transformer.
  You must provide earth-fault monitoring for any non-grounded load circuits.
- You must separately fuse (**6** and **7**) the load voltage for sensor circuits and for actuator circuits.
- You must connect the standard mounting rail of the S5-95U to the ground conductor through a capacitor (**8**, to suppress high-frequency noise) for non-grounded configuration.
- You need a power fuse (**9**) to protect against a short-circuit occurring in the power supply.
- You must have a low-resistance connection between the standard mounting rail and the cabinet's chassis ground (**10**) for grounded configuration.
- The IM 90 interface module has its own monitor for supply voltage. When it reports a power failure to the S5-90U, the controller goes into the "STOP" mode with the "NAU" error message (power failure). For this reason, it is recommended that you wire the S5-90U and the IM 90 interface module to the main power line in unison (see Figure 3-31).

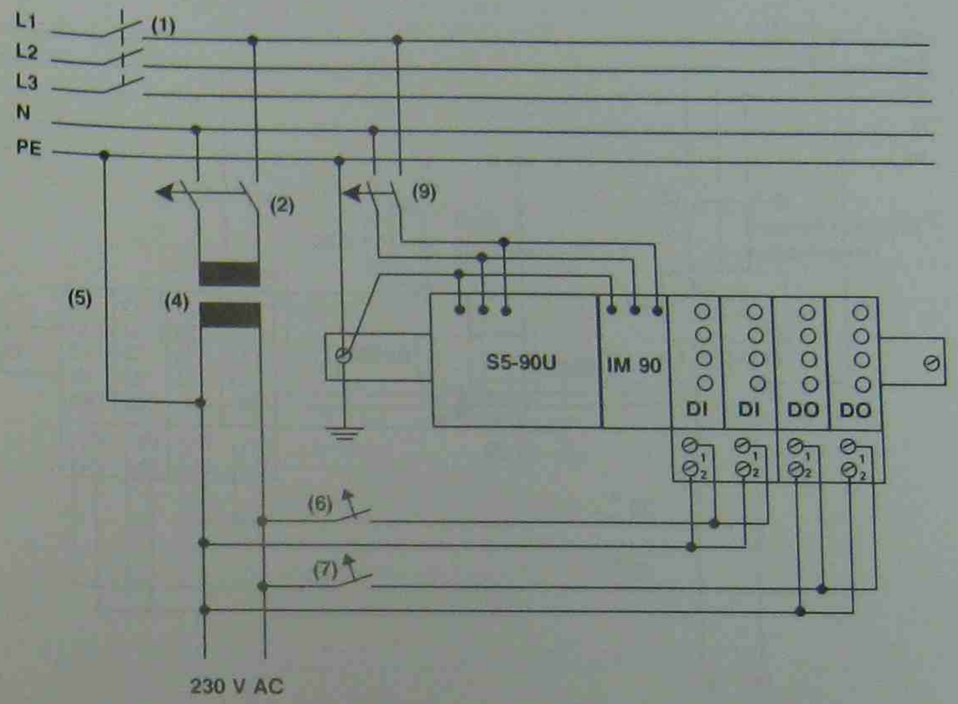

Figure 3-31. Configuration for the S5-90U with a Floating, External I/O and a 115-/220-V AC Power Supply

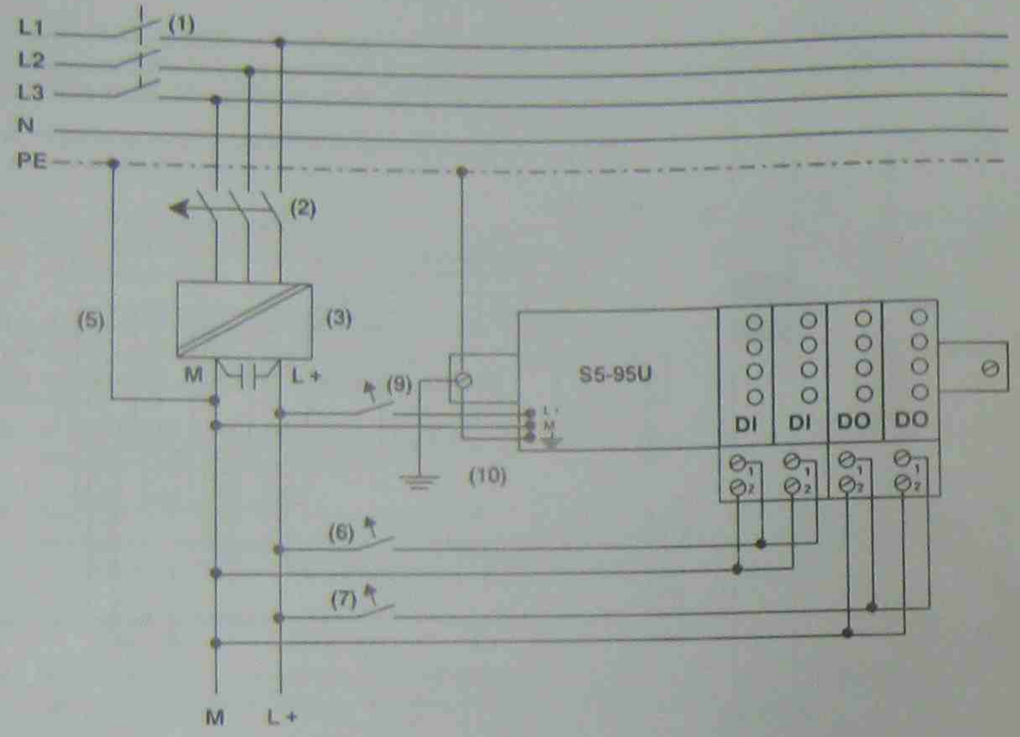

Figure 3-32. Configuration for the S5-95U with a 24-V DC Power Supply with Safe Electrical Isolation in Accordance with DIN VDE 0160 for a Programmable Controller and a Non-Floating, External I/O

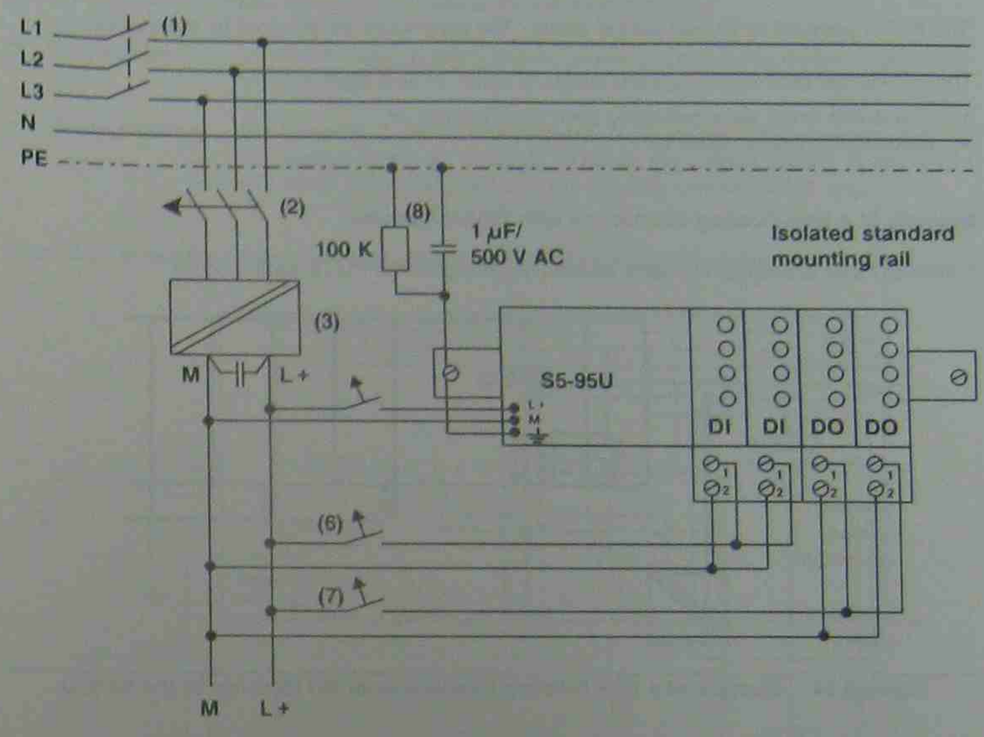

Figure 3-33. Ungrounded Operation: 24-V DC Power Supply with Safe Electrical Isolation according to VDE 0160 - For Use with a Programmable Controller and External I/O

Interference voltages are discharged to the ground conductor (PE) via a capacitor. You can prevent static charges by connecting a high-ohmic resistor (approx. 100 kΩ/½ W) parallel to the capacitor.

3.4.6 Potential Bonding and Galvanic Isolation of an External I/O

The PLC is powered by its own control circuit. The peripherals are powered by the load circuit.

The circuits can be:

- Connected to the same grounding point (non-floating); or
- Galvanically isolated (floating)

Example of a Non-Floating Connection with Digital Modules

A 24-V DC load circuit has the same chassis grounding as the PLC's control circuit.

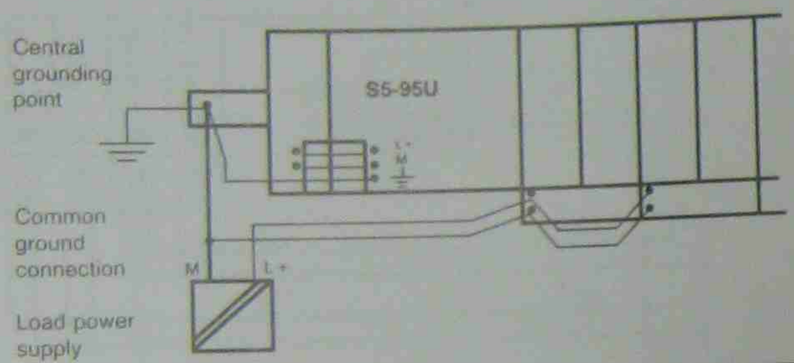

Figure 3-34. Example of a Non-Floating Connection of I/O Modules to the S5-95U

The common chassis grounding connection makes it possible for you to use reasonably priced non-floating I/Os. These modules function according to the following principles.

- Input modules: The M cable (control circuit chassis ground) is the reference potential. A voltage drop on cable ① affects the input signal level V_I.
- Output modules: Terminal 2 (M) of the terminal block is the reference potential. A voltage drop ΔV_2 on cable ② raises the chassis ground of the output driver and thereby reduces the resulting control voltage V_{CV}.

Figure 3-35 shows the connection of the S5-95U with non-floating external I/Os.

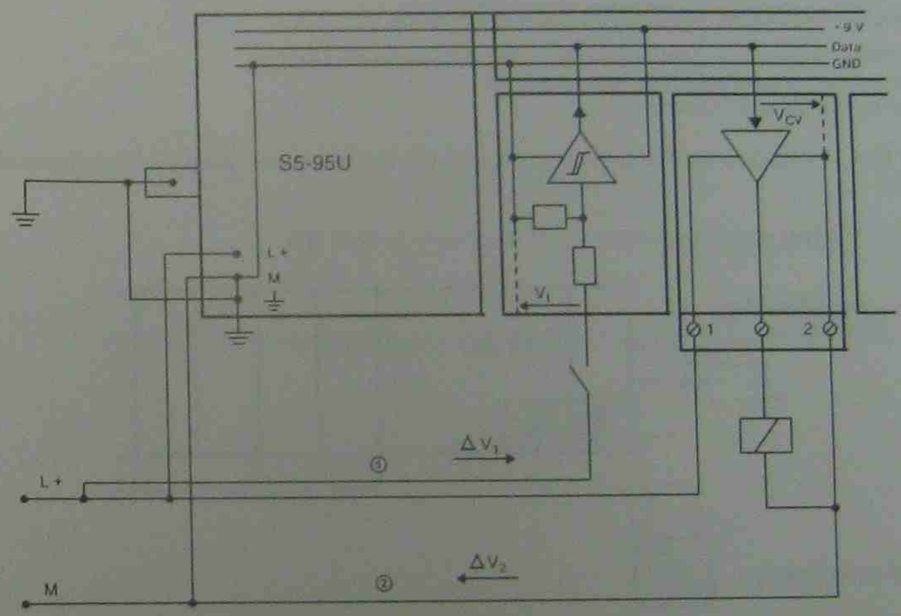

Figure 3-35. Simplified Display of a Non-Floating, External I/O Connection

When you have a non-floating configuration, you must make certain that the voltage drop on cables ① and ② does not exceed 1 V. If 1 V is exceeded, the reference potentials could change and the modules could malfunction.

Warning

If you use non-floating I/O modules, you must provide an external connection between the chassis ground of the non-floating I/O module and the chassis ground of the CPU.

Example of a Floating Configuration with Digital Modules

Floating configuration is required in the following situations.

- When you need to increase interference immunity in the load circuits
- When load circuits cannot be interconnected
- When you have AC load circuits

If you have a floating configuration, the PLC's control circuit and the load circuit must be galvanically isolated.

Figure 3-36 shows a simplified connection of galvanically isolated I/Os.

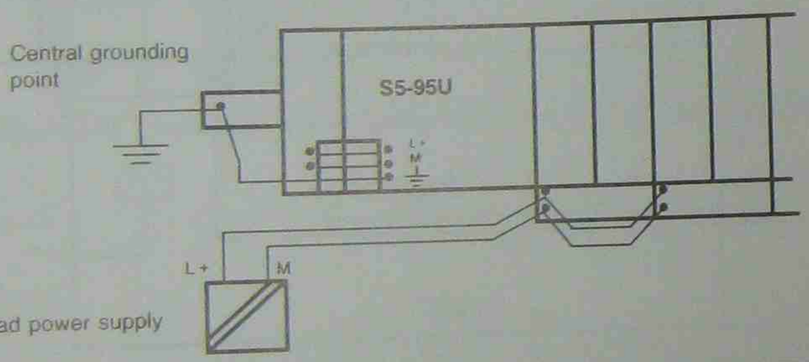

Figure 3-36. Example of a Galvanically Isolated Connection of I/Os to the S5-95U

Figure 3-37 shows a simplified schematic for the connection of floating I/O modules.

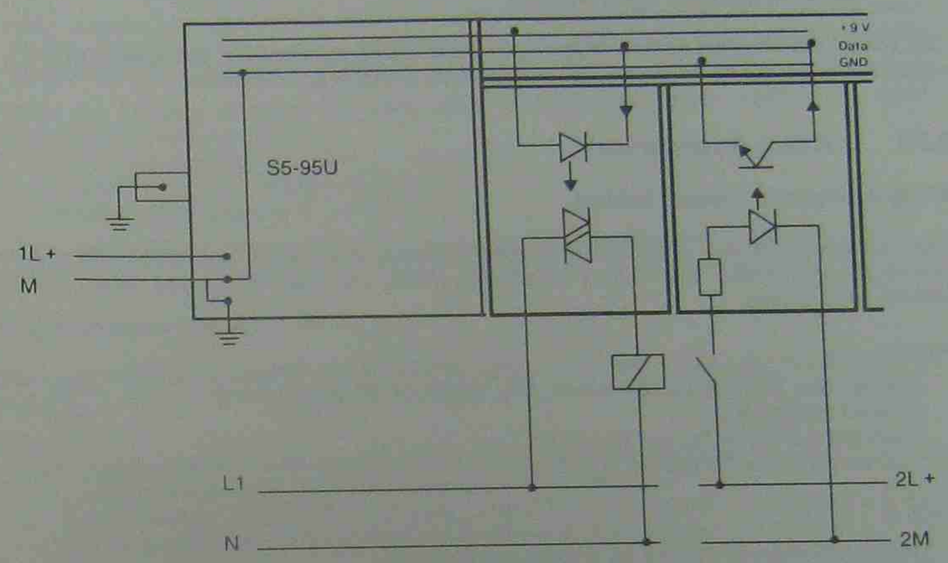

Figure 3-37. Simplified Display of a Floating, External I/O Connection

3.5 Wiring Arrangement, Shielding, and Measures to Guard against Electromagnetic Interference

This section describes the wiring arrangements for bus cables, signal cables, and power supply cables that guarantee the electromagnetic compatibility (EMC) of your installation.

3.5.1 Wiring Arrangement

Wiring Arrangement inside a Cabinet

When a cabling system is installed in a cabinet, the wiring arrangement significantly affects interference immunity (EMC). Even during the planning phase, you should divide your cables into the following three groups.

Group 1

Shielded data cables (for programmers, OPs, SINEC L1, ET 200 bus etc.)
Shielded analog cables
Unshielded cables for DC and AC ≤ 60 V
Shielded cables for DC and AC ≤ 230 V

Group 2

Unshielded cables for DC and AC > 60 V and ≤ 230 V

Group 2

Unshielded cables for DC and AC > 230 V and ≤ 1 kV

You should install each cable group in the cabinet **separately**. Separate installation refers to wiring that requires the following.

- Separate cable ducts
- Separate cable bundles

> **Note**
>
> Make sure that you have a minimum clearance of 10 cm (4 in.) between signal cables and power cables conducting over 500 V.

When you install shielded cables, make sure that you install the shield on a shield support rail. The shield should reach the module, but it should not be connected to the module.

Wiring Arrangement outside a Cabinet

- Install cables on a metal cable bearer when cabinets are physically apart but within the same building. Galvanically connect the cable bearer joints. The joints should be grounded at intervals of about 20 to 30 meters (65 to 98 feet).
- Install the following cables on the same cable raceways (cable routes, cable ducts, cable channels, and cable conduits):
  - Unshielded digital cables ≤ 60 V
  - Shielded data cables, shielded analog cables
  - Shielded signal cables of up to 230 V
- Install cables having voltages > 230 V in separate wiring channels (routes, conduits).

Wiring Arrangement outside a Building

Make certain that cables installed outside buildings adhere to the regulations regarding lightning and grounding.

- Lightning
  When installing cables outside a building use one of the following methods.
  - Use corrosion-resistant steel conduit that is well grounded.
  - Use nonmetallic conduit that is encased in steel-reinforced concrete. The reinforcing steel should be made electrically continuous and should be well grounded.
- Grounding
  Make certain that you have sufficient equipotential bonding between the devices.
  Install an equipotential bonding cable that has an impedance ≤ 10% of the shield impedance of the cables.

Tips for Cable Installations

- Use only shielded cables for analog signal cables.
- Do not install signal cables directly parallel to power cables.
- Install electromagnetically sensitive cables at least one meter (3.3 feet) away from any source of interference (contactor, transformer, motor, arc welder, etc.).
- Make certain that you bundle the cables together if two control components are joined together by several signal cables.
- Install signal cables and the corresponding equipotential bonding cables bundled together on the shortest route possible.
- Install individual cables that carry the same type of signal (outgoing and return cables and power supply cables) bundled together. Twist the cables, if needed.
- Route the cables against the chassis-grounded surfaces where possible.
- Avoid using terminal lugs to extend cables.
- Route power cables and signal cables through separate cable ducts and switch boxes.
- Use surface-type contact for the shields.

3.5.2 Shielding of Devices and Cables

Shielding is a means of weakening or damping magnetic, electrical, or electromagnetic interference fields. Both devices and cables should be shielded.

Shielding of Devices

Use the following information if cabinets and housing are used in shielding the control system.

- Cabinet enclosures, such as side walls, back walls, top plates, and bottom plates, should be bonded at certain intervals (e.g., 50 mm/2 inches) when you have an overlapping layout.
- Doors need additional bonding to the cabinet's chassis ground. Use wide grounding strips.
- The cables that exit the shield housing should either be shielded or filtered.
- Sheet metal must be used to separate strong interference sources located in the cabinet (transformers, cables leading to motors, etc.) from sensitive electronic areas. The multiple screw connections of the sheet metal to the cabinet's chassis ground must be of low impedance.

The noise interference coming into the PLC via the signal cables and supply lines must be discharged on the central grounding point (standard mounting rail).

Use a low impedance copper conductor, ≥ 10 mm², that is as short as possible to connect the central grounding point to the protective conductor PE (ground rail).

Shielding of Cables

Both ends of shielded cables should have a good electrical connection to the cabinet's chassis ground. You can effectively suppress interference of all coupled frequencies only if the cables are shielded at both ends. The shield should reach the module, but it should not be connected to the module.

> **Note**
>
> There can be a compensating current flowing across cables shielded at both ends if there are ground potential fluctuations. You should therefore join the connected components with an additional equipotential bonding cable.

It would be unusual to shield only one cable end because shielding only one cable end dampens only the low frequencies. Shield a single cable end in only the following instances.

- It is not possible to lay an equipotential bonding cable.
- Only very low analog signals (a few mV or µA) are transmitted.

With SIMATIC controllers, the interference current on cable shielding is discharged to ground both via the shielding rail and the equipotential bonding cable. To prevent these discharged currents from becoming a source of interference, ground them on a low-resistance path as follows:

- Tighten the hold-down screws on the cable connectors, modules, and equipotential bonding cables.
- Protect the contact surfaces of equipotential bonding cables against corrosion.

3.5.3 Measures to Guard against Electromagnetic Interference

Measures to guard against electromagnetic interference are frequently not taken until the after the controller is operating and problems develop with the reception of a signal.
When you install your controller, you can significantly reduce the number of problems caused by electromagnetic interference if you proceed as follows.

- Arrange devices and cables correctly.
- Ground all inactive metal parts to chassis.
- Filter power cables and signal cables.
- Shield devices and cables.
- Take specific interference suppression measures.

Physical Arrangement of Devices and Cables

It would cost a lot of money to significantly decrease the constant magnetic fields or alternating fields that occur at low frequencies (e.g., 50 Hz). You can frequently avoid this problem by having as much space as possible between the interference source and any potentially susceptible device.

Chassis Grounding of Inactive Metal Components

Correct chassis grounding is an important factor in ensuring that you won't experience interference problems. Chassis grounding refers to the conductive connection of all inactive metal components (VDE 0160). Always use surface-contact grounding. Chassis-ground all inactive metal components.

Basic rules for surface-contact grounding:

- All chassis connections should have a low impedance.
- All metal components should have a large surface contact.
  Use especially wide grounding strips when you connect the components. The surface area of the chassis ground is the deciding factor and not the cross-section of the interconnecting cable.
- Use spring lock washers or serrated lock washers on all screwed connections.

Filters for Main Cables and Signal Cables

Filtering main cables and signal cables is a means of reducing conductive-associated interferences. No overvoltages may be allowed to occur in the supply lines and signal cables located in a cabinet. Use the following procedures to avoid having overvoltages occur.

- Interference suppression in main cables
  A main filter (e.g., B84299-K64, 250-V AC/10 A) should be installed in the supply line for incoming supplies from the main supply. Always install the main filter on the cabinet opening. When you install the main filter, make certain that it has a large surface contact and a low impedance to the cabinet's chassis ground. Make sure that the contact surfaces are bare.
- Discharge capacitors for a DC power supply
  If a cabinet is connected to a central 24-V power supply, then noise interference can pass into the control system via this supply line.
  This can be avoided by installing interference-suppression capacitors on the cabinet opening of the 24-V supply. Mount these capacitors either on the cabinet's chassis ground or on the shielding rail.

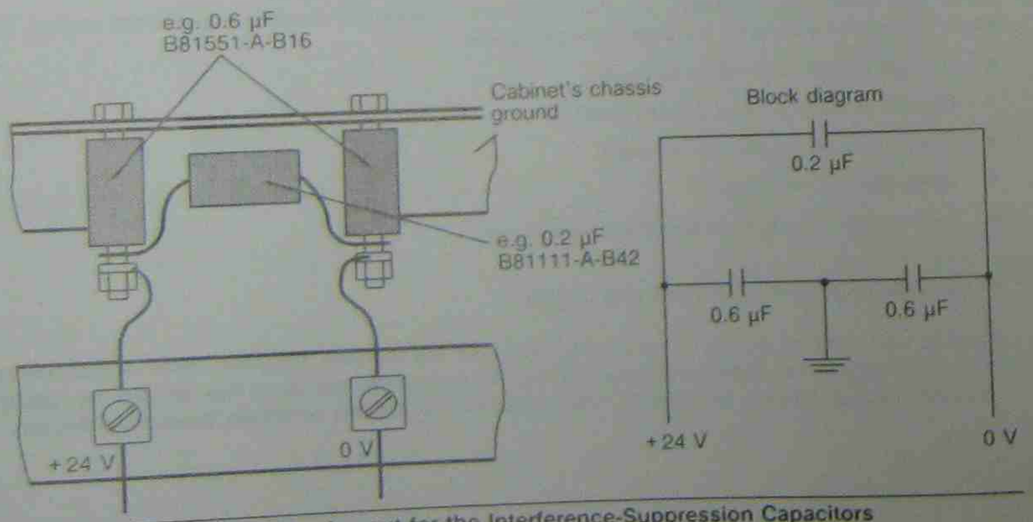

Figure 3-38. Layout for the Interference-Suppression Capacitors

Using Special Interference Suppression Measures

Protective Inductive Circuit

Inductors located in the same cabinet and not directly controlled by SIMATIC outputs (e.g., contactor coils and relay coils) must be bridged by arc suppressing elements (e.g., RC elements).

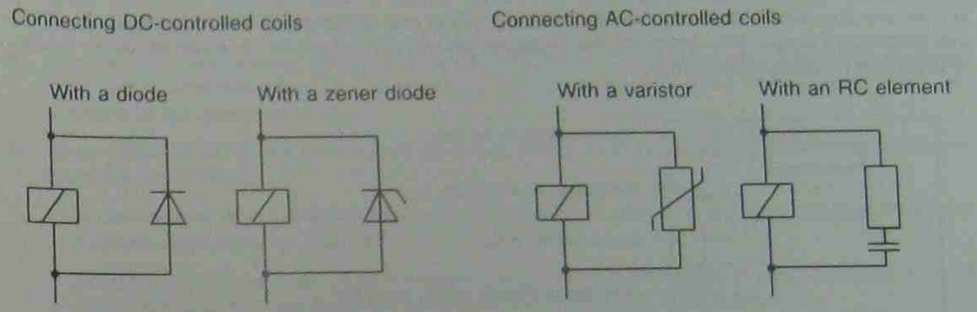

Figure 3-39. Connecting Coils

Partitioning Inductors

It is recommended that you use metal barriers to partition the portion of the cabinet that contains large inductors, such as transformers or contactors.

Protection against Electrostatic Discharge

You should use metal enclosures or cabinets closed on all sides to protect devices and modules against electrostatic discharges. These enclosures or cabinets should have a good conductive connection to the grounding point at the installation site.

If you install your control system in a terminal box, then use a cast-metal housing or sheet-metal housing if possible. A plastic housing should always have a metallic surface. Connect housing doors or covers to the chassis ground via grounding strips or contact springs.
If you work on the system and have the cabinet open, adhere to the guidelines for working with electrostatic sensitive devices (ESD).

Power Connection for Programmers

Every group of cabinets should have a grounded socket for the power supply to the programmers. The sockets should receive their power supply from the distributor that is also connected to the cabinet's protective ground.

Cabinet Lighting

Do not use any fluorescent lamps inside a cabinet. They can cause noise interference. If you must use fluorescent lamps, then carry out the measures shown in Figure 3-40. It would be better to use LINESTRA® (incandescent) lamps.

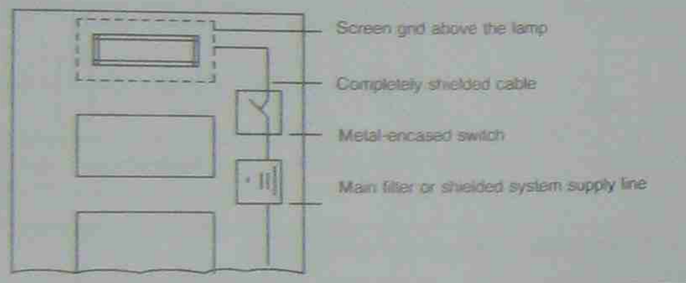

Figure 3-40. How to Reduce Noise Interference Caused by Fluorescent Lamps in a Cabinet

3.6 Protective Devices and Insulation Monitoring Devices

Safety Measures

When you configure systems that have programmable controllers, follow the relevant VDE regulations (e.g., VDE 0113 or VDE 0160). Pay special attention to the following points:

- Prevent conditions that can endanger people or property.
- When power is restored after a power failure or after EMERGENCY OFF devices are deactivated, machines must not be able to restart automatically.
- When a PLC malfunctions, commands for EMERGENCY OFF devices and safety limit switches must remain effective under all circumstances. These safety measures must directly affect the actuators in the power supply.
- When EMERGENCY OFF devices are activated, safety must be guaranteed for both people and the system as follows:
  - Actuators and drives that could cause dangerous situations (e.g., main spindle drives for machine tools) must be shut off.
  - Actuators and drives that could endanger persons or the controlled system by being shut off (e.g., clamping devices) must not be shut off by EMERGENCY OFF devices.
- The programmable controller must be able to record the activation of EMERGENCY OFF equipment, and the control system must be able to evaluate it.

Protection in Case of Indirect Contact

Accessible parts must not be dangerous to touch even if there is a fault.

This requirement is fulfilled if you make all accessible metal parts electrically safe that could be dangerous to touch in the event of a failure (e. g, standard mounting rails, transoms, the cabinet). This is done by connecting these parts to the protective ground conductor (PE). The maximum permissible resistance between the protective-conductor terminal and the accessible part that requires protecting is 0.5 Ω.

Protection against Lightning

If you run cables and lines for SIMATIC S5 devices outside buildings, you must adhere to the regulations regarding lightning.
In addition, you must connect signal cables to protective elements so that you don't have an overvoltage (varistors or lightning arresters filled with inert gas). The protective elements should be present where the cable enters the building, if possible. Otherwise, the protective elements should be where the cable enters the cabinet.

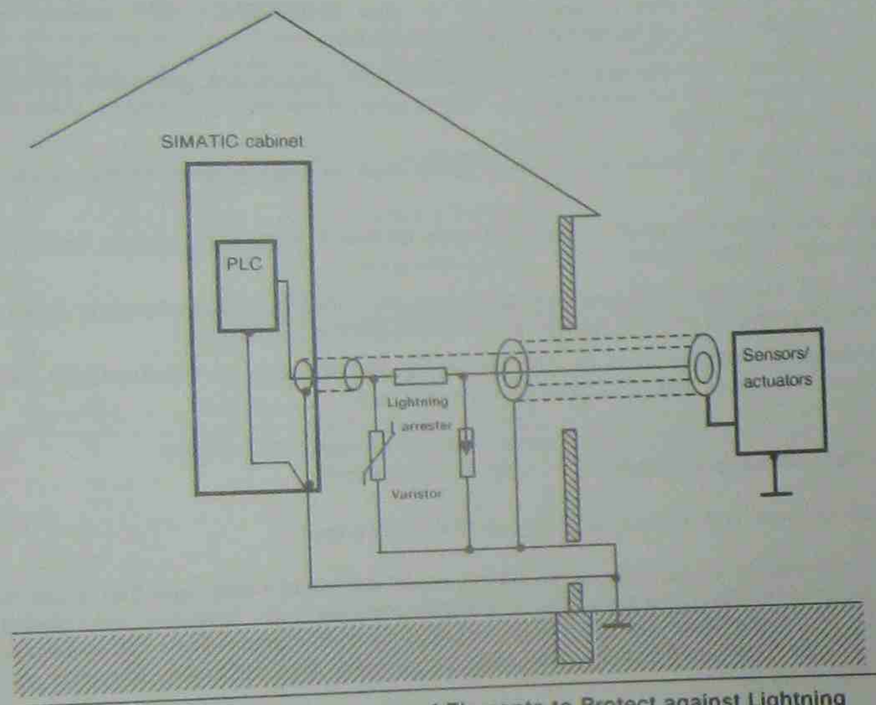

Figure 3-41. Layout of Elements to Protect against Lightning

Use varistors or lightning arresters filled with inert gas to protect against overvoltages.

Install these protective elements where the cable enters the building, if possible.
Otherwise, install them where the cable enters the cabinet.

Note

Each system must be looked at individually to determine measures that should be taken to protect it against lightning. Please address your questions to your local Siemens office.

Figures

Table

4 Start-up and Program Tests

4.1 Operating Instructions

4.1.1 Programmable Controller Operator Panel

S5-90U:

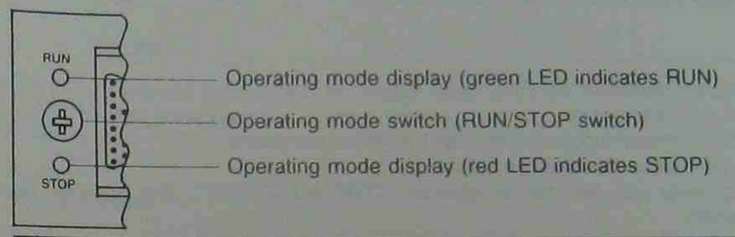

Figure 4-1. Operator Panel for the S5-90U

S5-95U:

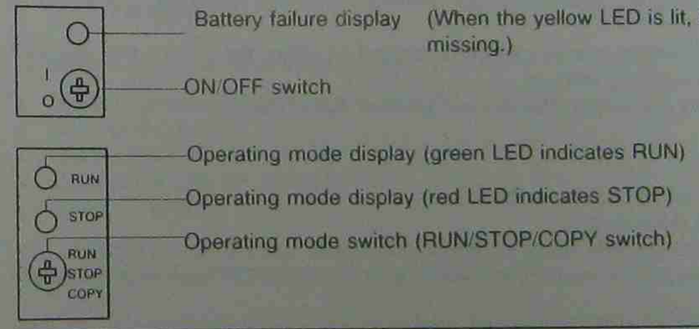

Figure 4-2. Operator Panel for the S5-95U

ON/OFF Switch (only for the S5-95U)

The ON/OFF switch turns on the programmable controller's voltage regulators. This switch does **NOT** separate the voltage regulator from the L+/M terminals.

Operating Mode Switch

Use the operating mode switch to select either the "RUN" or "STOP" operating mode. The programmable controller automatically goes into the "START-UP" mode during the transition from "STOP" to "RUN" (see section 7.4.1).

4.1.2 Operating Modes

"STOP" Operating Mode

- The program is not executed.
- The current values for timers, counters, flags, and process image I/O tables are saved when the "STOP" mode begins.
- The onboard outputs and the output modules are disabled (signal status "0").
- The process image I/O tables, timers, and non-retentive flags and counters are set to "zero" during the transition from "STOP" to "RUN."

"RUN" Operating Mode

- The program is processed cyclically.
- Already started timers continue to run.
- The signal states for the onboard inputs and the input modules are stored.
- The onboard outputs and output modules are addressed.
- The "RUN" operating mode can also be set after an "OVERALL RESET", that is, when the program memory is empty.

"START-UP" Operating Mode

- The operating system processes DB1 and accepts the parameters (see section 9.1).
- Either the start-up organization block OB21 or OB22 is processed (see section 7.4.1).
- The amount of time start-up requires is not limited since the scan time monitor is not activated.
- Neither time-controlled program processing nor interrupt-controlled program processing is possible.
- The onboard inputs and onboard outputs can be addressed by either the L PB/L PW operation or the T PB/T PW operation during start-up.
- The external input modules and output modules are disabled during start-up.

Changing Operating Modes

A change in operating mode can be caused by the follwing.

- Actuation of the operating mode switch.
- A programmer, if the operating mode switch on the programmable controller is set to "RUN."
- Malfunctions that cause the programmable controller to go into the "STOP" operating mode (see Chapter 5).

4.1.3 Performing an Overall Reset on the Programmable Controller

You should perform an overall reset before you input a new program. An overall reset erases the following.

- The programmable controller's program memory
- All data (flags, timers, and counters)
- All error IDs

> **Note**
>
> If you do not perform an overall reset, then the information indicated above is retained even if the program is overwritten.

Manual Reset

To perform an overall reset in the S5-90U, you must:

- Set the operating mode switch to "STOP."
- Remove the battery.
- Disconnect the power to the programmable controller for about 15 seconds.
- Re-establish the programmable controller's power supply.
- Insert the battery.

To perform an overall reset in the S5-95U, you must:

- Set the operating mode switch to "STOP".
- Remove the battery.
- Set the ON/OFF switch to "0."
- Change the ON/OFF switch to "1."
- Insert the battery.

Performing an Overall Reset with the Programmer

You can select the overall reset function from the programmer's menu line. Refer to the programmer manual.