SIEMENS

SIMATIC

S7-300 Programmable Controller Hardware and Installation

Manual

This manual is part of the documentation
package with order no.: **6ES7 398-8AA03-8BA0**

Safety Guidelines

This manual contains notices which you should observe to ensure your own personal safety, as well as to protect the product and connected equipment. These notices are highlighted in the manual by a warning triangle and are marked as follows according to the level of danger:

⚠ **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

draws your attention to particularly important information on the product, handling the product, or to a particular part of the documentation.

Qualified Personnel

Only **qualified personnel** should be allowed to install and work on this equipment. Qualified persons are defined as persons who are authorized to commission, to ground, and to tag circuits, equipment, and systems in accordance with established safety practices and standards.

Correct Usage

Note the following:

⚠ **Warning**

This device and its components may only be used for the applications described in the catalog or the technical descriptions, and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens.

This product can only function correctly and safely if it is transported, stored, set up, and installed correctly, and operated and maintained as recommended.

Trademarks

SIMATIC®, SIMATIC HMI® and SIMATIC NET® are registered trademarks of SIEMENS AG.

Some of other designations used in these documents are also registered trademarks; the owner's rights may be violated if they are used by third parties for their own purposes.

Important Information

Purpose of the Manual

The information contained in this manual enables you to:

- Install and wire an S7-300 programmable controller.

- Look up operator entries, functional descriptions and the technical specifications relevant to the S7-300's CPUs.

  You will find the function descriptions and technical specifications for the signal modules, power supply modules and interface modules in the *Module Specifications* Reference Manual.

Delivery Package

This documentation package (order number 6ES7 398-8AA03-8BA0) comprises two manuals and an instruction list with the following contents:

S7-300 Programmable Controller, Hardware and Installation	**S7-300, M7-300 Programmable Controllers, Module Specifications**	**Instruction List**
- Mechanical and electrical configuration - Installation and wiring - Preparing the S7-300 for operation - Characteristics and technical data for the S7-300 CPUs	- General technical data - Power supply modules - Digital modules - Analog modules - Order numbers for the S7-300	- Instruction set for all CPUs - Brief description of instructions and execution times - List of OBs and start events - List of SFCs/SFBs with brif descriptions and execution times - List of SSL IDs A detailed description of all instructions illustrated by examples can be found in the *STEP 7 manuals* (see Appendix E). You can also order the instruction list separately: 6ES7 398-8AA03-8BN0

Scope of the Manual

This manual applies for the following CPUs:

CPU	Order No.	As of Version	
		Firmware	**Hardware**
CPU 312 IFM	6ES7 312-5AC02-0AB0 6ES7 312-5AC82-0AB0	1.1.0	01
CPU 313	6ES7 313-1AD03-0AB0	1.1.0	01
CPU 314	6ES7 314-1AE04-0AB0 6ES7 314-1AE84-0AB0	1.1.0	01
CPU 314 IFM	6ES7 314-5AE03-0AB0 6ES7 314-5AE83-0AB0	1.1.0	01
CPU 314 IFM	6ES7 314-5AE10-0AB0	1.1.0	01
CPU 315	6ES7 315-1AF03-0AB0	1.1.0	01
CPU 315-2 DP	6ES7 315-2AF03-0AB0 6ES7 315-2AF83-0AB0	1.1.0	01
CPU 316-2 DP	6ES7 316-2AG00-0AB0	1.1.0	01
CPU 318-2	6ES7 318-2AJ00-0AB0	1.1.0	03

This manual describes all modules that are valid at the time the manual is released. For new modules or newer versions of modules, we reserve the option to add to the manual a product information containing the current information on this module.

SIMATIC Outdoor CPUs

CPUs with the order number 31x-xxx**8**x-... are SIMATIC outdoor modules that are suitable for use in a wider range of ambient conditions (see also Reference Manual *Module Data*).
The range of functions and technical specifications of these CPUs are the same as the "standard" CPUs. For that reason, the SIMATIC Outdoor CPUs will not be referred to separately again in this manual.

Alterations from Previous Version

The following changes have been made from the previous version of the manual (*S7-300 Programmable Controller, Installation and Hardware* (order no. 6ES7 398-8AA02-8BA0), Edition 1):

* New CPU:
    – CPU 314 IFM (as 314-5AE03 but with extra slot for memory card)

* CPUs 31x-2: the description of the configuration and parameter assignment frame is no longer part of this manual. Instead, you can find it on the internet at http://www.ad.siemens.de/simatic-cs under article ID 996685.

* The list of OBs, SFCs/SFBs and SSL IDs is no longer in this manual but rather in the instruction list

* New CPU features:
    – New SFCs: SFC 23 "DEL_DB" and SFC 81 "UBLKMOV"
    – Clock synchronisation on MPI as master/slave
    – 32-byte consistency for communications
    – Connection resources can be reserved for PG/OP/S7 basic communication (except for CPU 318-2)
    – CPU 315-1: user-defined address allocation

Agreement for CPU 314 IFM

The CPU 314 IFM is available in 2 versions as follows:

* with slot for memory card   (6ES7 314-5EA**10**-0AB0)
* without slot for memory card   (6ES7 314-5EA**0**-0AB0)

All details in this manual apply to both versions of the CPU 314 IFM unless explicit reference is made to differences between them.

Standards, Certificates and Approvals

The S7-300 programmable controller meets the requirements and criteria of standard IEC 1131, Part 2. The S7-300 meets the requirements for the CE mark. Approvals for CSA, UL and FM have been granted for the S7-300.

See Appendix A for detailed information on standards and approvals.

Recycling and Disposal

The SIMATIC S7-300 can be recycled thanks to the low level of pollutants in its equipment.

Please contact the following address for environmentally-friendly recycling and disposal of your old SIMATIC equipment:

Siemens Aktiengesellschaft
Anlagenbau und Technische Dienstleistungen
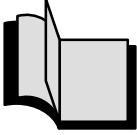ATD ERC Essen Recycling/Remarketing
Fronhauser Str. 69
D-45127 Essen

Phone: +49 201/816 1540 (hotline)
Fax: +49 201/816 1504

Documentation Required

Depending on the CPU, you require the following documentation for installing your S7-300:

The following documentation is required for installing the S7-300 and for preparing it for operation:

Hardware and Installation Manual

Module Specifications Reference Manual

Instruction List

Documentation package
Order number
6ES7 398-8AA03-8BA0

For CPUs 312 IFM and 314 IFM, you will also require the description of the integrated functions and the control functions in STEP 7:

Integrated Functions Manual

Order No. 6ES7 398-8CA00-8BA0

System and Standard Functions Reference Manual

(You can find this in *STEP 7* as an electronic manual)

Documentation for Programming

In Appendix E you will find a list of the documentation required to program and commission the S7-300. In addition, you will find a list of specialist books on programmable controllers.

CD-ROM

Furthermore, the complete SIMATIC S7 documentation is available on CD-ROM.

Guide

To help you find special information quickly, the manual contains the following access aids:

- At the start of the manual you will find a complete table of contents and a list of the diagrams and tables that appear in the manual.

- An overview of the contents of each section is provided in the left-hand column on each page of each chapter.

- You will find a glossary in the appendix at the end of the manual. The glossary contains definitions of the main technical terms used in the manual.

- At the end of the manual you will find a comprehensive index which gives you rapid access to the information you need.

Additional Support

Please contact your local Siemens representative if you have any queries about the products described in this manual. A list of Siemens representatives worldwide is contained in the appendix to this manual.

If you have any questions or suggestions concerning this manual, please fill in the form at the end of this manual and return it to the specified address. Please feel free to enter your personal assessment of the manual in the form provided.

We offer a range of courses to help get you started with the SIMATIC S7 programmable controller. Please contact your local training center or the central training center in Nuremberg, D-90327 Germany (tel. +49 (911) 895-3154)

Constantly Updated Information

You can receive up-to-date information on SIMATIC products from the following sources:

- On the Internet at http://www.ad.siemens.de/

- On the fax polling number +49-8765-93 00-55 00

In addition, the SIMATIC Customer Support provides up-to-date information and downloads for users of SIMATIC products:

- On the Internet at http://www.ad.siemens.de/simatic-cs

- Via the SIMATIC Customer Support mailbox on the following number:
  +49 (911) 895-7100

  To access the mailbox, use a modem with up to V.34 (28.8 kbps), and set the parameters as follows: 8, N, 1, ANSI. Alternatively, access it using ISDN (x.75, 64 kbps).

You can reach the SIMATIC Customer Support by telephone at
+49 (911) 895-7000 and by fax at +49 (911) 895-7002. Queries can also be addressed to us by Internet mail or by mail to the mailbox specified above.

Contents

Figures

Tables

Product Overview

1

Modular Design

The S7-300 has a modular design. You can set up your own individual system by combining components from a comprehensive range of S7-300 modules.

The range of modules includes the following components:

- CPUs for various performance ranges

- Signal modules for digital and analog input/output (see *Module Specifications* Reference Manual*)*

- Function modules for technological functions (see the function module manual for a description).

- CP communication processors (see the communication processor manual for a description)

- Load power supply modules for connecting the S7-300 to 120/230 V AC power supplies (see *Module Specifications* Reference Manual)

- Interface modules for the interconnection of racks in multi-rack installations (see *Module Specifications* Reference Manual)

All of the S7-300 modules are contained in housings protected to IP 20, i.e. they are encapsulated and can be operated without a fan.

In This Chapter

In this chapter, we will introduce you to the most important components that go to make up an S7-300.

Structure of an S7-300

An S7-300 programmable controller is made up of the following components:

- Power supply (PS)
- CPU
- Signal modules (SM)
- Function modules (FM)
- Communication processor (CP).

Several S7-300s can communicate together and with other SIMATIC S7 PLCs via PROFIBUS bus cables.

You require a programming device (PG) to program the S7-300. You hook the programming device up to the S7-300 with a special programming device cable.

Figure 1-1 shows a possible configuration with two S7-300 programmable controllers. The components in the shaded area are described in this manual.

①	Power supply (PS)
②	Central processing unit (CPU)
③	Signal module (SM)
④	PROFIBUS bus cable
⑤	Programming device cable
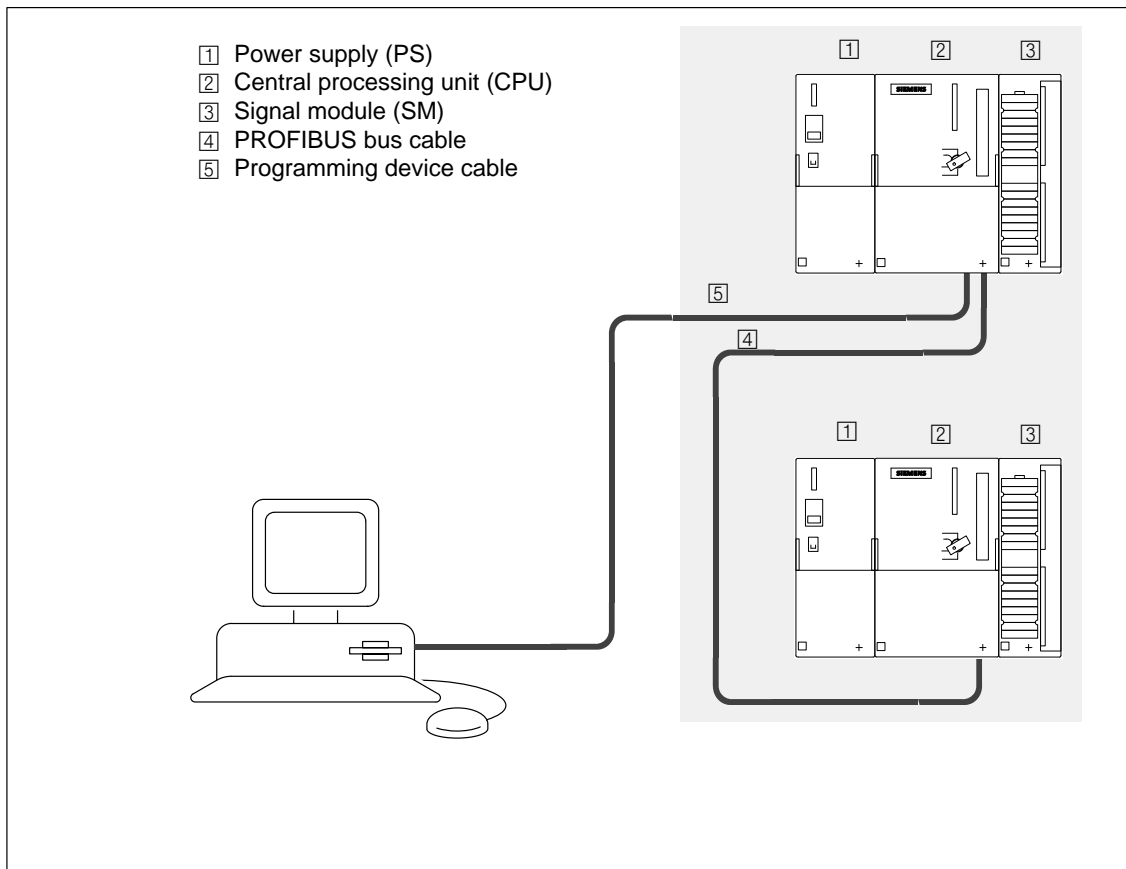
Figure 1-1   Components of an S7-300

Components of an S7-300

You have a number of components at your disposal for installing and starting up an S7-300 programmable controller. Table 1-1 lists the major components and their functions:

Table 1-1   Components of an S7-300
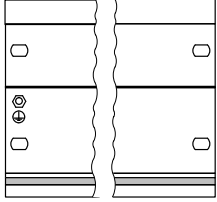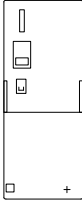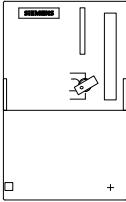
Components	Function	Illustration
Rail Accessory: Shield contact element	... accommodates the S7-300 modules	
Power supply (PS)	... converts the power system voltage (120/230 V AC) into 24 V DC for the S7-300 and load power supply for 24 V DC load circuits	

CPU
Accessory:
• CPU 312 IFM
  – Front-panel connector (20-pin)
• CPU 313
  – Memory card
  – Backup battery
• CPU 314 IFM
  – Memory card (...-5AE10–... only)
  – Backup battery/accumulator
  – Front-panel connector (40-pin)
• CPU 314/315/315-2DP/ 316-2DP/318
  – Memory card
  – Backup battery/accumulator
	... executes the user program; supplies the S7-300 backplane bus with 5 V; communicates with other nodes in an MPI network via the MPI interface.
	You can also use the CPU 31x-2 DP/318-2 in a PROFIBUS subnet:
	• as a DP master
	• as a DP slave on an S7/M7 DP master or another DP master.	

Table 1-1   Components of an S7-300, continued
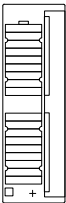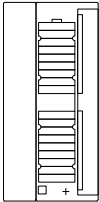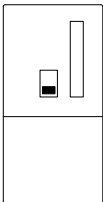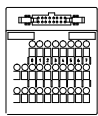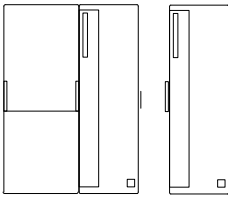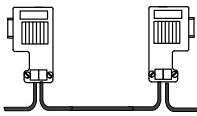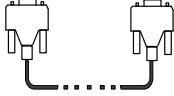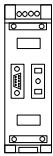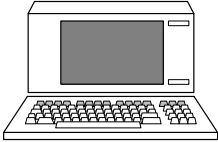
Components	Function	Illustration
Signal modules (SM) (digital input modules, digital output modules, digital input/output modules) analog input module analog output module analog input/output modules) Accessory: Front connector	... match different process signal levels to the S7-300	
Function modules (FM) Accessory: Front connector	... for time-critical and memory-intensive process signal processing tasks, for example, positioning or closed-loop control	
Communication processor (CP). Accessory: Connecting cable	... relieves the CPU of communication tasks, for example, CP 342-5 DP for connection to PROFIBUS-DP.	
SIMATIC TOP connect Accessory: Front connector module with ribbon cable connection	... for wiring of the digital modules	
Interface module (IM) Accessory: Connecting cables	... interconnects the individual tiers of an S7-300	
PROFIBUS bus cable with bus connector	... interconnects stations on an MPI or PROFIBUS subnet	
Programming device cable	... connects a CPU to a programming device/PC	

Table 1-1   Components of an S7-300, continued

Components	Function	Illustration
RS 485 Repeater	... for amplifying the signals in an MPI or PROFIBUS subnet and for connecting segments in these systems	
Programming device (PG) or PC with the STEP 7 software package	... configures, initializes, programs and tests the S7-300	

Installation

2

Introduction

In this chapter we will show you how to carry out the mechanical configuration, and prepare and install the S7-300 components.

To set up a S7-300, you must take into account the configuration of the electrical setup. Make sure you also read Chapter 3, "Wiring".

Contents

Section	Contents	Page
2.1	Configuration of an S7-300 Setup	2-2
2.2	Installation	2-9

Open Modules

The modules of an S7-300 are open components. That means you can only install the S7-300 in housings, cabinets or electrical operating areas that are only accessible by key or a special tool. Only trained or authorized personnel should have access to the housings, cabinets or electrical operating areas.

2.1   Configuring an S7-300 Installation

Section	Contents	Page
2.1.1	Horizontal and Vertical Installation	2-2
2.1.2	Clearance Measurements	2-3
2.1.3	Installation Dimensions of the Modules	2-4
2.1.4	Arranging the Modules on a Single Rack	2-5
2.1.5	Arranging the Modules on Multiple Racks (Not CPU 312 IFM/313)	2-6

2.1.1   Horizontal and Vertical Installation

Installation

You can install your S7-300 in either a horizontal or vertical position.

Permissible Ambient Temperature

- Horizontal installation   from 0 to 60°C

- Vertical installation   from 0 to 40°C
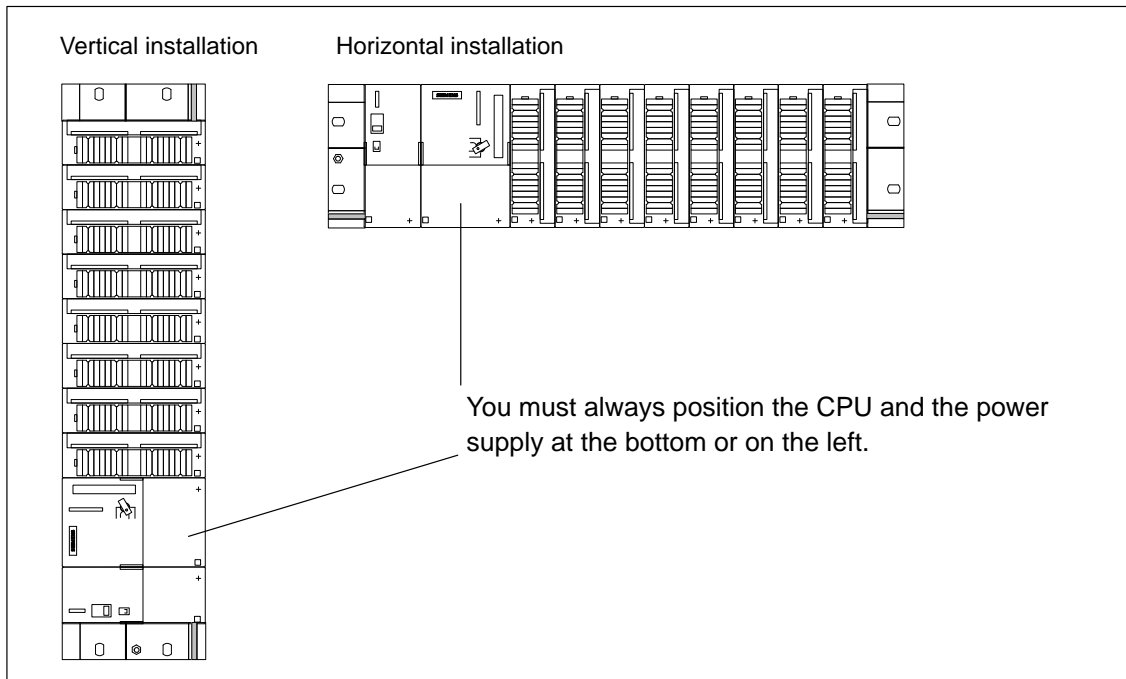
Figure 2-1   Horizontal and Vertical Installation of an S7-300

2.1.2 Clearance Measurements

Rules

If you adhere to the minimum clearance measurements:

* You will ensure that the S7-300 modules do not get too hot.

* You will have adequate space for inserting and removing the S7-300 modules.

* You will have sufficient space for running cables.

* The height of the S7-300 mounting rack increases to 185 mm.
  Despite this, you must maintain a clearance of 40 mm (1.56 in.).

Note

If you use a shield contact element (see Section 4.3.4), the dimension
specifications apply from the lower edge of the shield contact element.

Clearance Measurements

Figure 2-2 shows the necessary clearances between the individual racks and to
the adjacent equipment, cable ducts, cabinet walls etc. for standard S7-300
configurations on several racks.
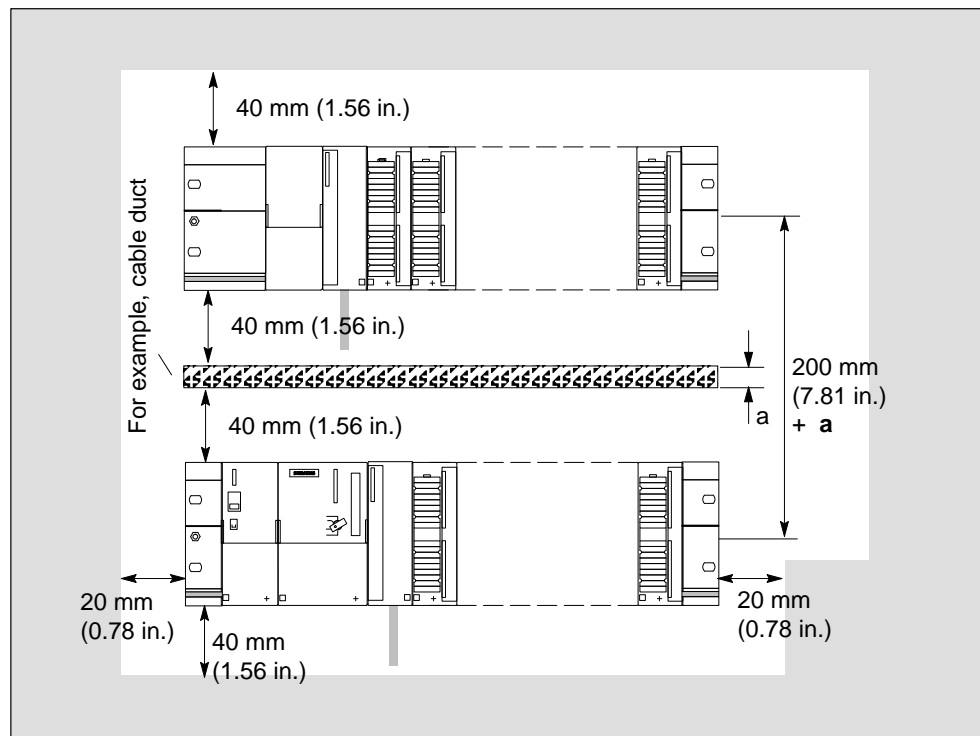
Figure 2-2   Clearance Measurements for an S7-300 Installation

2.1.3   Installation Dimensions of the Modules

Table 2-1 shows the installation dimensions of the S7-300 modules.

Table 2-1   Installation Dimensions of the S7-300 Modules

Modules	Module Width	Module Height	Max. Installation Depth
Power supply PS 307, 2 A Power supply PS 307, 5 A Power supply PS 307, 10 A	50 mm (1.95 in.) 80 mm (3.12 in.) 200 mm (7.8 in)	125 mm, 185 mm with shield contact element	130 mm or 180 mm (7.02 in.) with front cover of CPU and IM 361 open (195 mm (8.00 in.) for CPU 312 IFM)
CPU 31x/312 IFM, CPU 314 IFM/CPU 318-2	80 mm (3.12 in.) 160 mm (6.24 in.)		
Digital input module SM 321 Digital output module SM 322 Relay output module SM 322 Digital input/output module SM 323 Simulator module SM 374	40 mm (1.56 in.)		
Analog input module SM 331 Analog output module SM 332 Analog input/output module SM 334	40 mm (1.56 in.)		
Interface module IM 360 Interface module IM 361 Interface module IM 365	40 mm (1.56 in.) 80 mm (3.12 in.) 40 mm (1.56 in.)		

Rail Length

Depending on your S7-300 configuration, you can use rails of the following lengths:

Rail	Usable Lengths for Modules	Remarks
160 mm (6.24 in.)	120 mm (4.68 in.)	Comes with fixing holes
482.6 mm (18.82 in.)	450 mm (17.55 in.)	
530 mm (20.67 in.)	480 mm (18.72 in.)	
830 mm (32.37 in.)	780 mm (30.42 in.)	
2000 mm (1.56 in.)	Cut to length required	Fixing holes must be drilled

2.1.4   Arranging the Modules on a Single Rack

Rules

The following rules apply to the arrangement of the modules on a single rack:

- No more than eight modules(SM, FM, CP) may be installed to the right of the CPU.

- The number of modules (SM, FM, CP) that can be plugged in is limited by the amount of power they draw from the S7-300's backplane bus (see the table containing the technical specifications of the various modules).

  The power input from the S7-300 backplane bus to all the modules installed on a mounting rack must not exceed the following:

  - For the CPUs 313/314/314 IFM/315/315-2 DP/ 316-2 DP/318-2   1.2 A

  - For the CPU 312 IFM   0.8 A

Figure 2-3 shows the arrangement of the modules in an S7-300 configuration with 8 signal modules.
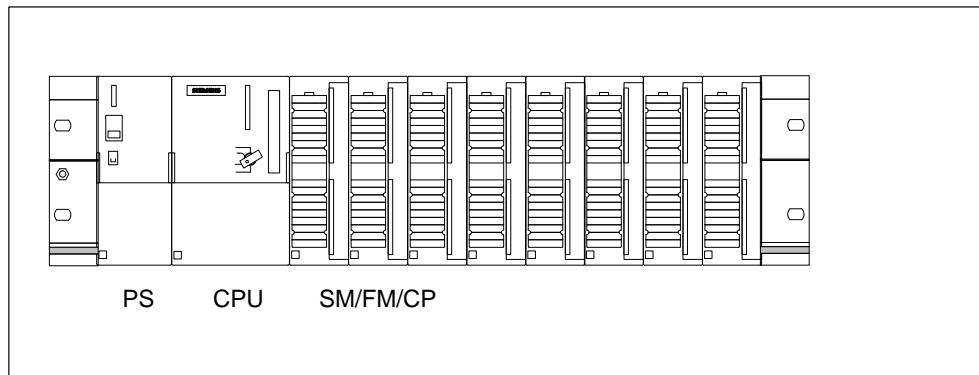
Figure 2-3   Arranging the Modules on a Single Rack

2.1.5   Arranging the Modules on Multiple Racks
         (Not CPU 312 IFM/313)

Exceptions

The CPU 312 IFM and CPU 313 can only be used for a configuration on **one** rack.

Rules

The following rules apply to the arrangement of modules on more than one rack:

*   The interface module is always be installed in slot 3, to the left of the first signal module.

*   No more than 8 modules (SM, FM, CP) are permitted per rack. These modules are always located to the right of the interface modules.
    Exception: In the case of the CPU 314 IFM, a module cannot be inserted in slot 11 on rack 3 (see Chapter 3).

*   The number of modules (SM, FM, CP) that can be installed is limited by the maximum permissible current that can be drawn from the S7-300 backplane bus. The power consumption must not exceed 1.2 A per line (see technical specifications of the modules).

Prerequisite: Interface modules

Interface modules that relay the S7-300 backplane bus from one rack to the next are required in multi-rack configurations. The CPU is always located on rack 0.

Interface Module	To Be Used for ...	Order No.
IM 360	Rack 0	6ES7 360-3AA01-0AA0
IM 361	Rack 1 to 3	6ES7 361-3CA01-0AA0
Two-Line Configuration Only..		
IM 365 S	Rack 0	6ES7 365-0BA00-0AA0
IM 365 R	Rack 1	

Connecting Cables for the IM 360/361 Interface Module

The following connecting cables are available for the interface modules:

Table 2-2   Connecting Cables for Interface Modules

Length	Order No. of the Connecting Cable
1 m	6ES7 368-3BB01-0AA0
2.5 m (8.2 ft.)	6ES7 368-3BC51-0AA0
5 m	6ES7 368-3BF01-0AA0
10 m	6ES7 368-3CB01-0AA0

Interface module IM 365

The S7-300 offers the IM 365 interface module for a configuration on 2 racks. The two IM 365 interface modules are connected by a 1 m long cable (fixed wiring).

If you use the IM 365 interface modules, you can use only signal modules on rack 1.

The total current drawn by the inserted signal modules from both mounting racks must not exceed 1.2 A; the current drawn by mounting rack 1 is limited to 800 mA.

Maximum Configuration of an Installation

Figure 2-4 shows the module arrangement in an S7-300 configuration on 4 mounting racks (not CPU 312 IFM/313).

Figure 2-4   Arrangement of Modules in a Four-Rack S7-300 Configuration

2.2 Installation

Section	Contents	Page
2.2.1	Installing the Rail	2-9
2.2.2	Installing Modules on the Rail	2-13
2.2.3	After Installation	2-15

2.2.1 Installing the Rail

Are you Installing a 2-Meter Rail?

If not, you can skip this section and read on from the section entitled **Dimensioned Drawing for Fixing Holes**.

If so, the 2-meter rail has to be prepared for installation. Proceed as follows:

1. Shorten the rail to the required length.

2. Mark out:

   – Four holes for the fixing screws (dimensions: see Table 2-3)

   – A hole to take the fixing screw for the protective conductor.

3. Is the rail longer than 830 mm/32.37 in.?

   If so: You must make additional holes for more fixing screws to ensure the rail is secure. Mark out these holes along the groove in the middle section of the rail (see Figure 2-5). These additional holes should be at 500 mm (19.5 in.) intervals.

   If not: No further steps must be taken.

4. Drill the marked holes to a diameter of 6.5$^{+0.2}$ mm for M6 screws.

5. Tighten the M6 screw to fix the protective conductor.
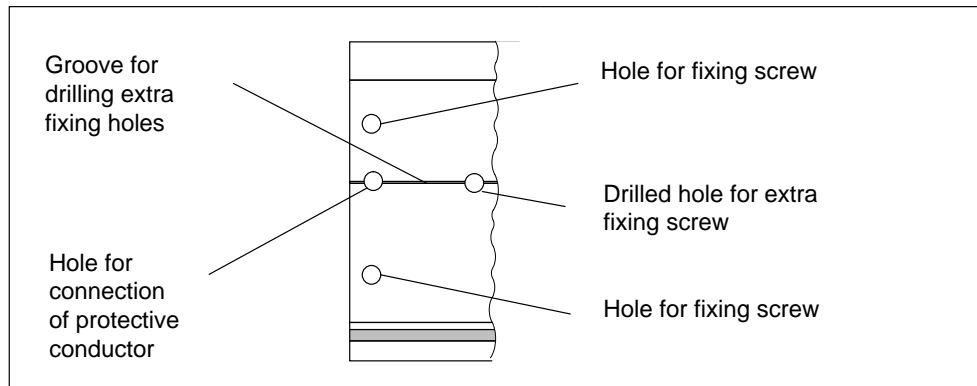
Figure 2-5   Fixing Holes of the 2 m/6.56 ft. Rail

Dimensioned Drawing for Fixing Holes

The fixing-hole dimensions for the rail are shown in Table 2-3.

Table 2-3   Fixing Holes for Rails

"Standard" Rail			2 m Rail
Length of Rail	**Dimension a**	**Dimension b**	–
160 mm (6.24 in.)	10 mm (0.39 in.)	140 mm (5.46 in.)	
482.6 mm (18.82 in.)	8.3 mm (0.32 in.)	466 mm (18.17 in.)	
530 mm (20.67 in.)	15 mm (0.59 in.)	500 mm (19.5 in.)	
830 mm (32.37 in.)	15 mm (0.59 in.)	800 mm (31.2 in.)	

Fixing Screws

You have a choice of the following screw types for fixing the rail.

for	Type of Screw	Description
Lateral fixing screws	M6 cheese-head screw M6 to ISO 1207/ ISO 1580 (DIN 84/DIN 85)	Choose a suitable screw length to for your configuration. You will also require 6,4 washers to ISO 7092 (DIN 433)
	M6 hexagon-head screw to ISO 4017 (DIN 4017)	
Extra fixing screw (only for 2 m rail)	M6 cheese-head screw to ISO 1207/ ISO 1580 (DIN 84/DIN 85)	

Installing the Rail

To install rails, proceed as follows:

1. Choose a position for the rail that leaves enough room to install it properly and enough space to cope with the temperature rise of the modules (leave at least 40 mm /1.56 in. free above and below the rail; see page 2-3).

2. Screw the rail to its base (size: M6). Is this base a metallic plate or a grounded supporting plate?

   If so: Make sure there is a low-impedance connection between the rail and the base. In the case of painted or anodized metals, for instance, use a suitable contacting agent or contact washers.

   If not: No particular steps are required.

3. Connect the rail to the protective conductor. An M6 screw is provided for this purpose on the rail.

   Minimum cross-section from the conductor to the protective conductor: 10 mm^2.

Note

Make absolutely sure that your connection to the protective conductor is low-impedance (see Figure 2-6). If the S7-300 is mounted on a hinged rail, you must use a flexible cable to establish the connection to the protective conductor.

Protective Conductor Connection

Figure 2-6 shows you how to connect the protective conductor to the rail.
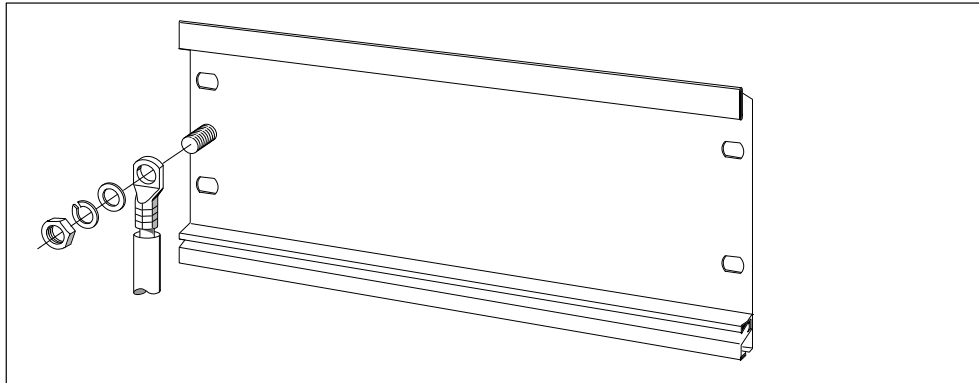
Figure 2-6   Connecting the Protective Conductor to the Rail

2.2.2 Installing Modules on the Rail

Accessories

The accessories you need for installation are included with the modules. Appendix D contains a list of accessories and spare parts together with the corresponding order numbers.

Table 2-4   Module Accessories

Module	Accessories Included	Description
CPU	1 × slot number label	For assigning slot numbers
	2 keys	The key is used for actuating the CPU's mode selector
	Labeling strip (CPU 312 IFM/314 IFM only)	For labeling the integrated input and output points of the CPU Tip: templates for labelling strips can be obtained from the internet at http://www.ad.siemens.de/simatic_cs under article ID 406745.
Signal module (SM)	1 bus connector	For establishing the electrical connections between the modules
	1 labeling strip	For labeling the input and output points on the module Tip: templates for labelling strips can be obtained from the internet at http://www.ad.siemens.de/simatic_cs under article ID 406745.
Interface module (IM)	1 × slot number label (IM 361 and IM 365 only)	For assigning slot numbers on racks 1 to 3

Sequence for Installing the Modules on the Rail
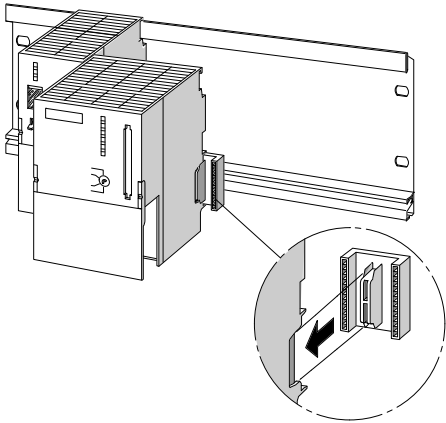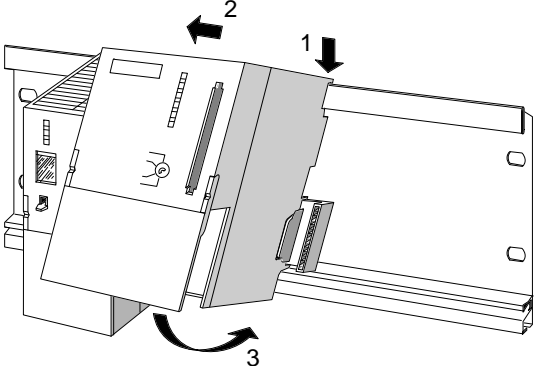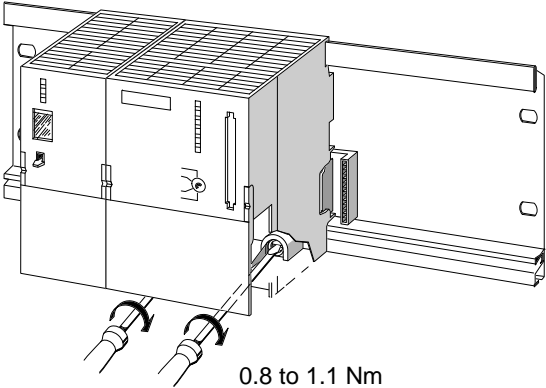
1. Power supply module

2. CPU

3. Signal module(s)

   Note: If you are installing SM 331 analog input modules, please check **before** installation whether you have to move the measuring range submodules on the side of the module. (see Chapter 4 on analog modules in the *Module Specifications* Reference Manual).

Sequence for Installation

The individual steps to be followed when installing the modules are described below.

Table 2-5   Installing the Modules on the Rail

Each signal module comes with a bus connector, but not the CPU. When attaching the bus connectors, always start with the CPU: • Remove the bus connector from the last module and plug it into the CPU. • You must not plug a bus connector into the "last" module.	
Hook the modules onto the rail (1), slide them along as far as the module on the left (2), and swing them down into place (3).	
Bolt the modules tight, applying a torque of between 0.8 and 1.1 Nm (7 to 10 in. lb.).	0.8 to 1.1 Nm

2.2.3   After Installation

Inserting the Key

After installing the CPU on the rail, you can insert the key into the CPU in the STOP or RUN switch position.
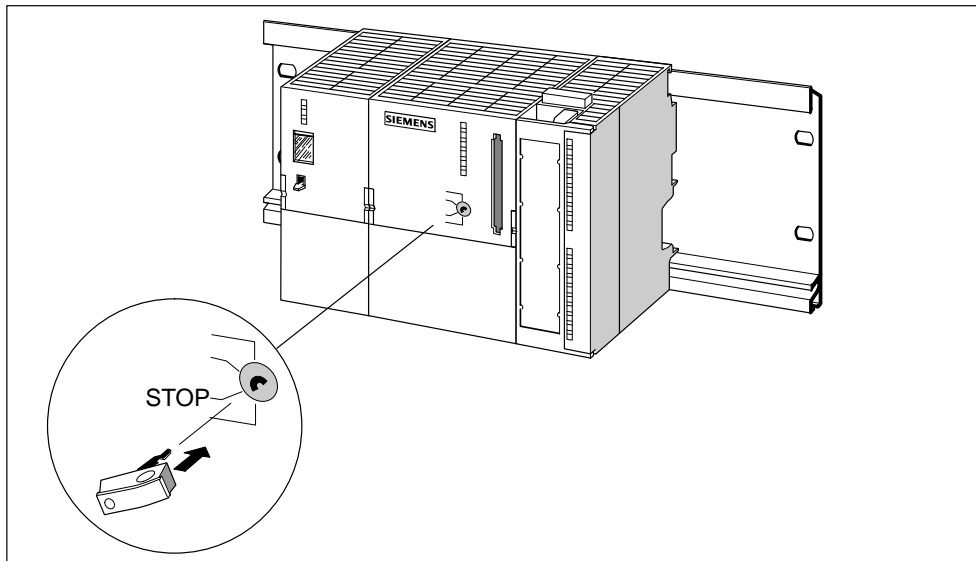
Figure 2-7   Inserting the Key in the CPU

Assigning Slot Numbers

After installation you can assign a slot number to each module. This makes it easier to assign the modules in the configuration table in *STEP 7*. Table 2-6 shows the slot number assignment.

Table 2-6   Slot Numbers for S7 Modules

Slot Number	Module	Remarks
1	Power supply (PS)	–
2	CPU	–
3	Interface module (IM)	To the right of the CPU
4	1st signal module	To the right of the CPU or IM
5	2nd signal module	–
6	3rd signal module	–
7	4th signal module	–
8	5th signal module	–
9	6th signal module	–
10	7th signal module	–
11	8th signal module	–

Applying Slot Numbers

Figure 2-8 shows you how to apply the slot numbers. The slot number labels are included with the CPU.
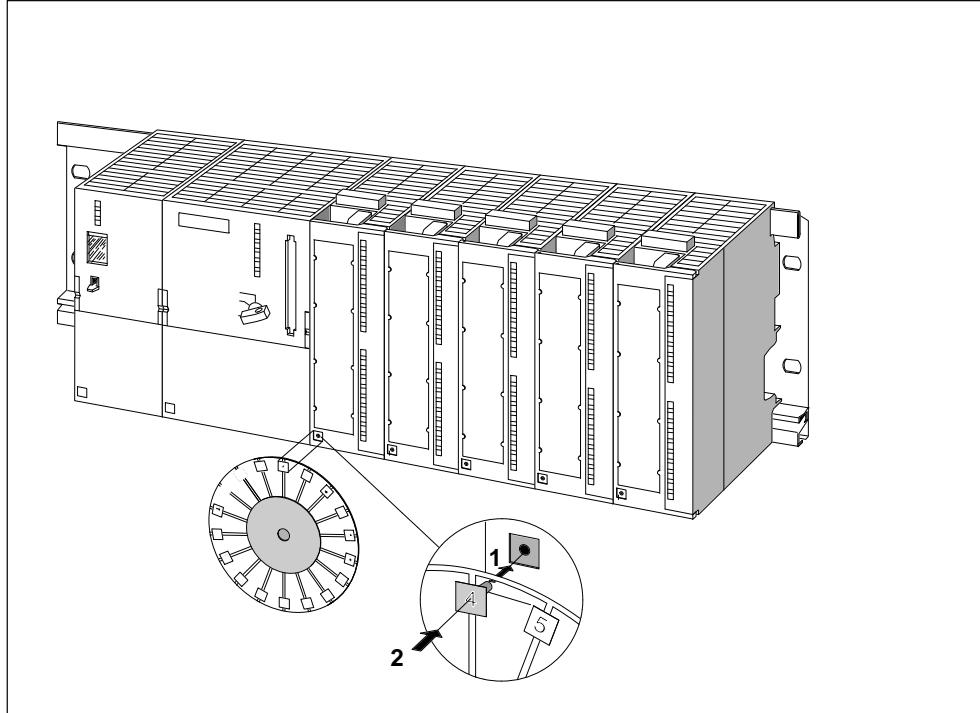
Figure 2-8   Applying Slot Numbers to the Modules

Addressing

3

In This Chapter

In this chapter, you will learn about the different ways of addressing the individual channels of the signal modules.

Slot-Based Address Allocation

Slot-based address allocation is the default addressing method on the *STEP 7*, i.e. a defined module start address is allocated to each slot number.

User-Defined Address Allocation

In user-defined address allocation, you can allocate any address within the available CPU address area to any module. User-defined allocation of addresses is only possible on the S7-300 with the CPUs 315, 315-2 DP, 316-2 DP and 318-2.

In This Section

Section	Contents	Page
3.1	Slot-Based Address Allocation for Modules (Default Addresses)	3-2
3.2	User-Defined Address Allocation	3-4
3.3	Addressing the Signal Modules	3-5
3.4	Addressing the Integrated Inputs and Outputs of the CPU 312 IFM und CPU 314 IFM	3-8

3.1 Slot-Based Addressing for Modules (Default Addressing)

Introduction

In slot-based addressing (default addressing), a module start address is allocated to each slot number (see Table 3-1). This section shows you which module start address is allocated to which slot number. You need this information to determine the module start addresses on the installed modules.

Maximum Configuration

Figure 3-1 shows a configuration of the S7-300 on four racks and all of the available module slots. Please note that with the CPUs 312 IFM and 313, only one configuration is possible on rack 0.

Slot number		IM	3	4	5	6	7	8	9	10	11	Rack 3
Slot number		IM	3	4	5	6	7	8	9	10	11	Rack 2
Slot number		IM	3	4	5	6	7	8	9	10	11	Rack 1
Slot number	1	2	3	4	5	6	7	8	9	10	11	Rack 0
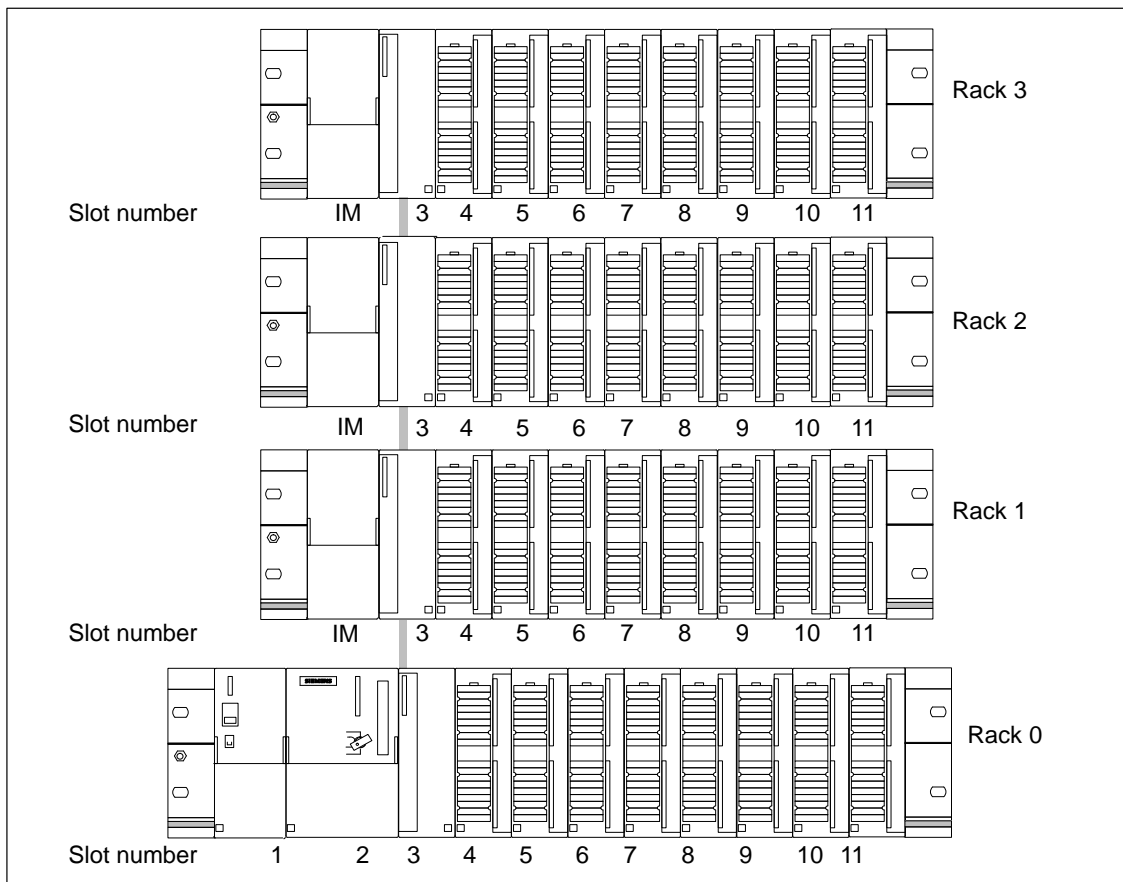
Figure 3-1   Slots of the S7-300

Module Start Addresses

Table 3-1 shows the allocation of the module start addresses to the slot numbers and racks.

The input and output addresses for I/O modules start from the same module start address.

Note

In the case of the CPU 314 IFM, a module cannot be plugged into slot 11 on rack 3. The address space is occupied by the integrated inputs and outputs.

Table 3-1   Start Addresses for the Signal Modules

Rack	Module Start Addresses	Slot number										
		1	2	3	4	5	6	7	8	9	10	11
0	Digital	PS	CPU	IM	0	4	8	12	16	20	24	28
	Analog				256	272	288	304	320	336	352	368
1[1]	Digital	–		IM	32	36	40	44	48	52	56	60
	Analog	–			384	400	416	432	448	464	480	496
2[1]	Digital	–		IM	64	68	72	76	80	84	88	92
	Analog	–			512	528	544	560	576	592	608	624
3[1]	Digital	–		IM	96	100	104	108	112	116	120	124[2]
	Analog	–			640	656	672	688	704	720	736	752[2]

1   Not with the CPU 312 IFM/313
2   Not with the CPU 314 IFM

3.2 User-Defined Address Allocation

Only CPUs 315, 315-2 DP, 316-2 DP and 318-2

... support user-defined address allocation.

User-Defined Address Allocation

User-defined address allocation means that you are free to allocate any module (SM/FM/CP) an address of your choice. The addresses are allocated in *STEP 7*. You define the start address of the module, and all other addresses of this module are based on this start address.

Advantages

Advantages of user-defined address allocation:

- Optimum utilization of the address areas available, since between the modules, address "gaps" will not occur.

- When generating standard software, you can program addresses which are independent of the S7-300 configuration.

Addresses of the Distributed I/Os

To address the distributed I/Os of the CPUs 31x-2 DP, please read Section 9.1.

3.3   Addressing the Signal Modules

Introduction

This section shows you how signal modules are addressed. You need this information in order to be able to address the channels of the signal modules in your user program.

Addresses of the Digital Modules

The address of an input or output of a digital module consists of a byte address and a bit address.

E.g.   I 1.2

Input   Byte address   Bit address
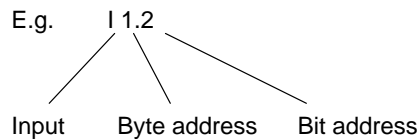
The byte address depends on the module start address.

The bit address is the number printed on the module.

Figure 3-2 shows you how the addresses of the individual channels of a digital module are obtained.
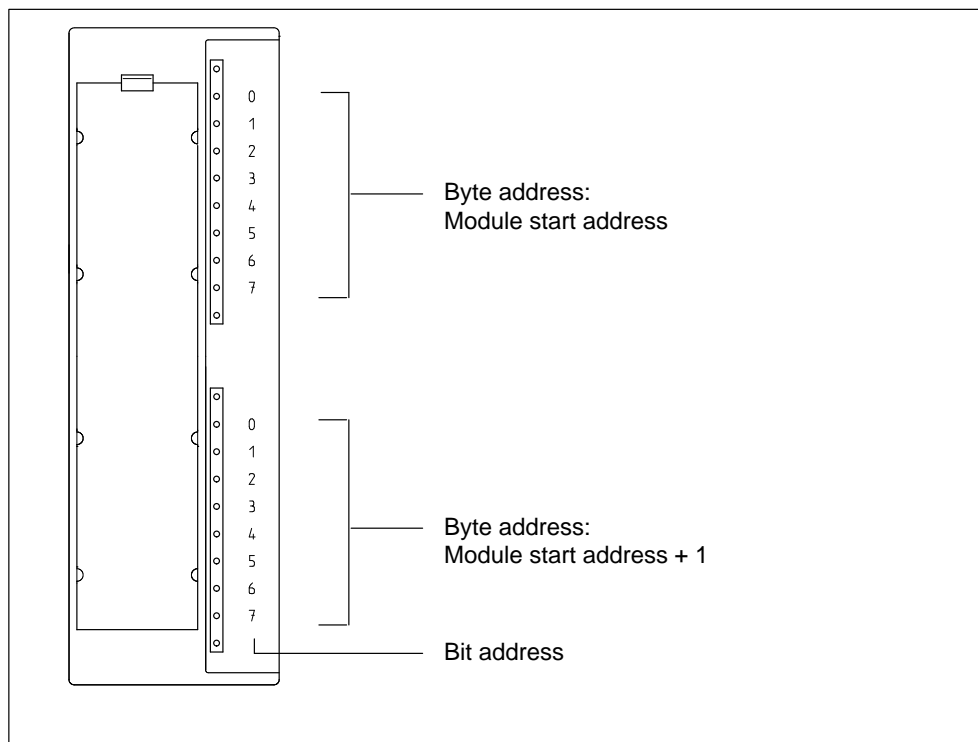
Figure 3-2   Addresses of the Inputs and Outputs of Digital Modules

An Example for Digital Modules

The example in Figure 3-3 shows which default addresses are obtained if a digital module is plugged into slot 4 (i.e. when the module start address is 0).

Slot number 3 has not been assigned since there is no interface module in the example.
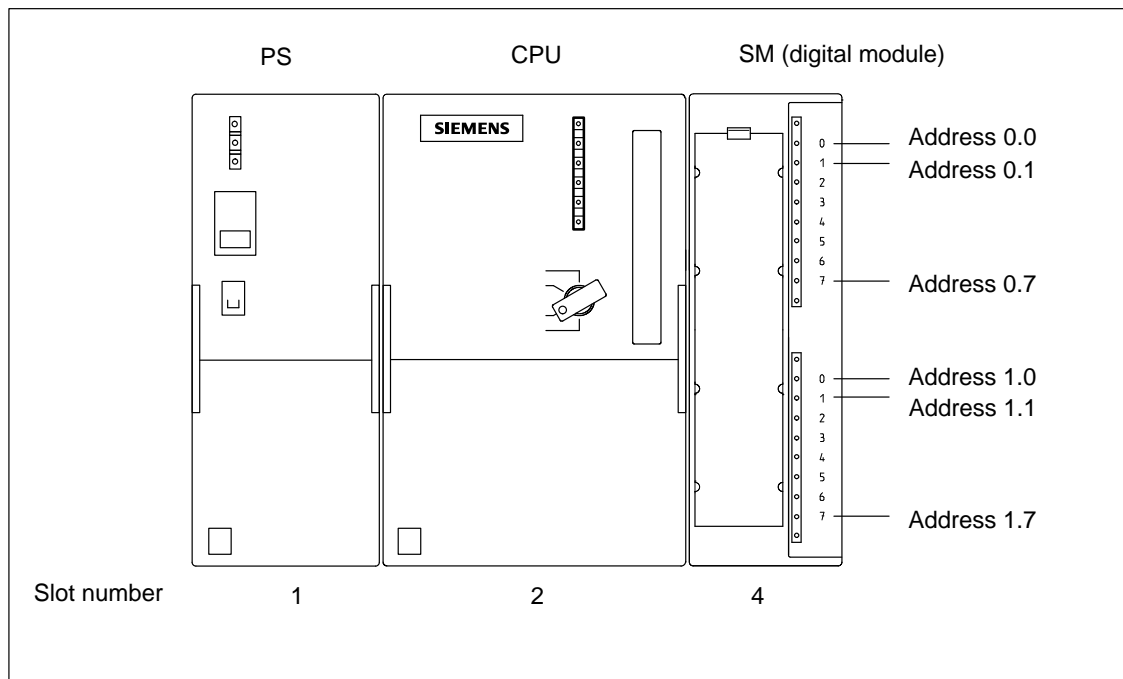
Figure 3-3   Addresses of the Inputs and Outputs of the Digital Module in Slot 4

Addresses of the Analog Modules

The address of an analog input or output channel is always a word address.

The channel address depends on the module start address.

If the first analog module is plugged into slot 4, it has the default start address 256. The start address of each further analog module increases by 16 per slot (see Table 3-1).

An analog input/output module has the same start addresses for its input and output channels.

An Example for Analog Modules

The example in Figure 3-4 shows you which default channel addresses are obtained for an analog module plugged into slot 4. As you can see, the input and output channels of an analog input/output module are addressed as of the same address (the module start address).

Slot number 3 has not been assigned since there is no interface module in the example.
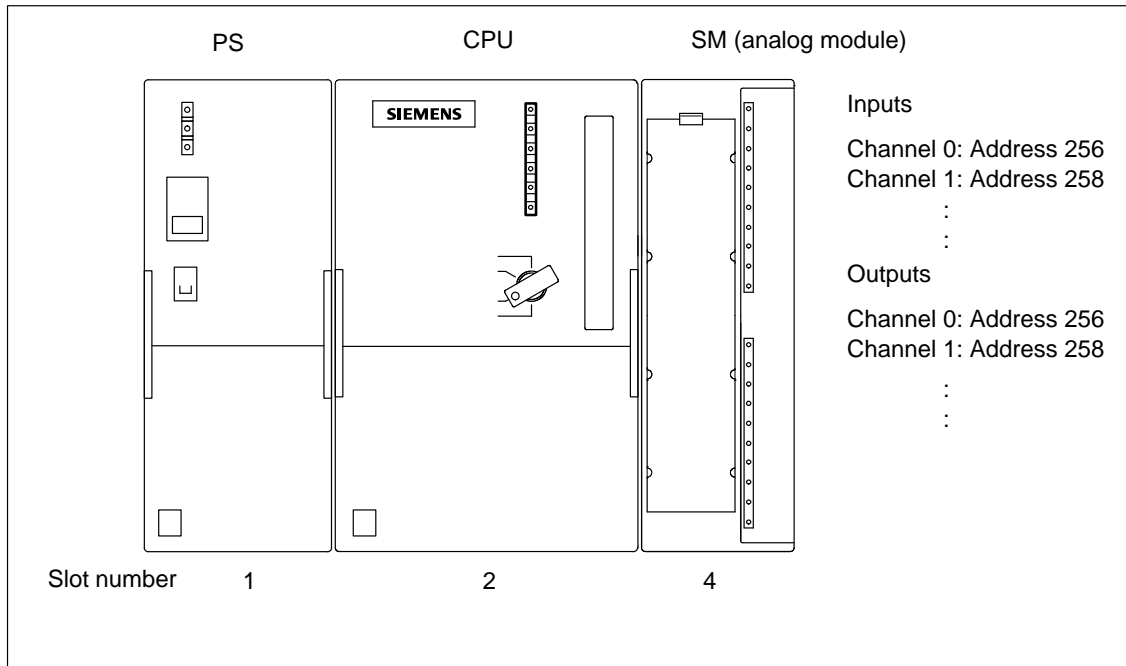
Figure 3-4   Addresses of the Inputs and Outputs of the Analog Module in Slot 4

3.4 Addressing the Integrated Inputs and Outputs of the CPU 312 IFM and CPU 314 IFM

CPU 312 IFM

The integrated inputs and outputs of the CPU 312 IFM have the following addresses:

Table 3-2   Integrated Inputs and Outputs of the CPU 312 IFM

Inputs/Outputs	Addresses	Remarks
10 digital inputs	124.0 to 125.1 Of these, **4 are special channels:** 124.6 to 125.1	You can assign these special channels the counter and frequency functions (see the *Integrated Functions* manual), or you can use them as interrupt inputs.
6 digital outputs	124.0 to 124.5	–

CPU 314 IFM

The integrated inputs and outputs of the CPU 314 IFM have the following addresses:

Table 3-3   Integrated Inputs and Outputs of the CPU 314 IFM

Inputs/Outputs	Addresses	Remarks
20 digital inputs	124.0 to 126.3 Of these, **4 are special channels:** 126.0 to 126.3	You can assign these special channels the functions "Counter", "Frequency meter", "Counter A/B" or "Positioning" (see the *Integrated Functions* manual), or you can use them as interrupt inputs.
16 digital outputs	124.0 to 125.7	–
4 analog inputs	128 to 135	–
1 analog output	128 to 129	–

Wiring

4

Introduction

In this chapter we will show you how to configure the electrical installation and how to wire an S7-300.

To configure an S7-300 you must take into account the mechanical configuration. Make sure you also read Section 2.1.

Basic Rules

In view of the many and varied applications an S7-300, this chapter can only describe a few basic rules on its electrical configuration. You must observe at least these basic rules if you want your S7-300 to operate faultlessly and satisfactorily.

Contents

4.1 Electrical Configuration

4.1.1 General Rules and Guidelines for Operating an S7-300 Programmable Controller

As part of a plant or system, and depending on its particular area of application, the S7-300 programmable controller requires that you observe a number of specific rules and guidelines.

Observe the safety and accident prevention regulations applying to particular applications or situations, for example the relevant machine protection guidelines.

This section outlines the most important rules you must observe when integrating your S7-300 in an existing plant or system.

Emergency Stop Systems

Emergency stop systems to IEC 204 (corresponds to VDE 113) must remain effective in all operating modes of the plant or system.

Starting Up a Plant Again Following Specific Events

The following table shows you what you have to observe when starting up a plant again following certain events.

If There Is...	What Must Not Happen ...
A restart following a voltage dip or power failure	No dangerous operating states may occur. If necessary, force an emergency stop.
A restart following resetting of the emergency stop system	An uncontrolled or undefined start-up must be avoided.

Mains Voltage

The following table shows you what to watch with respect to the mains voltage.

In the Case of ...	The Following Must Apply
Permanently installed plants or systems without all-pole mains disconnect switches	There must be a mains disconnect switch or a fuse in the building installation system
Load power supplies, power supply modules	The system voltage range set must correspond to the local system voltage
All circuits of the S7-300	Any fluctuations in, or deviations from, the rated mains voltage must be within the permissible tolerances (see the technical specifications of the S7-300 modules)

24 V DC Power Supply

The following table shows you what you must observe in connection with the 24 V DC power supply.

In the Case of ...	Measures to Take	
Buildings	External lightning protection	Install lightning protection (e.g. lightning conductors).
24 V DC power supply cables, signal cables	Internal lightning protection	
24 V DC Power Supply	Safe (electrical) extra-low voltage isolation	

Protection Against the Effects of External Electrical Interference

The following table will show you what you must do to protect your programmable controller against electrical interference or faults.

In the Case of ...	Make Sure That ...
All plants and systems in which the S7-300 is installed	A protective conductor is connected to the plant or system to divert electromagnetic interference.
Supply, signal and bus cables	The conductor routing and installation is correct. (see Section 4.1.7 and 4.1.8)
Signal and bus cables	A cable break or conductor break cannot result in undefined plant or system states.

Rules Relating to S7-300 Power Consumption and Power Loss

The S7-300 modules draw the power they need from the backplane bus and, if required, from an external load power supply.

- The power consumption of all the signal modules from the backplane bus must **not** exceed the current the CPU can deliver to the backplane bus.

- The PS 307 power supply is dependent on the power consumption from the 24 V load power supply; this is made up of the total power consumption of the signal modules and all other connected loads.

- The power loss of **all** the components in a cabinet must not exceed the maximum thermal rating of the cabinet.

  Tip: When establishing the required dimensions of the cabinet, ensure that the temperature inside the cabinet does not exceed the permissible 60 ˚C even where outside temperatures are high.

You will find the values for the power consumption and power loss of a module under the technical specifications of the relevant modules.

4.1.2   Configuring the S7-300 Process I/Os

This section contains information concerning the overall configuration of an S7-300 system with a grounded incoming supply (TN-S system). The following aspects are covered:

- Circuit-breaking devices, short-circuit and overload protection to VDE 0100 and VDE 0113

- Load power supplies and load circuits

Definition: Grounded Supply

In a grounded incoming supply system, the neutral is grounded. A single fault to ground or a grounded part of the plant causes the protective devices to trip.

Components and Protective Measures

A number of components and protective measures are prescribed for a plant. The type of components and the degree of compulsion pertaining to the protective measures will depend on the VDE specification applicable to your particular plant. The following table refers to Figure 4-1 on page 4-7.

Table 4-1   VDE Specifications for Configuring a PLC System

Compare ...	Refer to Figure 4-1	VDE 0100	VDE 0113
Disconnecting devices for control systems, sensors and actuators	①	... Part 460: Main switch	... Part 1: Disconnector
Short-circuit and over-load protection: In groups for sensors and actuators	②	... Part 725: Single-pole fusing of circuits	... Part 1: • In the case of a grounded secondary circuit: provide **single-pole** protection • Otherwise: provide **all-pole** protection
Load power supply for AC load circuits with more than five electro-magnetic devices	③	Galvanic isolation by transformer **recommended**	Galvanic isolation by transformer **mandatory**

Features of Load Power Supplies

The load power supply feeds input and output circuits (load circuits), as well as sensors and actuators. The characteristic features of load power supplies required in specific applications are listed in the following table.

Characteristics of the Load Power Supply	Mandatory for ...	Remarks
Protective separation	Modules that require a 60 V DC or 25 V AC power supply	The PS 307 power supplies and the Siemens load power supplies of the 6EP1 series have these characteristics
	24 V DC load circuits	
Output voltage tolerances: 20.4 V to 28.8 V	24 V DC load circuits	If the output voltage tolerances are exceeded, we recommend you fit a back-up capacitor Rating: 200 μF per 1A load current (in the case of full-wave rectification).
40.8 V to 57.6 V	48 V DC load circuits	
51 V to 72 V	60 V DC load circuits	

Rule: Ground Load Circuits

Load circuits should be grounded.

The common reference potential (ground) guarantees full functionality. Provide a detachable connection to the protective conductor on the load power supply (terminal L- or M) or on the isolating transformer (Figure 4-1, ④). In the event of power distribution faults, this makes it easier to localize ground faults.

S7-300 Grounding Concept

In the S7-300 grounding concept, a distinction is drawn between the CPU 312 IFM and the other CPUs.

- **CPU 312 IFM**: With the CPU 312 IFM, you can only implement a grounded configuration. The functional ground is connected to the chassis ground internally in CPU 312 IFM (see Section 8.4.1).

- **CPU 313/314/314 IFM/315/315-2 DP/316-2 DP/318-2:** If you use the S7-300 with one of these CPUs on a grounded supply, you should also ground the reference potential of the S7-300. The reference potential is grounded if the connection between the M terminal and the functional ground terminal on the CPUs is in place (factory setting of the CPU).

S7-300 in the Overall Configuration

Figure 4-1 shows the S7-300 in the overall configuration (load power supply and grounding concept) supplied from a TN-S system.

Note: The arrangement of the power supply connections shown does not reflect the actual physical arrangement; this has been done to improve clarity.
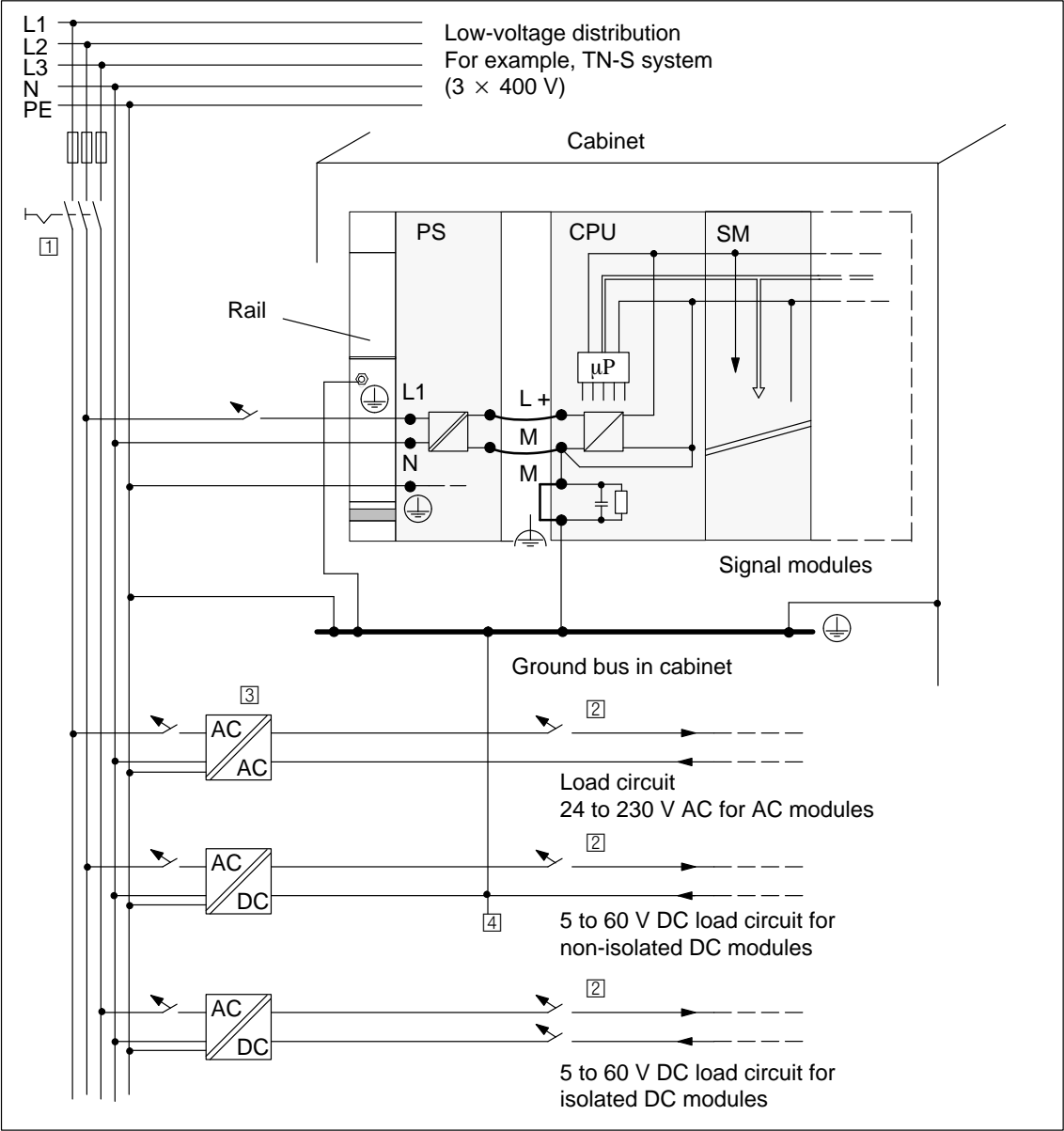
Figure 4-1   Signal Modules Operated on a Grounded Incoming Supply

S7-300 with Load Power Supply from the PS 307

Figure 4-2 shows the S7-300 in the overall configuration (load power supply and grounding concept) in a TN-S power system environment.

Apart from powering the CPU, the PS 307 also supplies the load current for the 24 V DC modules.

Note: The arrangement of the power supply connections shown does not reflect the actual physical arrangement; this has been done to improve clarity.
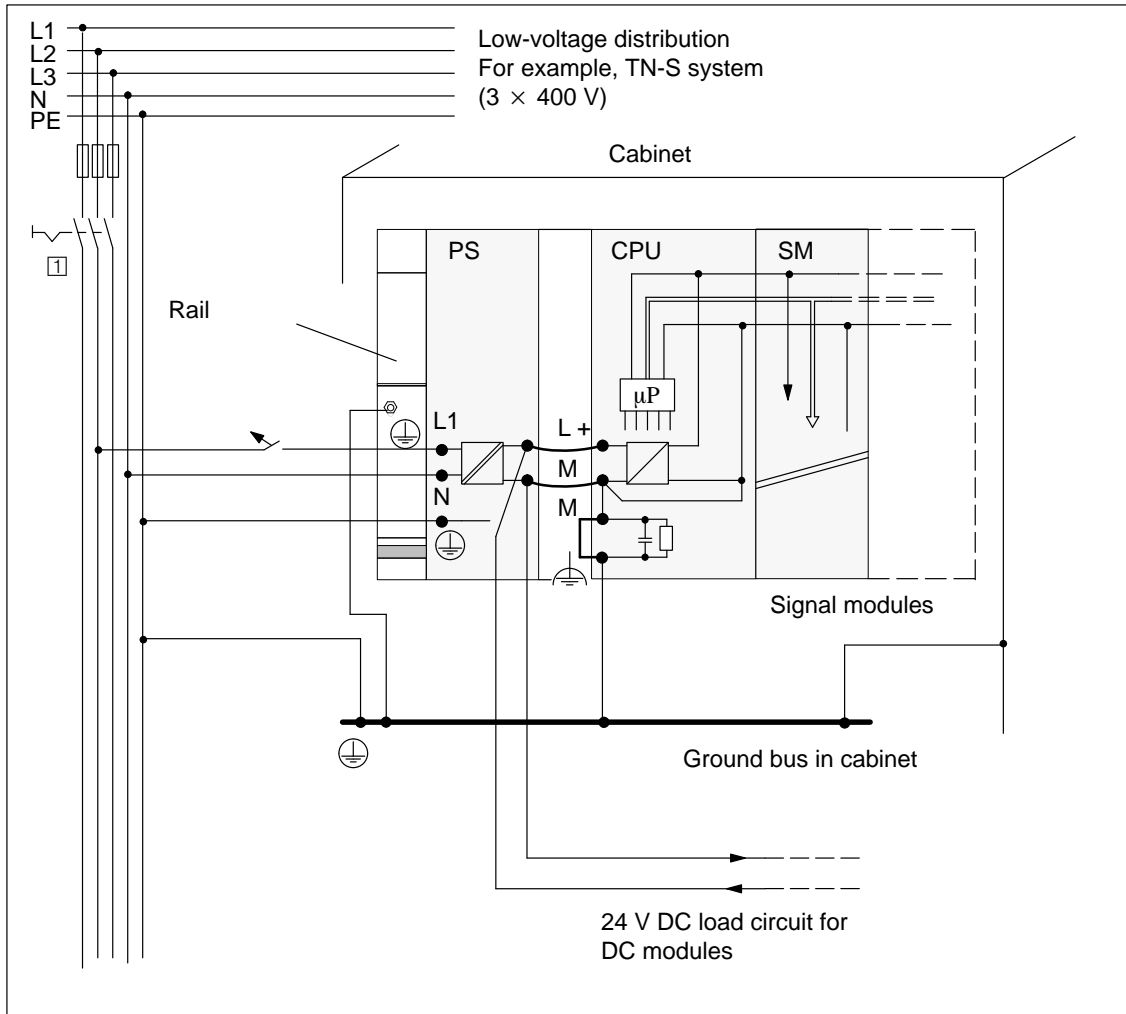
Figure 4-2   Signal Modules Powered from the PS 307

4.1.3   S7-300 Configuration with Grounded Reference Potential

If you install the S7-300 with grounded reference potential, interference currents that might occur are discharged to the protective conductor.

- In the case of CPUs 313/314/314 IFM/315/315-2 DP/316-2DP/318-2, via a jumper inserted between terminal M and functional ground (see Figure 4-3)

- In the case of the CPU 312 IFM, these terminals are connected internally (see Section 8.4.1).

Terminal Connection Model

Figure 4-3 shows the configuration of an S7-300 with CPU 313/314/314 IFM/315/ 315-2 DP/316-2 DP/318-2 with grounded reference potential. If you want to ground the reference potential, you **must not** remove the jumper on the CPU between the M terminal and functional ground**.**
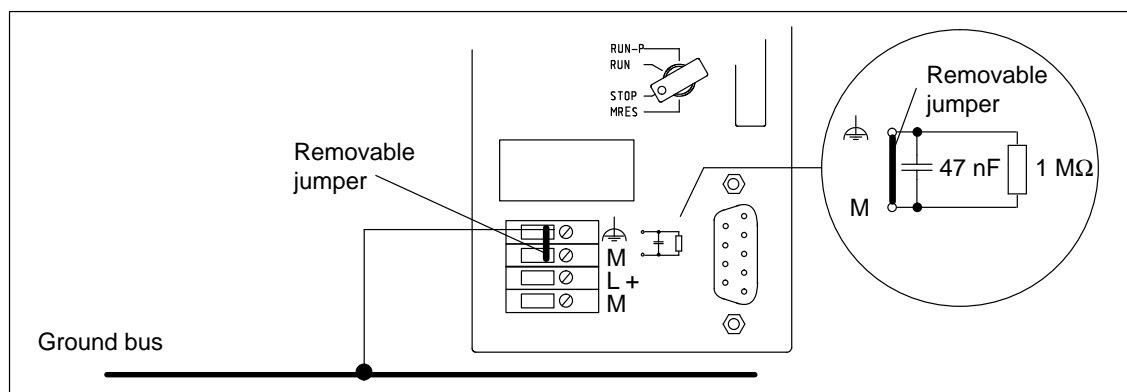
Figure 4-3   S7-300 Configuration with Grounded Reference Potential

4.1.4   S7-300 Configuration with Ungrounded Reference Potential (Not CPU 312 IFM)

If you install the S7-300 with ungrounded reference potential, any interference current is discharged to the protective conductor via an RC network integrated in CPUs 313/314/314 IFM/315/315-2 DP/ 316-2 DP/318-2 (see Figure 4-4).

Application

In plants covering large areas, it may be necessary to configure the S7-300 with ungrounded reference potential for ground fault monitoring purposes, for example. This is the case, for example, in the chemical industry and in power stations.

Terminal Connection Model

Figure 4-4 shows the configuration of an S7-300 (not with CPU 312 IFM) with ungrounded reference potential. If you do not want to ground the reference potential, you must remove the jumper **on the CPU between the M terminal and functional ground**. If the jumper is not in place, the S7-300's reference potential is connected internally to the protective conductor over an RC network and the rail. This discharges radio-frequency interference current and precludes static charges.
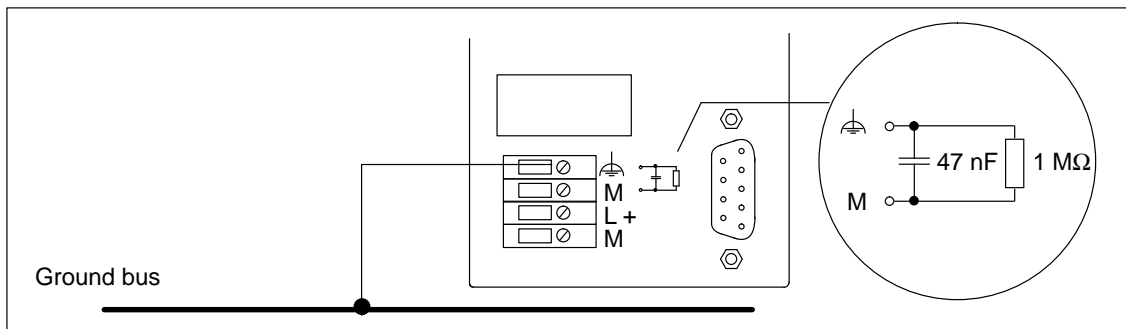
Figure 4-4   S7-300 Configuration with Ungrounded Reference Potential

Power Supply Units

In the case of power supply units, make sure that the secondary winding has no connection to the protective conductor. We recommend the use of the PS 307 power supply module.

Filtering the 24 V DC Supply

If you supply the CPU from a battery without grounding the reference potential, you must filter the 24 V DC supply. Use an interference suppression device from Siemens, for example, B84102-K40.

Insulation Monitoring

If dangerous plant conditions can arise as a result of double faults, you must provide some form of insulation monitoring.

4.1.5   S7-300 Configuration with Isolated Modules

Isolation Between...

In configurations with isolated modules, the reference potentials of the control circuit ($M_{internal}$) and load circuit ($M_{external}$) are electrically isolated (see Figure 4-5).

Application

You use isolated modules for the following:

- All AC load circuits

- DC load circuits with separate reference potential

  Examples of load circuits with separate reference potential:

  – DC load circuits whose sensors have different reference potentials (for example if grounded sensors are located at some considerable distance from the control system and no equipotential bonding is possible)

  – DC load circuits whose positive pole (L+) is grounded (battery circuits).

Isolated Modules and Grounding Concept

You can use isolated modules irrespective of whether the reference potential of the control system is grounded or not.

Potentials in a Configuration with Isolated Modules
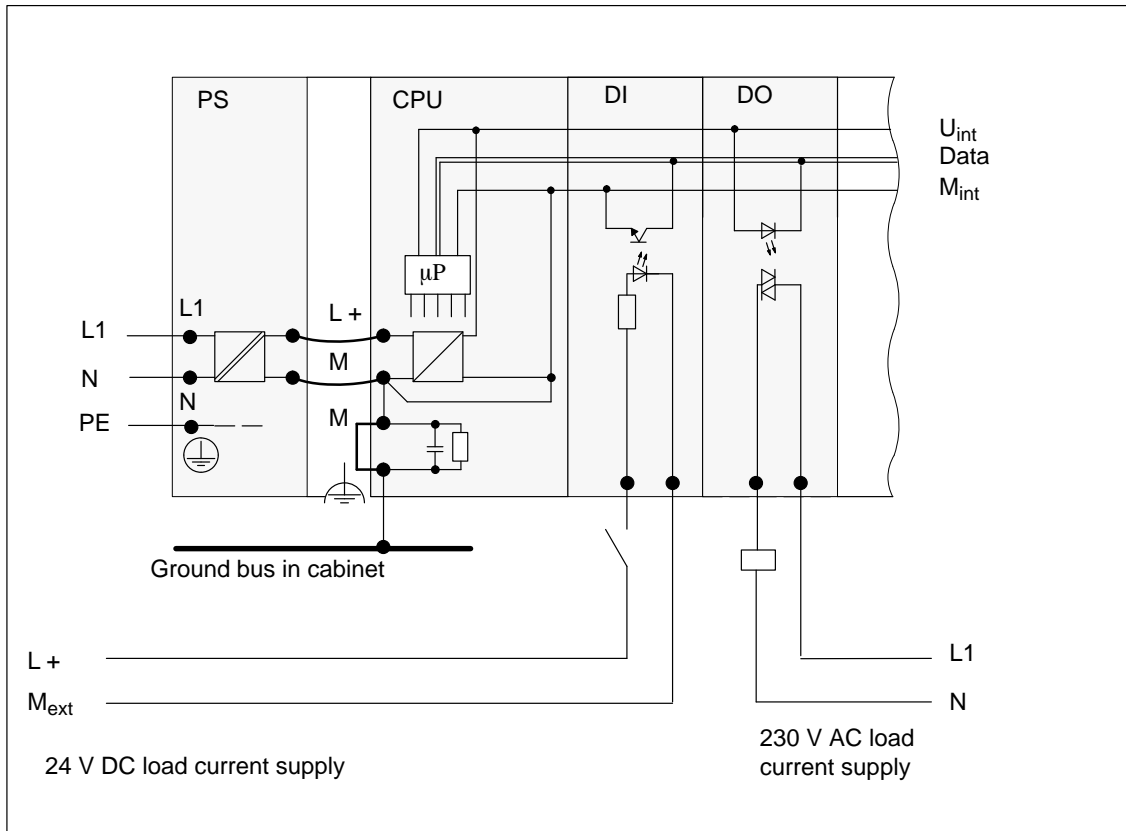
Figure 4-5   Potentials in a Configuration with Isolated Modules

4.1.6 Configuration of an S7-300 with Non-Isolated Modules

Potentials in a Configuration with Non-Isolated Modules

Figure 4-6 shows the potentials of an S7-300 configuration with grounded reference potential with the non-isolated analog input/output module SM 334; AI 4/AO 2 × 8/8Bit. For this analog input/output module, you must connect one of the M_{ANA} grounds with the chassis ground of the CPU.
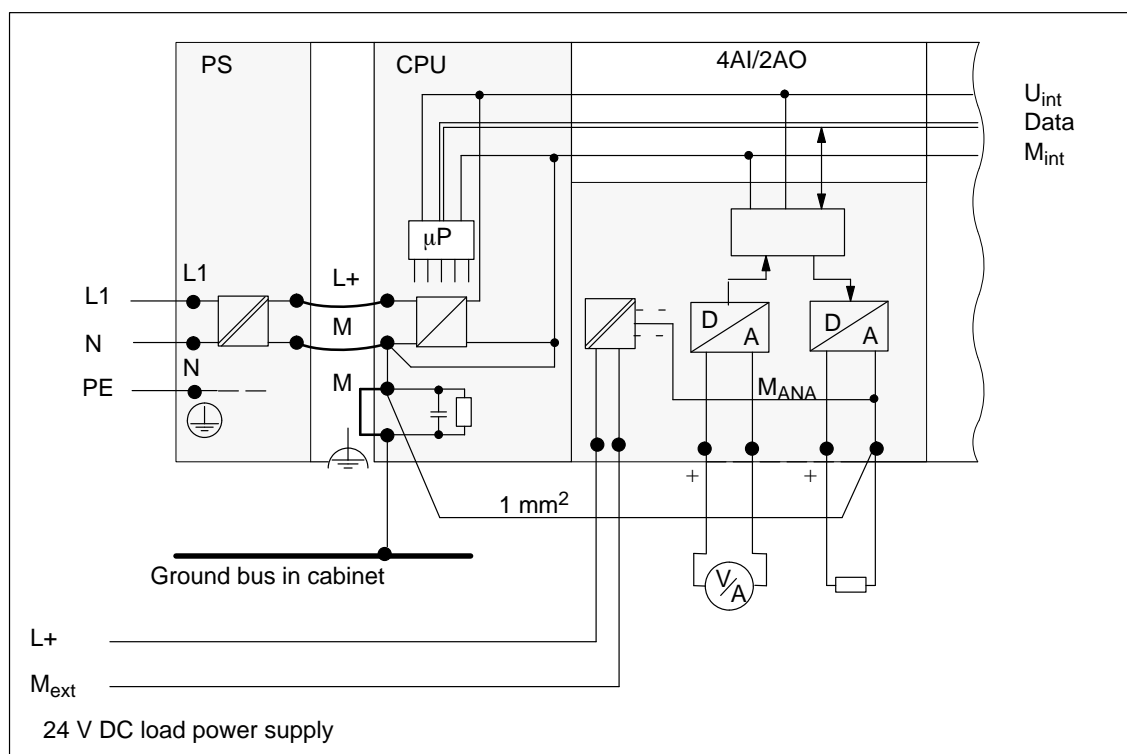
Figure 4-6   Potentials in a Configuration with the Non-Isolated SM 334 Analog Input/Output Module; AI 4/AO 2 × 8/8Bit

4.1.7 Cable/Wiring Routing Inside Buildings

Rules for EMC Cable/Wiring Routing

Inside buildings (inside and outside cabinets), clearances must be observed between groups of different cables to achieve the necessary electromagnetic compatibility (EMC). Table 4-2 provides you with information on the general rules governing clearances to enable you to choose the right cables.

How to Read the Table

To find out how to run two cables of different types, proceed as follows:

1. Look up the type of the first cable in column 1 (Cables for ...).

2. Look up the type of the second cable in the corresponding field in column 2 (and Cables for ...).

3. Read off the guidelines to be observed from column 3 (Run ...).

Table 4-2   Cabling Inside Buildings

Cables for ...	and Cables for ...	Run ...
Bus signals, shielded (SINEC L1, PROFIBUS) Data signals, shielded (programming devices, operator panels, printers, counter inputs, etc.) Analog signals, shielded Direct current ($\leq$ 60 V), unshielded Process signals ($\leq$ 25 V), shielded Alternating current ($\leq$ 25 V), unshielded Monitors (coaxial cable)	Bus signals, shielded (SINEC L1, PROFIBUS) Data signals, shielded (programming devices, operator panels, printers, counter inputs, etc.) Analog signals, shielded Direct current ($\leq$ 60 V), unshielded Process signals ($\leq$ 25 V), shielded Alternating current ($\leq$ 25 V), unshielded Monitors (coaxial cable)	In common bundles or cable ducts
	Direct current (> 60 V and $\leq$ 400 V), unshielded Alternating current (> 25 V and $\leq$ 400 V), unshielded	In separate bundles or cable ducts (no minimum clearance necessary)
	Direct and alternating current (> 400 V), unshielded	**Inside cabinets:** In separate bundles or cable ducts (no minimum clearance necessary) **Outside cabinets:** On separate cable racks with a clearance of at least 10 cm (3.93 in.)

Table 4-2   Cable/Wiring Routing Inside Buildings, continued

Cables for ...	and Cables for ...	Run ...

Direct current
   (> 60 V and ≤ 400 V),
   unshielded
 	
Alternating current
   (> 25 V and ≤ 400 V),
   unshielded
	Bus signals, shielded
	   (SINEC L1, PROFIBUS)
	
	Data signals, shielded
	   (programming devices, OPs,
	   printers, count signals, etc.)
	
	Analog signals, shielded
	
	Direct current
	   (≤ 60 V), unshielded
	
	Process signals
	   (≤ 25 V), shielded
	
	Alternating current
	   (≤ 25 V), unshielded
	
	Monitors (coaxial cable)
		In separate bundles or cable ducts (no minimum clearance necessary)

	Direct current
	   (> 60 V and ≤ 400 V),
	   unshielded
	
	Alternating current
	   (> 25 V and ≤ 400 V),
	   unshielded
		In common bundles or cable ducts

	Direct and alternating current
	   (> 400 V),
	   unshielded
		Inside cabinets:
		In separate bundles or cable ducts (no minimum clearance necessary)
		Outside cabinets:
		On separate cable racks with a clearance of at least 10 cm (3.93 in.)

Table 4-2   Cable/Wiring Routing Inside Buildings, continued

Cables for ...	and Cables for ...	Run ...
Direct and alternating current (400 V), unshielded	Bus signals, shielded (SINEC L1, PROFIBUS) Data signals, shielded (programming devices, OPs, printers, count signals, etc.) Analog signals, shielded Direct current (60 V), unshielded Process signals (25 V), shielded Alternating current ($\leq$ 25 V), unshielded Monitors (coaxial cable) Direct current (60 V and 400 V), unshielded Alternating current (25 V and 400 V), unshielded	**Inside cabinets:** In separate bundles or cable ducts (no minimum clearance necessary) **Outside cabinets:** On separate cable racks with a clearance of at least 10 cm (3.93 in.)
Direct and alternating current (400 V), unshielded	Direct and alternating current (400 V), unshielded	In common bundles or cable ducts
SINEC H1	SINEC H1	In common bundles or cable ducts
	Others	In separate bundles or cable ducts with a clearance of at least 50 cm (19.65 in.)

4.1.8   Cable/Wiring Routing Outside Buildings

Rules for EMC Cable/Wiring Routing

When installing cables outside buildings, the same EMC rules apply as for inside buildings. The following also applies:

- Run cables on metal cable supports.

- Establish an electrical connection between the joints in the cable supports.

- Ground the cable supports.

- If necessary, provide adequate equipotential bonding between the various items of equipment connected.

- Take the necessary (internal and external) lightning protection and grounding measures in as far as they are applicable to your particular application (see below).

Rules for Lightning Protection Outside Buildings

Run your cables either:

- in metal conduits grounded at both ends, or

- in concrete cable ducts with continuous end-to-end armoring.

Overvoltage Protection Equipment

An individual appraisal of the entire plant is necessary before any lightning protection measures are taken (see Section 4.2).

4.1.9   Protecting Digital Output Modules from Inductive Overvoltage

Integrated Overvoltage Protection

The digital output modules of the S7-300 have integral surge protectors. Surge voltages occur when inductive loads (for example, relay coils and contactors) are switched off.

Additional Overvoltage Protection

Inductive loads should only be fitted with supplementary surge protectors in the following cases:

- If SIMATIC output circuits can be switched off by means of additionally installed contacts (e.g. relay emergency stop contacts)
- If the inductive loads are not driven by SIMATIC modules

Note: Ask the supplier of the inductances how the various overvoltage protection devices should be rated.

Example:

Figure 4-7 shows an output circuit that makes supplementary overvoltage protection necessary.

Contact in the output circuit, for example, emergency stop switch

Inductance requires suppressor circuit (see Figures 4-8 and 4-9).
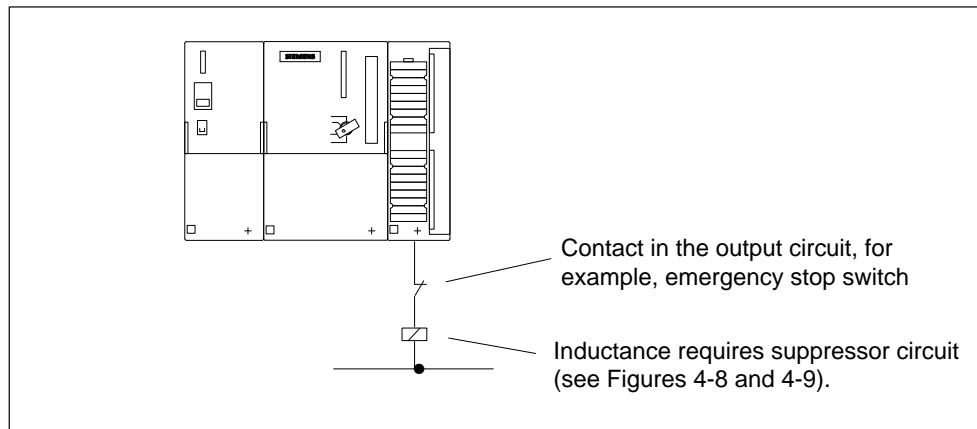
Figure 4-7   Relay Contact for Emergency Stop in the Output Circuit

Suppressor Circuit with DC-Operated Coils with Diodes and Zener Diodes

DC-operated coils are connected with diodes or Zener diodes.

Figure 4-8   Suppressor Circuit with DC-Operated Coils with Diodes and Zener Diodes

Suppressor Circuit with Diodes/Zener Diodes

Diode/Zener diode circuits have the following characteristics:

- The overvoltages induced on circuit interruption are completely suppressed/Zener diode has a higher cut-off voltage.

- They have a high time delay (six to nine times higher than without a diode circuit)/Zener diode interrupts switch faster than a diode circuit.

Suppressor Circuit with AC-Operated Coils

AC-operated coils are connected with varistors or RC elements.
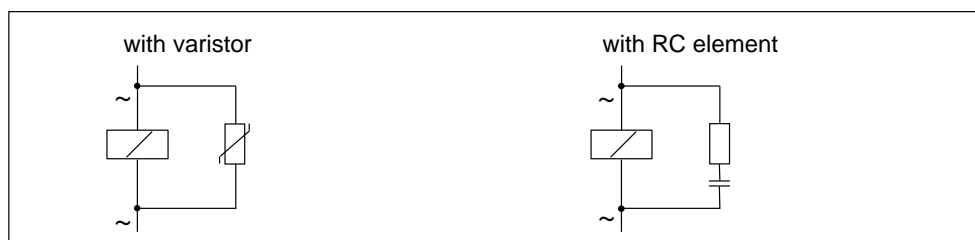
Figure 4-9   Suppressor Circuit with AC-Operated Coils

Suppressor Circuit with Varistors

Suppressor circuits with varistors have the following characteristics:

- The amplitude of the switching overvoltage is limited, but not damped

- The wavefront steepness remains the same

- Very short time delay

Suppressor Circuit with RC Elements

Suppressor circuits with RC elements have the following characteristics:

- The amplitude and wavefront steepness of the switching overvoltage are reduced

- Short time delay.

4.2   Lightning Protection

Reference Literature

The solutions given are based on the lightning protection zone concept described in the IEC 1312-1 "Protection against LEMP".

Overview

Failures are very often the result of overvoltages caused by:

*   Atmospheric discharge or

*   Electrostatic discharge.

We will begin by showing you what the theory of overvoltage protection is based on: the lightning protection zones concept.

At the end of this section, you will find rules for the transitions between the individual lightning protection zones.

Note

This section can only provide information on the protection of a **programmable controller** against overvoltages.

However, complete protection against overvoltage is guaranteed only if the whole surrounding building is designed to provide protection against overvoltages. This applies especially to constructional measures for the building at the planning stage.

If you wish to obtain detailed information on overvoltage protection, we therefore recommend you to address your Siemens contact or a company specialized in lightning protection.

4.2.1 Lightning Protection Zone Concept

The Principle of the Lightning Protection Zone Concept

The principle of the lightning protection zone concept states that the volume to be protected, for example, a manufacturing hall, is subdivided into lightning protection zones in accordance with EMC guidelines (see Figure 4-10).

The individual lightning protection zones are made up of:

The outer lightning protection of the building (field side)	Lightning protection zone 0
Shielding	
• Buildings	Lightning protection zone 1
• Rooms and/or	Lightning protection zone 2
• Devices	Lightning protection zone 3

Effects of the Lightning Strike

Direct lightning strikes occur in lightning protection zone 0. The lightning strike creates high-energy electromagnetic fields which can be reduced or removed from one lightning protection zone to the next by suitable lightning protection elements/measures.

Overvoltage

In lightning protection zones 1 and higher, surges can result from switching operations and interference.

Schematic of the Lightning Protection Zones

Figure 4-10 shows a schematic of the lightning protection zone concept for a free-standing building.
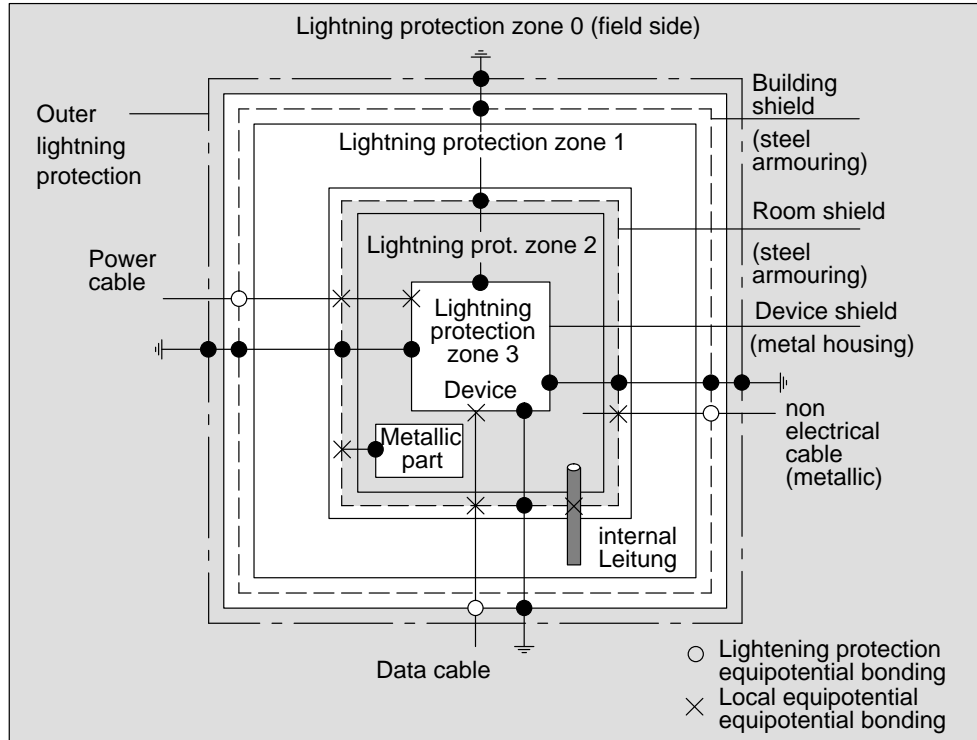
Figure 4-10   Lightning Protection Zones of a Building

Principle of the Transitions between Lightning Protection Zones

At the transitions between the lightning protection zones, you must take measures to prevent surges being conducted further.

The lightning protection zone concept also states that all cables at the transitions between the lightning protection zones that can carry lightning stroke current (!) must be included in the lightning protection equipotential bonding.

Lines that can carry lightning stroke current include:

- Metal pipelines (for example, water, gas and heat)
- Power cables (for example, line voltage, 24 V supply)

  and

- Data cables (for example, bus cable).

4.2.2 Rules for the Transition Between Lightning Protection Zones 0 ↔ 1

Rule for the Transition 0 ↔ 1 (Lightning Protection Equipotential Bonding)

The following measures are suitable for lightning protection equipotential bonding at the transition between lightning protection zones 0 ↔ 1:

- Use grounded, spiraled, current-conducting metal strips or metal braiding, for example, NYCY or A2Y(K)Y, as a cable shield at the start and end,

  and

- lay cable

  – in continuous metal pipes that are grounded at the start and end, or

  – in ducts of armored concrete with continuous armoring or

  – on closed metal cable racks grounded at the start and end,

  or

- use fiber optic cables instead of lightning stroke current-carrying cables.

Additional Measures

If you cannot take the measures listed above, you must install a high-voltage protector at the 0 ↔ 1 transition with a corresponding lightning conductor.
Table 4-3 contains the components you can use for high-voltage protection of your plant.

Table 4-3   High-Voltage Protection of Cables Using Surge Protection Components

Ser. No.	Cables for ...		... with the Following at Transition 0 ↔ 1	Order No.
1	• 3-phase TN-C system	3	DEHNport lightning conductors Phase L1/L2/L3 to PEN	5 SD 7 028*
	• 3-phase TN-S and TT system	4	DEHNport lightning conductors Phase L1/L2/L3/N to PE	5 SD 7 028*
	• AC TN-L, TN-S, TT system	2	DEHNport lightning conductors Phase L1 + N to PE	5 SD 7 028*
2	24 V DC Power Supply	1	KT lightning conductor Type A D 24 V	DSN: 919 253

Table 4-3   High-Voltage Protection of Cables Using Surge Protection Components, continued

Ser. No.	Cables for ...	... with the Following at Transition 0 ↔ 1		Order No.
3	Bus cable • MPI, RS 485	• up to 500 kbps 1	KT lightning conductor Type ARE 8 V -	DSN: 919 232
		• over 500 kbps 1	KT lightning conductor Type AHFD 5 V -	DSN: 919 270
	• RS 232 (V.24)	• per core pair 1	KT lightning conductor Type ARE 15 V -	DSN: 919 231
4	Inputs/outputs of digital modules and power supply			
	• 24 V DC	1	KT lightning conductor Type AD 24 V -	DSN: 919 253
	• 120/230 V AC	2	DEHNguard 150 surge arresters	900 603*
5	Inputs/outputs of analog modules			
	• Up to 12 V +/–	1	KT lightning conductor Type ALE 15 V -	DSN: 919 220
	• Up to 24 V +/–	1	KT lightning conductor Type ALE 48 V -	DSN: 919 227
	• Up to 48 V +/–	1	KT lightning conductor Type ALE 60 V -	DSN: 919 222

*   You can order these components direct from   DEHN + SÖHNE
GmbH + Co. KG
Elektrotechnische Fabrik
Hans-Dehn-Str. 1
D-92318 Neumarkt
Federal Republic of Germany

4.2.3   Rules for the Transitions Between 1 ↔ 2 and Greater Lightning Protection Zones

Rules for 1 ↔ 2 and Greater Transitions (Local Equipotential Bonding)

The following applies to all 1 ↔ 2 and greater lightning protection zone transitions:

- Set up local equipotential bonding at each subsequent lightning protection zone transition.

- Include all cables (also metal conduits, for example) in the local equipotential bonding at all subsequent lightning protection zone transitions.

- Include all metal installations located within the lightning protection zone in the local equipotential bonding (for example, metal part within lightning protection zone 2 at transition 1 ↔ 2).

Additional Measures

We recommend low-voltage protection:

- For all 1 ↔ 2 and greater lightning protection zone transitions

  and

- For all cables that run within a lightning protection zone and are longer than 100 m

Lightning Protection Element for the 24 V DC Power Supply

You must use only the KT lightning conductor, Type AD 24 V SIMATIC for the 24 V DC power supply of the S7-300. All other surge protection components do not meet the required tolerance range of 20.4 V to 28.8 V of the S7-300's power supply.

Lightning Conductor for Signal Modules

You can use standard surge protection components for the digital input/output modules. However, please note that these only permit a maximum of $1.15 \times V_{Nom}$ = 27.6 V for a rated voltage of 24 V DC. If the tolerance of your 24 V DC power supply is higher, use the surge protection components for 48 V DC nominal voltage.

You can also use the KT lightning conductor, Type AD 24 V SIMATIC. However, this can result in the following restrictions:

- Digital inputs: An increased input current can flow in the case of negative input voltages.

- Digital outputs: The release time of contactors can increase significantly.

Low-Voltage Protection Elements for 1 ↔ 2

We recommend the surge protection components listed in Table 4-4 for the interfaces between lightning protection zones 1 ↔ 2. You must use these low-voltage protection elements for the S7-300 in order to meet the conditions for the CE mark.

Table 4-4   Low-Voltage Protection for Lightning Protection Zone 1 ↔ 2

Ser. No.	Cables for ...		... with the Following at Transition 1 ↔ 2		Order No.
1	• 3-phase TN-C system		3	DEHNguard 275 surge arresters	900 600* 5 SD 7 030
	• 3-phase TN-S and TT system		4	DEHNguard 275 surge arresters	900 600* 5 SD 7 030
	• AC TN-L, TN-S, TT system		2	DEHNguard 275 surge arresters	900 600* 5 SD 7 030
2	24 V DC Power Supply		1	KT lightning conductor Type A D 24 V	DSN: 919 253
3	Bus cable				
	• MPI, RS 485		• up to 500 kbps		
			1	KT lightning conductor Type ARE 8 V -	DSN: 919 232
			• over 500 kbps		
			1	KT lightning conductor Type AHFD 5 V -	DSN: 919 270
	• RS 232 (V.24)		• per core pair		
			1	KT lightning conductor Type ARE 15 V -	DSN: 919 231
4	Inputs/outputs of digital modules				
	• 24 V DC		1	KT lightning conductor Type AD 24 V -	DSN: 919 253
	• 120/230 V AC		2	DEHNguard 150 surge arresters	900 603*
5	Inputs of analog modules				
	• Up to 12 V +/–		1	KT ALD 12 V terminal block on insulated rail	DSN: 919 216

*   You can order these components direct from   DEHN + SÖHNE
GmbH + Co. KG
Elektrotechnische Fabrik
Hans-Dehn-Str. 1
D-92318 Neumarkt
Federal Republic of Germany

Low-Voltage Protection Elements for 2 ↔ 3

We recommend the surge protection components listed in Table 4-5 for the transitions between lightning protection zones 2 ↔ 3. You must use these low-voltage protection elements for the S7-300 in order to meet the conditions for the CE mark.

Table 4-5   Low-Voltage Protection for Lightning Protection Zone 2 ↔ 3

Ser. No.	Cables for ...	... with the Following at Transition 2 ↔ 3		Order No.
1	• 3-phase TN-C system	3	DEHNguard 275 surge arresters	900 600* 5 SD 7 030
	• 3-phase TN-S and TT system	4	DEHNguard 275 surge arresters	900 600* 5 SD 7 030
	• AC TN-L, TN-S, TT system	2	DEHNguard 275 surge arresters	900 600* 5 SD 7 030
2	24 V DC Power Supply	1	KT lightning conductor Type A D 24 V	DSN: 919 253
3	Bus cable • MPI, RS 485	•	up to 500 kbps	
		1	KT lightning conductor Type ARE 8 V -	DSN: 919 232
		•	over 500 kbps	
		1	KT lightning conductor Type AHFD 5 V -	DSN: 919 270
	• RS 232 (V.24)	•	per core pair	
		1	KT lightning conductor Type ARE 15 V -	DSN: 919 231
4	Inputs of digital modules • 24 V DC	1	Terminal block FDK 60 V on insulated rail	DSN: 919 997
	• 120/230 V AC	2	DEHNguard 150 surge arresters	900 603*
5	Outputs of analog modules • Up to 12 V +/–	1	Terminal block Type FDK 12 V on an insulated rail, which is connected to M – of the module supply	DSN: 919 999
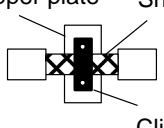
*   You can order these components direct from   DEHN + SÖHNE
GmbH + Co. KG
Elektrotechnische Fabrik
Hans-Dehn-Str. 1
D-92318 Neumarkt
Federal Republic of Germany

4.2.4 Sample Circuit for Overvoltage Protection of Networked S7-300s

Components in Figure 4-11

Table 4-6 explains the consecutive numbers in Figure 4-11:

Table 4-6   Example of a Configuration Fulfilling Lightning Protection Requirements (Legend for Figure 4-11)

Ser. No. from Figure 4-11	Components	Description
1	DEHNport lightning conductors, 2 - 4 depending on mains system Order no.: 900 100*	High-voltage protection against direct lightning strikes and surges as of transition 0 ↔ 1
2	2 DEHNguard 275 surge arresters, Order no.: 900 600*	High-voltage surge protection at transition 1 ↔ 2

3	• In the spur line
	  1 intermediate adapter Type FS 9E-PB Order no.: DSN 924 017
	• In the spur line
	  1 standard rail 35 mm with connecting cable Type ÜSD-9-PB/S-KB Order no.: DSN 924 064
		Low-voltage surge protection for RS 485 interfaces at transition 1 ↔ 2

4	Digital modules: KT lightning conductor, type AD 24 V SIMATIC Analog modules: KT lightning conductor, type ARE 12 V–	Low-voltage surge protection at inputs and outputs of the signal modules at transition 1 ↔ 2
5	Shielding the bus cable: Copper plate Shielding Clip	–
6	Equipotential bonding cable 16 mm^2	–
7	KT lightning conductor, type AHFD, for building entry point Order No.: DSN 919 270	Low-voltage surge protection for RS 485 interfaces at transition 0 ↔ 1

Interconnection Example

Figure 4-11 gives an example of how to wire connect networked S7-300s in order to achieve effective protection against surges:
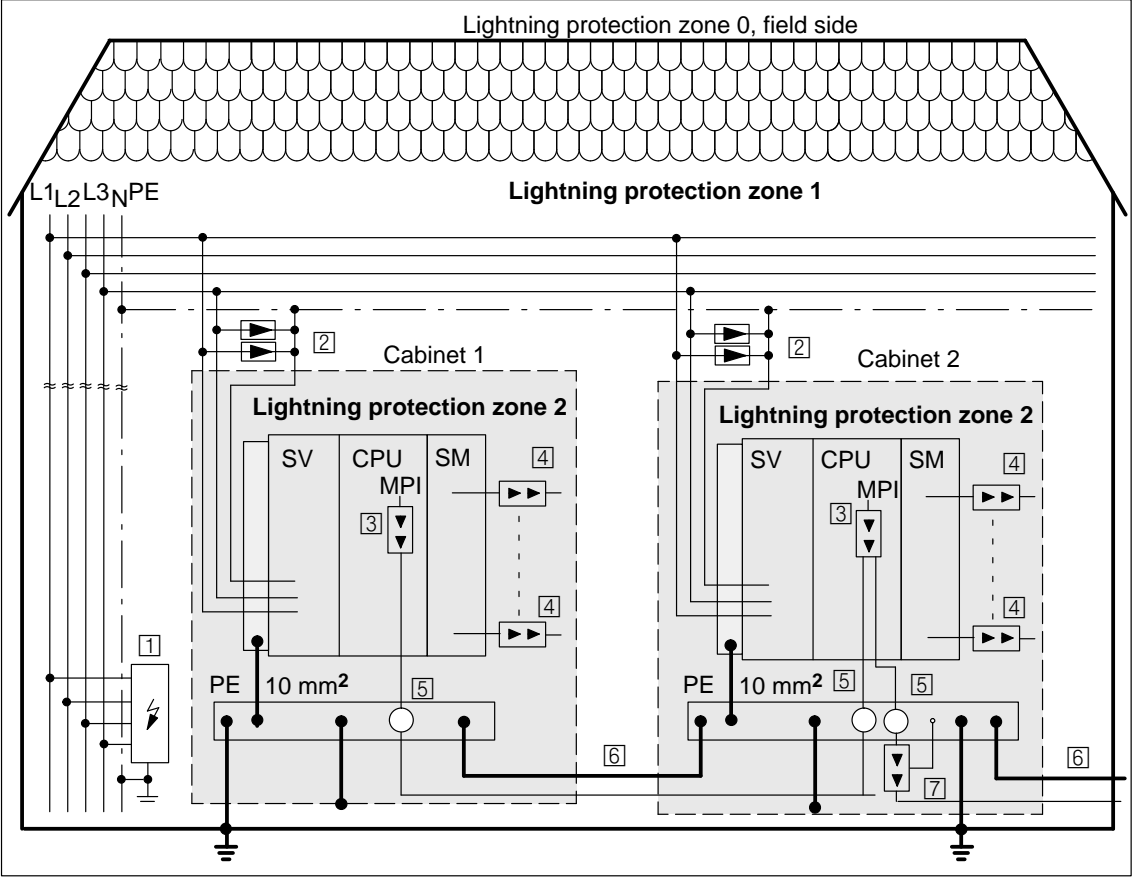
Figure 4-11   Example of the Interconnection of Networked S7-300s

4.3 Wiring

Prerequisite

You have already installed the S7-300 as described in Chapter 2.

4.3.1 Wiring Rules

Table 4-7   Wiring Rules for the Power Supply and CPU

Wiring Rules for...		Power Supply and CPU
Connectable cable cross-sections for rigid cables		No
Connectable cable cross-sections for flexible cables	Without wire end ferrule	0.25 to 2.5 mm^2
	With wire end ferrule	0.25 to 1.5 mm^2
Number of cables per terminal connection		1 or combination of 2 conductors up to 1.5 mm^2 (total) in a common wire end ferrule
Maximum outside diameter of the insulation		$\varnothing$ 3.8 mm
Length of stripped lines	Without insulating collar	11 mm
	With insulating collar	11 mm
Wire end ferrules to DIN 46228	Without insulating collar	Version A, 10 to 12 mm long
	With insulating collar	Version E, up to 12 mm long

Table 4-8   Wiring Rules for Module Front Connectors

Wiring Rules for...		Module Front Connectors (Spring Terminal and Screw-Type Terminal)	
		20-pin	40-pin
Connectable cable cross-sections for rigid cables		No	No
Connectable cable cross-sections for flexible cables	Without wire end ferrule	0.25 to 1.5 mm^2	0.25 to 0.75 mm^2
	With wire end ferrule	0.25 to 1.5 mm^2	0.25 to 0.75 mm^2 Potential infeed: 1.5 mm^2
Number of cables per terminal connection		1 or combination of 2 conductors up to 1.5 mm^2 (total) in a common wire end ferrule	1 or combination of 2 conductors up to 0.75 mm^2 (total) in a common wire end ferrule
Maximum outside diameter of the insulation		$\varnothing$ 3.1 mm Max. qty. 20	$\varnothing$ 2.0 mm Max. qty. 40
			$\varnothing$ 3.1 mm Max. qty. 20
Length of stripped lines	Without insulating collar	6 mm	6 mm
	With insulating collar	6 mm	6 mm
Wire end ferrules to DIN 46228	Without insulating collar	Version A, 5 to 7 mm long	Version A, 5 to 7 mm long
	With insulating collar	Version E, up to 6 mm long	Version E, up to 6 mm long

4.3.2 Wiring the Power Supply Module and CPU

Power Cables

Use flexible cables with a cross-section of between 0.25 and 2.5 mm^2 to wire the power supply.

If you use only one cable per connection, you don't need an end ferrule.

Power Connector (not for CPU 312 IFM)

Use the power connector when wiring the PS 307 power supply module to the CPU. The power connector comes with the power supply module.

Wiring the CPU 312 IFM

The PS 307 power supply module and the CPU 312 IFM are wired via the front connector of the integrated inputs/outputs of the CPU 312 IFM (see Section 8.4.1). You therefore cannot use the power connector for the CPU 312 IFM.

Other 24 V Connections

Above the power connector on the PS 307 power supply there are still a number of free 24 V connections for powering the I/O modules.

Wiring with the Power Connector

To wire the PS 307 power supply module and CPU, proceed as follows (see Figure 4-12).

⚠ **Warning**

Accidental contact with live conductors is possible, if the power supply module and any additional load power supplies are switched on.

Make sure the S7-300 is absolutely dead before doing any wiring!

1. Open the front doors of the PS 307 power supply and CPU.

2. Undo the strain-relief assembly on the PS 307.

3. Strip the insulation from the power cable (230 V/120 V), and connect it to the PS 307.

4. Screw the strain-relief assembly tight.

5. **CPU 312 IFM:** Strip the insulation off the power cable of the CPU 312 IFM, and connect it to the PS 307 an.

   CPU 313/314/314 IFM/315/315-2 DP/316-2 DP/318-2: Insert the power connector, and screw it in tightly.

6. Close the front doors.
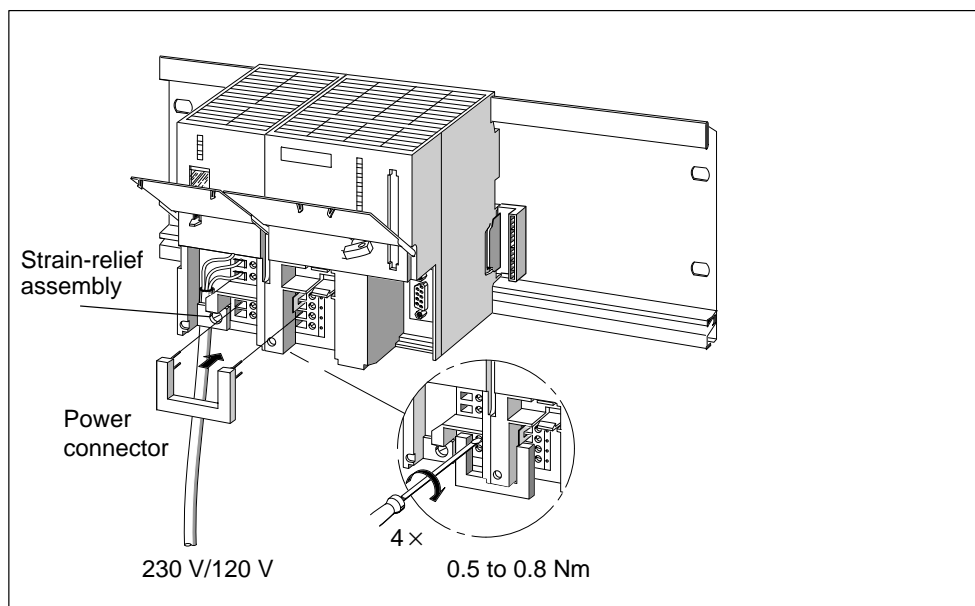
Figure 4-12   Wiring the Power Supply Module and CPU to the Power Connector

Setting the Power Supply to the Required Mains Voltage

Check to see that the voltage selector switch on the power supply module is set to your local mains voltage. This switch is always factory-set to 230 V on the PS 307. To select another mains voltage, do the following:

1. Pry the cover off with a screwdriver.

2. Set the selector to your mains voltage.

3. Replace the cover.
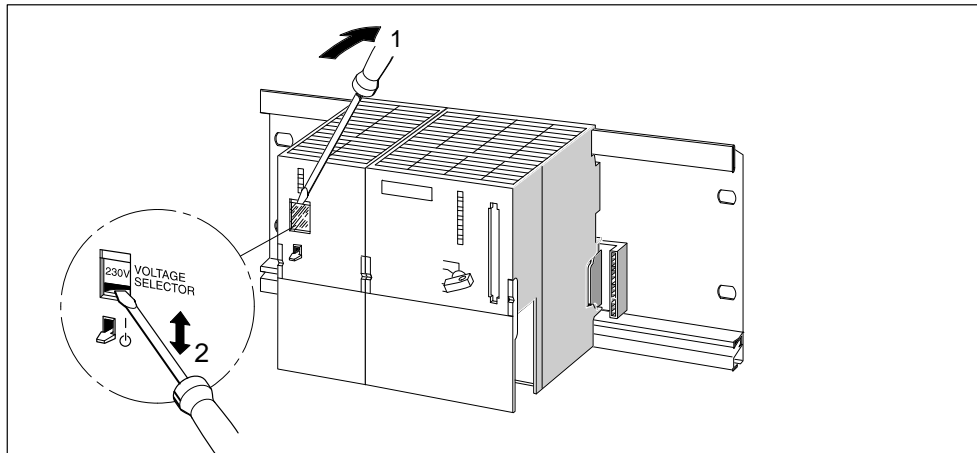
Figure 4-13   Setting the Mains Voltage for the PS 307

4.3.3   Wiring the Front Connectors of the Signal Modules

Cables

You can use flexible cables with cross-sections as in Table 4-8 on page 4-31.

You do not need wire end ferrules. If you use wire end ferrules, only use those listed in Table 4-8 on page 4-31.

Integrated Inputs/Outputs

You wire the integrated inputs/outputs of the CPU 312 IFM and 314 IFM also via the front connector as described in this section.

If you use the possible digital inputs of the CPUs for the special functions, you wire these inputs with shielded cables via a shield contact element (see Section 4.3.4). This also applies when wiring the analog inputs/outputs of the CPU 314 IFM.

Types of Front Connector

You can order the 20 and 40-pin front connectors with spring or screw-type terminals. You will find the order numbers in Appendix F.

Spring Terminals

To wire the front connector using spring terminals, simply insert the screwdriver vertically into the opening with the red opening mechanism, put the cable into the correct terminal, and remove the screwdriver.

Tip: There is a separate opening for test probes up to 2 mm in diameter to the left of the opening for the screwdriver.

Wiring the Front Connector

Wire the screw-type front connector as follows:

1. Prepare the connector for wiring.

2. Wire the connector.

3. Prepare the module for operation.

These three steps are described on the following pages.

Preparing the Connector for Wiring.

⚠️ **Warning**

Accidental contact with live conductors is possible, if the power supply module and any additional load power supplies are switched on.

Make sure the S7-300 is absolutely dead before doing any wiring!

---

1. Open the front door.

2. Place the front connector in the wiring position.

   To do this, push the front connector into the signal module until it snaps into place. The front connector still protrudes from the module in this position.

   An advantage of the wiring position is that it makes wiring easier; in the wiring position a wired front connector has no contact with the module.
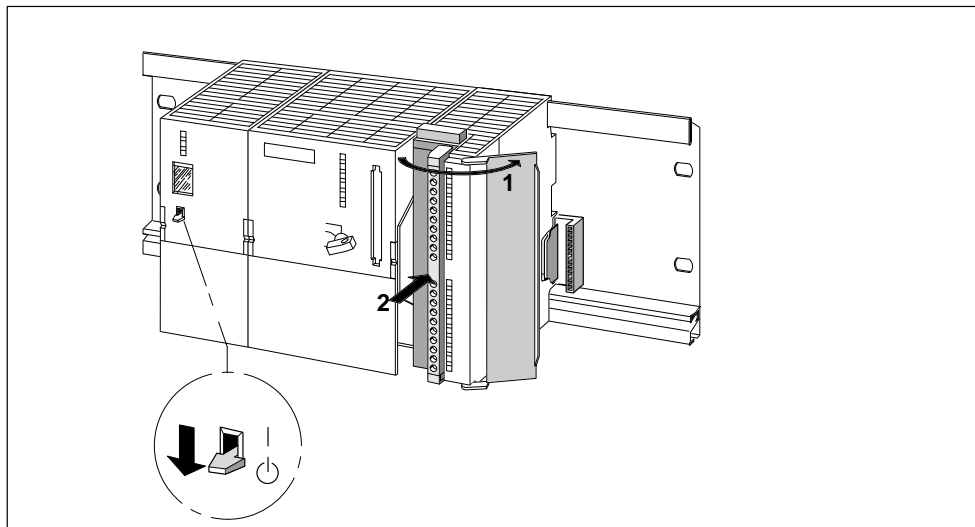
Figure 4-14   Bringing the Front Connector into the Wiring Position

3. Strip the insulation off the cables (see Table 4-8 on page 4-31)

4. Do you want to use end ferrules?

   If so: Press the end ferrules and the cables together
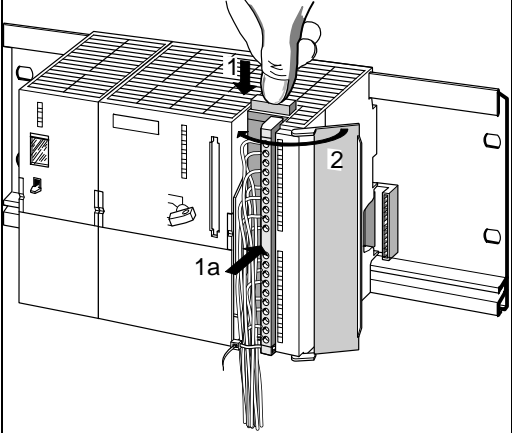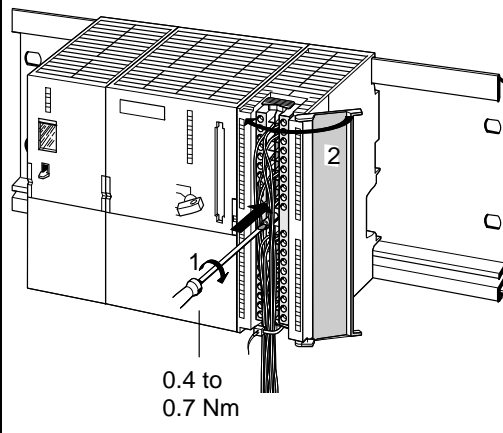
Wiring the Front Connector

Table 4-9   Wiring the Front Connector

Step	20-Pin Front Connector	40-Pin Front Connector
1.	Thread the cable strain-relief assembly into the front connector.	–
2.	Do you want to bring the cables out at the bottom of the module?	
	If so:	
	Start with terminal 20, and wire the terminals in the following order: terminal 20, 19, ... 1.	Starting at terminal 40 or 20, connect up the terminals in alternating order, that is terminals 39, 19, 38, 18 etc., down to terminals 21 and 1.
	If not:	
	Start with terminal 1, and wire the terminals in the following order: terminal 1, 2, ... 20.	Starting at terminal 1 or 21, connect up the terminals in alternating order, that is terminals 2, 22, 3, 23 etc., up to terminals 20 and 40.
3.	**With screw-type terminals:** Also tighten the screws of any terminals that are not wired.	
4.	–	Attach the cable strain-relief assembly around the cable and the front connector.
5.	Pull the cable strain-relief assembly tight. Push the retainer on the strain-relief assembly in to the left; this will improve utilization of the available space.	
–		

Preparing the Signal Module for Operation

Table 4-10   Preparing the Signal Module for Operation

Step	20-Pin Front Connector	40-Pin Front Connector
1.	Press down the unlocking button on the top of the module and, at the same time, push the front connector into its operating position on the module. When the front connector reaches its operating position, the unlocking button will snap back into the locking position.	Tighten screws to bring front connector to its operating position.
	Note: When the front connector is put in its operating position, a front connector encoding device engages in the front connector. The front connector then only fits this type of module (see Section 7.4).	
2.	Close the front door.	
3.	Enter the addresses for identifying the individual channels on the labeling strip. Tip: templates for labelling strips can be obtained from the internet at http://www.ad.siemens.de/simatic_cs under article ID 406745.	
4.	Slide the labeling strip into the guides on the front door.	
–		

4.3.4 Connecting Shielded Cables via a Shield Contact Element

Application

Using the shield contact element you can easily connect all the shielded cables of S7 modules to ground by directly connecting the shield contact element to the rail.

Also for the CPU 312 IFM and 314 IFM

You can also use the shield contact element for wiring the integral inputs/outputs of the CPU 312 IFM and 314 IFM, when using inputs for the special functions or when wiring the analog inputs/outputs for the CPU 314 IFM.

Design of the Shield Contact Element

The shield contact element consists of the following parts:

*   A fixing bracket with two bolts for attaching the element to the rail (Order No.: 6ES5 390-5AA00-0AA0) and
*   The shield terminals

Depending on the cable cross-sections used, you must use the following shield terminal:

Table 4-11   Assignment of Cable Cross-Sections and Terminal Elements

Cable with Shield Diameter	Shield Terminal Order No.:
2 cables with a shield diameter of 2 to 6 mm (0.08 to 0.23 in.) each	6ES7 390-5AB00-0AA0
1 cable with a shield diameter of 3 to 8 mm (0.12 to 0.31 in.)	6ES7 390-5BA00-0AA0
1 cable with a shield diameter of 4 to 13 mm (0.16 to 0.51 in.)	6ES7 390-5CA00-0AA0

The shield contact element is 80 mm (3.15 in.) wide with space for two rows each with 4 shield terminals.

Installing the Shield Contact Element

Install the shield contact element as follows:

1. Push the two bolts of the fixing bracket into the guide on the underside of the rail. Position the fixing bracket under the modules to be wired.

2. Bolt the fixing bracket tight to the rail.

3. A slotted web is arranged at the bottom side of the terminal element. Place the shield terminal at this position onto edge a of the fixing bracket (see Figure 4-15). Press the shield terminals down and swing them into the desired position.

   You can attach up to four terminal elements on each of the two rows of the shield contact element.
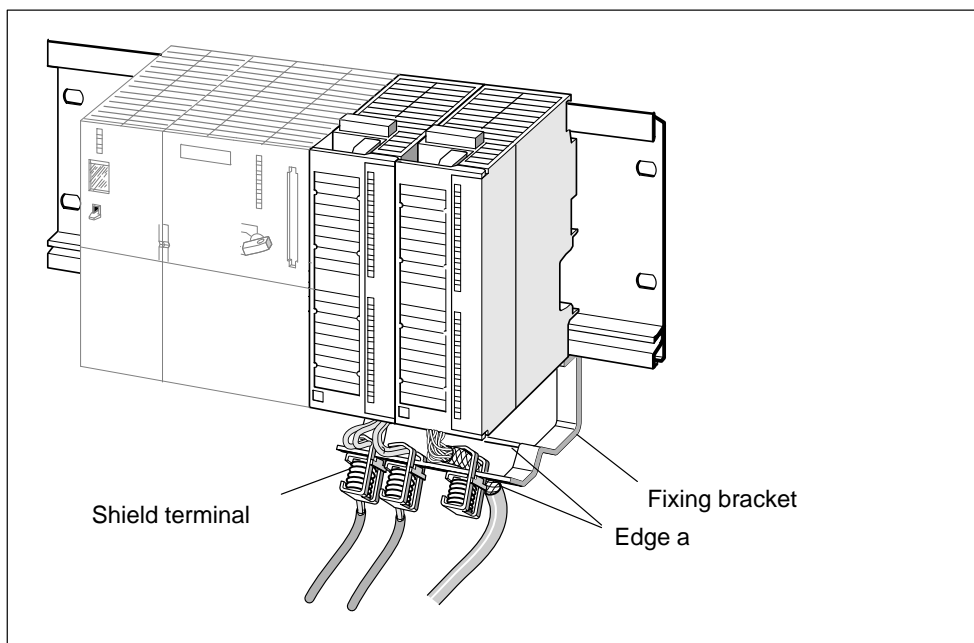
Figure 4-15   Configuration of Two Signal Modules With Shield Contact Element

Attaching Cables

You can only attach one or two shielded cables per shield terminal (see Figure 4-16 and Table 4-11). The cable is connected by its bare cable shield. There must be at least 20 mm (0.78 in.) of bare cable shield. If you need more than 4 shield terminals, start wiring at the rear row of the shield contact element.

Tip Use a sufficiently long cable between the shield terminal and the front connector. You can thus remove the front connector without the need to also remove the shield terminal.
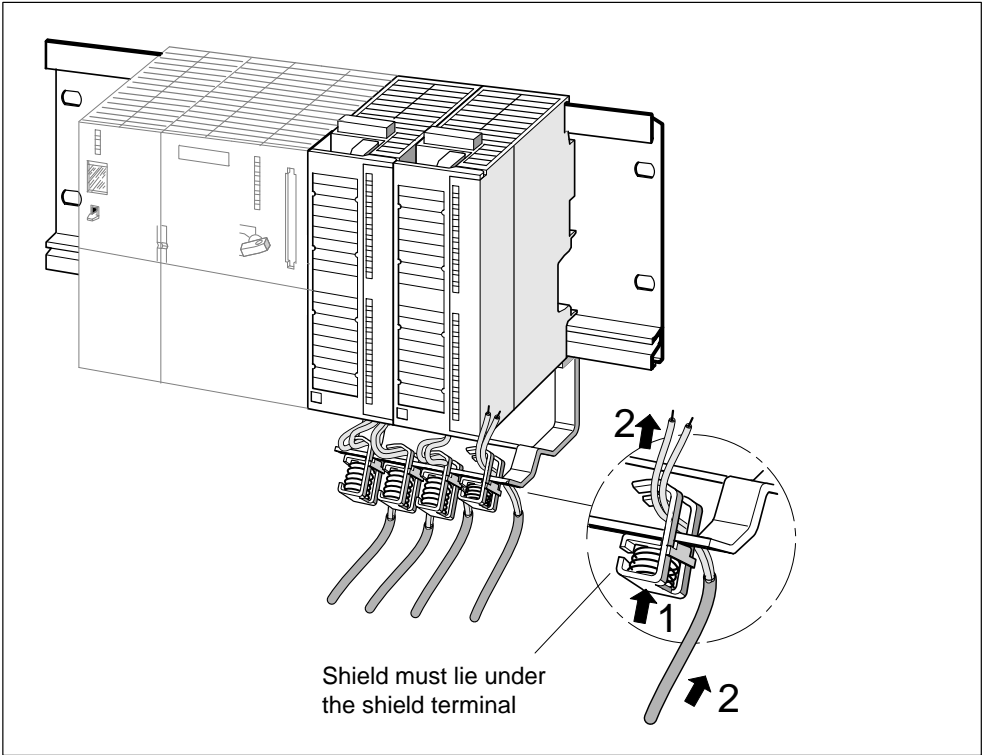
Figure 4-16   Attaching Shielded 2-Wire Cables to a Shield Contact Element

Networking 5

Similar Structure

The structure of an MPI subnet is basically the same as a PROFIBUS subnet. That means the same rules and the same components are used to set up the subnet. The only exception arises if you set a transmission rate > 1.5 Mbps in a PROFIBUS subnet. In this case, you will need other components. Special reference is made to these components where relevant in this documentation.

Since the structure of an MPI subnet does not differ from that of a PROFIBUS subnet, general reference is made in the following sections to configuring a subnet.

In This Section

Section	Contents	Page
5.1	Configuring a Subnet	5-2
5.2	Network Components	5-16

5.1 Configuring a Subnet

In This Section

Section	Contents	Page
5.1.1	Prerequisites	5-2
5.1.2	Rules for Configuring a Subnet	5-5
5.1.3	Cable length	5-13

Device = Node

Declaration: In the following, all devices that you connect in an MPI subnet are called nodes.

5.1.1 Prerequisites

MPI/PROFIBUS Addresses

To ensure that all nodes can communicate with one another, you must allocate them an address **before** networking:

- An "MPI address" and a "highest MPI address" in the MPI subnet

- A "PROFIBUS address" and a "highest PROFIBUS address" in a PROFIBUS subnet.

Set these MPI/PROFIBUS addresses individually for each node using the programming device (also on the slave switch in the case of some PROFIBUS-DP slaves).

Note

The RS 485 repeater is not allocated an "MPI address" or a "PROFIBUS address".

Table 5-1   Permissible MPI/PROFIBUS Addresses

MPI Addresses	PROFIBUS Addresses
0 to 126	0 to 125
Of these, the following are reserved: 0 for the PG 1 for the OP 2 for the CPU	Of these, the following are reserved: 0 for the PG

Rules for the MPI/PROFIBUS Addresses

Observe the following rules before assigning MPI/PROFIBUS addresses:
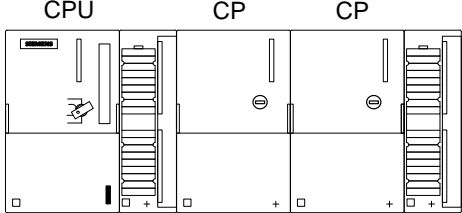
- All MPI/PROFIBUS addresses in a subnet must be different.

- The highest MPI/PROFIBUS address must be the highest actual MPI/PROFIBUS address and must be identical for each node. (Exception: If the programming device is connected to several nodes; see Section 6.3.2).

Differences in the Case of MPI Addresses of CPs/FMs in an S7-300

Please note the following peculiarities and differences when using CPs/FMs with a separate MPI address dependent on the CPU being used.

CPU 312 IFM to 316-2 DP:

Table 5-2   MPI Addresses of CPs/FMs in an S7-300 (with the CPU 312 IFM to 316-2 DP)

Options	Example:		
Example: S7-300 with a CPU and 2 CPs in a configuration. The following 2 possibilities exist for the assignment of MPI addresses of the CP/FM in one configuration:			
Option 1 The CPU accepts the MPI addresses of the CPs you set in *STEP 7*. As of *STEP 7 V 4.02* (see Section 11.2)	MPI addr.	MPI addr. "x"	MPI addr. "z"
Option 2 The CPU automatically establishes the MPI addresses of the CPs in their configuration in accordance with the MPI addr. pattern. CPU MPI addr.+1 MPI addr.+2	MPI addr.	MPI addr.+1	MPI addr.+2

CPU 318-2

An S7-300 with the CPU 318-2 only occupies **one** MPI address in the MPI subnet.
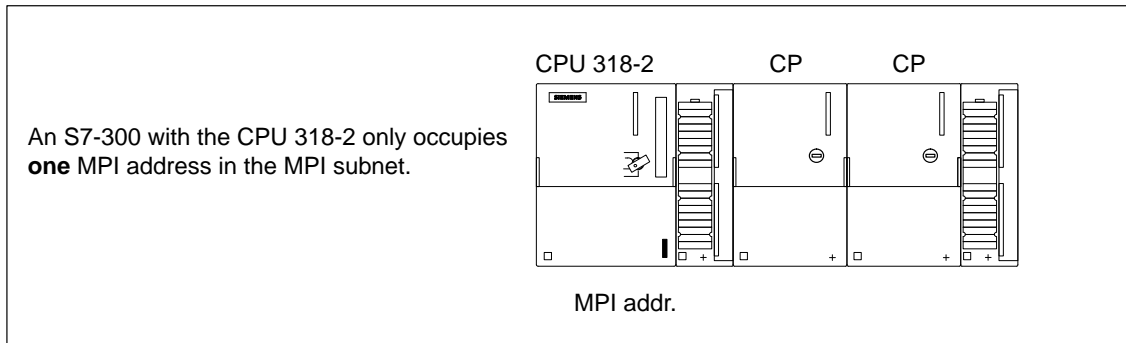
MPI addr.

Recommendation for MPI Addresses

Reserve the MPI address "0" for a service programming device and "1" for a service OP that will be connected temporarily to the MPI if required. This means, that you must assign different addresses to programming devices/OPs that are integrated in the MPI subnet.

Recommendation for the MPI address of the CPU in the event of replacement or servicing:

Reserve the MPI address "2" for a CPU. You thus prevent double MPI addresses occurring after connection of a CPU with default settings to the MPI subnet (for example, when replacing a CPU). This means that you must assign an MPI address greater than "2" to the CPUs in the MPI subnet.

Recommendation for PROFIBUS Addresses

Reserve the PROFIBUS address "0" for a service programming device that may subsequently be temporarily connected to the PROFIBUS subnet if required. Allocate other PROFIBUS addresses to the programming devices integrated in the PROFIBUS subnet.

5.1.2   Rules for Configuring a Subnet

In This Section

This chapter describes how to configure a subnet and provides examples.

Segment

A segment is a bus cable between two terminating resistors. A segment can contain up to 32 nodes. A segment is further limited by the permissible cable length, which depends on the transmission rate (see Section 5.1.3).

Rules on Connecting the Nodes of a Subnet

- **Before** you interconnect the individual nodes of the subnet you must assign the MPI address and the highest MPI address or the "PROFIBUS address" and the "highest PROFIBUS address" to each node (except for RS 485 repeater).

  Tip: Mark all the nodes in a subnet by putting their address on their housings. In this way, you can always see which node has been assigned which address in your system. For this purpose, each CPU comes with an enclosed sheet of address labels.

- Connect all nodes in the subnet "in a row"; that is, integrate the stationary programming devices and OPs direct in the subnet.

  Connect only those programming devices/OPs that are required for commissioning or maintenance via spur lines to the subnet.

Note

As of 3 Mbps, use only bus connectors with the order no. 6ES7 972-0B.**1**0-0XA0 or 6ES7 972-0B.**4**0-0XA0 to connect the nodes.

As of 3 Mbps, use only the programming device connecting cable with the order no. 6ES7 901-4BD00-0XA0 to connect the programming device.

Rules (Continued)

- If you operate more than 32 nodes on a network, you must connect the bus segments via RS 485 repeaters.

  All bus segments in a PROFIBUS subnet must have at least one DP master and one DP slave between them.

- You connect non-grounded bus segments and grounded bus segments via RS 485 repeaters (see the description of the RS 485 repeater in the *Module Specifications* Reference Manual).

- Each RS 485 repeater that you use reduces the maximum number of nodes on each bus segment. That means if a RS 485 repeater is installed in one of the bus segments, only a further 31 nodes can be installed in that segment. The number of RS 485 repeaters has **no** impact on the maximum number of nodes on the bus, however.

  Up to 10 segments can be installed in a row.

- Switch the terminating resistor on at the first and last node of a segment.

- **Before** you integrate a new node in the subnet, you must switch off its supply voltage.

Components

You connect the individual nodes by means of bus connectors and the PROFIBUS bus cable. Make sure that the bus connector is provided with a programming device socket so that a programming device can be connected if required.

Use RS 485 repeaters to connect segments or extend the cable.

Terminal Resistor

A cable must be terminated with its surge impedance. To do this, switch on the terminating resistor on the first and last node of a subnet or a segment.

The nodes with a terminating resistor switched on must have their power supply switched on during power up and operation.

The Terminating Resistor on the Bus Connector

Figure 5-1 shows you how to switch on the terminating resistor on the bus connector.
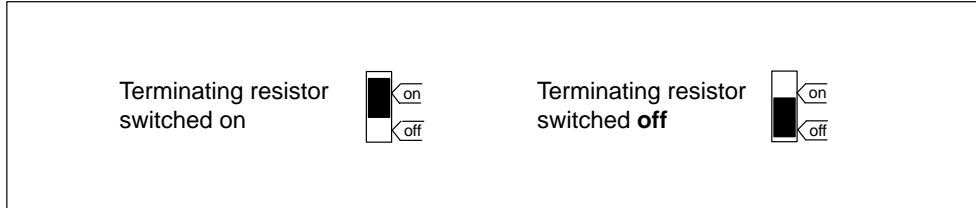
Figure 5-1   Terminating Resistor on the Bus Connector Switched On and Off

The Terminating Resistor on the RS 485 Repeater

Figure 5-2 shows you where to switch on the terminating resistor on the RS 485 repeater.
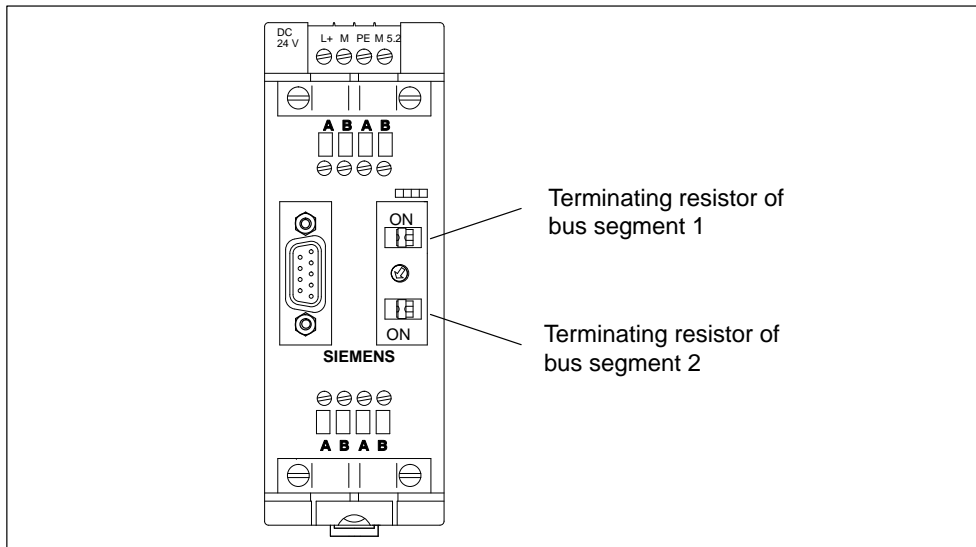
Figure 5-2   Terminating Resistor on the RS 485 Repeater

Example: Terminating Resistor in the MPI Subnet

Figure 5-3 shows where you must connect the terminating resistor in an example MPI subnet configuration.

* Connected via spur line for commissioning/maintenance only

① Terminating resistor switched on
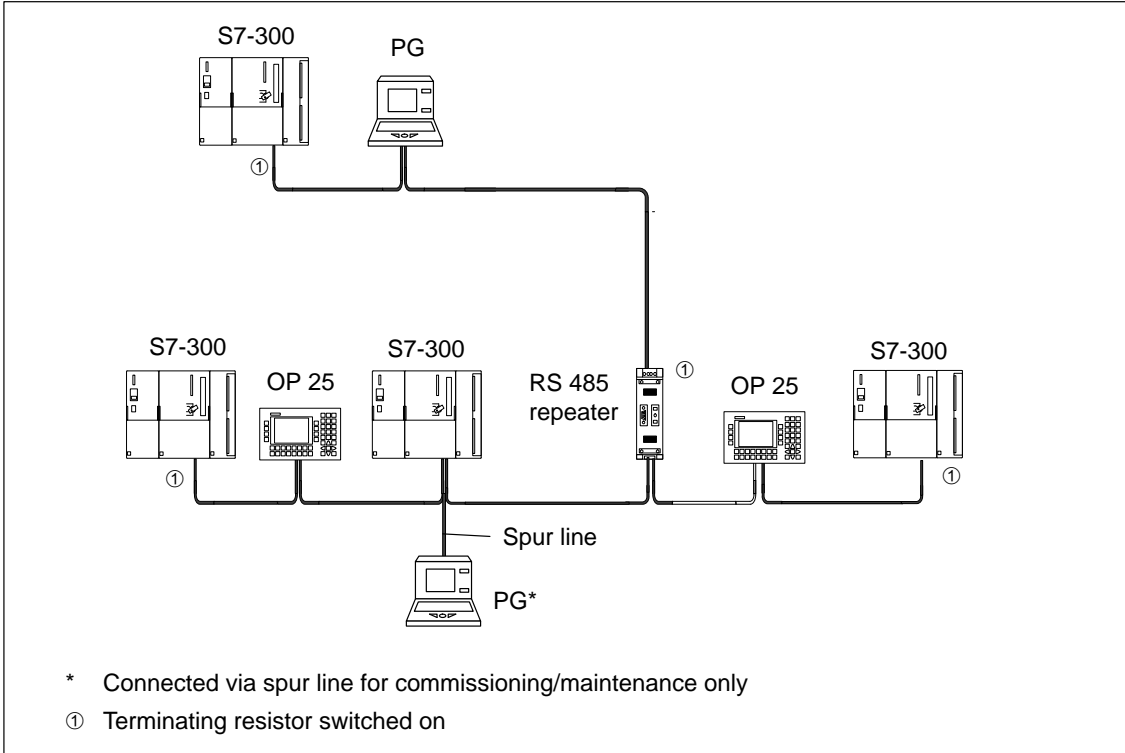
Figure 5-3   Connecting Terminating Resistors in an MPI Subnet

Example of an MPI Subnet

Figure 5-4 shows an MPI subnet that is configured in accordance with the above rules.

| * | Connected via spur line for commissioning/maintenance only (with default MPI address) |

* Connected via spur line for commissioning/maintenance only
(with default MPI address)

** Connected to the MPI subnet later (with default MPI address)

*** The CP also has a PROFIBUS address in addition to the MPI address (address 7 here)

****In the case of the CPU 318-2-DP, the FMs/CPs do not have their own MPI addresses
In the case of the CPU 312 IFM to 316-2 DP, you can allocate the MPI addresses as you wish

0 ... x MPI addresses of the nodes
① Terminating resistor switched on

Figure 5-4   Example of an MPI Subnet

Example of a PROFIBUS Subnet

Figure 5-5 shows a PROFIBUS subnet that is configured in accordance with the above rules.
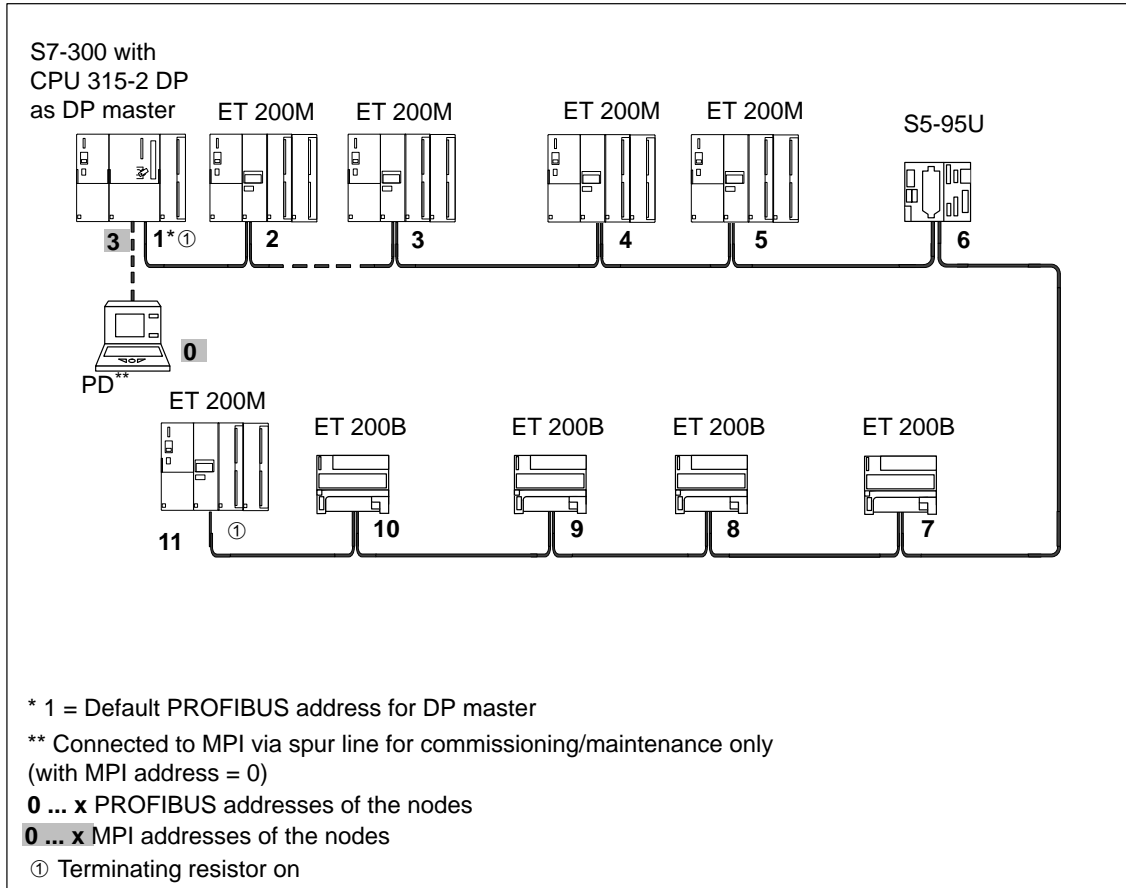
Figure 5-5   Example of a PROFIBUS Subnet

Example showing CPU 315-2 DP as MPI and PROFIBUS node

Figure 5-6 shows an MPI subnet with an integrated CPU 315-2 DP that is also operating as a DP master in a PROFIBUS subnet.
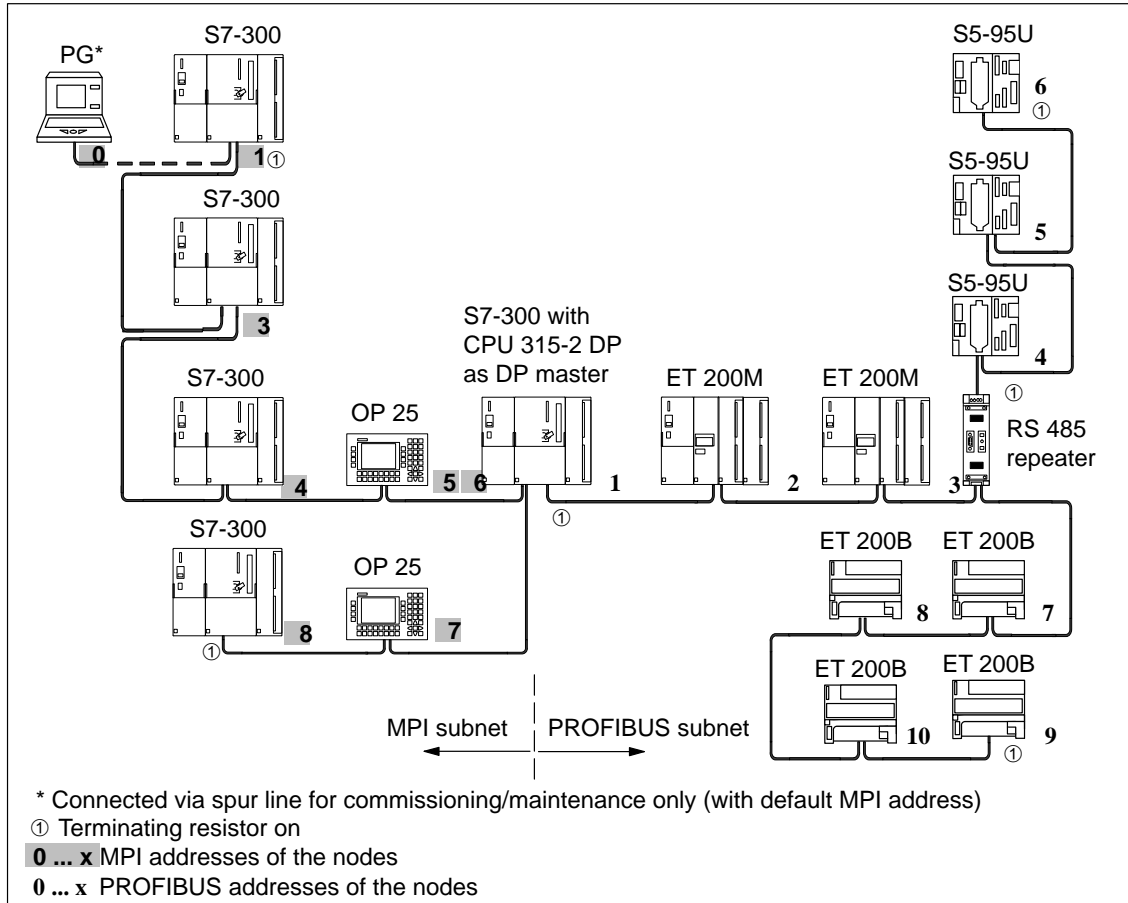
Figure 5-6   Example of a Configuration with the CPU 315-2 DP in an MPI and PROFIBUS Subnet

Example of PD access across network boundaries (routing)

With a programming device you can access all modules across network boundaries.
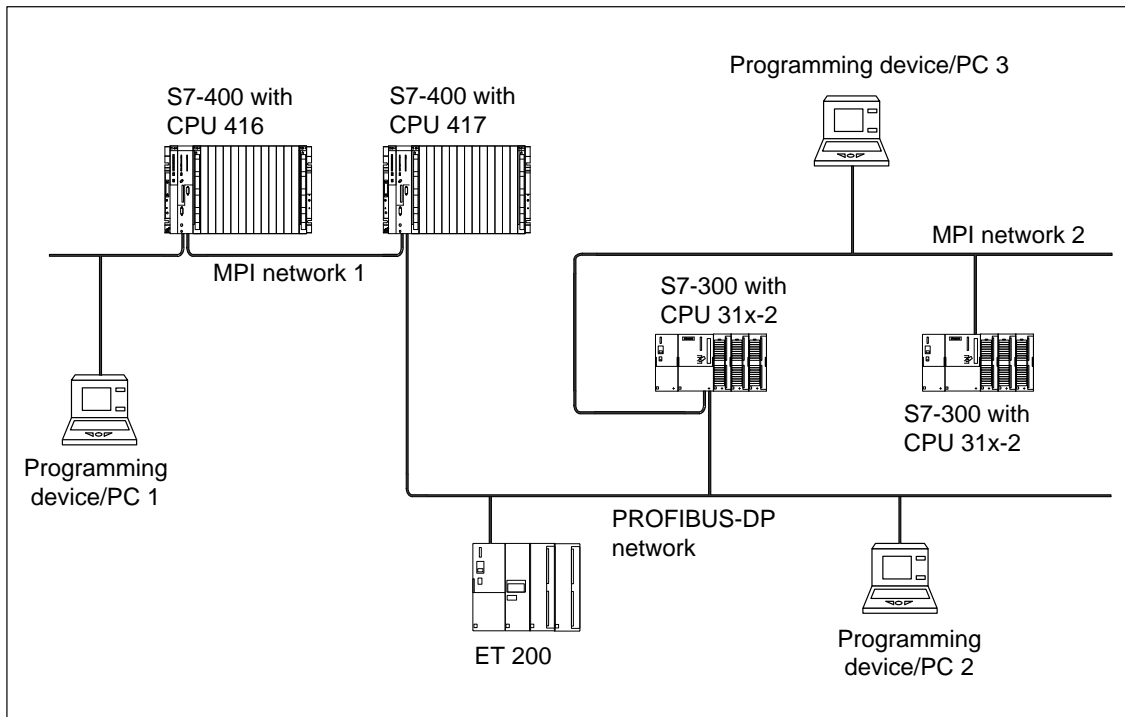
Figure 5-7   Example of PD Access Across Network Boundaries (Routing)

Prerequisites

- You must be using STEP 7 Version 5.0 or later.
- You must assign the PD/PC to a network in your STEP 7 project (assign SIMATIC Manager to PD/PC).
- The network boundaries must be bridged by modules with routing capability.

5.1.3   Cable Lengths

Segment in the MPI Subnet

You can implement cable lengths of up to 50 m (164 ft.) in an MPI subnet segment. The 50 m is measured from the 1st node to the last node of a segment.

Table 5-3   Permissible Cable Lengths in an MPI Subnet Segment

Transmission rate	Maximum Cable Length of a Segment (in mm)	
	CPU 312 IFM to 316-2 DP (Non-Isolated MPI Interface)	**318-2 (Non-Isolated MPI Interface)**
19.2 kbps	50	1000
187.5 kbps		
1.5 Mbps	–	200
3.0 Mbps	–	100
6.0 Mbps		
12.0 Mbps		

Segment in the PROFIBUS Subnet

The cable length in a segment of a PROFIBUS subnet depends on the transmission rate (see Table 5-4).

Table 5-4   Permissible Cable Lengths in a PROFIBUS Subnet Depending on the Transmission Rate

Transmission rate	Maximum Cable Length of a Segment (in mm)
9.6 to 187.5 kbps	1000
500 kbps	400
1.5 Mbps	200
3 to 12 Mbps	100

 * With a non-isolated interface

Longer Cable Lengths

If you want to implement cable lengths above those permitted in a segment, you must use RS 485 repeaters. The maximum cable length possible between two RS 485 repeaters corresponds to the cable length of a segment (see Table 5-4). Please note that these maximum cable lengths only apply if **no** other node is installed between the two RS 485 repeaters. You can connect up to 9 RS 485 repeaters in series.

When counting the total number of all nodes to be connected, you must observe, that an RS 485 repeater counts as a node of the MPI subnet, even if it is not assigned an MPI/PROFIBUS address.

Figure 5-8 shows how you can increase the maximum cable length for an MPI subnet by means of RS 485 repeaters.
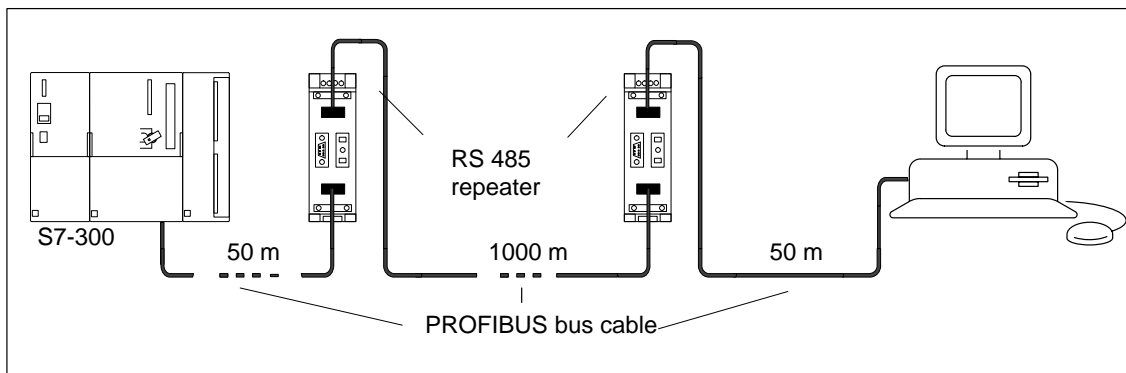
Figure 5-8   Maximum Cable Length Between Two RS 485 Repeaters

Length of the Spur Lines

If you do not attach the bus cable directly to the bus connector (for example when using a L2 bus terminal), you must take into account the maximum possible length of the spur line!

The following table lists the maximum permissible lengths of spur lines per segment:

As of 3 Mbps, use the programming device connecting cable with the order no. 6ES7 901-4BD00-0XA0 to connect the programming device or PC. Other types of spur lines must not be used.

Table 5-5   Lengths of Spur Lines per Segment

Transmission rate	Max. Length of Spur Line per Segment	Number of Nodes with Spur Line Length of ...	
		1.5 m or 1.6 m	3 m
9.6 to 93.75 kbps	96 m	32	32
187.5 kbps	75 m	32	25
500 kbps	30 m	20	10
1.5 Mbps	10 m	6	3
3 to 12 Mbps	–	–	–

Example:

Figure 5-9 shows you a possible configuration of an MPI subnet. This example illustrates the maximum possible distances in an MPI subnet.
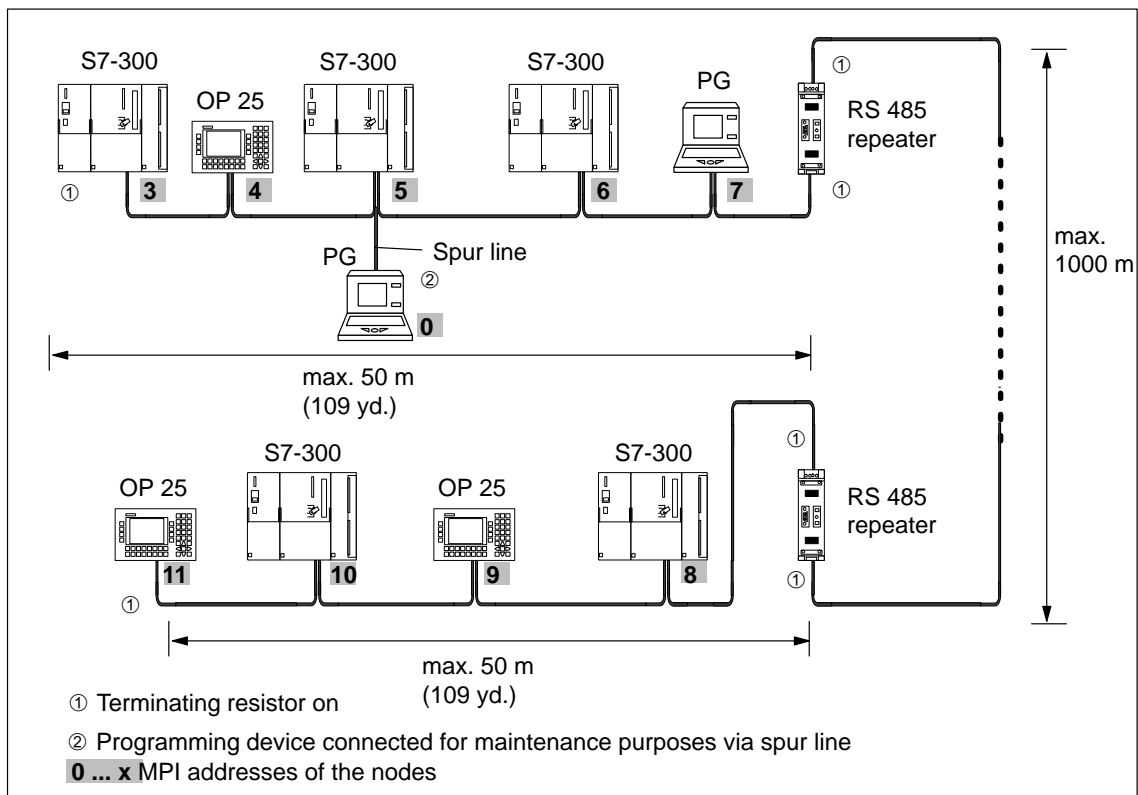
Figure 5-9   Cable Lengths in an MPI Subnet

5.2   Network Components

Purpose

Table 5-6   Network Components

Purpose	Components	Description
... to configure a network	PROFIBUS bus cable	Section 5.2.1
... to connect a node to the network	Bus connector	Section 5.2.2
... to amplify the signal ... to connect segments	RS 485 Repeater	Section 5.2.4 and Reference Manual *Module Specifications*
... to convert the signal for a fiber-optic network (for PROFIBUS-DP network only)	Optical Link Module	In the manual *SIMATIC NET PROFIBUS Networks*
... to connect programming devices/OPs to the network	Programming device connecting cables (spur line)	Section 5.1.3

In This Section

This section describes the properties of the network components and information for their installation and handling. You will find the technical specifications of the RS 485 repeater in the Reference Manual *Module Specifications*.

5.2.1 PROFIBUS Bus Cable

PROFIBUS bus cable

We can provide you with the following PROFIBUS bus cables:

PROFIBUS bus cable	6XV1 830-0AH10
PROFIBUS underground cable	6XV1 830-3AH10
PROFIBUS drum cable	6XV1 830-3BH10
PROFIBUS bus cable with PE sheath (for food and beverages industry)	6XV1 830-0BH10
PROFIBUS bus cable for festooning	6XV1 830-3CH10

Properties of the PROFIBUS Bus Cable

The PROFIBUS bus cable is a shielded twisted-pair cable with the following properties:

Table 5-7   Properties of the PROFIBUS Bus Cable

Properties	Values
Line impedance	Approx. 135 to 160 Ω (f = 3 to 20 MHz)
Loop resistance	$\leqq$ 115 Ω/km
Effective capacitance	30 nF/km
Attenuation	0.9 dB/100 m (f = 200 kHz)
Permissible cross-sectional core area	0.3 mm^2 to 0.5 mm^2
Permissible cable diameter	8 mm $\pm$ 0.5 mm

Rules for Laying

When laying the PROFIBUS bus cable, you should take care not to:

- Twist the cable

- Stretch the cable

- Compress the cable

You should also observe the following when laying the indoor bus cable (d_A = outer diameter of the cable):

Table 5-8   Specifications for Installation of Indoor Bus Cable

Properties	Specifications
Bending radius (one-off)	$\geq$ 80 mm ($10 \times d_A$)
Bending radius (multiple times)	$\geq$ 160 mm ($20 \times d_A$)
Permissible temperature range during installation	$-$ 5 °C to + 50 °C
Storage and stationary operating temperature range	$-$ 30 °C to + 65 °C

5.2.2   Bus Connectors

Purpose of the Bus Connector

The bus connector is used to connect the PROFIBUS cable to the MPI or PROFIBUS-DP interface. You thus make the connections to further nodes.

The following bus connectors are available:

- Up to 12 Mbps
    - Without PD socket (6ES7 972-0BA11-0XA0 or 6ES7 972-0BA50-0XA0)
    - With PD socket (6ES7 972-0BB11-0XA0 or 6ES7 972-0BB50-0XA0)
- Up to 12 Mbps, angular outgoing cable
    - Without programming device socket   (6ES7 972-0BA40-0XA0)
    - With programming device socket   (6ES7 972-0BB40-0XA0)

No Application

You do **not** require the bus connector for:

- DP slaves in degree of protection IP 65 (e.g. ET 200C)

- RS 485 Repeater

5.2.3 Plugging the Bus Connector into a Module

Connecting the Bus Connector

Proceed as follows to connect the bus connector:

1. Plug the bus connector into the module.

2. Screw the bus connector tight on the module.

3. If the bus connector is installed at the start or end of a segment, you must switch on the terminating resistor (switch setting "ON") (see Figure 5-10).

Note

The bus connector 6ES7 972-0BA30-0XA0 does not have a terminating resistor. You cannot connect it at the beginning or end of a segment.

Please make sure that power is always supplied to the stations where the terminating resistor is fitted during start-up and normal operation.

Terminating resistor switched on   Terminating resistor switched **off**
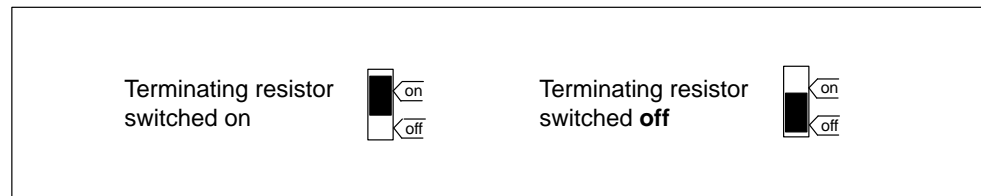
Figure 5-10   Bus Connector (6ES7 ...): Terminating Resistor Switched On and Off

Disconnecting the Bus Connector

With a **looped-through network cable**, you can unplug the bus connector from the PROFIBUS-DP interface at any time, without interrupting data communication on the network.

⚠ **Warning**

A data communication error may occur on the network.

A network segment must always be terminated at both ends with the terminating resistor. This is not the case, for example, if the power supply is not activated on the last slave with a bus connector. Since the bus connector draws power from the station, the terminating resistor has no effect.

Please make sure that power is always supplied to stations on which the terminating resistor is active.

5.2.4   RS 485 Repeater

The Purpose of the RS 485 Repeater

The RS 485 repeater amplifies data signals on bus lines and interconnects network segments.

You need an RS 485 repeater if:

* more than 32 nodes are connected to the network

* a grounded segment is to be connected to a non-grounded segment, or

* the maximum cable length of a segment is exceeded.

Description of the RS 485 Repeater

You will find a description and the technical specifications of the RS 485 repeater in Chapter 7 of the *Module Specifications* Reference Manual.

Installation

You can mount the RS 485 repeater either on the S7-300 rail or on a 35-mm standard rail.

To mount it on the S7-300 rail, remove the slide at the rear of the RS 485 repeater as follows:

1. Insert a screwdriver under the edge of the latching element.

2. Move the screwdriver towards the rear of the module. Keep this position.

3. Move the slide upwards.

Figure 5-11 shows how the slide of the RS 485 repeater is removed.
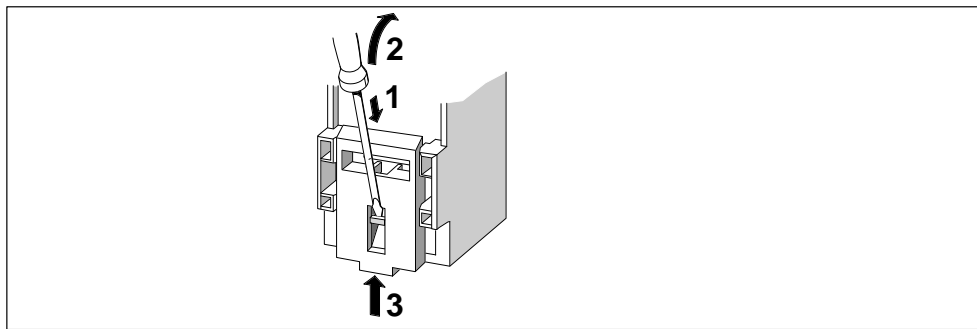
Figure 5-11   Removing the Slide on the RS 485 Repeater

After you have removed the slide, you can install the RS 485 repeater on the rail in the same way as the other S7-300 modules (see Chapter 2).

Use flexible cables with a cross-sectional core area of 0.25 mm^2 to 2.5 mm^2 (AWG 26 to 14) to connect the 24 V DC power supply.

Wiring the Power Supply Module

Proceed as follows to wire the power supply of the RS 485 repeater:

1. Loosen the screws "M" and "PE".

2. Strip the insulation off the 24 V DC power supply cable.

3. Connect the cable to terminals "L+" and "M" or "PE".

Terminal "M5.2"

Terminal "M5.2" is a terminal that you do not need to wire, as it is only used for servicing. The terminal "M5.2" supplies the reference potential. You need this reference potential to measure the voltage characteristic between terminals "A1" and "B1".

Connecting the PROFIBUS Bus Cable

You must connect the PROFIBUS bus cable to the RS 485 repeater as follows:

1. Cut the PROFIBUS bus cable to the length you require.

2. Strip the insulation off the PROFIBUS bus cable as shown in Figure 5-12.

   The shield braiding must be turned up onto the cable. Only thus, the shielding point can later act as a strain relief and a shield support element.
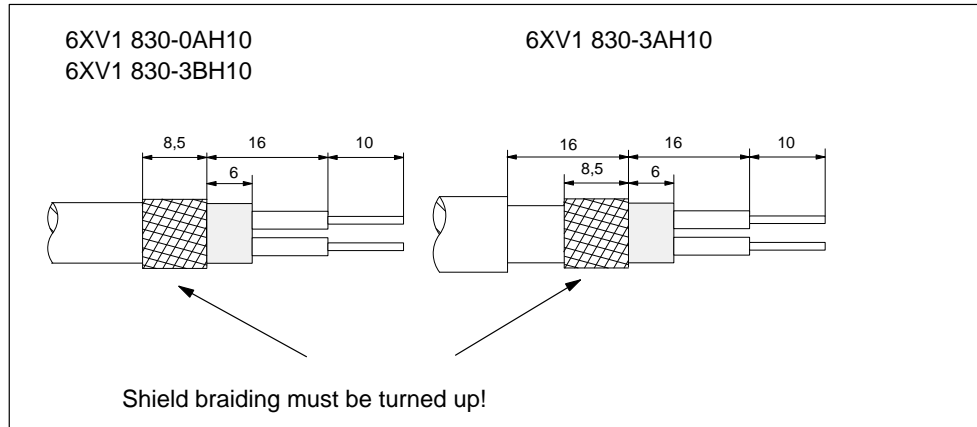
Figure 5-12   Lengths of the Stripped Insulation for Connection to the RS 485 Repeater

3. Connect the PROFIBUS bus cable to the RS 485 repeater:

   Connect similar cores (green/red for PROFIBUS bus cable) to similar terminals A or B (for example, always connect a green wire to terminal A and a red wire to terminal B).

4. Tighten the pressure saddles, so that the shielding is bare under the pressure saddle.

Commissioning

6

Software Prerequisites

You must have **STEP 7 V 5.x or later** in order to be able to use the complete range of functions of the CPUs listed in the chapter entitled *Important Information*.

If you have installed **STEP 7 < V 5.x** and you want to configure your system with these CPUs, you have the following alternatives:

- If you don't upgrade *STEP 7* < V 5.x, you can use the relevant CPUs with low order numbers from the *STEP 7* hardware catalogue.

  Note that you can then "only" use the functions of the previous CPU and of *STEP 7* V 5for the new CPU.

  Important: the CPUs 316-2 DP, 318-2 and 314 IFM (314-5AE**10**) are not included in the hardware catalogue of *STEP 7* < V 5.x.

CPU	*STEP 7* < V 5.x	*STEP 7* V 5.x or later
316-2 DP	No	Service Pack 1 or later
318-2		
314 IFM (314-5AE**10**)	No	Service Pack 3 or later

- Upgrade *STEP 7*. Get information on update options from the Internet at our Customer Support site or ask your Siemens customer advisor.

- Install the new version of *STEP 7*.

Prerequisites for Commissioning

Prerequisite	See...
The S7-300 must be installed	Chapter 2
The S7-300 must be wired	Chapter 4
In the case of a networked S7-300: • MPI/PROFIBUS addresses must be set • Terminating resistors must be switched on (at the segment borders)	Chapter 5

In This Section

Section	Contents	Page
6.1	Inserting the Memory Card (Not CPU 312 IFM/314 IFM (314-5AE0x))	6-3
6.2	Inserting the Backup Battery or Accumulator (Not CPU 312 IFM)	6-4
6.3	Connecting the Programming Device	6-5
6.4	Switching On a S7-300 for the First Time	6-10
6.5	Resetting the CPU Memory	6-11
6.6	Commissioning PROFIBUS-DP	6-16

6.1 Inserting and Replacing the Memory Card (Not CPU 312 IFM/314 IFM (314-5AE0x))

Exceptions

You cannot insert a memory card with the CPUs 312 IFM and 314 IFM (314-5AE0x).

Inserting/Changing a Memory Card

1. Set the CPU to STOP mode.

Note

If you insert the memory card in a CPU mode other than STOP, the CPU will go into STOP mode and the STOP LED will flash at 1 second intervals to request a reset (see Section 6.5).

---

2. Is a memory card already inserted? If so: remove it.

3. Insert the new memory card in the CPU module shaft. Please note that the insertion marking on the memory card points to the marking on the CPU (see Figure 6-1).

4. Reset the CPU (see Section 6.5).

Insertion marking
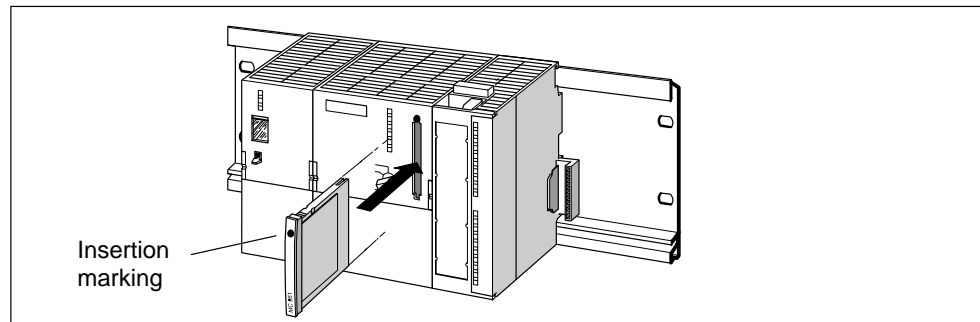
Figure 6-1   Inserting the Memory Card in the CPU

6.2 Inserting the Backup Battery/Accumulator (Not CPU 312 IFM)

Exceptions

A **CPU 312 IFM** doesn't have a backup battery or accumulator.

You do not require a backup battery for the **CPU 313** (see also Section 8.1.3).

Inserting the Backup Battery/Accumulator

You insert a backup battery or the accumulator in the CPU as follows:

Note

Only insert the backup battery in the CPU at power on.

If you insert the backup battery before power on, the CPU requests a reset.

---

1. Open the front door of the CPU.

2. Plug the battery or accumulator connector into the corresponding socket in the battery compartment of the CPU. The notch on the connector must point to the left.

3. Place the backup battery/accumulator into the battery compartment on the CPU.

4. Close the front door of the CPU.
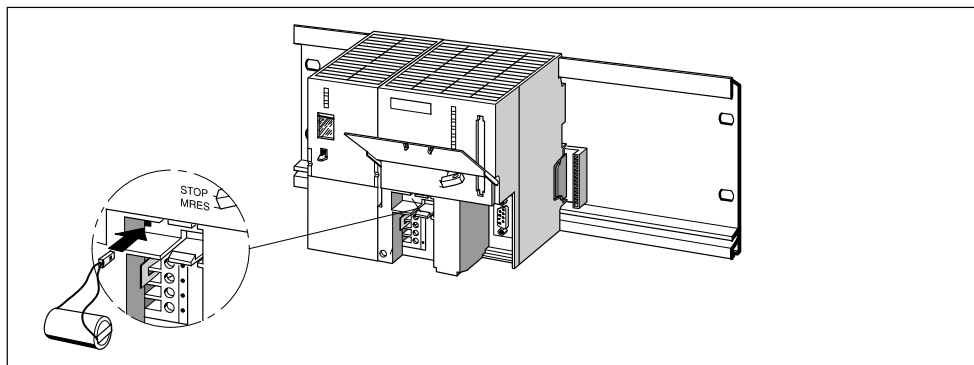
Figure 6-2   Inserting a Backup Battery in the CPUs 313/314

6.3 Connecting a Programming Device

Prerequisites

The programming device must be equipped with an integrated MPI interface or an MPI card in order to connect it to an MPI.

Cable length

For information on possible cable lengths, refer to Section 5.1.3.

6.3.1 Connecting a Programming Device to an S7-300

You can connect the programming device to the MPI of the CPU via a preprepared programming device cable.

Alternatively, you can prepare the connecting cable yourself using the PROFIBUS bus cable and bus connectors (see Section 5.2.2).
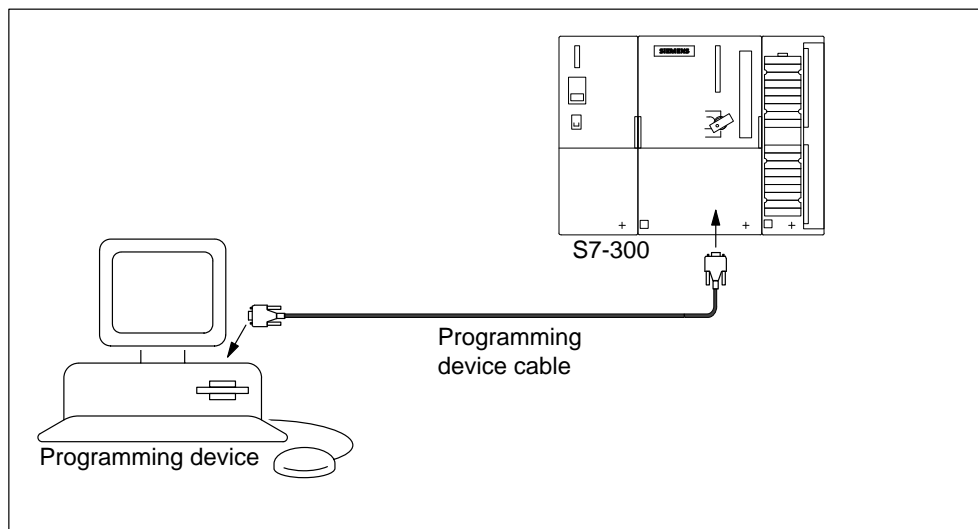
Figure 6-3   Connecting a Programming Device to an S7-300

6.3.2 Connecting a Programming Device to Several Nodes

Two Configuration Options

When connecting a programming device to several nodes, you must differentiate between two types of configuration:

- Programming device permanently installed in the MPI subnet
- Programming device connected for startup or maintenance purposes.

Depending on which of these configurations you choose, connect the programming device to the other nodes as follows (see also Section 5.1.2).

Type of Configuration	Connection
Programming device permanently installed in the MPI subnet	Integrated directly in the MPI subnet
Programming device installed for commissioning or maintenance	Programming device connected to a node via a spur line

Permanently Installed Programming Device

You connect the programming device that is permanently installed in the MPI subnet directly to the other nodes in the MPI subnet via bus connectors in accordance with the rules described in Section 5.1.2.

Figure 6-4 shows two networked S7-300s. The two S7-300s are interconnected via bus connectors.
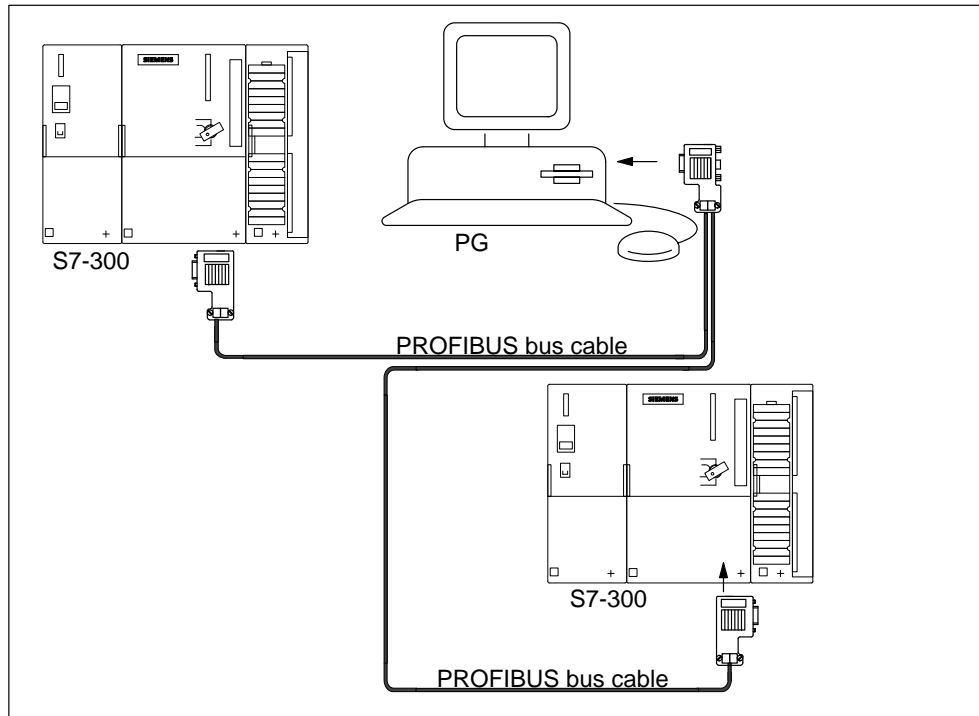
Figure 6-4   Connecting a Programming Device to Several S7-300s

Connecting the Programming Device for Service Purposes: Recommendation for MPI Addresses

If there is no stationary programming device, we recommend the following:

In order to connect a programming device for service purposes to an MPI subnet with "unknown" nodes addresses, we recommend to set the following address on the service programming device:

- MPI address: 0
- Highest MPI address: 126.

Afterwards, use *STEP 7* to determine the highest MPI address in the MPI subnet and adjust the highest MPI address in the programming device to that of the MPI subnet.

Programming Device During Commissioning or Maintenance

For commissioning or maintenance purposes, you connect the programming device via a spur line to a node of the MPI subnet. The bus connector of this node must therefore be provided with a programming device socket (see also Section 5.2.2).

Figure 6-5 shows two S7-300s to which a programming device is connected.
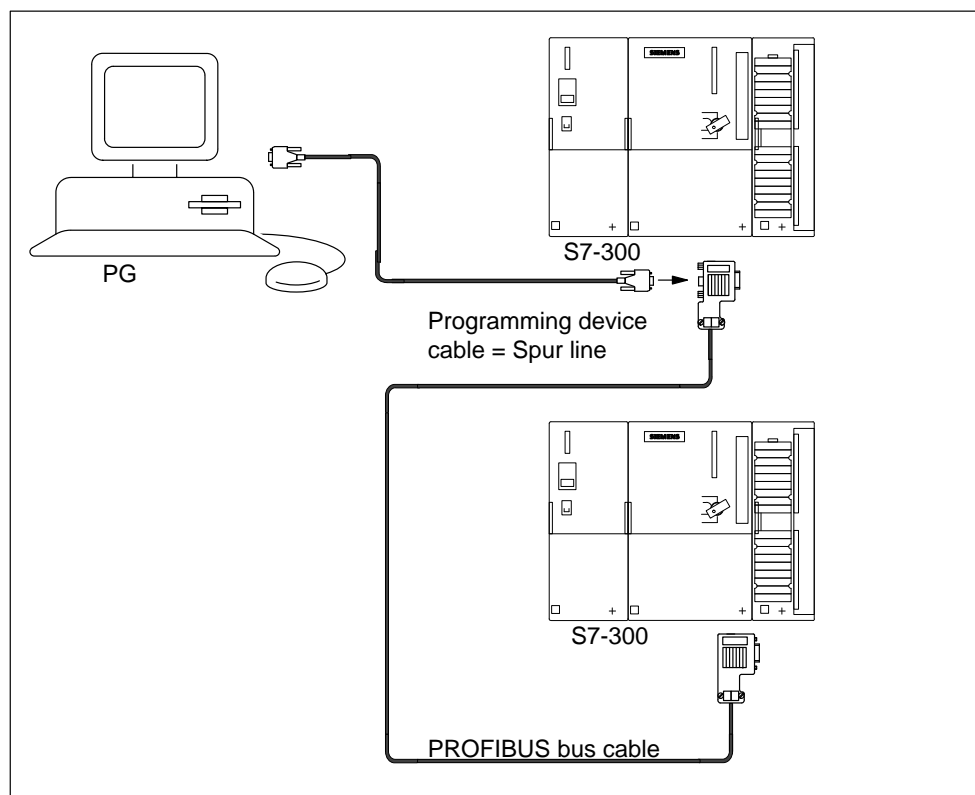
Figure 6-5   Connecting a Programming Device to a Subnet

6.3.3 Connecting a Programming Device to Ungrounded Nodes of an MPI Subnet

Connecting a Programming Device to Ungrounded Nodes

If you have an ungrounded configuration of nodes in an MPI subnet or an ungrounded S7-300 (see Section 4.1.4), you may only connect an ungrounded programming device to the MPI subnet or the S7-300.

Connecting a Grounded Programming Device to the MPI

You want to operate the nodes in an ungrounded configuration (see Section 4.1.4). If the MPI at the programming device is grounded, you must connect an RS 485 repeater between the nodes and the programming device. You must connect the ungrounded nodes to bus segment 2, if you connect the programming device to bus segment 1 (terminals A1 B1) or the PG/OP interface (see Chapter 7 in the *Module Specifications* Reference Manual).

Figure 6-6 shows the RS 485 repeater as an interface between a grounded and an ungrounded node in the MPI subnet.
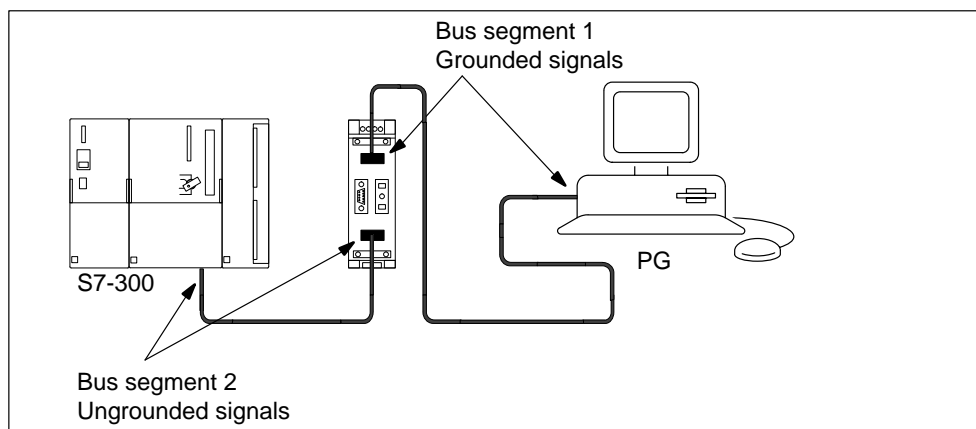
Figure 6-6   Programming Device Connected to an Ungrounded S7-300

6.4 Switching On a S7-300 for the First Time

Prerequisite

The S7-300 is installed and wired.

The mode selector should be in STOP mode.

Switching On for the First Time.

Switch the PS 307 power supply module on.

Result:

- The 24 V DC LED on the power supply module comes on.
- On the CPU
    - The 5 V DC LED comes on.
    - The STOP LED flashes at one second intervals while the CPU carries out an automatic reset.
    - The STOP LED comes on after the memory reset.

If there is no backup battery in the CPU, the BATF LED comes on.

Note

If you insert a memory card and a backup battery before power on, the CPU also requests a memory reset after start-up.

6.5   Resetting the CPU

When Do You Reset the CPU Memory?

You must reset the CPU memory:

• Before you transfer a new (complete) user program to the CPU

• If the CPU requests a MRES with its STOP LED flashing at 1-second intervals
  Possible reasons for this request are listed in Table 6-1.

Table 6-1   Possible Reasons for MRES Request by CPU

Reasons for MRES Request by CPU	Remarks
Wrong memory card has been plugged in.	**Not** with **CPU 312 IFM / 314 IFM (314-5AE0x)**
RAM error in CPU	–
Working memory too small, that is not all blocks of the user program on a memory card could be loaded.	CPU with 5 V-FEPROM memory card inserted: In these circumstances the CPU requests a one-off memory reset. After that, the CPU ignores the contents of the memory card, enters the error reasons in the diagnostics buffer and goes to STOP. You can erase the contents of the 5 V-FEPROM memory card in the CPU or enter new program.
Attempt to load blocks with errors, for example if a wrong command has been programmed.	

How to Reset the Memory

There are two ways of resetting the CPU memory:

Memory Reset with the Mode Selector	Memory Reset with Programming Device
... is described in this section.	... is only possible in STOP mode of the CPU (see *STEP 7*-Online help).

Cold start in the CPU 318-2

In the CPU 318-2 you can also carry out a cold start instead of resetting the memory.

Cold start means:

- The data blocks in the working memory created by SFC 22 are deleted. The remaining data blocks have the preassigned value from the load memory.

- The process image as well as all times, counters and memory markers are reset – irrespective of whether they were parameterized as retentive.

- The OB 102 is processed.

- Before the first command in OB 1, the process image of the inputs is read.

Resetting the CPU Memory or Carrying Out a Cold Start (CPU 318-2 only) with the Mode Selector

Step	Resetting the CPU Memory (Figure 6-7)	Carrying Out a Cold Start (Figure 6-8) CPU 318-2 Only
1	Turn the key to the STOP position	
2	Turn the key to the MRES position. Hold the key in this position until the STOP LED comes on for the second time and remains on (this takes 3 seconds).	
3	Within 3 seconds you must turn the switch back to the MRES position and keep holding it until the STOP LED flashes (at 2 Hz). When the CPU has completed the reset, the STOP LED stops flashing and remains lit. The CPU has reset the memory.	Within 3 seconds you must turn the switch to the RUN position. During start-up the RUN LED flashes at 2 Hz.

Memory Reset
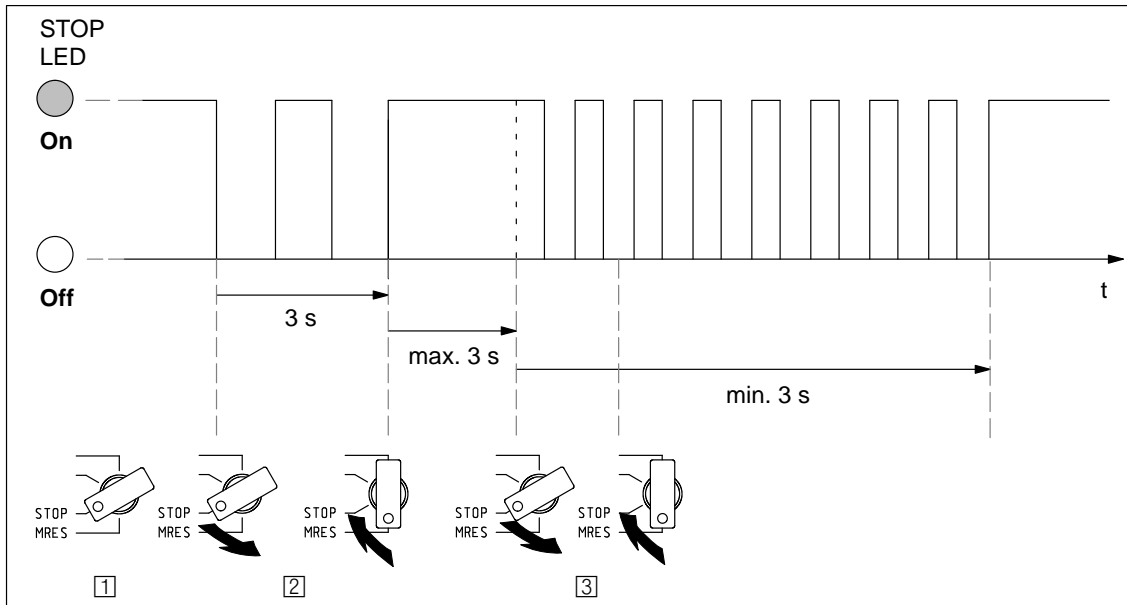
Figure 6-7   Switching Sequence for the Mode Selector for Resetting the CPU

Is the STOP LED Not Flashing During Memory Reset?

If the STOP LED doesn't flash during memory reset or other LEDs come on (with the exception of the BATF LED), you must repeat steps 2 and 3. If the CPU does not perform the reset this time, evaluate the diagnostic buffer of the CPU.

Cold Start
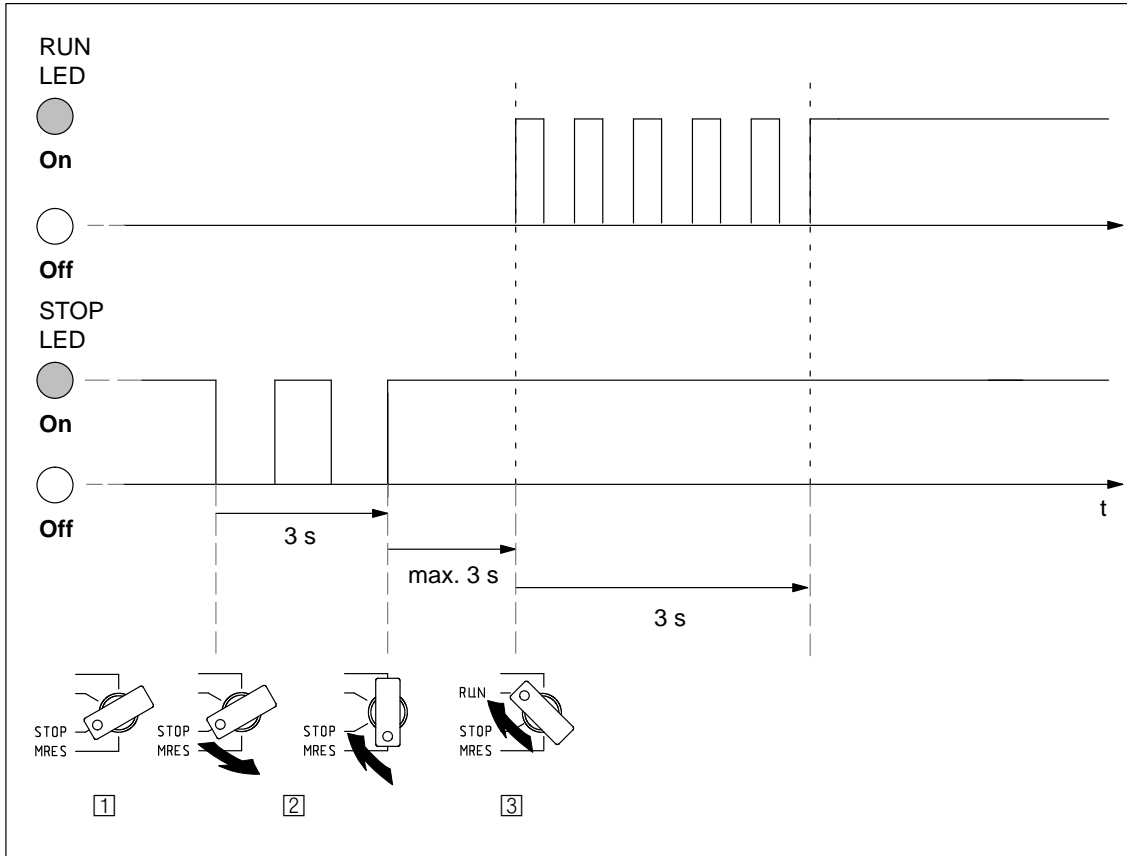
Figure 6-8   Switching Sequence for the Mode Selector for Cold Start (CPU 318-2 Only)

What Happens in the CPU During Memory Reset?

Table 6-2   Internal CPU Events on Memory Reset

Event	CPU 313 / 314 / 314 IFM (314-5AE10) / 315 / 315-2 DP / 316-2 DP / 318-2	CPU 312 IFM / 314 IFM (314-5AE0x)
CPU activities	1. The CPU deletes the entire user program in its RAM and in the load memory (except for FEPROM load memory).	
	2. The CPU deletes the retentive data.	
	3. The CPU tests its own hardware.	
	4. If you have inserted a memory card, the CPU copies the relevant contents of the memory card into the working memory. **Tip:** If the CPU cannot copy the contents of the memory card and requests memory reset: – Remove the memory card. – Resetting the CPU Memory – Read the diagnostic buffer.	The CPU copies the relevant contents of the EPROM memory into the working memory
Memory contents after reset	The CPU memory is initialized to "0". If there is a memory card plugged in, the user program is loaded back into the RAM.	The user program is loaded back into the RAM from the integrated retentive EPROM of the CPU.
What's left?	The contents of the diagnostics buffer. You can read the diagnostic buffer with the programming device (see the *STEP 7 online help system*).	
	The parameters of the MPI (MPI address and highest MPI address, transmission rate, configured MPI addresses of CPs/FMs in an S7-300).	
	The contents of the operating hours counter (not for CPU 312 IFM).	

Note: MPI Parameters

The following applies for the validity of the MPI parameters at memory reset:

Memory Reset ...	MPI Parameters ...
With memory card inserted (FEPROM) (CPU 313 / 314 / 314 IFM (314-5AE10) / 315 / 31x-2 DP)	... located on the memory card or on the integral FEPROM of the CPU are valid.
With integral FEPROM load memory (CPU 312 IFM / 314 IFM (314-5AE0x))	
Without memory card inserted (FEPROM) (CPU 313 / 314 / 314 IFM (314-5AE10) / 315 / 31x-2 DP)	... are retained and are valid.

6.6 Commissioning the PROFIBUS-DP

In This Section

This section provides you with vital information on commissioning a PROFIBUS subnet with a CPU 31x-2 DP.

Section	Contents	Page
6.6.1	Commissioning the CPU 31x-2 DP as a DP Master	6-17
6.6.2	Commissioning the CPU 31x-2 DP as a DP Slave	6-18

Software Prerequisites

CPU 315-2 DP	As of *STEP 7* V 3.1 As of *COM PROFIBUS* V 3.0
CPU 316-2 DP	As of *STEP 7* V 5.x As of *COM PROFIBUS* V 5.0
CPU 318-2	

6.6.1 Commissioning the CPU 31x-2 DP as a DP Master

Prerequisites for Commissioning

- The PROFIBUS subnet must be configured.
- The DP slaves must be prepared for operation (see relevant DP slave manual).

Commissioning

To commission the CPU 31x-2 DP as a DP master in a PROFIBUS subnet, proceed as follows:

1. Load the PROFIBUS subnet configuration (preset configuration) created using *STEP 7* with the programming device in the CPU 31x-2 DP.

2. Switch on all of the DP slaves.

3. Switch the CPU 31x-2 DP from STOP mode to RUN mode.

Start-Up of the CPU 31x-2 DP as a DP Master

When the CPU 31x-2 DP is powered up, it checks the preset configuration of your DP master system against the actual configuration.
Tip: You can set a check time for the test in *STEP 7*.

If the preset configuration matches the actual configuration, the CPU switches to RUN.

If the preset configuration does not match the actual configuration, the behavior of the CPU depends on the setting of the parameter "Startup when Preset $\neq$ Actual Config"

Startup when Preset $\neq$ Actual Config = Yes (Default)	Startup when Preset $\neq$ Actual Config = No
The CPU 31x-2 DP switches to RUN mode (BUSF LED flashes if any of the DP slaves cannot be addressed)	The CPU 31x-2 DP remains in STOP mode and the BUSF LED flashes after the time set parameter transfer to modules has elapsed. The flashing BUSF LED indicates that at least one DP slave is not addressable. In this case, you should check that all DP slaves are switched on, or you should read out the diagnostic buffer (see *STEP 7* User Manual).

Recognizing the Operational States of the DP Slave

In Chapter 9 you will find the dependencies of the operating modes of the CPU 31x-2 DP as a DP master and of a DP slave.

Tip: When starting up the CPU as a DP master, always program OBs 82 and 86. This allows you to identify and evaluate faults and interruptions in data transfer (for CPUs configured as DP slaves see also Table 9-3 on page 9-9).

6.6.2   Commissioning the CPU 31x-2 DP as a DP Slave

Prerequisites for Commissioning

- The CPU 31x-2 DP must be parameterized and configured as a DP slave (see Chapter 9).

    When configuring it as a DP slave, you must already have decided on the following:

    - Should functions such as programming and status/control be available via the DP interface?

    - Is the DP master an S7 DP master or another DP master?

- All other DP slaves are parameterized and configured.

- The DP master is parameterized and configured.

    Note that the CPU 31x-2 DP as DP slave provides address areas of an immediate memory for data interchange with the DP master. You use *STEP 7* to configure these address areas when configuring the CPU as a DP slave (see Chapter 9).

Commissioning

To commission the CPU 31x-2 DP as a DP slave in the PROFIBUS subnet, proceed as follows:

1. Switch the CPU 31x-2 DP from STOP mode to RUN.

2. Switch on all of the DP slaves.

3. Switch on the DP master.

The CPU 31x-2 DP as a DP Slave at Start-Up

When the CPU 31x-2 DP is switched to RUN, two operating mode transitions take place independently of each other:
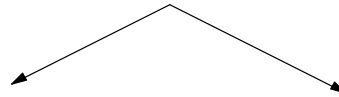
The **CPU** switches from STOP mode to RUN.

At the **PROFIBUS-DP interface** the CPU starts data transfer with the DP master.

Recognizing the Operational Modes of the DP Master

In Chapter 9 you will find the dependencies of the operating modes of the CPU 31x-2 DP as a DP slave or as a DP master.

Tip: When commissioning the CPU as a DP slave, always program OBs 82 and 86. This allows you to identify and evaluate operating modes and interruptions in data transfer (see Table 9-8 on page 0-20).

Maintenance

<div style="text-align: right; font-size: large; font-weight: bold;">7</div>

Maintenance = Backing Up/Updating Firmware and Replacing Specific Units

The S7-300 is a **maintenance-free** programmable controller.

For that reason maintenance refers to the following operations:

- Backing up the operating system to memory card
- Updating the operating system using a memory card, and

Replacing

- Backup battery/accumulator
- Modules
- Fuses on the digital output modules

In This Section

Section	Contents	Page
7.1	Backing Up the Operating System to Memory Card	7-2
7.2	Updating the Operating System Using a Memory Card	7-3
7.3	Changing the Backup Battery/Accumulator (Not CPU 312 IFM)	7-4
7.4	Replacing Modules	7-7
7.5	Replacing Fuses on 120/230 V AC Digital Output Modules	7-11

7.1 Backing Up the Operating System to Memory Card

... is possible with the following CPU versions or later

CPU 313	6ES7 313-1AD03-0AB0, firmware V 1.0.0 or later
CPU 314	6ES7 314-1AEx4-0AB0, firmware V 1.0.0 or later
CPU 314 IFM	6ES7 314-5AE10-0AB0, firmware V 1.1.0 or later
CPU 315	6ES7 315-1AF03-0AB0, firmware V 1.0.0 or later
CPU 315-2 DP	6ES7 315-2AFx3-0AB0, firmware V 1.0.0 or later
CPU 316-2 DP	6ES7 316-2AG00-0AB0, firmware V 1.0.0 or later

Backing up the operating system to memory card is **not** possible with the CPU 318-2.

Memory Cards Required

For the CPUs 313, 314 and 315:	1-MB memory card or larger
For the CPUs 314-IFM (314-5AE10), 315-2 DP and 316-2 DP:	2-MB memory card or larger

Backup Procedure

Step	Action Required	CPU Response
1.	Insert the (new) memory card in the CPU.	The CPU requests a memory reset
2.	Set mode selector to MRES and hold	–
3.	Hold POWER ON/OFF and mode selector in MRES position for another 5 seconds	STOP, RUN and FRCE LEDs flash.
4.	Set mode selector to STOP	–
5.	Set mode selector to MRES and then back to STOP	All LEDs light up; the operating system is backed up to the memory card.
–	–	When only the STOP LED is flashing, the backup is complete.
6.	Remove the memory card.	The CPU requests a memory reset

7.2   Updating the Operating System Using a Memory Card

... is possible with the following CPU versions or later

CPU 313   6ES7 313-1AD03-0AB0, firmware V 1.0.0 or later
CPU 314   6ES7 314-1AEx4-0AB0, firmware V 1.0.0 or later
CPU 314 IFM   6ES7 314-5AE10-0AB0, firmware V 1.1.0 or later
CPU 315   6ES7 315-1AF03-0AB0, firmware V 1.0.0 or later
CPU 315-2 DP   6ES7 315-2AFx3-0AB0, firmware V 1.0.0 or later
CPU 316-2 DP   6ES7 316-2AG00-0AB0, firmware V 1.0.0 or later
CPU 318-2 DP   6ES7 318-2AJ00-0AB0, firmware V 1.0.1 or later

When is an Operating System Update Required?

Following addition of (compatible) extended functions or correction of errors on the operating system you can upgrade the operating system to the relevant new version.

Where Do You Get New Versions?

New versions of the operating system are available from your Siemens representative.

Procedure for Updating Operating System

The procedure for copying the UPD files from the update disks to the memory card is explained in the *STEP 7* Online Help.

Performing an operating system update on the CPU:

1. Remove the backup battery/accumulator from the CPU.

2. Switch the power off on the power supply unit.

3. Insert the prepared memory card containing the operating system update in die CPU.

4. Switch the power ON on the power supply unit.
   The operating system is transferred from the memory card to the internal FLASH EPROM. While this is taking place, all LED indicators on the CPU light up.

5. After about 2 minutes, the operating system update is complete, which is indicated by the STOP LED on the CPU flashing slowly. → memory reset request from system.

6. Switch the power OFF on the power supply unit and insert the memory card for normal operation, if applicable.

7. Switch the power ON on the power supply unit. The CPU then performs an automatic memory reset. If the CPU requests another memory reset as a result of replacement of a module, acknowledge the reset with the mode selector.The CPU is then ready for operation.

8. Replace the battery/accumulator in the CPU.

7.3 Replacing the Backup Battery/Accumulator (Not CPU 312 IFM)

Replacing the Backup Battery/Accumulator

You should only change the backup battery or accumulator when the power is on, in order to prevent the loss of data from the internal user memory, and to keep the clock of the CPU running.

Note

The data in the internal user memory are lost if you change the backup battery when the power is off.

Change the backup battery with the power switch in the ON position only!

To change the backup battery/accumulator proceed as follows:

Step	CPU 313/314	CPU 314 IFM/315/315-2 DP/ 316-2 DP/318-2
1.	Open the front door of the CPU.	
2.	Pull the backup battery/accumulator out of the compartment with a screwdriver.	Pull the backup battery or accumulator out of the compartment by the cable
3.	Plug the connector of the new backup battery/accumulator into the corresponding socket in the battery compartment of the CPU. The notch on the battery connector must point to the left!	
4.	Place the backup battery/accumulator into the battery compartment on the CPU	
5.	Close the front door of the CPU	
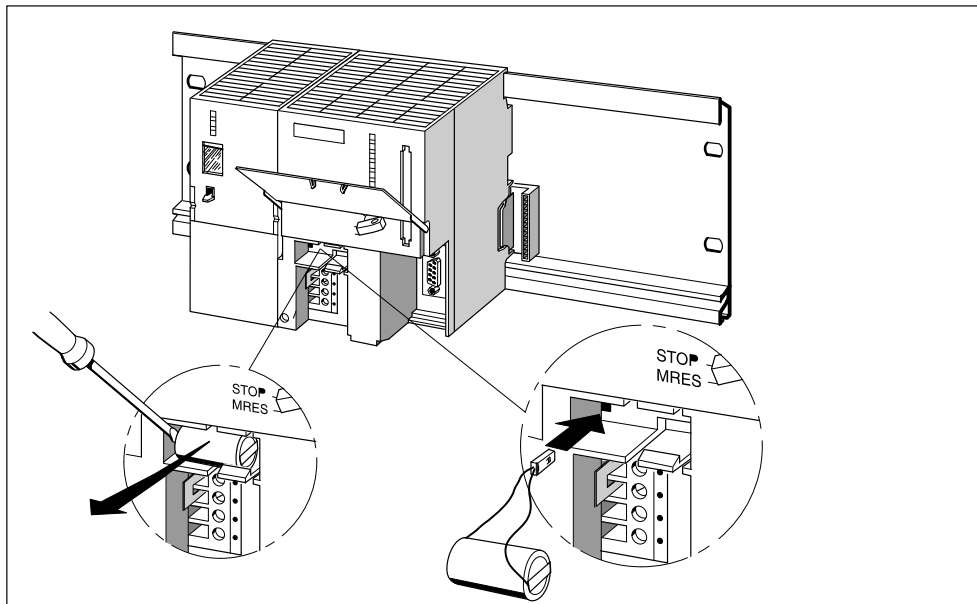
Figure 7-1   Changing the Backup Battery in the CPU 313/314

How Often Is Replacement Necessary?

Backup battery: We recommend changing the backup battery every year.

Accumulator: The accumulator never needs changing.

Disposal

Backup batteries must be disposed of in keeping with the relevant national environment protection regulations/guidelines.

Storing Backup Batteries

Store backup batteries in a dry and cool place.

Backup batteries can be stored for five years.

⚠️ **Warning**

If backup batteries are not treated properly, they can ignite, explode and cause severe burning.

Store backup batteries in a dry and cool place.

Rules for the Handling of Backup Batteries

To reduce the risk of danger when handling backup batteries, you must observe the following rules:

⚠ **Warning**

Improper handling of backup batteries can cause injuries and property damage.

Backup batteries that are not handled properly can explode and cause severe burns.

Do not
- recharge
- overheat
- burn
- puncture
- crush
- short-circuit backup batteries!

Rules for Handling the Accumulator

You must not charge the accumulator when not inserted in the CPU! The accumulator can only be charged by the CPU when the power is on.

7.4 Replacing Modules

Rules for Installation and Wiring

The following table tells you what you have to do when wiring, detaching and installing the S7-300 modules.

Rules Governing	... Power Supply	... CPU	... SM/FM/CP
Blade width of screwdriver	3.5 mm (cylindrical model)		
Tightening torque			
Attaching modules to the rail	0.8 to 1.1 Nm		0.8 to 1.1 Nm
Terminating cables	0.5 to 0.8 Nm		–
POWER OFF when replacing the ...	Yes		No
Operating mode of S7-300 when replacing the ...	–		STOP
Load voltage OFF when replacing the ...	Yes		Yes

Initial Situation

The module you want to replace is installed and wired. You want to install a new module of the same type.

> ⚠ **Warning**
>
> If you remove or plug in the S7-300 modules during data transmission via the MPI, the data might be corrupted by disturbing pulses.
>
> You must not plug in or remove any S7-300 modules during data transmission via the MPI!
>
> If you are not sure whether any communications activities are taking place, pull the connector out of the MPI port.

Removing a Module (SM/FM/CP)

Detach the module from the rail as follows:

Step	20-Pin Front Connector	40-Pin Front Connector
1.	Set the CPU to the STOP mode with the key-operated switch	
2.	Switch off the load voltage to the module	
3.	Take out the labeling strip	
4.	Open the front door	
5.	Unlock the front connector and pull it off the module	
	To do this, press down on the locking button (5) and, with the other hand, grip the front connector (5a) and pull it out.	Remove the fixing screw from the middle of the front connector. Pull the front connector out while holding the grips.
6.	Undo the module fixing screw(s).	
7.	Swing the module up and off the rail.	
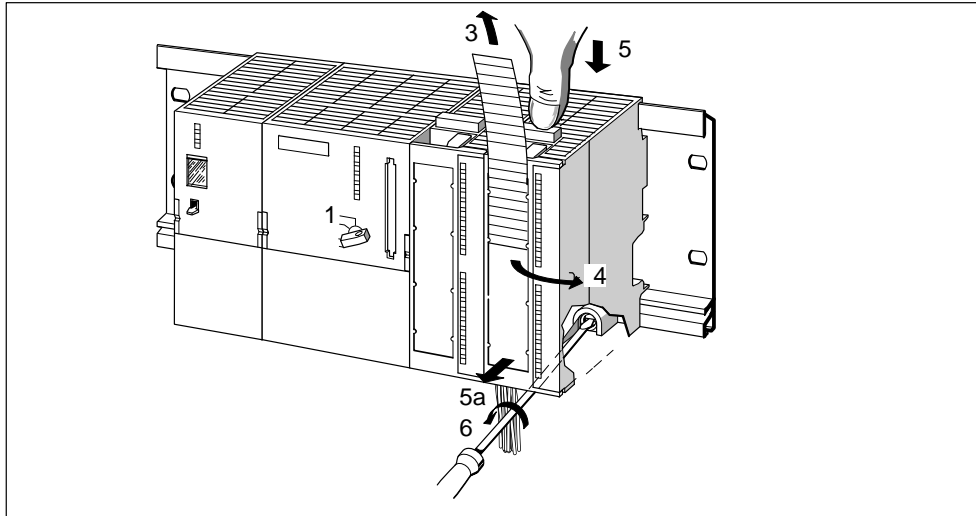
Figure 7-2   Unlocking the Front Connector and Detaching the Module from the Rail

Removing the Front Connector Coding Key from the Module

Prior to installing the new module, you must remove the front connector coding key from the new module.

Reason: This part is already in the front connector (see Figure 7-3).
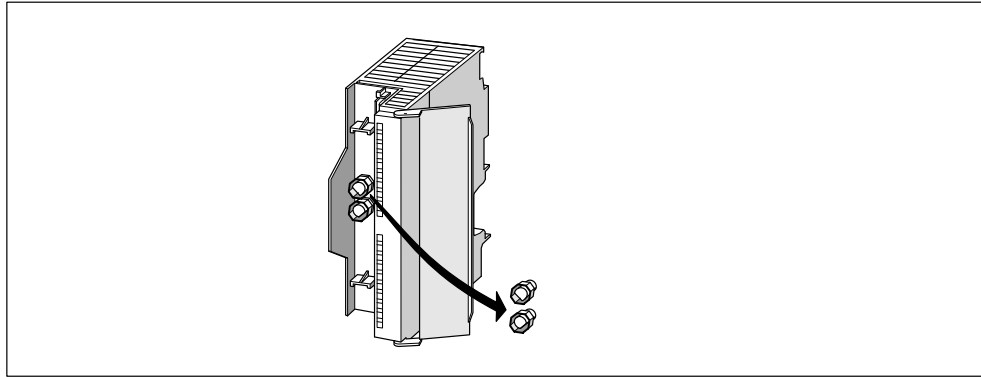
Figure 7-3   Removing the Front Connector Coding Key

Installing a New Module

Install the new module as follows:

1. Hook the new module of the same type onto the rail and swing it down into place.

2. Bolt the module tight.

3. Slip the labeling strip of the old module into its guide on the new module.

0.8 to 1.1 Nm
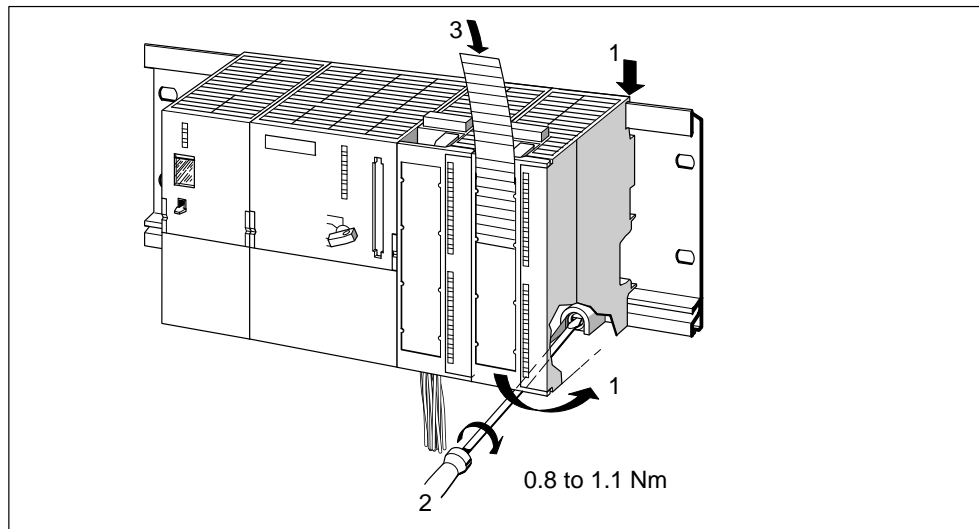
Figure 7-4   Installing a New Module

Removing the Front Connector Coding Key from the Front Connector

If you want to wire a used front connector for another module, just remove the front connector coding key from the front connector by pressing it out of the front connector with a screwdriver. This upper part of the coding key must then be plugged back into the old module.

Putting a New Module into Service

Proceed as follows to put the new module into service:

1. Open the front door.

2. Bring the front connector back into its operating position (see Section 4.3.3)
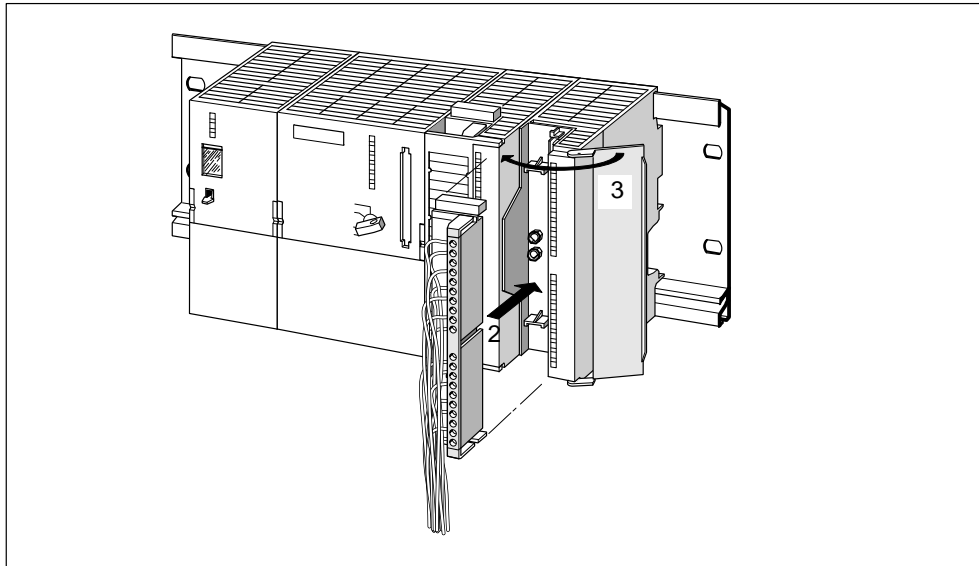
Figure 7-5   Plugging In the Front Connector

3. Close the front door.

4. Switch the load voltage back on.

5. Set the CPU again to RUN.

Performance of the S7-300 After Module Replacement

When you have replaced a module and no errors have occurred, the CPU enters the RUN mode. If the CPU stays in the STOP mode, you can have the cause of the error displayed with *STEP 7* (see *STEP 7* User Manual).

7.5 Replacing Fuses on 120/230 V AC Digital Output Modules

Fuses for Digital Outputs

Fuses are used for the individual channel groups of the digital outputs of the following digital output modules, to protect these against short circuit:

- SM 322 DO 16 × AC120 V digital output module
- SM 322 DO 8 × AC120/230 V digital output module

Replacement Fuses

If you have to change fuses, you can use, for example, the following replacement fuses:

- 8 A, 250 V fuse
    - Wickmann   19 194-8 A
    - Schurter   SP001.013
    - Littlefuse   217.008
- Fuse holder
    - Wickmann   19 653

Position of the Fuses

The digital output modules have 1 fuse per channel group. The fuses are located at the left side of the digital output module. Figure 7-6 shows you where to find the fuses on the digital output modules.
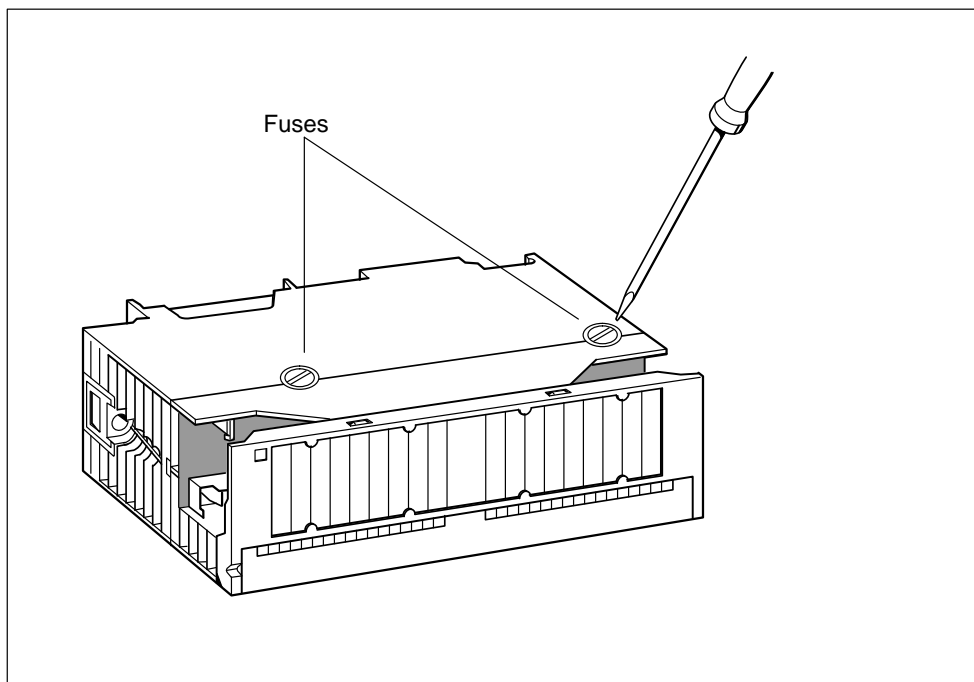
Figure 7-6   Location of the Fuses on Digital Output Modules

Changing Fuses

The fuses are located at the left side of the module. To change the fuses, proceed as follows:

1. Switch the CPU to STOP using the key switch.

2. Switch off the load voltage of the digital output module.

3. Remove the front connector from the digital output module.

4. Loosen the fixing screw of the digital output module.

5. Swing out the digital output module.

6. Remove the fuse holder from the digital output module.

7. Replace the fuse.

8. Screw the fuse holder back into the digital output module.

9. Install the digital output module (see Section 2.2.2).

CPUs

<div style="text-align: right; font-size: 2em;">**8**</div>

In This Section

Section	Contents	Page
8.1	Control and Display Elements	8-2
8.2	CPU Communication Options	8-12
8.3	Test Functions and Diagnostics	8-19
8.4	CPUs – Technical Specifications	8-23

Agreement for CPU 314 IFM

The CPU 314 IFM is available in 2 versions as follows:

- with slot for memory card (6ES7 314-5EA**10**-0AB0)

- without slot for memory card (6ES7 314-5EA**0x**-0AB0/ 6ES7 314-5EA**8x**-0AB0)

All details in this chapter apply to both versions of the CPU 314 IFM unless explicit reference is made to differences between them.

8.1 Control and Display Elements

Figure 8-1 shows you the control and display elements of a CPU.
The order of the elements in some CPUs might differ from the order shown in the figure below. The individual CPUs do not always have all the elements shown here. Table 8-1 shows you the differences.
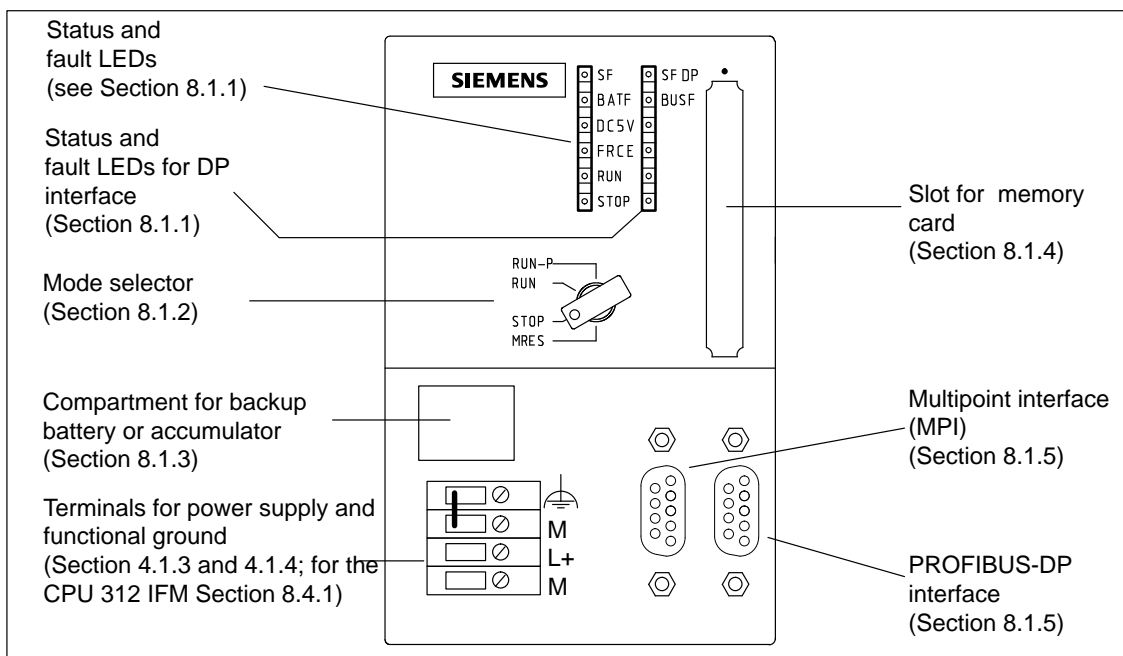
Figure 8-1   Control and Display Elements of the CPUs

Differences Between CPUs

Table 8-1   The Differences in Control and Display Elements Between CPUs

Element	312 IFM	313	314	314 IFM		315	315-2 DP	316-2 DP	318-2
				-5AE0 x-	-5AE1 0-				
LEDs for DP interface	No						Yes		
Backup battery/ accumulator	No	No accu- mulator	Yes						
Terminal connection for power supply	No; via the front con- nector	Yes							
Memory card	No	Yes		No	Yes	Yes			
PROFIBUS-DP interface	No						Yes		

8.1.1   Status and Fault Displays

Displays for the CPU:

SF ... (red) ... hardware or software faults (see Section 8.3.2)
BATF ... (red) ... battery fault (see Section 8.3.2) (not CPU 312 IFM)
DC5V ... (green) ... 5 V DC supply for CPU and S7-300 bus is ok.
FRCE ... (yellow) ... force request is active (see Section 8.3.1)
RUN ... (green) ... CPU in RUN; LED flashes at start-up with 1 Hz; in HALT mode with 0.5 Hz
STOP ... (yellow) ... CPU in STOP or HALT or start-up; LED flashes at
                          memory reset request (see Section 6.5)

Displays for PROFIBUS: (see Chapter 9)

CPU 315-2 DP/   BUSF ... (red) ... hardware or software fault at PROFIBUS interface
CPU 316-2 DP

CPU 318-2   BUS1F ... (red) ... hardware or software fault at interface 1
                  BUS2F ... (red) ... hardware or software fault at interface 2

Figure 8-2   Status and Fault Displays of the CPUs

8.1.2   Mode Selector Switch

The mode selector is the same in all CPUs.

Mode Selector Positions

The positions of the mode selector are explained in the order in which they appear on the CPU.

You will find detailed information on the modes of the CPU in the *STEP 7* online help system.

Position	Description	Description
RUN-P	RUN-PROGRAM mode	The CPU scans the user program.
		The key cannot be taken out in this position.
RUN mode	RUN mode	The CPU scans the user program.
		The user program cannot be changed without password confirmation.
		The key can be removed in this position to prevent anyone changing the operating mode.
STOP mode	STOP mode	The CPU does not scan user programs.
		The key can be removed in this position to prevent anyone changing the operating mode.
MRES mode	Memory reset	Momentary-contact position of the mode selector for CPU memory reset (or a cold start as well in the case of the 318-2).
		Resetting the memory using the mode selector requires a special sequence of operations (see Section 6.5)

8.1.3   Backup Battery/Accumulator

Exceptions

The CPUs 312 IFM and 313 do not have a real time clock so they do not need an accumulator battery.
The CPU 312 IFM does not have a buffer which means that you can not insert a battery.

Backup Battery or Accumulator?

Table 8-2 shows the differences in the backup provided by an accumulator and a backup battery.

Table 8-2   Using a Backup Battery or Accumulator

Backup with...	... Backs up	Remarks	Backup Time
Accumula-tor	Real-time clock only	The accumulator is recharged when the power of the CPU is on. **Note:** The user program must be backed up to memory card or, in the case of CPU 314 IFM (-5AE**0x**-), to the FEPROM.	120 h (at 25°C) 60 h (at 60C) ... after 1 hour recharging
Backup battery	• User program (if not stored on memory card and protected against loss on power failure) • More data areas in data blocks are to be retained than possible without battery • The real-time clock	**Note:** The CPU can retain some of the data without a battery. You only need a backup battery if you want to retain more data than this.	1 year

8.1.4   Memory Card

Exceptions

You cannot insert a memory card with the CPUs 312 IFM and 314 IFM (-5AE**0x**). These CPUs have an integrated read-only memory.

Purpose of the Memory Card

With the memory card, you can expand the load memory of your CPU.

You can store the user program and the parameters that set the responses of the CPU and modules on the memory card.

You can also back up your CPU operating system to a memory card except in the case of CPU 318-2 (see section 7.1).

If you store the user program on the memory card, it will remain in the CPU when the power is off even without a backup battery.

Available Memory Cards
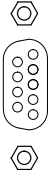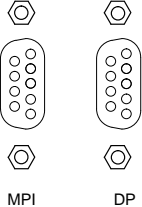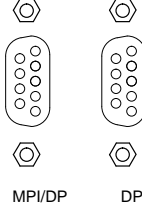
The following memory cards are available:

Table 8-3   Memory Cards

Capacity	Type	Remarks
16 KB	5 V FEPROM	The CPU supports the following functions:
32 KB		• Loading of the user program on the module into the CPU
64 KB		With this function, the memory of the CPU is reset, the user program is downloaded onto the memory card, and then uploaded from the memory card to the CPU's RAM.
256 KB		
128 KB		
512 KB		
1 MB		
2 MB		• Copying of RAM to ROM (not with the CPU 318-2)
4 MB		
128 KB	5 V RAM	Only with the CPU 318-2
256 KB		
512 KB		
1 MB		
2 MB		

8.1.5　MPI and PROFIBUS-DP Interface

Table 8-4　CPU Interfaces

CPU 312 IFM CPU 313 CPU 314 IFM CPU 314	CPU 315-2 DP CPU 316-2 DP		CPU 318-2	
MPI interface	MPI interface	PROFIBUS-DP interface	MPI/DP Interface	PROFIBUS-DP interface
MPI	MPI	DP	MPI/DP	DP
–	–	–	Reconfiguration as a PROFIBUS-DP interface is possible	–

MPI Interface

The MPI is the interface of the CPU for the programming device/OP and for communication in an MPI subnet.
The typical (preset) transmission rate is 187.5 kbps (CPU 318-2: can be set up to 12 Mbps)
You must set 19.2 kbps to communicate with a S7-200.

The CPU automatically broadcasts its set bus parameters (e.g. baud rate) at the MPI interface. This means that a programming device, for example, can automatically "hook up" to an MPI subnetwork.

PROFIBUS-DP Interface

CPUs with 2 interfaces offer you the PROFIBUS-DP interface, which allows them to be connected to a PROFIBUS-DP bus system. Transmission rates up to 12 Mbps are possible.

The CPU automatically broadcasts its set bus parameters (e.g. baud rate) at the PROFIBUS-DP interface. This means that a programming device, for example, can automatically "hook up" to a PROFIBUS subnetwork.

You can deactivate automatic broadcasting of bus parameters in STEP 7.

Connectable Devices

MPI	PROFIBUS-DP
• Programming device/PC and OP	• Programming device/PC and OP
• S7 programmable controller with MPI interface (S7-300, M7-300, S7-400, M7-400, C7-6xx)	• S7 programmable controllers with the PROFIBUS-DP interface (S7-200, S7-300, M7-300, S7-400, M7-400, C7-6xx)
• S7-200 (**Note:** only 19.2 kbps)	• Other DP masters and DP slaves

Only 19.2 Kbps for S7-200 in MPI Subnet

Note

At 19.2 kbps for communicating with S7-200,

– a **maximum of 8 nodes** (CPU, PD/OP, FM/CP with own MPI address) is permitted in a subnet, and

– **no global data communication** can be carried out.

Please consult the *S7-200 Manual* for further information!

Removing and Inserting Modules in the MPI Subnet

You must not plug in or remove any modules (SM, FM, CP) of an S7-300 configuration while data are being transmitted over the MPI.

Warning

If you remove or plug in S7-300 modules (SM, FM, CP) during data transmission via the MPI, the data might be corrupted by disturbing pulses.

You must not plug in or remove modules (SM, FM, CP) of an S7-300 configuration during data transmission via the MPI!

Loss of GD Packets Following Change in the MPI Subnet During Operation

---

<div>⚠</div>

Warning

Loss of data packets in the MPI subnet:

Connecting an additional CPU to the MPI subnet during operation can lead to loss of GD packets and to an increase in cycle time.

Remedy:
1. Disconnect the node to be connected from the supply.
2. Connect the node to the MPI subnet.
3. Switch the node on.

8.1.6　Clock and Runtime Meter

Table 8-5 shows the characteristics and functions of the clock for the various CPUs.

When you parameterize the CPU in *STEP 7*, you can also set functions such as synchronization and the correction factor (see the *STEP 7* online help system).

Table 8-5　Characteristics of the Clock of the CPUs

Characteristics	312 IFM	313	314	314 IFM	315	315-2 DP	316-2 DP	318-2
Type	Software clock		Hardware clock (integrated "real-time clock")					
Manufacturer setting	DT#1994-01-01-00:00:00							
Backup	Not possible		• Backup battery • Accumulator					
Operating hours counter	–	1						8
Number		0						0 to 7
Value range		0 to 32767 hours						0 to 32767 hours
Accuracy • With power supply switched on 0 to 60° C • With power supply switch off 0° C 25° C 40° C 60° C	... max deviation per day: ± 9s +2s to –5s ± 2s +2s to –3s +2s to –7s							

Behavior of Clock in POWER OFF Mode

The following table shows the clock behavior with the power of the CPU off, depending on the backup:

Backup	CPU 314 to 318-2	CPU 312 IFM and 313
With backup battery	The clock continues to operate in power off mode.	At POWER ON, the clock continues to operate using the clock time at which POWER OFF took place. Since the clock does not have a power buffer, it does not continue to run in POWER OFF mode.
With accumulator	The clock continues to operate in power off mode for the backup time of the accumulator. When the power is on, the accumulator is recharged.	
	In the event of backup failure, an error message is **not** generated. When the power comes on again, the clock continues at the clock time at which the power went off.	
None	At POWER ON, the clock continues to operate using the clock time at which POWER OFF took place. Since the CPU is not backed up, the clock does not continue at POWER OFF.	

8.2　Communication Options of the CPU

The CPUs offer you the following communication options:

Table 8-6　CPU Communication Options

Communications	MPI	DP	Description
PD/OP Communication	x	x	A CPU can maintain several on-line connections simultaneously with one or more programming devices or operator panels. For PD/OP communication via the DP interface, you must activate the "Programming, modifying and monitoring via the PROFIBUS" function when configuring and parameterizing the CPU.
S7 basic communication	x	x	Using the I system functions, you can transfer data over the MPI/DP network within an S7-300 (acknowledged data exchange). Data exchange takes place via unconfigured S7 connections.
	x	–	Using the X system functions, you can transfer data to other communication peers in the MPI subnet (acknowledged data exchange). Data exchange takes place via unconfigured S7 connections.
			The list of the I/X SFCs can be found in the *List of Instructions* and a detailed description in the *STEP 7* Online Help or the reference manual *System und Standard Functions*.
Routing of PD functions	x	x	With the 31x-2 CPUs and *STEP 7* V 5/0 or later, you can reach S7 stations online across subnet boundaries with the programming device/PC and, for example, load user programs or a hardware configuration or execute testing and commissioning functions. To route via the DP interface, you must activate the "Programming, modifying and monitoring via the PROFIBUS" function when configuring and parameterizing the CPU. You can find a detailed description of routing in the *STEP 7* online help system.
S7 Communication	x	–	S7 communication takes place via configured S7 connections. With these connections, the S7-300-CPUs act as servers for S7-400 CPUs. That means the S7-400 CPUs can write data to or read data from the S7-300 CPUs.
Global data communication	x	–	The CPUs of the S7-300/400 can exchange global data with one another (unacknowledged data exchange).

Connection Resources

Every communication connection requires a communication resource on the S7 CPU as a management unit for the duration of the communication. Every S7 CPU has a certain number of connection resources available to it according to its technical specifications which can be assigned to various communication services (PD/OP communication, S7 communication or S7 basic communication).

The allocation of connection resources varies between the the CPUs 312 IFM to 316-2 DP (see Table 10-6) and CPU 318-2 (see Table 8-8):

Connection Resources for CPUs 312 IFM to 316-2 DP

In the case of CPUs 315-2 DP and 316-2 DP, the connection resources are interface-dependent. That means that a PD communication connection uses a connection resource regardless of whether the connection is made via the MPI or the DP interface.

Table 8-7   Connection Resources for CPUs 312 IFM to 316-2 DP

Communication Function	Description
PD communication/ OP communication S7 basic communication	In order to make the allocation of connection resources dependent not only on the chronological sequence in which various communication services are registered, connection resources can be reserved for the following services: • PD communication and OP communication • S7 basic communication For PD/OP communication, at least one connection resource is reserved as the default setting. Lower values are not possible. The technical specifications of the CPUs detail the possible connection resources settings and the default settings in each case. "Reallocation" of connection resources is carried out in *STEP 7* in the process of assigning parameters for the CPU.
S7 communication	Other communication services such as S7 communication using PUT/GET functions can not use these communication resources even if they establish their connection at an earlier time. Instead, the remaining available connection resources that have not been specifically reserved for a particular service are used. Example based on CPU 314 which has 12 connection resources available: – You reserve 2 connection resources for PD communication – You reserve 6 connection resources for OP communication – You reserve 1 connection resource for S7 basic communication → There are then 3 connection resources remaining for S7 communication, PD/OP communication and S7 basic communication. **Note** on OP connection resources: with more than 3 OPs, error messages may occur due to temporary resource shortages on the CPU. Examples of such error messages are "44 Transmission error #13" or "#368 S7 communication error class 131 Nr. 4". Remedy: acknowledge the error messages manually or after a time delay configured in PROTOOL (in "System Messages" → "Display Period").
Routing of PD functions (CPU 31x-2 DP)	The CPUs provide connection resources for 4 routing connections. Those connection resources are available in addition.
Communication via a CP 343-1 with data lengths > 240 bytes for Send/Receive	The CP requires a free connection resource that is not reserved for PD/OP/S7 basic communication.

Connection Resources for CPU 318-2

Table 8-8   Connection Resources for CPU 318-2

Communication Function	Description
PD/OP communication	The CPU 318-2 provides a total of 32 connection resources (with CPU as connection terminal point) for these communication functions. Those 32 connection resources can be freely allocated to the various communication functions.
S7 basic communication	When allocating connection resources, you should observe the following points: • The number of connection resources differs for each interface as follows: – MPI/DP interface: 32 connection resources
Routing of PD functions	– DP-SS: 16 connection resources • In the case of connections that do not have the CPU as their terminal point (e.g. an FM or in the case of routing) you must deduct 2 connection resources from the total resources and 1 connection resource per interface.
S7 communication	Figure 8-3 shows the principle of allocation of connection resources. An example of how connection resources are calculated is given in Chapter 12.

Principle of Connection Resource Allocation for CPU 318-2
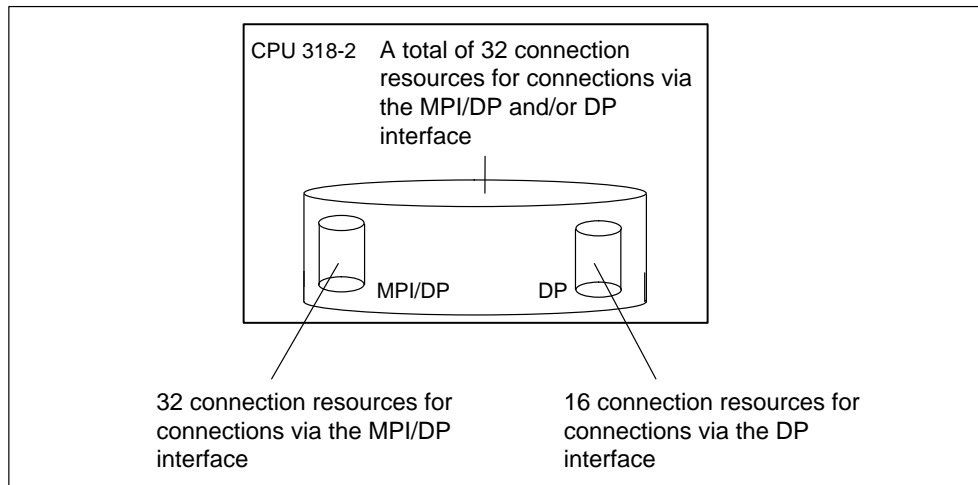
Figure 8-3   Principle of Connection Resource Allocation for CPU 318-2

Interface Resources for CPU 318-2 - Example Calculation

1.: 2 network transitions by routing on the CPU

That means that
– 2 MPI/DP interface connection resources are used;
– 2 DP interface connection resources are used;
– 4 connection resources that are available in total to both interfaces
   are used;

2.: 4 connections for S7 basic communication and PD/OP communication with the CPU as connection terminal point via the MPI/DP interface

That means that
– 4 MPI/DP interface connection resources are used;
– 4 connection resources that are available to both interfaces
   are used;

That means that **in total the following are free:**
– 26 of the MPI/DP interface connection resources;
– 14 of the DP interface connection resources;
– 24 of the connection resources that are available in total to both interfaces

Data Consistency for Communication

An essential aspect of the transmission of data between devices is its consistency. The data that is transmitted together should all originate from the same processing cycle and should thus belong together, i.e. be consistent.

If there is a programmed communication function such as X-SEND/ X-RCV which accesses shared data, then access to that data area can be coordinated by means of the parameter "BUSY" itself.

However, in the case of S7 communication functions such as PUT/GET or Read/Write using OP communication which do not require a block in the user program of the CPU 31x (as server), the extent of data consistency must be taken into account during the actual programming. The following differences between CPUs 312IFM to 316-2 DP and CPU 318-2 must be taken into account:

CPU 312 IFM to 316-2 DP	CPU 318-2
The PUT/GET functions for S7 communication or, as the case may be, the reading/writing of variables using OP communication are processed at the scan cycle checkpoint of the CPU. In order to ensure a defined process alarm response time, the communication variables are copied consistently in 32-byte blocks (CPU versions earlier than those described in this manual use 8-byte blocks) to/from the user memory at the operating system scan cycle checkpoint. Data consistency is not guaranteed for data areas that are any larger. If a defined level of data consistency is required, therefore, the communication variables in the user program must not be larger than 8 or 32 bytes. If you copy communication variables using SFC 81 "UBLKMOV", the copying process is not interrupted by higher priority classes.	With the CPU 318-2, the PUT/GET functions for S7 communication or, as the case may be, the reading/writing of variables using S7 communication are processed in defined time slices by the operating system. For that reason, the user program can be interrupted after every command (Byte/Word/Double Word command) when a communication variable is being accessed. The data consistency of a communication variable is therefore only possible within the limits of the command boundaries used in the user program. If the extent of data consistency required is greater than Byte, Word or Double Word, the communication variables in the user program must always be copied using SFC 81 ,"UBLKMOV", which guarantees consistent reading/writing of the complete communication variable area.

Detailed Information

You can find out more about communication in the *STEP 7* online help system and in the *Communication with SIMATIC* Manual.

... on the subject of the communication SFCs/SFBs can be found in the *STEP 7* Online Help and the Reference Manual *Standard and System Functions*.

Global Data Communication with S7-300 CPUs

Below you will find important features of global data communication in the S7-300.

Send and Receive Conditions

For the communication via GD circuits, you should observe the following conditions:

- The following must apply for a GB packet sender:
  Scan rate$_{sender}$ $\times$ Cycle time$_{sender}$ $\geq$ 60 ms (CPU 318-2: $\geq$ 10 ms)

- The following must apply for a GD packet receiver:
  Scan rate$_{receiver}$ $\times$ cycle time$_{receiver}$ < scan rate$_{sender}$ $\times$ cycle time$_{sender}$

Non-observance of these conditions can lead to the loss of a GD packet. The reasons for this are:

- The performance capability of the smallest CPU in the GD circuit

- Sending and receiving of global data is carried out asynchronously by the sender and receiver.

Loss of global data is displayed in the status field of a GD circuit if you have configured this with *STEP 7*.

Note

Please note the following in relation to global data communication: global data sent will not be acknowledged by the receiver!

The sender therefore receives no information on whether a receiver and which receiver has received the sent global data.

Send Cycles for Global Data

If you set "Send after every CPU cycle" in *STEP 7* (as of version 3.0) and the CPU has a short CPU cycle (< 60 ms), the operating system might overwrite an unsent CPU GD packet. **Tip:** The loss of global data is displayed in the status field of a GD circuit if you have configure this using *STEP 7*.

8.3   Testing Functions and Diagnostics

The CPUs provide you with:

- Testing functions for commissioning
- Diagnostics via LEDs and via *STEP 7*

8.3.1   Testing Functions

The CPUs offer you the following testing functions:

- Monitor Variables
- Modify Variables
- Forcen (note the differences between CPUs)
- Monitor block
- Set Breakpoint

You can find a detailed description of the testing functions in the *STEP 7* online help system.

Important with "Monitor Block"

The *STEP 7* function "Monitor Block" increases the cycle time of the CPU.

In *STEP 7* you can set a maximum permissible increase in cycle time (not in the case of the CPU 318-2). To do this, you must set "Process Mode" when setting the CPU parameters in *STEP 7*.

Different Features of Forcing S7-300

Please note the different features of forcing in the different CPUs:

CPU 318-2	CPU 312 IFM to 316-2 DP
The variables of a user program with fixed preset values (force values) cannot be changed or overwritten by the user program.	The variables of a user program with fixed preset values (force values) can be changed or overwritten in the user program. (See Figure 8-4 on page 8-20)
The following can be variables: Inputs/outputs Peripheral I/Os Memory markers You can force up to 256 variables.	The following can be variables: Inputs/Outputs You can force up to 10 variables.

Forcing with the CPU 312 IFM to 316-2 DP:

⚠️ **Caution**

The forced values in the process-image input table can be overwritten by write commands (for example T IB x, = I x.y, copy with SFC, etc.) as well as by peripheral read commands (for example L PIW x) in the user program or by PG/OP write functions!

Outputs initialized with forced values only return the forced value if the user program does not execute any write accesses to the outputs using peripheral write commands (e.g. T PQB x) and if no PG/OP functions write to these outputs!

Note: The interrupt response time may increase up to 5.5 ms if forcing is active.
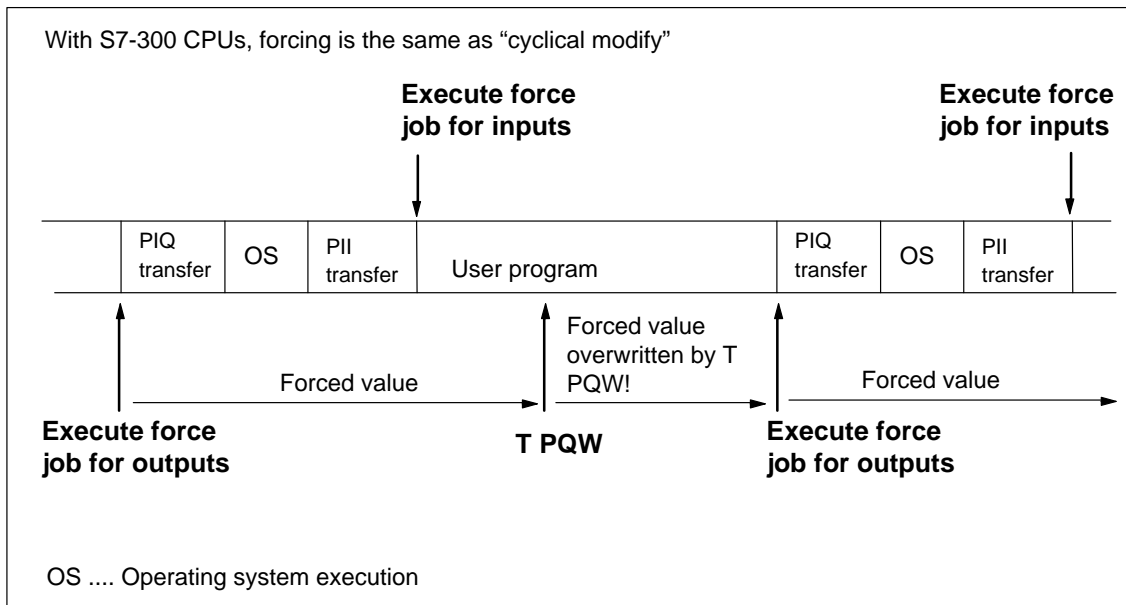
Figure 8-4   The Principle of Forcing with S7-300 CPUs (CPU 312 IFM to 316-2 DP)

8.3.2 Diagnosis with LED Displays

In Table 8-9, only the LEDs relevant to the diagnosis of the CPU and S7-300 are listed. You will find the significance of the PROFIBUS-DP interface LEDs explained in Chapter 9.

Table 8-9   Diagnostic LEDs of the CPU

LED		Description
SF	**Comes on** in the event of	Hardware faults Programming errors Parameter assignment errors Calculation errors Timing errors Faulty memory card Battery fault or no backup at power on I/O fault/error (external I/O only) Communication error
BATF	**Comes on** when	The backup battery is missing, faulty or not charged. **Note:** It also comes on when an accumulator is connected. The reason for this is that the user program is not backed up by the accumulator.
STOP	**Comes on** when	The CPU is not processing a user program
	Flashes when	The CPU requests a memory reset

8.3.3 Diagnosis with *STEP 7*

Note

Please note that despite the extensive monitoring and error response functions provided, this is not a safety-oriented or fault-tolerant system.

If an error occurs, the CPU enters the cause of the error in the diagnostic buffer. You can read the diagnostic buffer using the programming device.

When an error occurs or there is an interrupt event, the CPU either goes into STOP mode or you can respond in the user program via error or interrupt OBs. You will find a detailed description of diagnosis with *STEP 7* in the *STEP 7* online help system.

The *List of Instructions* provides a summary of

- Which errors or interrupt events you can respond to with which OBs
- Which OB you can program in which CPU

CPU Behavior When There Is No Error OB

If you have not programmed an error OB, the CPU reacts as follows:

CPU Goes to STOP with Missing ...	CPU Remains in RUN with Missing ...
OB 80 (Time-out)	OB 81 (Power supply fault)
OB 85 (Program execution error)	
OB 86 (Node failure in PROFIBUS-DP network)	
OB 87 (Communication error)	
OB 121 (Programming error)	
OB 122 (I/O direct access error)	

CPU Behavior When There Is No Interrupt OB

If you have not programmed an interrupt OB, the CPU reacts as follows:

CPU Goes to STOP with Missing ...	CPU Remains in RUN with Missing ...
OB 10/11 (Time-of-day interrupt)	OB 32/35 (Watchdog interrupt)
OB 20/21 (Delay interrupt)	
OB 40/41 (Process interrupt)	
OB 82 (Diagnostic interrupt)	

Tip for OB 35 (CPU 318-2: and OB 32)

For the watchdog interrupt OB 35/32, you can set times from 1 ms upwards. Note: The smaller the selected watchdog interrupt period, the more likely watchdog interrupt errors will occur. You must take into account the operating system times of the CPU in question, the runtime of the user program and the extension of the cycle by active programming device functions, for example.

8.4 CPUs – Technical Specifications

In This Section

- You will find the technical specifications of the CPU.
- You will find the technical specifications of the integrated inputs/outputs of the CPU 312 IFM and 314 IFM.
- You will **not** find the features of the CPU 31x-2 DP as a DP master/DP slave. Refer to Chapter 9.

Section	Contents	Page
8.4.1	CPU 312 IFM	8-24
8.4.2	CPU 313	8-36
8.4.3	CPU 314	8-39
8.4.4	CPU 314 IFM	8-42
8.4.5	CPU 315	8-59
8.4.6	CPU 315-2 DP	8-62
8.4.7	CPU 316-2 DP	8-66
8.4.8	CPU 318-2	8-70

8.4.1   CPU 312 IFM

Special Features

- Integrated inputs and outputs (wired up via a 20-pin front connector)
- No backup battery and therefore maintenance-free
- An S7-300 with CPU 312 IFM can be mounted only on one rack

Integrated Functions of the CPU 312 IFM

Integrated Functions	Description
Process interrupt	Interrupt inputs: Inputs parameterized in this way trigger a process interrupt at the corresponding signal edge. If you wish to use the digital inputs 124.6 to 125.1 as interrupt inputs, you must program these using *STEP 7*.
Counter	The CPU 312 IFM offers these special functions as an alternative at the digital inputs 124.6 to 125.1.
Frequency meter	For a description of the special functions "Counter" and "Frequency meter", please refer to the *Integrated Functions* Manual.

"Interrupt Inputs" of the CPU 312 IFM

If you wish to use the digital inputs 124.6 to 125.1 as interrupt inputs, you must program these in *STEP 7* in the CPU parameters.

Note the following points:

- These digital inputs have a very low signal delay. At this interrupt input, the module recognizes pulses with a length as of approx. 10 to 50 µs. In order to prevent interference pulses from triggering interrupts, you must connect shielded cables to the activated interrupt inputs (see Section 4.3.4).
  Note: The interrupt-triggering pulse must be at least 50 µs in length.

- The input status associated with an interrupt in the process image input table or with L PIB always changes with the normal input delay of approx. 3 ms.

Start Information for OB 40

Table 8-10 describes the relevant temporary (TEMP) variables of OB 40 for the "interrupt inputs" of the CPU 312 IFM. The process interrupt OB 40 is described in the *System and Standard Functions* Reference Manual.

Table 8-10   Start Information for OB 40 for the Interrupt Inputs of the Integrated I/Os

Byte	Variable	Data Type	Description	
6/7	OB40_MDL_ADDR	WORD	B#16#7C	Address of the interrupt triggering module (the CPU here)
8 on	OB40_POINT_ADDR	DWORD	See Figure 8-5	Signaling of the interrupt triggering integrated inputs

Display of the Interrupt Inputs

You can read which interrupt input has triggered a process interrupt from the variable OB40_POINT_ADDR. Figure 8-5 shows the allocation of the interrupt inputs to the bits of the double word.

Note: If interrupts of different inputs occur at very short intervals (< 100 µs apart), more than one bit can be set at the same time. This means that several interrupts may cause OB 40 to start only once.


```
31 30        5  4  3  2  1  0    Bit No.
┌──┬──┬ ─ ─ ┬──┬──┬──┬──┬──┐
│  │  │     │  │  │  │  │  │
└──┴──┴ ─ ─ ┴──┴──┴──┴──┴──┘
 └──────┬──────┘   │  │  │  └──── PRIN from   I 124.6
     Reserved      │  │  └─────── PRIN from   I 124.7
                   │  └────────── PRIN from   I 125.0
                   └───────────── PRIN from   I 125.1

PRIN: Process interrupt
```
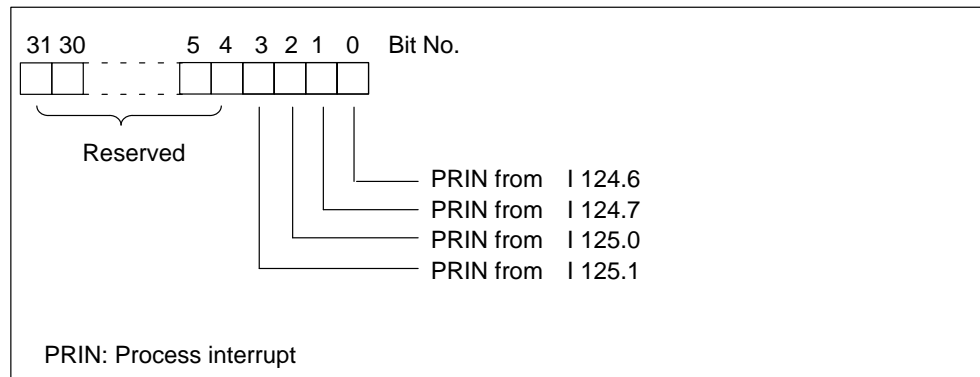
Figure 8-5   Display of the States of the Interrupt Inputs of the CPU 312 IFM

Front View

Status and
fault LEDs

Mode selector

Multipoint Interface
(MPI)

SF
DC5V
FRCE
RUN
STOP

SIEMENS

RUN-P
RUN

STOP
MRES

I124.0
I   1
I   2
I   3
I   4
I   5
I   6
I   7
I125.0

I   1
Q124.0
Q   1
Q   2
Q   3
Q   4
Q   5

Front connector
for front
connection of
the onboard I/O,
power supply
and functional
ground
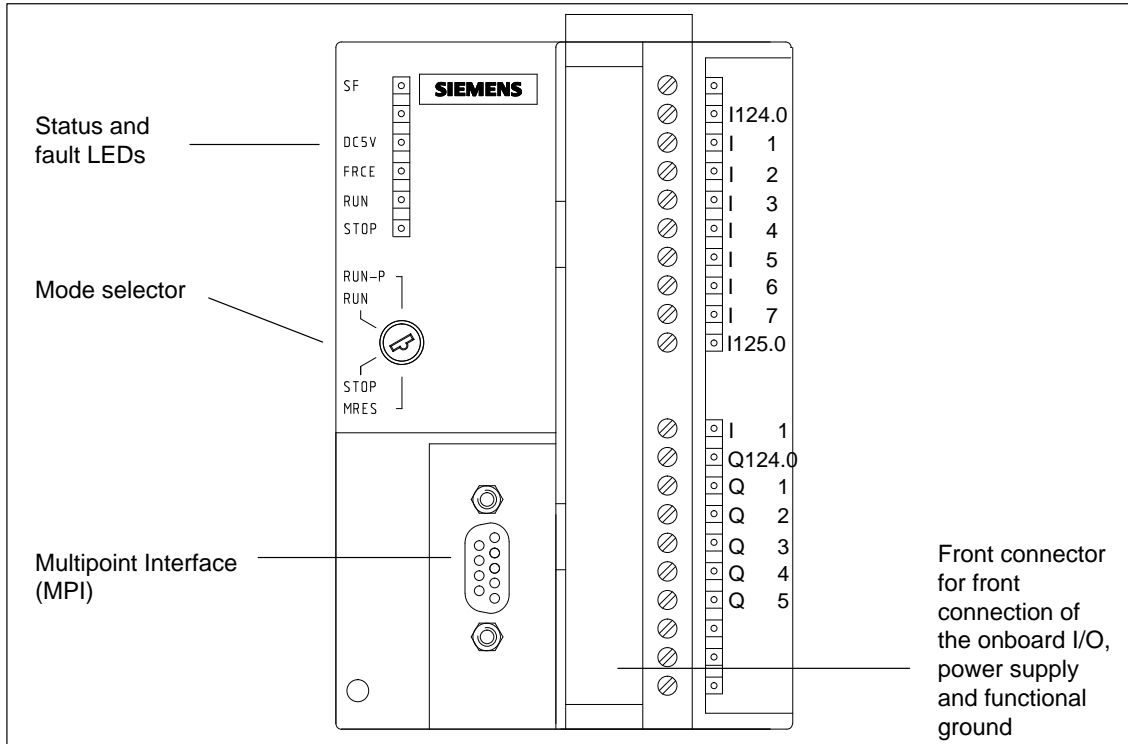
Figure 8-6   Front View of the CPU 312 IFM

Technical Specifications of the CPU 312 IFM

CPU and Product Version	
MLFB	6ES7 312-5AC02-0AB0
• Hardware version	01
• Firmware version	V 1.1.0
• Matching programming package	*STEP 7* V 5.0; Service Pack 03

Memory	
Work memory	
• Integral	6 KB
• Expandable	No
Load memory	
• Integral	20 KB RAM 20 KB EEPROM
• Expandable FEPROM	No
• Expandable RAM	No
Backup	Yes
• With battery	No
• Without battery	72 bytes retentive Parameterizable (data, flags, timers)

Processing times	
Processing times for	
• Bit instructions	0.6 µs minimum
• Word instructions	2 µs minimum
• Double integer math	3 µs minimum
• Floating-point math instructions	60 µs minimum

Timers/Counters and their retentive characteristics	
S7 counters	32
• Adjustable retentivity	from C 0 to C 31
• Preset	from C 0 to C 7
• Counting range	1 to 999
IEC Counters	Yes
• Type	SFBs
S7 timers	64
• Adjustable retentivity	No
• Timing range	10 ms to 9990 s
IEC Timers	Yes
• Type	SFBs

Data areas and their retentive characteristics	
Retentive data area as a whole (inc. flags, timers, counters)	max. 1 DB, 72 data bytes
Bit memories	1024
• Adjustable retentivity	MB 0 to MB 71
• Preset	MB 0 to MB 15
Clock memories	8 (1 memory byte)
Data blocks	max. 63 (DB 0 reserved)
• Size	max. 6 KB
• Adjustable retentivity	max. 1 DB, 72 bytes
• Preset	No retentivity
Local data (non-alterable)	max. 512 bytes
• Per priority class	256 bytes

Blocks	
OBs	See Instruction List
• Size	max. 6 KB
Nesting depth	
• Per priority class	8
• additional levels within an error OB	None
FBs	max. 32
• Size	max. 6 KB
FCs	max. 32
• Size	max. 6 KB

Address areas (inputs/outputs)	
Peripheral address area	
• Digital	0 to 31/0 to 31
– Integral	124,125 E/124 A
• Analog	256 to 383/256 to 383
Process image (non-alterable)	32 bytes+4 bytes integral/ 32 bytes+4 bytes integral
Digital channels	256+10 integral/256+6 integral
Analog channels	64/32

Configuration	
Rack	1
Modules per module rack	max. 8
DP Master	
• Integral	None
• via CP	Yes
S7 message functions	
Simultaneously active Alarm-S blocks	None
Time	
Real-time clock	Yes
• Backed-up	No
• Accuracy	See Section 8.1.6
Operating hours counter	No
Clock synchronisation	Yes
• On PLC	Master
• On MPI	Master/Slave
Testing and commissioning functions	
Status/Modify Variables	Yes
• Variable	Inputs, outputs, flags, DBs, timers, counters
• Number	
– Monitor Variables	max. 30
– Modify Variables	max. 14
Force	Yes
• Variable	Inputs, outputs
• Number	max. 10
Monitor block	Yes
Single sequence	Yes
Breakpoint	2
Diagnostic buffer	Yes
• Number of entries (non-alterable)	100

Communication functions	
PD/OP communication	Yes
Global data communication	Yes
• Number of GD packets	
– Sender	1
– Receiver	1
• Size of GD packets	max. 22 bytes
– Number of which consistent	8 bytes
S7 basic communication	Yes
• User data per job	max. 76 bytes
– Number of which consistent	32 bytes for X/I_PUT/_GET; 76 bytes for X_SEND/_RCV
S7 communication	Yes (server)
• User data per job	max. 160 bytes
– Number of which consistent	32 bytes
S5-compatible communication	No
Standard communication	No
Number of connection resources	6 for PD/OP/S7 basic/S7 communication
• Reservation for	
– PD communication User-definable Default	max. 5 from 1 to 5 1
– OP communication User-definable Default	max. 5 from 1 to 5 1
– S7 basic communication User-definable Default	max. 2 from 0 to 2 2
Interfaces	
1st interface	
Functionality	
• MPI	Yes
• DP Master	No
• DP Slave	No
• Galvanically isolated	No

MPI	
• Services	
– PD/OP communication	Yes
– Global data communication	Yes
– S7 basic communication	Yes
– S7 communication	Yes (server)
• Transmission rates	19.2; 187.5 kbps

Dimensions	
Installation dimensions W $\times$ H $\times$ D (mm)	80 $\times$ 125 $\times$ 130
Weight	approx. 0.45 kg

Programming	
Programming language	STEP 7
Stored instructions	See Instruction List
Nesting levels	8
System functions (SFCs)	See Instruction List
System function blocks (SFBs)	See Instruction List
User program security	Password protected

Voltages, Currents	
Power supply	24 V DC
• Permissible range	20,4 to 28,8 V
Power consumption (No load)	0.7 A (typical)
Inrush current	8 A (typical)
$I^2 t$	0.4 A^2s
External fusing for supply lines (recommendation)	Circuit breaker; 10 A, Type B or C
PG supply on MPI (15 to 30 V DC)	max. 200 mA
Power losses	9 W (typical)
Battery	No
Accumulator	No

Integrated inputs/outputs	
Addresses of integral	
• Digital inputs	E 124.0 to E 127.7
• Digital outputs	A 124.0 to A 124.7

Integrated Functions	
Counter	1 (see *Integrated Functions* manual)
Frequency meter	up to 10 kHz max. (see *Integrated Functions* manual)

Technical Specifications of the Special Inputs of the CPU 312 IFM

Module-Specific Data	
Number of inputs	4 I 124.6 to 125.1
Cable length	
• Shielded	max. 100 m (109 yd.)

Voltages, Currents, Potentials	
Number of inputs that can be triggered simultaneously	4
• (horizontal configuration)	
up to 60 °C	4
• (vertical configuration)	
up to 40 °C	4

Status, Interrupts; Diagnostics	
Status display	1 green LED per channel
Interrupts	
• Process interrupt	Parameterizable
Diagnostic functions	None

Sensor Selection Data	
Input voltage	
• Rated value	24 V DC
• For "1" signal I 125.0 and I 125.1 I 124.6 and I 124.7	 15 to 30 V 15 to 30 V
• For "0" signal	−3 to 5 V
Input current	
• For "1" signal I 125.0 and I 125.1 I 124.6 and I 124.7	 min. 2 mA min. 6.5 mA
Input delay time	
• For "0" to "1"	max. 50 μs
• For "1" to "0"	max. 50 μs
Input characteristic	
E 125.0 and E 125.1 E 124.6 and 124.7	to IEC 1131, type 1 to IEC 1131, type 1
Connection of 2-wire BEROs	No
• Permissible quiescent current I 125.0 and I 125.1 I 124.6 and I 124.7	 max. 0.5 mA max. 2 mA

Time, Frequency	
Internal conditioning time for	
• Interrupt processing	max. 1.5 ms
Input frequency	≤ 10 kHz

Technical Specifications of the Digital Inputs of the CPU 312 IFM

Note

Alternatively, you can parameterize the inputs I 124.6 and I 124.7 as special inputs, in which case the technical specifications listed for the special inputs apply to the inputs I 124.6 and I 124.7.

Module-Specific Data		Status, Interrupts; Diagnostics	
Number of inputs	8	Status display	1 green LED per channel
Cable length		Interrupts	None
• Unshielded	max. 600 m	Diagnostic functions	None
• Shielded	max. 1000 m		
Voltages, Currents, Potentials		**Sensor Selection Data**	
Number of inputs that can be triggered simultaneously	8	Input voltage	
• (horizontal configuration)		• Rated value	24 V DC
		• For "1" signal	11 to 30 V
up to 60 °C	8	• For "0" signal	–3 to 5 V
• (vertical configuration)		Input current	
up to 40 °C	8	• For "1" signal	7 mA (typical)
Galvanic isolation	No	Input delay time	
		• For "0" to "1"	1.2 to 4.8 ms
		• For "1" to "0"	1.2 to 4.8 ms
		Input characteristic	to IEC 1131, Type 2
		Connection of 2-wire BEROs	Possible
		• Permissible quiescent current	max. 2 mA

Technical Specifications of the Digital Outputs of the CPU 312 IFM

Module-Specific Data		Actuator Selection Data	
Module-Specific Data		**Actuator Selection Data**	
Number of outputs	6	Output voltage	
Cable length		• For "1" signal	min. L + (− 0.8 V)
• Unshielded	max. 600 m	Output current	
• Shielded	max. 1000 m	• For "1" signal	
Voltages, Currents, Potentials		Rated value	0.5 A
Total current of outputs (per group)		Permissible range	5 mA to 0.6 A
• (horizontal configuration)		• For "0" signal Residual current	max. 0.5 mA
up to 40 °C	max. 3 A	Load impedance range	48 Ω to 4 kW
up to 60 °C	max. 3 A	Lamp load	max. 5 W
• (vertical configuration)		Parallel connection of 2 outputs	
up to 40 °C	max. 3 A	• For dual-channel triggering of a load	Possible
Galvanic isolation	No	• For performance increase	Not possible
Status, Interrupts; Diagnostics		Triggering of a digital input	Possible
Status display	1 green LED per channel	Switching frequency	
Interrupts	None	• For resistive load	max. 100 Hz
Diagnostic functions	None	• For inductive load to IEC 947-5-1, DC 13	max. 0.5 Hz
		• For lamp load	max. 100 Hz
		Inductive breaking voltage limited internally to	30 V (typical)
		Short-citcuit protection of the output	Yes, electronically timed
		• Response threshold	1 A (typical)

Terminal Assignment Diagram of the CPU 312 IFM

Figure 8-7 shows the terminal assignment of the CPU 312 IFM. You wire the integrated inputs/outputs of the CPU using a 20-pin front connector (see Section 4.3.3).

> ⚠️ **Caution**
>
> The CPU 312 IFM has no reverse polarity protection. If the poles are reversed, the integral outputs are defective but despite this, the CPU does not go to STOP and the status LEDs light up. In other words, the fault is not indicated.
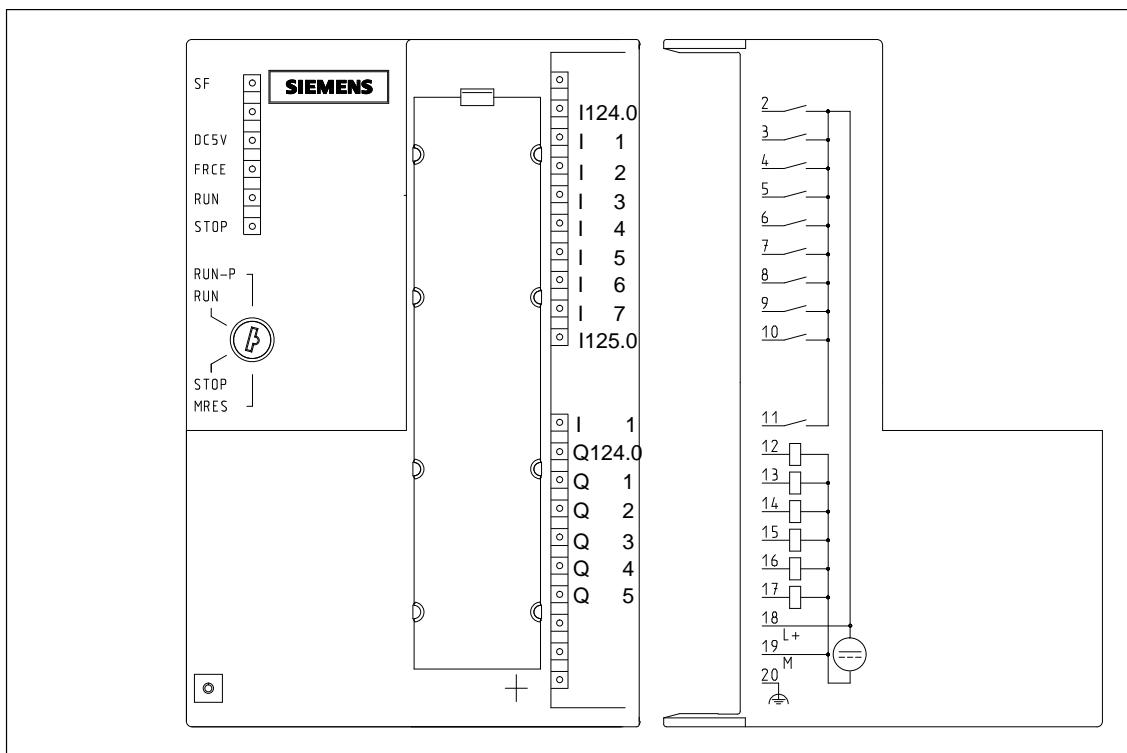
Figure 8-7   Terminal Assignment Diagram of the CPU 312 IFM

Grounded Configuration Only

You can use the CPU 312 IFM in a grounded configuration only. The functional ground is jumpered internally in the CPU 312 IFM with the M terminal (see Figure 8-8 on page 8-35).

Power Supply Connections

The power supply

- for CPU 312 IFM **and**

- for integrated I/Os

is connected to terminals 18 and 19 (see Figure 8-7).

Short-Circuit Characteristics

If a short-circuit occurs at one of the integral outputs of the CPU 312 IFM, you must proceed as follows:

1. Switch the CPU 312 IFM to STOP or switch off the power supply.

2. Remove the cause of the short-circuit.

3. Switch the CPU 312 IFM back to RUN or switch the power supply back on.

Basic Circuit Diagram of the CPU 312 IFM

Figure 8-8 shows the basic circuit diagram of the CPU 312 IFM.
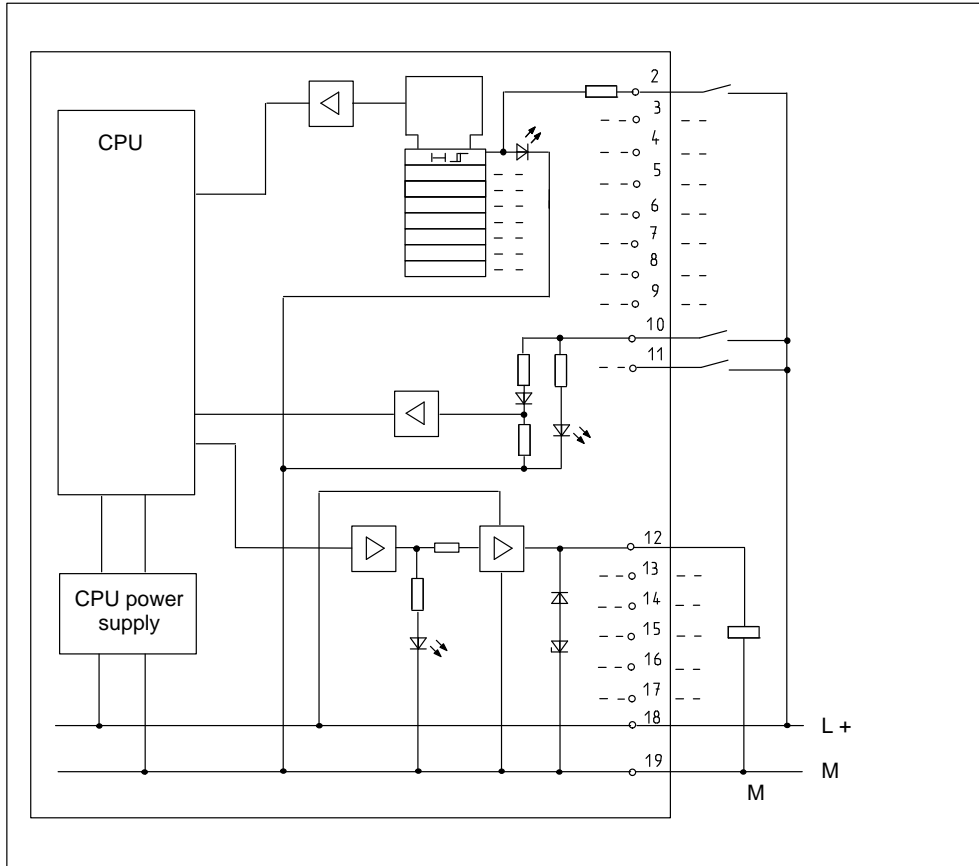
Figure 8-8   Basic Circuit Diagram of the CPU 312 IFM

8.4.2 CPU 313

Technical Specifications of the CPU 313

CPU and Product Version	
MLFB	6ES7 313-1AD03-0AB0
• Hardware version	01
• Firmware version	V 1.1.0
• Matching programming package	*STEP 7* V 5.0; Service Pack 03
Memory	
Work memory	
• Integral	12 KB
• Expandable	No
Load memory	
• Integral	20 KB RAM
• Expandable FEPROM	up to 4 MB
• Expandable RAM	No
Backup	Yes
• With battery	All data
• Without battery	72 bytes retentive Parameterizable (data, flags, timers)
Processing times	
Processing times for	
• Bit instructions	0.6 µs minimum
• Word instructions	2 µs minimum
• Double integer math	2 µs minimum
• Floating-point math instructions	60 µs minimum
Timers/Counters and their retentive characteristics	
S7 counters	64
• Adjustable retentivity	from C 0 to C 63
• Preset	from C 0 to C 7
• Counting range	1 to 999
IEC Counters	Yes
• Type	SFB
S7 timers	128
• Adjustable retentivity	from T 0 to T 31
• Preset	No retentive times
• Timing range	10 ms to 9990 s
IEC Timers	Yes
• Type	SFB

Data areas and their retentive characteristics	
Retentive data area as a whole (inc. flags, timers, counters)	max. 1 DB, 72 data bytes
Bit memories	2048
• Adjustable retentivity	MB 0 to MB 71
• Preset	MB 0 to MB 15
Clock memories	8 (1 memory byte)
Data blocks	max. 127 (DB 0 reserved)
• Size	max. 8 KB
• Adjustable retentivity	1 DB, 72 bytes
• Preset	No retentivity
Local data (non-alterable)	max. 1536 bytes
• Per priority class	256 bytes
Blocks	
OBs	See Instruction List
• Size	max. 8 KB
Nesting depth	
• Per priority class	8
• additional levels within an error OB	4
FBs	128
• Size	max. 8 KB
FCs	128
• Size	max. 8 KB
Address areas (inputs/outputs)	
Peripheral address area	
• Digital	0 to 31/0 to 31
• Analog	256 to 383/256 to 383
Process image (non-alterable)	32 bytes/32 bytes
Digital channels	max. 256/256
Analog channels	max. 64/32

Configuration	
Rack	1
Modules per module rack	max. 8
Number of DP masters	
• Integral	No
• via CP	1

S7 message functions	
Simultaneously active Alarm-S blocks	None

Time	
Real-time clock	Yes
• Backed-up	No
• Accuracy	See Section 8.1.6
Operating hours counter	1
• Number	0
• Value range	0 to 32767 hours
• Selectivity	1 hour
• Retentive	Yes
Clock synchronisation	Yes
• On PLC	Master
• On MPI	Master/Slave

Testing and commissioning functions	
Status/Modify Variables	Yes
• Variable	Inputs, outputs, flags, DBs, timers, counters
• Number	
– Monitor Variables	max. 30
– Modify Variables	max. 14
Force	Yes
• Variable	Inputs, outputs
• Number	max. 10
Monitor block	Yes
Single sequence	Yes
Breakpoint	2
Diagnostic buffer	Yes
• Number of entries (non-alterable)	100

Communication functions	
PD/OP communication	Yes
Global data communication	Yes
• Number of GD packets	
– Sender	1
– Receiver	1
• Size of GD packets	max. 22 bytes
– Number of which consistent	8 bytes
S7 basic communication	Yes
• User data per job	max. 76 bytes
– Number of which consistent	32 bytes for X/I_PUT/_GET; 76 bytes for X_SEND/_RCV
S7 communication	Yes (server)
• User data per job	max. 160 bytes
– Number of which consistent	32 bytes
S5-compatible communication	No
Standard communication	No
Number of connection resources	8 for PD/OP/S7 basic/S7 communication
• Reservation for	
– PD communication User-definable Default	max. 7 from 1 to 7 1
– OP communication User-definable Default	max. 7 from 1 to 7 1
– S7 basic communication User-definable Default	max. 4 from 0 to 4 4

Interfaces	
1st Interface	
Functionality	
• MPI	Yes
• DP Master	No
• DP Slave	No
• Galvanically isolated	No

MPI	
• Services	
– PD/OP communication	Yes
– Global data communication	Yes
– S7 basic communication	Yes
– S7 communication	Yes (server)
• Transmission rates	19.2; 187.5 kbps

Dimensions	
Installation dimensions $W \times H \times D$ (mm)	$80 \times 125 \times 130$
Weight	approx. 0.53 kg

Programming	
Programming language	STEP 7
Stored instructions	See Instruction List
Nesting levels	8
System functions (SFCs)	See Instruction List
System function blocks (SFBs)	See Instruction List
User program security	Password protected

Voltages, Currents	
Power supply	24 V DC
• Permissible range	20,4 to 28,8
Power consumption (No load)	0.7 A (typical)
Inrush current	8 A (typical)
$I^2 t$	$0.4\ A^2s$
External fusing for supply lines (recommendation)	Circuit breaker; 2A Type B or C
PD supply at MPI (15 to 30 V DC)	max. 200 mA
Power losses	8 W (typical)
Battery	
• Backup period at 25°C and uninterrupted backup of the CPU	min. 1 year
• Storage life of battery at 25°C	approx. 5 years
Accumulator	No

8.4.3   CPU 314

Technical Specifications of the CPU 314

CPU and Product Version	
MLFB	6ES7 314-1AE04-0AB0
• Hardware version	01
• Firmware version	V 1.1.0
• Matching programming package	*STEP 7* V 5.0; Service Pack 03

Memory	
Work memory	
• Integral	24 KB
• Expandable	No
Load memory	
• Integral	40 KB RAM
• Expandable FEPROM	up to 4 MB
• Expandable RAM	No
Backup	Yes
• With battery	All data
• Without battery	4736 bytes, configurable, (data, flags, timers)

Processing times	
Processing times for	
• Bit instructions	0.3 µs minimum
• Word instructions	1 µs minimum
• Double integer math	2 µs minimum
• Floating-point math instructions	50 µs minimum

Timers/Counters and their retentive characteristics	
S7 counters	64
• Adjustable retentivity	from C 0 to C 63
• Preset	from C 0 to C 7
• Counting range	0 to 999
IEC Counters	Yes
• Type	SFB
S7 timers	128
• Adjustable retentivity	from T 0 to T 127
• Preset	No retentive times
• Timing range	10 ms to 9990 s
IEC Timers	Yes
• Type	SFB

Data areas and their retentive characteristics	
Retentive data area as a whole (inc. flags, timers, counters)	4736 bytes
Bit memories	2048
• Adjustable retentivity	MB 0 to MB 255
• Preset	MB 0 to MB 15
Clock memories	8 (1 memory byte)
Data blocks	max. 127 (DB 0 reserved)
• Size	max. 8 KB
• Adjustable retentivity	max. 8 DB, 4096 data bytes in all
• Preset	No retentivity
Local data (non-alterable)	max. 1536 bytes
• Per priority class	256 bytes

Blocks	
OBs	See Instruction List
• Size	max. 8 KB
Nesting depth	
• Per priority class	8
• additional levels within an error OB	4
FBs	max. 128
• Size	max. 8 KB
FCs	max. 128
• Size	max. 8 KB

Address areas (inputs/outputs)	
Peripheral address area	
• Digital	0 to 127/0 to 127
• Analog	256 to 767/256 to 767
Process image (non-alterable)	128 bytes/128 bytes
Digital channels	max. 1024/1024
Analog channels	max. 256/128

Configuration	
Rack	max. 4
Modules per module rack	max. 8
Number of DP masters	
• Integral	None
• via CP	1
S7 message functions	
Simultaneously active Alarm-S blocks	max. 40
Time	
Real-time clock	Yes
• Backed-up	Yes
• Accuracy	See Section 8.1.6
Operating hours counter	1
• Number	0
• Value range	0 to 32767 hours
• Selectivity	1 hour
• Retentive	Yes
Clock synchronisation	Yes
• On PLC	Master
• On MPI	Master/Slave
Testing and commissioning functions	
Status/Modify Variables	Yes
• Variable	Inputs, outputs, flags, DBs, timers, counters
• Number	
– Monitor Variables	max. 30
– Modify Variables	max. 14
Force	Yes
• Variable	Inputs, outputs
• Number	max. 10
Monitor block	Yes
Single sequence	Yes
Breakpoint	2
Diagnostic buffer	Yes
• Number of entries (non-alterable)	100

Communication functions	
PD/OP communication	Yes
Global data communication	Yes
• Number of GD packets	
– Sender	1
– Receiver	1
• Size of GD packets	max. 22 bytes
– Number of which consistent	8 bytes
S7 basic communication	Yes
• User data per job	max. 76 bytes
– Number of which consistent	32 bytes for X/I_PUT/_GET; 76 bytes for X_SEND/_RCV
S7 communication	Yes (server)
• User data per job	max. 160 bytes
– Number of which consistent	32 bytes
S5-compatible communication	Yes (via CP and loadable FC)
• User data per job	Dependent on CP
– Number of which consistent	Dependent on CP
Standard communication	Yes (via CP and loadable FC)
• User data per job	Dependent on CP
– Number of which consistent	Dependent on CP
Number of connection resources	12 for PD/OP/S7 basic/S7 communication
• Reservation for	
– PD communication User-definable Default	max. 11 from 1 to 11 1
– OP communication User-definable Default	max. 11 from 1 to 11 1
– S7 basic communication User-definable Default	max. 8 from 0 to 8 8
Interfaces	
1st interface	
Functionality	
• MPI	Yes
• DP Master	No
• DP Slave	No
• Galvanically isolated	No

MPI	
• Services	
– PD/OP communication	Yes
– Global data communication	Yes
– S7 basic communication	Yes
– S7 communication	Yes (server)
• Transmission rates	19.2; 187.5 kbps

Dimensions	
Installation dimensions W × H × D (mm)	80 × 125 × 130
Weight	approx. 0.53 kg

Programming	
Programming language	STEP 7
Stored instructions	See Instruction List
Nesting levels	8
System functions (SFCs)	See Instruction List
System function blocks (SFBs)	See Instruction List
User program security	Password protected

Voltages, Currents	
Power supply	24 V DC
• Permissible range	20.4 V to 28.8 V
Power consumption (No load)	0.7 A (typical)
Inrush current	8 A (typical)
$I^2 t$	0.4 A^2s
External fusing for supply lines (recommendation)	Circuit breaker; 2 A, Type B or C
PD supply at MPI (15 to 30 V DC)	max. 200 mA
Power losses	8 W (typical)
Battery	Yes
• Backup period at 25°C and uninterrupted backup of the CPU	min. 1 year
• Storage life of battery at 25°C	approx. 5 years
Accumulator	Yes
• Clock back-up period	
– At 0 to 25° C	approx. 4 weeks
– At 40° C	approx. 3 weeks
– At 60° C	approx. 1 week
• Battery charging time	approx. 1 hour

8.4.4   CPU 314 IFM

Special Features

- Integrated inputs/outputs (wired up via 40-pin front connectors)

You can find detailed information on analog value processing and on connecting measuring sensors and loads/actuators to the analog inputs/outputs in the *Module Specifications* Reference Manual. Figures 8-14 and 8-15 on page 8-58 show wiring examples.

Memory card

There are two versions of the CPU 314 IFM, i.e. with or without slot for memory card.

- With slot for memory card: 6ES7 314-5AE**10**-0AB0
- Without slot for memory card: 6ES7 314-5AE**0x**-0AB0

Integrated Functions of the CPU 314 IFM

Integrated Functions	Description
Process interrupt	Interrupt inputs: Inputs parameterized in this way trigger a process interrupt at the corresponding signal edge.
	If you wish to use the digital inputs 126.0 to 126.3 as interrupt inputs, you must program these using *STEP 7*.
	Note: To prevent the interrupt response times of the CPU being increased, you should address the analog inputs of the CPU separately in the user program using L PIW. Double-word addressing can increase the access times by up to 200 μs!
Counter	The CPU 314 IFM offers these special functions as an alternative at digital inputs 126.0 to 126.3. For a description of these special functions, please refer to the *Integrated Functions* Manual.
Frequency meter	
Counter A/B	
Positioning	
CONT_C	These functions are not restricted to specific inputs and outputs of the CPU 314 IFM. For a description of these functions, please refer to the *System and Standard Functions* Reference Manual.
CONT_S	
PULSEGEN	

"Interrupt Inputs" of the CPU 314 IFM

If you wish to use the digital inputs 126.0 to 126.4 as interrupt inputs, you must program these in *STEP 7* in the CPU parameters.

Note the following points:

These digital inputs have a very low signal delay. At this interrupt input, the module recognizes pulses with a length as of approx. 10 to 50 μs. In order to prevent interference pulses from triggering interrupts, you must connect shielded cables to the activated interrupt inputs (see Section 4.3.4).

Note: The interrupt-triggering pulse must be at least 50 μs in length.

Start Information for OB 40

Table 8-10 describes the relevant temporary (TEMP) variables of OB 40 for the "interrupt inputs" of the CPU 314 IFM. The process interrupt OB 40 is described in the *System and Standard Functions* Reference Manual.

Table 8-11   Start Information for OB 40 for the Interrupt Inputs of the Integrated I/Os

Byte	Variable	Data Type		Description
6/7	OB40_MDL_ADDR	WORD	B#16#7C	Address of the interrupt triggering module (the CPU here)
8 on	OB40_POINT_ADDR	DWORD	See Figure 8-9	Signaling of the interrupt triggering integrated inputs

Display of the Interrupt Inputs

You can read which interrupt input has triggered a process interrupt from the variable OB40_POINT_ADDR. Figure 8-9 shows the allocation of the interrupt inputs to the bits of the double word.

Note: If interrupts of different inputs occur at very short intervals (< 100 μs apart), more than one bit can be set at the same time. This means that several interrupts may cause OB 40 to start only once.
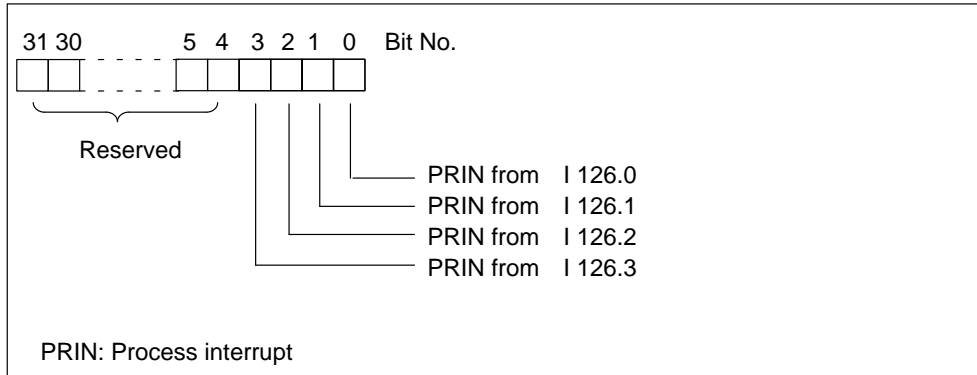
Figure 8-9   Display of the States of the Interrupt Inputs of the CPU 314 IFM

Front View of the CPU 314 IFM

① Status and fault LEDs
② Mode selector
③ Compartment for backup battery or accumulator
④ Jumper (removable)
⑤ Terminals for power supply and functional ground
⑥ Multipoint Interface (MPI)
⑦ Integrated inputs/outputs
⑧ Slot for memory card (-5AE**10**- only)
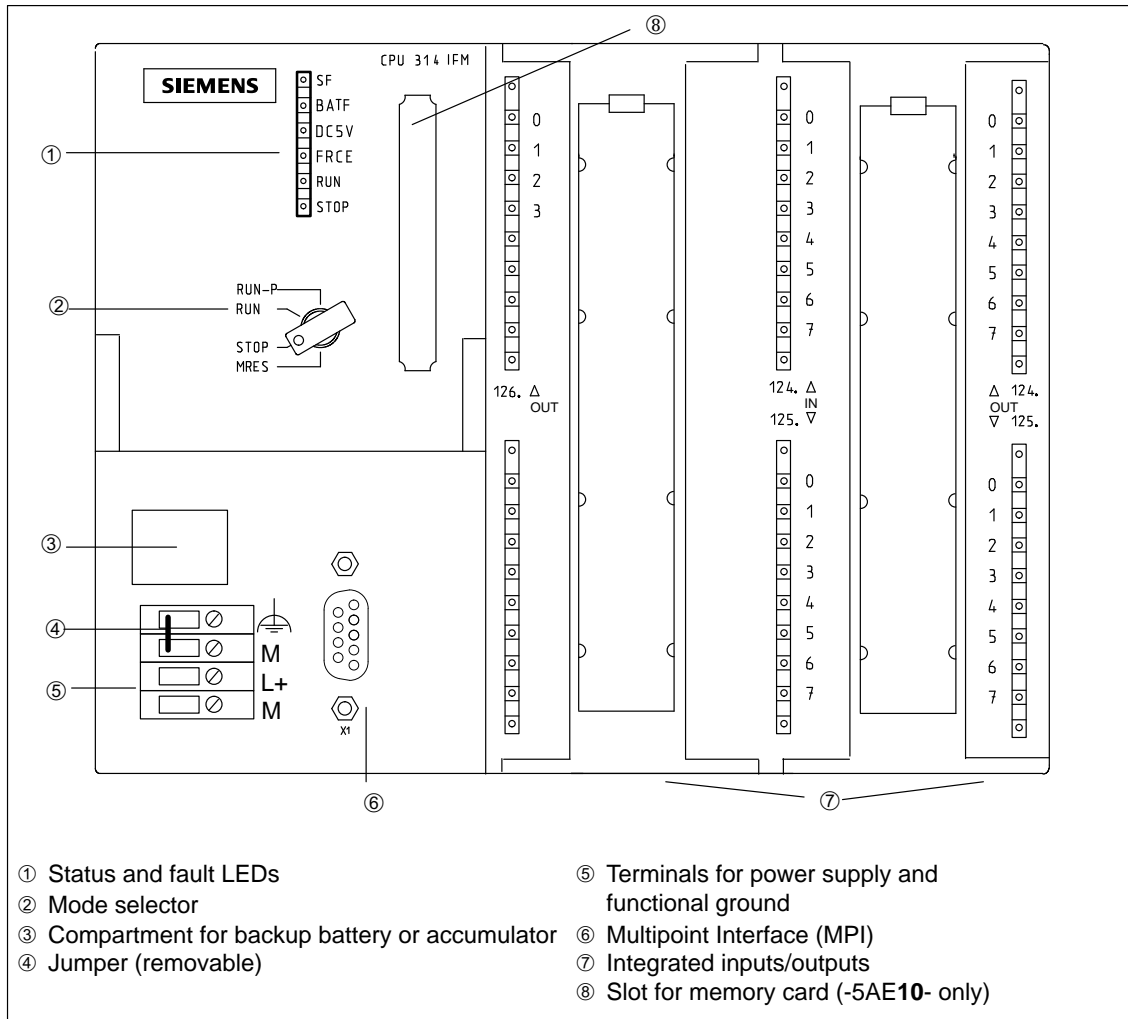
Figure 8-10   Front View of the CPU 314 IFM

Technical Specifications of the CPU 314 IFM

CPU and Product Version		
MLFB 6ES7 314-...-0AB0	-5AE**03**-01	-5AE**10**-01
• Hardware version	01	01
• Firmware version	V 1.1.0	V 1.1.0
• Matching programming package	*STEP 7* V5.0, Service Pack 3	

Memory		
Work memory		
• Integral	32 KB	32 KB
• Expandable	No	No
Load memory		
• Integral	48 KB RAM 48 KB FEPROM	48 KB RAM
• Expandable FEPROM	No	up to 4 MB
• Expandable RAM	No	No
Backup	Yes	
• With battery	All data	
• Without battery	144 bytes	

Processing times	
Processing times for	
• Bit instructions	0.3 μs minimum
• Word instructions	1 μs minimum
• Double integer math	2 μs minimum
• Floating-point math instructions	50 μs minimum

Timers/Counters and their retentive characteristics	
S7 counters	64
• Adjustable retentivity	from C 0 to C 63
• Preset	from C 0 to C 7
• Counting range	0 to 999
IEC Counters	Yes
• Type	SFB
S7 timers	128
• Adjustable retentivity	from T 0 to T 7
• Preset	No retentive times
• Timing range	10 ms to 9990 s
IEC Timers	Yes
• Type	SFB

Data areas and their retentive characteristics	
Retentive data area as a whole (inc. flags, timers, counters)	max. 2 DB, 144 bytes
Bit memories	2048
• Adjustable retentivity	MB 0 to MB 143
• Preset	MB 0 to MB 15
Clock memories	8 (1 memory byte)
Data blocks	max. 127 (DB 0 reserved)
• Size	max. 8 KB
• Adjustable retentivity	max. 2 DB, 144 data bytes
• Preset	No retentivity
Local data (non-alterable)	1536 bytes
• Per priority class	256 bytes

Blocks	
OBs	See Instruction List
• Size	max. 8 KB
Nesting depth	
• Per priority class	8
• additional levels within an error OB	4
FBs	128
• Size	max. 8 KB
FCs	128
• Size	max. 8 KB

Address areas (inputs/outputs)	
Peripheral address area	
• Digital	0 to 123/0 to 123
– Integral	124 to 127/124, 125
• Analog	256 to 751/256 to 751
– Integral	128 to 135/128, 129
Process image (non-alterable)	128 bytes/128 bytes
Digital channels	max. 992+20 integral/ max. 992+16 integral
Analog channels	max. 248+4 integral/ max. 124+1 integral

Configuration	
Rack	max. 4
Modules per module rack	max. 8; max. 7 in module rack 3
Number of DP masters	
• Integral	None
• via CP	1
S7 message functions	
Simultaneously active Alarm-S blocks	max. 40
Time	
Real-time clock	Yes
• Backed-up	Yes
• Accuracy	See Section 8.1.6
Operating hours counter	1
• Number	0
• Value range	0 to 32767 hours
• Selectivity	1 hour
• Retentive	Yes
Clock synchronisation	Yes
• On PLC	Master
• On MPI	Master/Slave
Testing and commissioning functions	
Status/Modify Variables	Yes
• Variable	Inputs, outputs, flags, DBs, timers, counters
• Number	
– Monitor Variables	max. 30
– Modify Variables	max. 14
Force	Yes
• Variable	Inputs, outputs
• Number	max. 10
Monitor block	Yes
Single sequence	Yes
Breakpoint	2
Diagnostic buffer	Yes
• Number of entries (non-alterable)	100

Communication functions	
PD/OP communication	Yes
Global data communication	Yes
• Number of GD packets	
– Sender	1
– Receiver	1
• Size of GD packets	max. 22 bytes
– Number of which consistent	8 bytes
S7 basic communication	Yes
• User data per job	max. 76 bytes
– Number of which consistent	32 bytes for X/I_PUT/_GET; 76 bytes for X_SEND/_RCV
S7 communication	Yes (server)
• User data per job	max. 160 bytes
– Number of which consistent	32 bytes
S5-compatible communication	Yes (via CP and loadable FC)
• User data per job	Dependent on CP
– Number of which consistent	Dependent on CP
Standard communication	Yes (via FC and loadable FC)
• User data per job	Dependent on CP
– Number of which consistent	Dependent on CP
Number of connection resources	12 for PD/OP/S7 basic/S7 communication
• Reservation for	
– PD communication User-definable Default	max. 11 from 1 to 11 1
– OP communication User-definable Default	max. 11 from 1 to 11 1
– S7 basic communication User-definable Default	max. 8 from 0 to 8 8
Interfaces	
1st interface	
Functionality	
• MPI	Yes
• DP Master	No
• DP Slave	No
• Galvanically isolated	No

MPI	
• Services	
– PD/OP communication	Yes
– Global data communication	Yes
– S7 basic communication	Yes
– S7 communication	Yes (server)
• Transmission rates	19.2; 187.5 kbps

Dimensions	
Installation dimensions $W \times H \times D$ (mm)	$160 \times 125 \times 130$
Weight	approx. 0.9 kg

Programming	
Programming language	STEP 7
Stored instructions	See Instruction List
Nesting levels	8
System functions (SFCs)	See Instruction List
System function blocks (SFBs)	See Instruction List
User program security	Password protected

Voltages, Currents	
Power supply	24 V DC
• Permissible range	20,4 to 28,8 V
Power consumption (No load)	1.0 A (typical)
Inrush current	8 A (typical)
$I^2 t$	0.4 A^2s
External fusing for supply lines (recommendation)	Circuit breaker; 2 A Type B or C

PD supply at MPI (15 to 30 V DC)	max. 200 mA
Power losses	16 W (typical)
Battery	Yes
• Backup period at 25°C and uninterrupted backup of the CPU	min. 1 year
• Storage life of battery at 25°C	approx. 5 years
Accumulator	Yes
• Clock back-up period	
– At 0 to 25° C	approx. 4 weeks
– At 40° C	approx. 3 weeks
– At 60° C	approx. 1 week
• Battery charging time	approx. 1 hour

Integrated inputs/outputs	
Addresses of Integral	
• Digital inputs	E 124.0 to E 127.7
• Digital outputs	A 124.0 to A 127.7
• Analog inputs	PIW 128 to PIW 134
• Analog outputs	PQW 128

Integrated Functions	
Counter	1 or 2, 2 directional comparisons
	(see *Integrated Functions*) manual
Frequency meter	up to 10 kHz max.
	(see *Integrated Functions*) manual
Positioning	Channel 1
	(see *Integrated Functions*) manual

Characteristic Features of the Integrated Inputs and Outputs of the CPU 314 IFM

Table 8-12 Characteristic Features of the Integrated Inputs and Outputs of the CPU 314 IFM

Inputs/Outputs	Characteristics	
Analog inputs	• Voltage inputs ±10 V • Current inputs ±20 mA • Resolution 11 bits + sign bit • Galvanically isolated	All information required for • Analog value display and • Connecting measuring sensors and loads/actuators to the analog inputs and outputs can be found in the *Module Specifications* Reference Manual.
Analog output	• Voltage output ±10 V • Current output ±20 mA • Resolution 11 bits + sign bit • Galvanically isolated	
Digital inputs	**Special Inputs (I 126.0 to I 126.3)** • Input frequency up to 10 kHz • Non-isolated	**"Standard" Inputs** • Galvanically isolated
	• Rated input voltage 24 V DC • Suitable for switch and 2-wire proximity switches (BEROs)	
Digital outputs	• Output current 0.5 A • Rated load voltage 24 V DC • Galvanically isolated • Suitable for solenoid valves and DC contactors	

Technical Specifications of the Analog Inputs of the CPU 314 IFM

Module-Specific Data	
Number of inputs	4
Cable length	
• Shielded	max. 100 m (109 yd.)

Voltages, Currents, Potentials	
Galvanic isolation	
• Between channels and backplane bus	Yes
Permissible potential difference	
• Between inputs and M_{ANA} (U_{CM})	1.0 V DC
• Between M_{ANA} and $M_{internal}$ (U_{ISO})	75 V DC 60 V AC
Insulation tested at	500 V DC

Analog Value Generation	
Measuring principle	Momentary value encoding (successive approximation)
Conversion time/resolution (per channel)	
• Basic conversion time	
• Resolution (inc. overdrive range)	100 μs 11 bits + sign bit

Interference Suppression, Error Limits	
Interference voltage suppression	
• Common-mode interference (U_{CM} < 1.0 V)	> 40 dB
Crosstalk between the inputs	> 60 dB
Operational error limits (throughout temperature range, relative to input range)	
• Voltage input	± 1.0 %
• Current input	± 1.0 %

Interference Suppression, Error Limits, Continued	
Basic error limits (operational limit at 25 °C, relative to input range)	
• Voltage input	± 0.9 %
• Current input	± 0.8 %
Temperature error (related to input range)	± 0.01 %/K
Linearity error (related to input range)	± 0.06 %
Repeatability (in the settled state at 25 °C, relative to input range)	± 0.06 %

Status, Interrupts; Diagnostics	
Interrupts	None
Diagnostic functions	None

Sensor Selection Data	
Input ranges (rated value)/input resistance	
• Voltage	± 10 V/50 kΩ
• Current	± 20 mA/105.5 Ω
Permissible input voltage for voltage input (destruction limit)	max. 30 V continuous; 38 V for max. 1 s (pulse duty factor 1:20)
Permissible input current for current input (destruction limit)	34 mA
Connection of signal encoders	
• For voltage measurement	Possible
• For current measurement	
as 2-wire measurement transducer	Not possible
as 4-wire measurement transducer	Possible

Technical Specifications of the Analog Output of the CPU 314 IFM

Module-Specific Data	
Number of outputs	1
Cable length	
• Shielded	max. 100 m (109 yd.)

Voltages, Currents, Potentials	
Galvanic isolation	
• Between channels and backplane bus	Yes
Permissible potential difference	
• Between M_{ANA} and $M_{internal}$ (U_{ISO})	75 V DC 60 V AC
Insulation tested at	500 V DC

Analog Value Generation	
Resolution (inc. overdrive range)	11 bits + sign bit
Conversion time	40 μs
Settling time	
• For resistive load	0.6 ms
• For capacitive load	1.0 ms
• For inductive load	0.5 ms
Connection of substitute values	No

Interference Suppression, Error Limits	
Operational error limits (throughout temperature range, relative to output range)	
• Voltage output	± 1.0 %
• Current output	± 1.0 %
Basic error limit (operational limit at 25 °C, relative to output range)	
• Voltage output	± 0.8 %
• Current output	± 0.9 %
Temperature error (relative to output range)	± 0.01 %/K
Linearity error (relative to output range)	± 0.06 %
Repeat accuracy (in the settled state at 25 °C, relative to output range)	± 0.05 %

Output ripple; Range 0 to 50 kHz (relative to output range)	± 0.05 %

Status, Interrupts; Diagnostics	
Interrupts	None
Diagnostic functions	None

Actuator Selection Data	
Output ranges (rated values)	
• Voltage	± 10 V
• Current	± 20 mA
Load impedance	
• For voltage output	min. 2.0 kΩ
capacitive load	max. 0.1 μF
• For current output	max. 300 Ω
inductive load	max. 0.1 mH
Voltage output	
• Short-circuit protection	Yes
• Short-circuit current	max. 40 mA
Current output	
• Idle voltage	max. 16 V
Destruction limit for externally applied voltages/currents	
• Voltages at the output with ref. to M_{ANA}	max. ± 15 V continuous; ± 15 V for max. 1 s (pulse duty factor 1:20)
• Current	max. 30 mA
Connection of actuators	
• For voltage output	
2-wire connection	Possible
4-wire connection	Not possible
• For current output	
2-wire connection	Possible

Technical Specifications of the Special Inputs of the CPU 314 IFM

Module-Specific Data	
Number of inputs	4 I 126.0 to 126.3
Cable length	
• Shielded	max. 100 m (109 yd.)

Voltages, Currents, Potentials	
Number of inputs that can be triggered simultaneously	4
• (horizontal configuration) up to 60 °C	4
• (vertical configuration) up to 40 °C	4

Status, Interrupts; Diagnostics	
Status display	1 green LED per channel
Interrupts	
• Process interrupt	Parameterizable
Diagnostic functions	None

Sensor Selection Data	
Input voltage	
• Rated value	24 V DC
• For "1" signal	11 to 30 V or 18 to 30 V for angle step encoder for int. function "Positioning"
• For "0" signal	–3 to 5 V
Input current	
• For "1" signal	6.5 mA (typical)
Input delay time	
• For "0" to "1"	< 50 µs (17 µs typical)
• For "1" to "0"	< 50 µs (20 µs typical)
Input characteristic	to IEC 1131, Type 2
Connection of 2-wire BEROs	Possible
• Permissible quiescent current	max. 2 mA

Time, Frequency	
Internal conditioning time for	
• Interrupt processing	max. 1.2 ms
Input frequency	≤ 10 kHz

Technical Specifications of the Digital Inputs of the CPU 314 IFM

Module-Specific Data		Status, Interrupts; Diagnostics	
Number of inputs	16	Status display	1 green LED per channel
Cable length		Interrupts	None
• Unshielded	max. 600 m	Diagnostic functions	None
• Shielded	max. 1000 m		
Voltages, Currents, Potentials		**Sensor Selection Data**	
Rated load current L+	24 V DC	Input voltage	
• Polarity reversal protection	Yes	• Rated value	24 V DC
		• For "1" signal	11 to 30 V
Number of inputs that can be triggered simultaneously	16	• For "0" signal	–3 to 5 V
		Input current	
• (horizontal configuration)		• For "1" signal	7 mA (typical)
up to 60 °C	16	Input delay time	
• (vertical configuration)		• For "0" to "1"	1.2 to 4.8 ms
up to 40 °C	16	• For "1" to "0"	1.2 to 4.8 ms
Galvanic isolation		Input characteristic	to IEC 1131, Type 2
• between channels and backplane bus	Yes	Connection of 2-wire BEROs	Possible
Permissible potential difference		• Permissible quiescent current	max. 2 mA
• Between different circuits	75 V DC 60 V AC		
Insulation tested at	500 V DC		
Current consumption			
• from L+ supply	max. 40 mA		

Technical Specifications of the Digital Outputs of the CPU 314 IFM

Remarks

When the supply voltage is switched on a pulse occurs on the digital outputs! This can be $50 \ \mu$s long within the permissible output current range. You must not, therefore, use the digital outputs to trigger high-speed counters.

Module-Specific Data		Actuator Selection Data	
Number of outputs	16	Output voltage	
Cable length		• For "1" signal	min. L + (− 0.8 V)
• Unshielded	max. 600 m	Output current	
• Shielded	max. 1000 m	• For "1" signal	
Voltages, Currents, Potentials		Rated value	0.5 A
Rated load current L+	24 V DC	Permissible range	5 mA to 0.6 A
• Polarity reversal protection	No	• For "0" signal (residual current)	max. 0.5 mA
Total current of outputs (per group)		Load impedance range	48 Ω to 4 kΩ
• (horizontal configuration)		Lamp load	max. 5 W
up to 40 °C	max. 4 A	Parallel connection of 2 outputs	
up to 60 °C	max. 2 A	• For dual-channel triggering of a load	Possible, only outputs of the same group
• (vertical configuration)			
up to 40 °C	max. 2 A	• For performance increase	Not possible
Galvanic isolation		Triggering of a digital input	Possible
• between channels and backplane bus	Yes	Switching frequency	
• Between the channels	Yes	• For resistive load	max. 100 Hz
in groups of	8	• For inductive load to IEC 947-5-1, DC 13	max. 0.5 Hz
Permissible potential difference		• For lamp load	max. 100 Hz
• Between different circuits	75 V DC 60 V AC	Inductive breaking voltage limited internally to	L+ (− 48 V) typical
Insulation tested at	500 V DC	Short-citcuit protection of the output	Yes, electronically timed
Current consumption		• Response threshold	1 A (typical)
• from L+ supply (No-load)	max. 100 mA		
Status, Interrupts; Diagnostics			
Status display	1 green LED per channel		
Interrupts	None		
Diagnostic functions	None		

Terminal Assignment Diagram of the CPU 314 IFM

Figure 8-11 shows the terminal assignment of the CPU 314 IFM.

For wiring up the integrated I/Os you require two 40-pin front connectors (order number: 6ES7 392-1AM00-0AA0).

Always wire up digital inputs 126.0 to 126.3 with shielded cable due to their low input delay time.

> ⚠ **Caution**
>
> Wiring errors at the analog outputs can cause the integrated analog I/O of the CPU to be destroyed! (for example, if the interrupt inputs are wired by mistake to the analog output).
> The analog output of the CPU is only indestructible up to 15 V (output with respect to M_{ANA}).
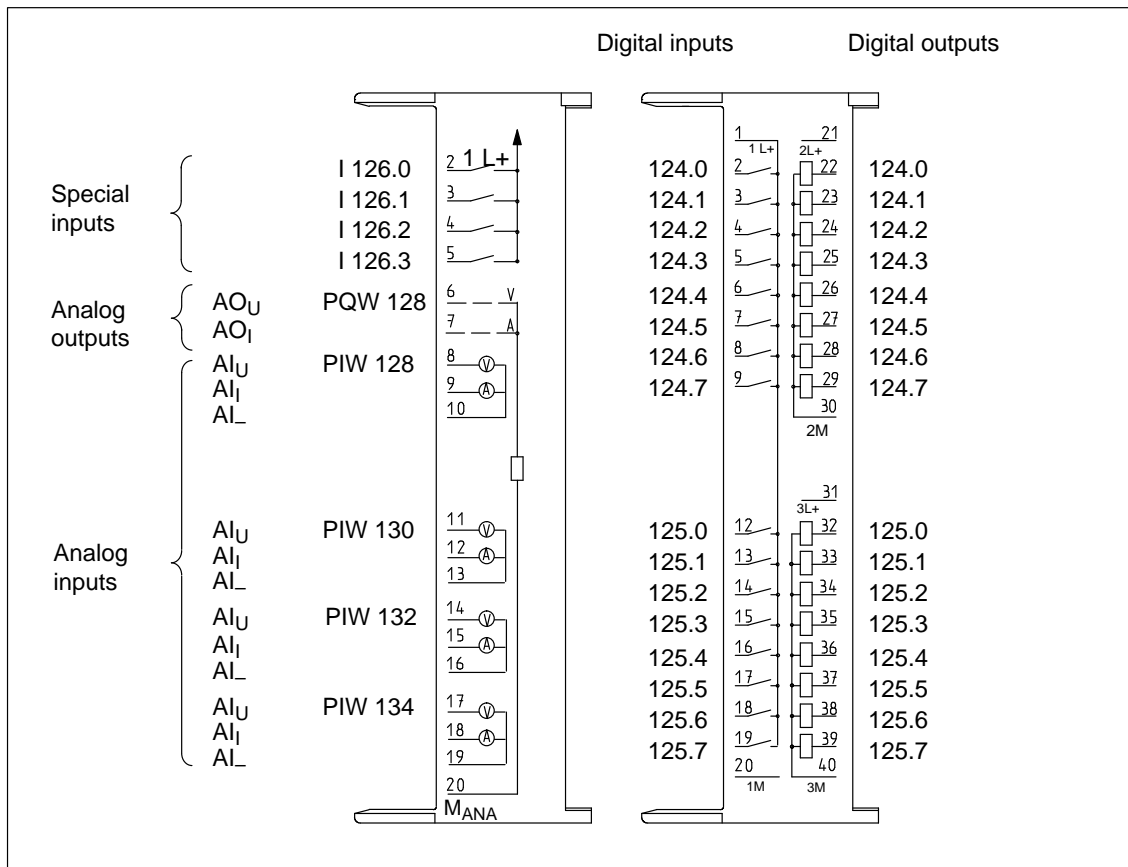
Figure 8-11   Terminal Assignment Diagram of the CPU 314 IFM

Basic Circuit Diagrams of the CPU 314 IFM

Figures 8-12 and 8-13 show the basic circuit diagrams for the integrated inputs/outputs of the CPU 314 IFM.
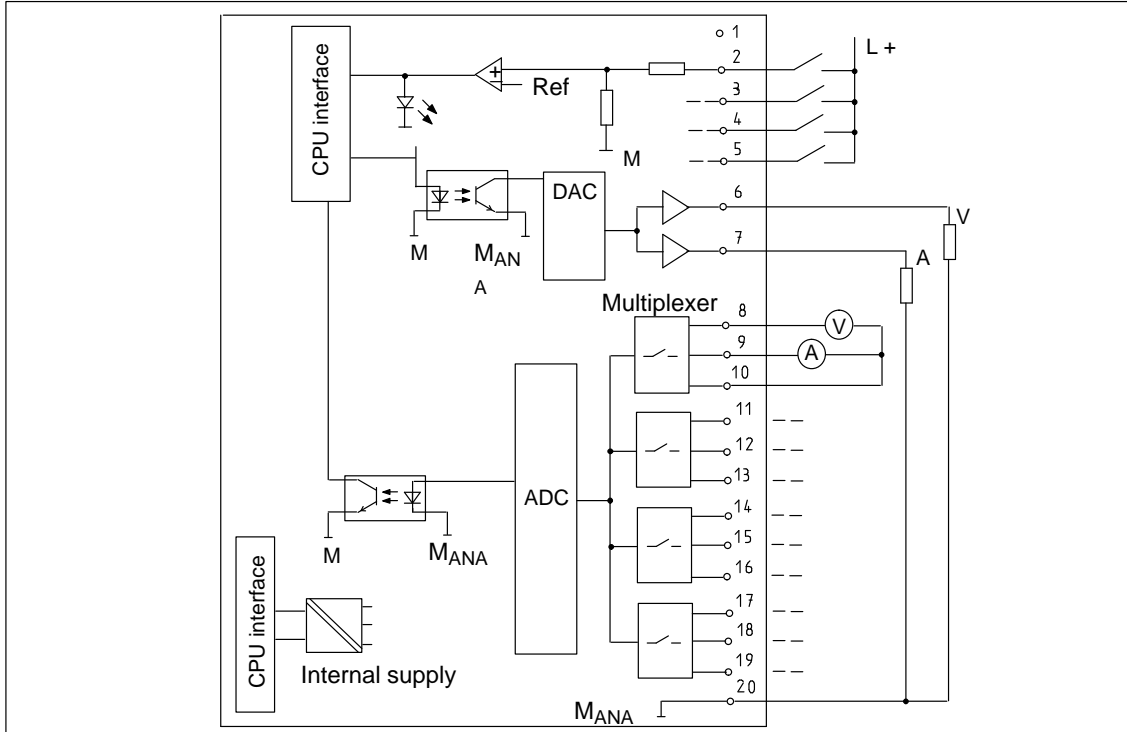
Figure 8-12   Basic Circuit Diagram of the CPU 314 IFM (Special Inputs and Analog Inputs/Outputs)
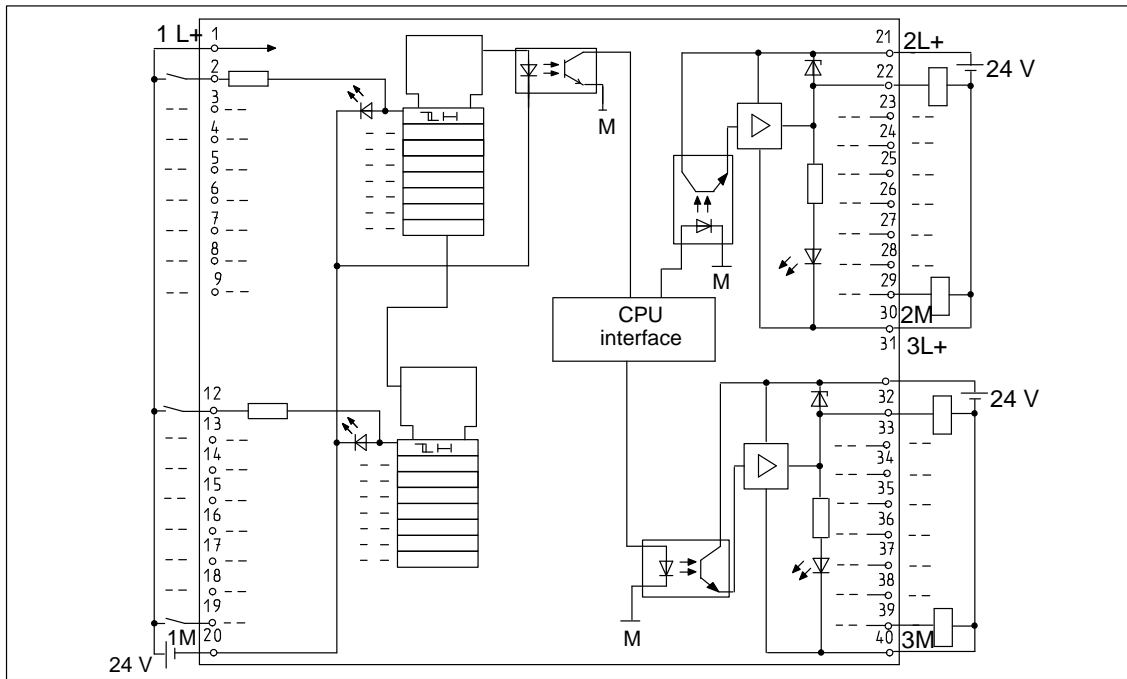
Figure 8-13   Basic Circuit Diagram of the CPU 314 IFM (Digital Inputs/Outputs)

Wiring the Analog Inputs
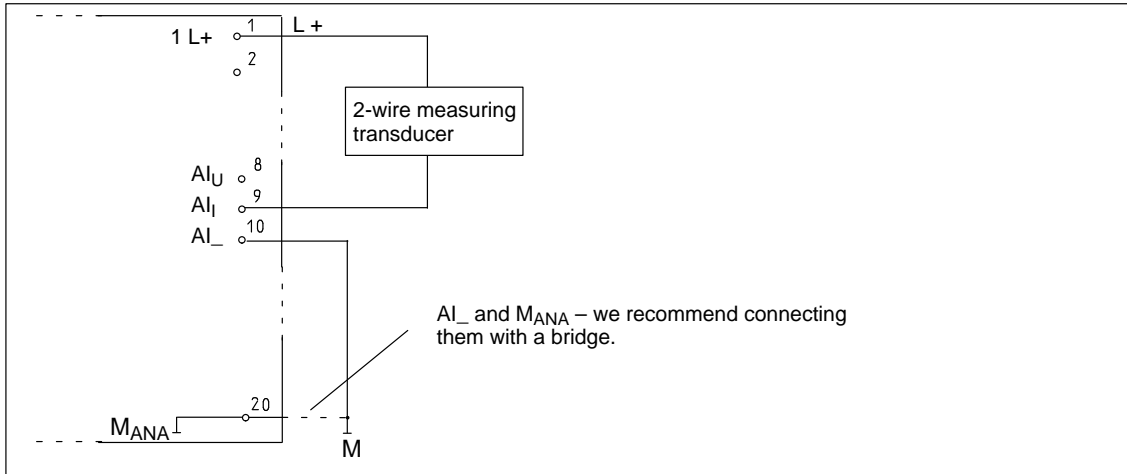
Figure 8-14   Wiring the Analog Inputs of the CPU 314 IFM with a 2-Wire Measuring Transducer
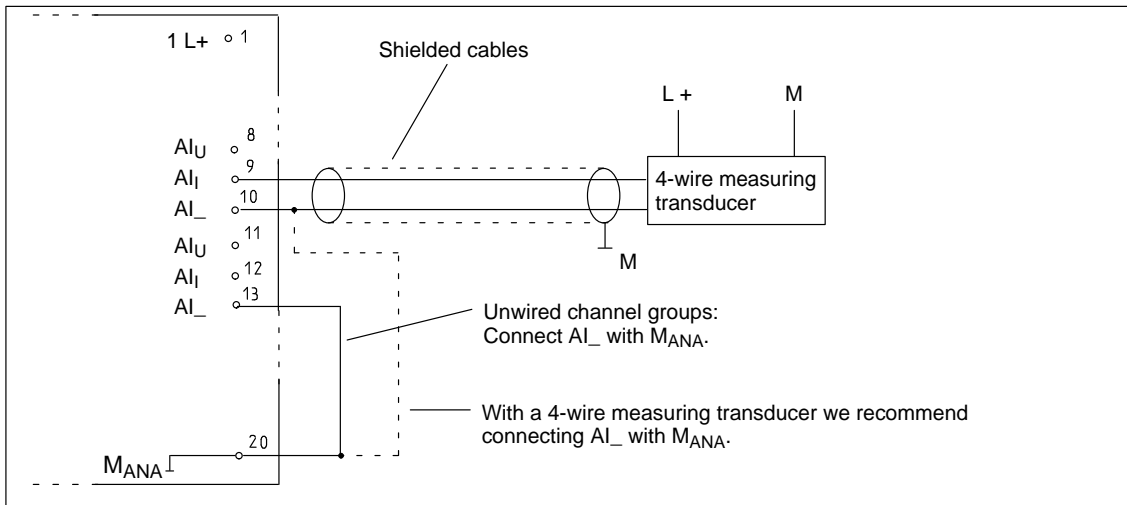
Figure 8-15   Wiring the Analog Inputs of the CPU 314 IFM with a 4-Wire Measuring Transducer

8.4.5 CPU 315

Technical Specifications of the CPU 315

CPU and Product Version	
MLFB	6ES7 315-5AF03-0AB0
• Hardware version	01
• Firmware version	V 1.1.0
• Matching programming package	*STEP 7* V 5.0; Service Pack 03
Memory	
Work memory	
• Integral	48 KB
• Expandable	No
Load memory	
• Integral	80 KB RAM
• Expandable FEPROM	up to 4 MB
• Expandable RAM	No
Backup	Yes
• With battery	All data
• Without battery	4736 bytes, configurable, (data, flags, timers)
Processing times	
Processing times for	
• Bit instructions	0.3 μs minimum
• Word instructions	1 μs minimum
• Double integer math	2 μs minimum
• Floating-point math instructions	50 μs minimum
Timers/Counters and their retentive characteristics	
S7 counters	64
• Adjustable retentivity	from C 0 to C 63
• Preset	from C 0 to C 7
• Counting range	0 to 999
IEC Counters	Yes
• Type	SFB
S7 timers	128
• Adjustable retentivity	from T 0 to T 127
• Preset	No retentive times
• Timing range	10 ms to 9990 s
IEC Timers	Yes
• Type	SFB

Data areas and their retentive characteristics	
Retentive data area as a whole (inc. flags, timers, counters)	4736 bytes
Bit memories	2048
• Adjustable retentivity	MB 0 to MB 255
• Preset	MB 0 to MB 15
Clock memories	8 (1 memory byte)
Data blocks	max. 255 (DB 0 reserved)
• Size	max. 16 KB
• Adjustable retentivity	max. 8 DB, 4096 data bytes in all
• Preset	No retentivity
Local data (non-alterable)	max. 1536 bytes
• Per priority class	256 bytes
Blocks	
OBs	See Instruction List
• Size	max. 16 KB
Nesting depth	
• Per priority class	8
• additional levels within an error OB	4
FBs	max. 192
• Size	max. 16 KB
FCs	max. 192
• Size	max. 16 KB
Address areas (inputs/outputs)	
Peripheral address area	
Digital/Analog	1 KB/1 KB (freely addressable)
Process image (non-alterable)	128 bytes/128 bytes
Digital channels	max. 1024/1024
Analog channels	max. 256/128

Configuration	
Rack	max. 4
Modules per module rack	max. 8
Number of DP masters	
• Integral	None
• via CP	1
S7 message functions	
Simultaneously active Alarm-S blocks	50
Time	
Real-time clock	Yes
• Backed-up	Yes
• Accuracy	See Section 8.1.6
Operating hours counter	1
• Number	0
• Value range	0 to 32767 hours
• Selectivity	1 hour
• Retentive	Yes
Clock synchronisation	Yes
• On PLC	Master
• On MPI	Master/Slave
Testing and commissioning functions	
Status/Modify Variables	Yes
• Variable	Inputs, outputs, flags, DPs, timers, counters
• Number	
– Monitor Variables	max. 30
– Modify Variables	max. 14
Force	Yes
• Variable	Inputs, outputs
• Number	max. 10
Monitor block	Yes
Single sequence	Yes
Breakpoint	2
Diagnostic buffer	Yes
• Number of entries (non-alterable)	100

Communication functions	
PD/OP communication	Yes
Global data communication	Yes
• Number of GD packets	
– Sender	1
– Receiver	1
• Size of GD packets	max. 22 bytes
– Number of which consistent	8 bytes
S7 basic communication	Yes
• User data per job	max. 76 bytes
– Number of which consistent	32 bytes for X/I_PUT/_GET; 76 bytes for X_SEND/_RCV
S7 communication	Yes (server)
• User data per job	max. 160 bytes
– Number of which consistent	32 bytes
S5-compatible communication	Yes (via CP and loadable FC)
• User data per job	Dependent on CP
– Number of which consistent	Dependent on CP
Standard communication	Yes (via CP and loadable FC)
• User data per job	Dependent on CP
– Number of which consistent	Dependent on CP
Number of connection resources	12 for PD/OP/S7 basic/S7 communication
• Reservation for	
– PD communication User-definable Default	max. 11 from 1 to 11 1
– OP communication User-definable Default	max. 11 from 1 to 11 1
– S7 basic communication User-definable Default	max. 8 from 0 to 8 8
Interfaces	
1st interface	
Functionality	
• MPI	Yes
• DP Master	No
• DP Slave	No
• Galvanically isolated	No

MPI	
• Services	
– PD/OP communication	Yes
– Global data communication	Yes
– S7 basic communication	Yes
– S7 communication	Yes (server)
• Transmission rates	19.2; 187.5 kbps

Dimensions	
Installation dimensions $W \times H \times D$ (mm)	$80 \times 125 \times 130$
Weight	approx. 0.53 kg

Programming	
Programming language	STEP 7
Stored instructions	See Instruction List
Nesting levels	8
System functions (SFCs)	See Instruction List
System function blocks (SFBs)	See Instruction List
User program security	Password protected

Voltages, Currents	
Power supply	24 V DC
• Permissible range	20.4 to 28.8 V
Power consumption (No load)	7.0 A (typical)
Inrush current	8 A (typical)
$I^2 t$	0.4 $A^2 s$
External fusing for supply lines (recommendation)	Circuit breaker; 2 A Type B or C
PD supply at MPI (15 to 30 V DC)	max. 200 mA
Power losses	8 W (typical)
Battery	Yes
• Backup period at 25°C and uninterrupted backup of the CPU	min. 1 year
• Storage life of battery at 25°C	approx. 5 years
Accumulator	Yes
– At 0 to 25° C	approx. 4 weeks
– At 40° C	approx. 3 weeks
– At 60° C	approx. 1 week
• Battery charging time	approx. 1 hour

8.4.6 CPU 315-2 DP

DP master or DP slave

You can use the CPU 315-2 DP with its 2nd interface (PROFIBUS-DP interface) either as a DP master or as a DP slave in a PROFIBUS-DP network.

See Chapter 9 for a detailed description of the PROFIBUS-DP features of the CPU 315-2 DP.

Technical Specifications of the CPU 315-2 DP

CPU and Product Version	
MLFB	6ES7 315-2AF03-0AB0
• Hardware version	01
• Firmware version	V 1.1.0
• Matching programming package	*STEP 7* V 5.0; Service Pack 03
Memory	
Work memory	
• Integral	64 KB
• Expandable	No
Load memory	
• Integral	96 KB RAM
• Expandable FEPROM	up to 4 MB
• Expandable RAM	No
Backup	Yes
• With battery	All data
• Without battery	4736 bytes
Processing times	
Processing times for	
• Bit instructions	0.3 μs minimum
• Word instructions	1 μs minimum
• Double integer math	2 μs minimum
• Floating-point math instructions	50 μs minimum
Timers/Counters and their retentive characteristics	
S7 counters	64
• Adjustable retentivity	from C 0 to C 63
• Preset	from C 0 to C 7
• Counting range	0 to 999
IEC Counters	Yes
• Type	SFB

S7 timers	128
• Adjustable retentivity	from T 0 to T 127
• Preset	No retentive times
• Timing range	10 ms to 9990 s
IEC Timers	Yes
• Type	SFB
Data areas and their retentive characteristics	
Retentive data area as a whole (inc. flags, timers, counters)	4736 bytes
Bit memories	2048
• Adjustable retentivity	MB 0 to MB 255
• Preset	MB 0 to MB 15
Clock memories	8 (1 memory byte)
Data blocks	max. 255 (DB 0 reserved)
• Size	max. 16 KB
• Adjustable retentivity	8 DB; max. 4096 data bytes
• Preset	No retentivity
Local data (non-alterable)	max. 1536 bytes
• Per priority class	256 bytes
Blocks	
OBs	See Instruction List
• Size	max. 16 KB
Nesting depth	
• Per priority class	8
• additional levels within an error OB	4
FBs	max. 192
• Size	max. 16 KB
FCs	max. 192
• Size	max. 16 KB

Address areas (inputs/outputs)	
Peripheral address area, digital/analog	1 KB/1 KB (freely addressable)
• Distributed	1 KB/1 KB
Process image (non-alterable)	128/128 bytes
Digital channels	max. 8192 (minus 1 byte diagnostic address per DP slave)/8192
• Centralized	max. 1024/1024
Analog channels	max. 512 (minus 1 byte diagnostic address per DP slave)/512
• Centralized	max. 256/128
Configuration	
Rack	max. 4
Modules per module rack	max. 8
Number of DP masters	
• Integral	1
• via CP	1
S7 message functions	
Simultaneously active Alarm-S blocks	max. 50
Time	
Real-time clock	Yes
• Backed-up	Yes
• Accuracy	See Section 8.1.6
Operating hours counter	1
• Number	0
• Value range	0 to 32767 hours
• Selectivity	1 hour
• Retentive	Yes
Clock synchronisation	Yes
• On PLC	Master
• CP on MPI	Master/Slave
Testing and commissioning functions	
Status/Modify Variables	Yes
• Variable	Inputs, outputs, flags, DBs, timers, counters
• Number	
– Monitor Variables	max. 30
– Modify Variables	max. 14

Force	Yes
• Variable	Inputs, outputs
• Number	max. 10
Monitor block	Yes
Single sequence	Yes
Breakpoint	2
Diagnostic buffer	Yes
• Number of entries (non-alterable)	100
Communication functions	
PD/OP communication	Yes
Global data communication	Yes
• Number of GD packets	
– Sender	1
– Receiver	1
• Size of GD packets	max. 22 bytes
– Number of which consistent	8 bytes
S7 basic communication	Yes (server)
• User data per job	max. 76 bytes
– Number of which consistent	32 bytes for X/I_PUT/_GET; 76 bytes f. X_SEND/_RCV
S7 communication	Yes
• User data per job	max. 160 bytes
– of which consistent	32 bytes
S5-compatible communication	Yes (via CP and loadable FC)
• User data per job	Dependent on CP
– Number of which consistent	Dependent on CP
Standard communication	Yes (via CP and load. FC)
• User data per job	Dependent on CP
– Number of which consistent	Dependent on CP
Number of connection resources	12 for PD/OP/S7 basic/S7 communication
• Reservation for	
– PD communication User-definable Default	max. 11 from 1 to 11 1
– OP communication User-definable Default	max. 11 from 1 to 11 1
– S7 basic communication User-definable Default	max. 8 from 0 to 8 8
Routing connections	max. 4

Interfaces	
1st interface	
Functionality	
• MPI	Yes
• DP Master	No
• DP Slave	No
• Galvanically isolated	No
MPI	
• Services	
– PD/OP communication	Yes
– Global data communication	Yes
– S7 basic communication	Yes
– S7 communication	Yes (server)
• Transmission rates	19.2; 187.5 kbps
2nd interface	
Functionality	
• DP Master	Yes
• DP Slave	Yes
– Status/Modify; Program Routing	Yes, activatable
• Direct data exchange	Yes
• Point-to-point connection	No
• Default setting	None
• Galvanically isolated	Yes
DP Master	
• Services	
– Equidistance	Yes
– SYNC/FREEZE	Yes
– Activation/deactivation of DP slaves	Yes

• Transmission rates	up to 12 Mbps
• Number of DP slaves	max. 64
• Address Area	max. 1 KB I/1 kByte O
• User data per DP slave	max. 244 bytes I/244 bytes O
DP Slave	
• Services	
– Status/Modify; Program via PROFIBUS Routing	Yes, activatable
• Device master file	Sie3802f.gsg
• Transmission rate	... up to 12 Mbps
• Transfer memory	244 bytes I/244 bytes O
– Address areas	max. 32 with max. 32 bytes each
Dimensions	
Installation dimensions W × H × D (mm)	80 × 125 × 130
Weight	approx. 0.53 kg
Programming	
Programming language	STEP 7
Stored instructions	See Instruction List
Nesting levels	8
System functions (SFCs)	See Instruction List
System function blocks (SFBs)	See Instruction List
User program security	Password protected

Voltages, Currents	
Power supply	24 V DC
• Permissible range	20.4 to 28.8 V
Power consumption (No load)	0.9 A (typical)
Inrush current	8 A (typical)
I ^{2} t	0.4 A^{2}s
External fusing for supply lines (recommendation)	Circuit breaker; 2 A, Type B or C
PD supply at MPI (15 to 30 V DC)	max. 200 mA
Power losses	10 W (typical)
Battery	Yes
• Backup period at 25°C and uninterrupted backup of the CPU	min. 1 year
• Storage life of battery at 25°C	approx. 5 years
Accumulator	Yes
– At 0 to 25° C	approx. 4 weeks
– At 40° C	approx. 3 weeks
– At 60° C	approx. 1 week
• Battery charging time	approx. 1 hour

8.4.7 CPU 316-2 DP

DP master or DP slave

You can use the CPU 316-2 DP with its 2nd interface (PROFIBUS-DP interface) either as a DP master or as a DP slave in a PROFIBUS-DP network.

See Chapter 9 for a detailed description of the PROFIBUS-DP features of the CPU 316-2 DP.

Technical Specifications of the CPU 316-2 DP

CPU and Product Version	
MLFB	6ES57 316-2AG00-0AB0
• Hardware version	01
• Firmware version	V 1.1.0
• Matching programming package	*STEP 7* V 5.0; Service Pack 03
Memory	
Work memory	
• Integral	128 KB
• Expandable	No
Load memory	
• Integral	192 KB
• Expandable FEPROM	up to 4 MB
• Expandable RAM	No
Backup	Yes
• With battery	All data
• Without battery	4736 bytes
Processing times	
Processing times for	
• Bit instructions	0.3 μs minimum
• Word instructions	1 μs minimum
• Double integer math	2 μs minimum
• Floating-point math instructions	50 μs minimum
Timers/Counters and their retentive characteristics	
S7 counters	64
• Adjustable retentivity	from C 0 to C 63
• Preset	from C 0 to C 7
• Counting range	0 to 999
IEC Counters	Yes
• Type	SFB

S7 timers	128
• Adjustable retentivity	from T 0 to T 127
• Preset	No retentive times
• Timing range	10 ms to 9990 s
IEC Timers	Yes
• Type	SFB
Data areas and their retentive characteristics	
Retentive data area as a whole (inc. flags, timers, counters)	4736 bytes
Bit memories	2048
• Adjustable retentivity	MB 0 to MB 255
• Preset	MB 0 to MB 17
Clock memories	8 (1 memory byte)
Data blocks	511 (DB 0 reserved)
• Size	max. 16 KB
• Adjustable retentivity	max. 8 DB 4096 data bytes
• Preset	No retentivity
Local data (non-alterable)	max. 1536 bytes
• Per priority class	256 bytes
Blocks	
OBs	See Instruction List
• Size	max. 16 KB
Nesting depth	
• Per priority class	8
• additional levels within an error OB	4
FBs	max. 256
• Size	max. 16 KB
FCs	max. 256
• Size	max. 16 KB

Address areas (inputs/outputs)	
Peripheral address area, digital/analog	2 KB/2 KB (freely addressable)
• Distributed	2 KB/2 KB
Process image (non-alterable)	128/128 bytes
Digital channels	max. 16384 (minus 1 byte diagnostic address per DP slave)/16384
• Centralized	max. 1024/1024
Analog channels	max. 1024 (minus 1 byte diagnostic address per DP slave)/1024
• Centralized	max. 256/128
Configuration	
Rack	max. 4
Modules per	max. 8
Rack	
Number of DP masters	
• Integral	1
• via CP	1
S7 message functions	
Simultaneously active	max. 50
Alarm-S blocks	
Time	
Real-time clock	Yes
• Backed-up	Yes
• Accuracy	See Section 8.1.6
Operating hours counter	1
• Number	0
• Value range	0 to 32767 hours
• Selectivity	1 hour
• Retentive	Yes
Clock synchronisation	Yes
• On PLC	Master
• On MPI	Master/Slave

Testing and commissioning functions	
Status/Modify Variables	Yes
• Variable	Inputs, outputs, flags, DBs, timers, counters
• Number	
– Monitor Variables	max. 30
– Modify Variables	max. 14
Force	Yes
• Variable	Inputs, outputs
• Number	max. 10
Monitor block	Yes
Single sequence	Yes
Breakpoint	2
Diagnostic buffer	Yes
• Number of entries (non-alterable)	100
Communication functions	
PD/OP communication	Yes
Global data communication	Yes
• Number of GD packets	
– Sender	1
– Receiver	1
• Size of GD packets	max. 22 bytes
– Number of which consistent	8 bytes
S7 basic communication	Yes
• User data per job	max. 76 bytes
– Number of which consistent	32 bytes for X/I_PUT/_GET; 76 bytes for X_SEND/_RCV
S7 communication	Yes (server)
• User data per job	max. 160 bytes
– Number of which consistent	32 bytes
S5-compatible communication	Yes (via CP and loadable FC)
• User data per job	Dependent on CP
– Number of which consistent	Dependent on CP
Standard communication	Yes (via CP and loadable FC)
• User data per job	Dependent on CP
– Number of which consistent	Dependent on CP

Number of connection resources	12 for PD/OP/S7 basic/S7 communication
• Reservation for	
– PD communication User-definable Default	max. 11 from 1 to 11 1
– OP communication User-definable Default	max. 11 from 1 to 11 1
– S7 basic communication User-definable Default	max. 8 from 0 to 8 8
Routing connections	max. 4

Interfaces	

1st interface	

Functionality	
• MPI	Yes
• DP Master	No
• DP Slave	No
• Galvanically isolated	No

MPI	**No**
• Services	
– PD/OP communication	Yes
– Global data communication	Yes
– S7 basic communication	Yes
– S7 communication	Yes (server)
• Transmission rates	19.2; 187.5 kbps

2nd interface	

Functionality	
• DP Master	Yes
• DP Slave	Yes
– Status/Modify; Program; Routing	Yes, activatable
• Direct data exchange	Yes
• Point-to-point connection	No
• Default setting	None
• Galvanically isolated	Yes

DP Master	
• Services	
– Equidistance	Yes
– SYNC/FREEZE	Yes
– Activation/deactivation of DP slaves	Yes
• Transmission rates	up to 12 Mbps
• Number of DP slaves	max. 125
• Address Area	max. 2 KB I/2 KB O
• User data per DP slave	max. 244 bytes I/244 bytes O

DP Slave	
• Services	
– Status/Modify; Program; Routing	Yes, activatable
• Device master file	Siem806f.gsg
• Transmission rate	up to 12 Mbps
• Transfer memory	244 bytes I/244 bytes O
– Address areas	max. 32 with max. 32 bytes each

Dimensions	
Installation dimensions W × H × D (mm)	80 × 125 × 130
Weight	approx. 0.53 kg

Programming	
Programming language	STEP 7
Stored instructions	See Instruction List
Nesting levels	8
System functions (SFCs)	See Instruction List
System function blocks (SFBs)	See Instruction List
User program security	Password protected

Voltages, Currents	
Power supply	24 V DC
• Permissible range	20.4 to 28.8 V
Power consumption (No load)	0.9 A (typical)
Inrush current	8 A (typical)
$I^2 t$	0.4 A^2S
External fusing for supply lines (recommendation)	Circuit breaker; 2A, Type B or C
PD supply at MPI (15 to 30 V DC)	max. 200 mA
Power losses	10 W (typical)
Battery	Yes
• Backup period at 25°C and uninterrupted backup of the CPU	min. 1 year
• Storage life of battery at 25°C	approx. 5 years
Accumulator	Yes
• Clock back-up period	
– At 0 to 25° C	approx. 4 weeks
– At 40° C	approx. 3 weeks
– At 60° C	approx. 1 week
• Battery charging time	approx. 1 hour

8.4.8   CPU 318-2

Special Features

- 4 accumulators

- The MPI interface can be reconfigured: MPI or PROFIBUS DP (DP master).

- Data areas can be set (process image, local data)

For more information on the differences between the CPU 318-2 and the other CPUs, see Section 11.1.

DP Master or DP Slave

You can use the CPU 318-2 DP either as a DP master or as a DP slave in a PROFIBUS-DP network.

See Chapter 9 for a detailed description of the PROFIBUS-DP features of the CPU 318-2.

Definable Data Areas and Occupied Working Memory

You can change the size of the process image for the inputs/outputs and the local data areas when parameterizing the CPU 318-2.
If you increase the preset values for the process image and local data, this occupies additional working memory that is then no longer available for user programs.
The following proportions must be taken into consideration:

- Process image input table: 1 byte PII occupied 12 bytes in the working memory
  Process image output table:1 byte PIQ occupied12 bytes in the working memory

  For example:
  256 bytes in the PII occupy 3072 bytes and
  2047 bytes in the PII occupy 24564 bytes in the working memory.

- Local data   1 local data byte occupies   1 byte in the working memory
  There are 256 preset bytes per priority class. With 14 priority classes there are therefore 3584 bytes occupied in the working memory. With a maximum size of 8192 bytes you can still allocate 4608 bytes, which are then no longer available for the user program in the working memory.

Communication

You can reconfigure the first interface of the CPU from an MPI interface to a DP interface (DP master).
You can run the CPU as a DP master or a DP slave via the second DP interface.

In routing, the maximum number of possible connections is reduced for each of the two interfaces by 1 connection for each active PG/OP connection that the CPU 318-2 uses as a gateway.

Technical Specifications of the CPU 318-2

CPU and Product Version	
MLFB	6ES7 318-2AJ00-0AB0
• Hardware version	03
• Firmware version	V 1.1.0
• Matching programming package	*STEP 7* V 5.0; Service Pack 03

Memory	
Work memory	
• Integral	256 KB data/ 256 KB code
• Expandable	No
Load memory	
• Integral	64 KB
• Expandable FEPROM	up to 4 MB
• Expandable RAM	up to 2 MB
Backup	Yes
• With battery	All data
• Without battery	max. 11 KB

Processing times	
Processing times for	
• Bit instructions	0.1 µs minimum
• Word instructions	0.1 µs minimum
• Double integer math	0.1 µs minimum
• Floating-point math instructions	0.6 µs minimum

Timers/Counters and their retentive characteristics	
S7 counters	512
• Adjustable retentivity	from C 0 to C 511
• Preset	from C 0 to C 7
• Counting range	0 to 999
IEC Counters	Yes
• Type	SFB
S7 timers	512
• Adjustable retentivity	from T 0 to T 511
• Preset	No retentive times
• Timing range	10 ms to 9990 s
IEC Timers	Yes
• Type	SFB

Data areas and their retentive characteristics	
Retentive data area as a whole (inc. flags, timers, counters)	max. 11 KB
Bit memories	8192
• Adjustable retentivity	MB 0 to MB 1023
• Preset	MB 0 to MB 15
Clock memories	8 (1 memory byte)
Data blocks	2047 (DB 0 reserved)KB
• Size	max. 64 KB
• Adjustable retentivity	max. 8 DB, max. 8192 data bytes
• Preset	No retentivity
Local data (alterable)	max. 8192 bytes
• Preset	3584 bytes
• Per priority class	256 bytes (expandable to 8192 bytes)

Blocks	
OBs	See Instruction List
• Size	max. 64 KB
Nesting depth	
• Per priority class	16
• additional levels within an error OB	3
FBs	max. 1024
• Size	max. 64 KB
FCs	max. 1024
• Size	max. 64 KB

Address areas (inputs/outputs)	
Peripheral address area digital/analog	max. 8 KB/8 KB (freely addressable)
• Distributed	
– MPI/DP Interface	max. 2 KB/2 KB
– DP interface	max. 8 KB/8 KB
Process image (alterable)	2048/2048 bytes
• Preset	256/256 bytes
Digital channels	max. 65536 (minus 1 byte diagnostic address per DP slave)/65536
• Centralized	max. 1024/1024
Analog channels	max. 4096/4096
• Centralized	max. 256/128

Configuration	
Rack	max. 4
Modules per module rack	max. 8
Number of DP masters	
• Integral	2
• via CP	2
S7 message functions	
Simultaneously active Alarm-S blocks	max. 100
Time	
Real-time clock	Yes
• Backed-up	Yes
• Accuracy	See Section 8.1.6
Operating hours counter	8
• Number	0 to 7
• Value range	0 to 32767 hours
• Selectivity	1 hour
• Retentive	Yes
Clock synchronisation	Yes
• On PLC	Master
• On MPI	Master/Slave
Testing and commissioning functions	
Status/Modify Variables	Yes
• Variable	Inputs, outputs, flags, DBs, timers, counters
• Number	max. 70
Force	Yes
• Variable	Inputs, outputs, flags, peripheral inputs, peripheral outputs
• Number	max. 256
Monitor block	Yes
Single sequence	Yes
Breakpoint	4
Diagnostic buffer	
• Number of entries (non-alterable)	100
Communication functions	
PD/OP communication	Yes
Global data communication	Yes
• Number of GD packets	
– Sender	1
– Receiver	2
• Size of GD packets	54 bytes
– Number of which consistent	32 bytes

S7 basic communication	Yes
• User data per job	max. 76 bytes
– Number of which consistent	76 bytes
S7 communication	Yes (server)
• User data per job	max. 160 KB
– Number of which consistent	Byte, Word, Double word
S5-compatible communication	Yes (via CP and loadable FC)
• User data per job	Dependent on CP
– Number of which consistent	Dependent on CP
Standard communication	Yes (via CP and loadable FC)
• User data per job	Dependent on CP
– Number of which consistent	Dependent on CP
Interfaces	
1st interface	
Functionality	
• MPI	Yes
• DP Master	Yes
• DP Slave	No
• Direct data exchange	Yes (receiver)
• Default setting	MPI
• Electrically isolated	Yes
Number of connections	max. 32;
– Of these, the following are reserved:	1 PD connection 1 OP connection
MPI	
• Services	
– PD/OP communication	Yes
– Global data communication	Yes
– S7 basic communication	Yes
– S7 communication	Yes (server)
• Transmission rates	up to 12 Mbps

DP Master	
• Services	
– Equidistance	Yes
– SYNC/FREEZE	Yes
– Activation/deactivation of DP slaves	No
• Transmission rates	up to 12 Mbps
• Address Area	max. 2 KB I/2 KB O
• User data per DP slave	max. 244 bytes I/244 bytes O

2nd interface	

Functionality	
• DP Master	Yes
• DP Slave	Yes
– Status/Modify; Program; Routing	Yes, activatable
• Direct data exchange	Yes
• Point-to-point connection	No
• Default setting	None
• Galvanically isolated	Yes
Number of connections	max. 16
– Of these, the following are reserved:	1 PD connection 1 OP connection

DP Master	
• Services	
– PD/OP communication	Yes
– Equidistance	Yes
– SYNC/FREEZE	Yes
– Activation/deactivation of DP slaves	No
• Transmission rates	up to 12 Mbps
• Number of DP slaves	max. 125
• Address Area	max. 8 KB I/8 KB O
• User data per DP slave	max. 244 bytes I/244 bytes O

DP Slave	
• Services	
– Status/Modify; Program; Routing	Yes, activatable
• Device master file	siem807f.gsg
• Transmission rate	up to 12 Mbps
• Transfer memory	244 bytes I/244 bytes O

Dimensions	
Installation dimensions $W \times H \times D$ (mm)	$160 \times 125 \times 130$
Weight	approx. 0.93 kg

Programming	
Programming language	STEP 7
Stored instructions	See Instruction List
Nesting levels	16
System functions (SFCs)	See Instruction List
System function blocks (SFBs)	See Instruction List
User program security	Password protected

Voltages, Currents	
Power supply	24 V DC
• Permissible range	20.4 V to 28.8 V
Power consumption (No load)	1.2 A (typical)
Inrush current	8 A (typical)
$I^2 t$	$0.4 \ A^2 s$
External fusing for supply lines (recommendation)	Circuit breaker; 2 A, Type B or C
PD supply at MPI (15 to 30 V DC)	max. 200 mA
Power losses	12 W (typical)
Battery	Yes
• Backup period at 25°C and uninterrupted backup of the CPU	min. 1 year
• Storage life of battery at 25°C	approx. 5 years
Accumulator	Yes
• Clock back-up period	
– At 0 to 25° C	approx. 4 weeks
– At 40° C	approx. 3 weeks
– At 60° C	approx. 1 week
• Battery charging time	approx. 1 hour

CPU 31x-2 as DP Master/DP Slave and Direct Communication

9

Introduction

In this chapter you will find the features and technical specifications of the CPUs 315-2 DP, 316-2 DP and 318-2. You will need these in order to use the CPU as a DP master or a DP slave and configure it for direct communication.

Declaration: Since the DP master/DP slave behavior is the same for all CPUs, the CPUs are described below as CPU 31x-2.

Note on CPU 318-2: with the CPU 318-2 you can use the MPI/DP interface as a DP interface but in this case it is configurable only as a DP master and not a DP slave.

In This Chapter

Additional Literature

Descriptions and notes pertaining to configuration in general, configuration of a PROFIBUS subnet and diagnostics in the PROFIBUS subnet can be found in the *STEP 7* online help system.

9.1   DP Address Areas of the CPUs 31x-2

Address Areas of the CPU 31x-2

Address Area	315-2 DP	316-2 DP	318-2
DP address area for both inputs and outputs	1024 bytes	2048 bytes	8192 bytes
Number of those in the process image for both inputs and outputs	Bytes 0 to 127	Bytes 0 to 127	Bytes 0 to 255 (default) Can be set up to byte 2047

DP diagnostic addresses occupy 1 byte for the DP master and for each DP slave in the address area for the inputs. Under these addresses, for example, the DP standard diagnosis for the respective nodes can be called (LADDR parameter of SFC 13). The DP diagnostic addresses are specified during configuration. If you do not specify any DP diagnostic addresses, *STEP 7* allocates the addresses from the highest byte address downwards as DP diagnostic addresses.

9.2 CPU 31x-2 as DP Master

Introduction

This section covers the features and technical specifications of the CPU when it is used as a DP master.

The features and technical specifications of the CPU 31x-2 as the "standard" CPU are listed in Section 8.

Prerequisite

Should the MPI/DP interface be a DP interface? If so, you must then configure the interface as a DP interface.

Before the CPU can be put into operation, it must be configured as a DP master. This means carrying out the following steps in *STEP 7*:

- Configure the CPU as a DP master.
- Assign a PROFIBUS address.
- Assign a master diagnostic address.
- Integrate DP slaves into the DP master system.

  Is a DP slave a CPU 31x-2?

  If so, you will find that DP slave in the PROFIBUS-DP catalog as "pre-configured station". This DP slave CPU must be assigned a slave diagnostic address in the DP master. You must then interconnect the DP master with the DP slave CPU and stipulate the address areas for data interchange with the DP slave CPU.

Programming, Modifying and Monitoring via the PROFIBUS

As an alternative to the MPI interface, you can program the CPU or execute the PG's Monitor and Modify functions via the PROFIBUS-DP interface.

Note

The use of Monitor and Modify via the PROFIBUS-DP interface lengthens the DP cycle.

Equidistance

As of STEP7 V 5.x you can parameterize bus cycles of the same length (equidistant) for PROFIBUS subnets. You can find a detailed description of equidistance in the STEP7 online help system.

Power-Up of the DP Master System

CPU 31x-2 DP is DP Master	CPU 318-2 is DP Master
You can also set power-up time monitoring of the DP slaves with the "Transfer of parameters to modules" parameter.	Using the parameters "Transfer of parameters to modules" and "Ready message from modules" you can set power-up time monitoring for the DP slaves.
This means that the DP slaves must be powered up and parameterized by the CPU (as DP master) in the set time.	

PROFIBUS Address of the DP Master

You cannot set the 126 as the PROFIBUS address for the CPU 31x-2.

9.3 Diagnostics of the CPU 31x-2 as DP Master

Diagnosis with LEDs

Table 9-1 explains the meaning of the BUSF LED.
The BUSF LED assigned to the interface configured as the PROFIBUS-DP interface will always come on or flash.

Table 9-1   Meaning of the BUSF LED of the CPU 31x-2 as DP Master

BUSF	Description	Remedy
LED off	Configuring data OK; all configured slaves are addressable.	–
LED on	• Bus fault (hardware fault) • DP interface fault • Different transmission rates in multiple DP master mode	• Check the bus cable for short-circuit or interruption. • Evaluate the diagnostic data. Reconfigure or correct the configuring data.
LED flashes	• Station failure • At least one of the configured slaves cannot be addressed.	• Ensure that the bus cable is connected to the CPU 31x-2 and that the bus is not interrupted. • Wait until the CPU 31x-2 has powered up. If the LED does not stop flashing, check the DP slaves or evaluate the diagnostic data for the DP slaves.

Reading Out the Diagnostic Data with STEP 7

Table 9-2   Reading Out the Diagnostic Data with *STEP 7*

DP Master	Block or Register in *STEP 7*	Application	See...
CPU 31x-2	DP slave diagnosis register	Display slave diagnosis as plain text on the *STEP 7* user interface	See the section on hardware diagnostics in the *STEP 7* online help system and in the *STEP 7* User Manual
	SFC 13 "DPNRM_DG"	Read out slave diagnosis (store in the data area of the user program)	Configuration for the CPU 31x-2, see Section 9.5.4; SFC, see *System and Standard Functions* Reference Manual Configuration for other slaves, see their description
	SFC 59 "RD_REC"	Read out data records of the S7 diagnosis (store in the data area of the user program)	*System and Standard Functions* Reference Manual
	SFC 51 "RDSYSST"	Read out system state sublists. Call SFC 51 in the diagnostic interrupt with the system state list ID W#16#00B4, and read out the system state list of the slave CPU.	

Evaluating a Diagnosis in the User Program

The following figures show you how to evaluate the diagnosis in the user program. Note the order number for the CPU 315-2 DP:

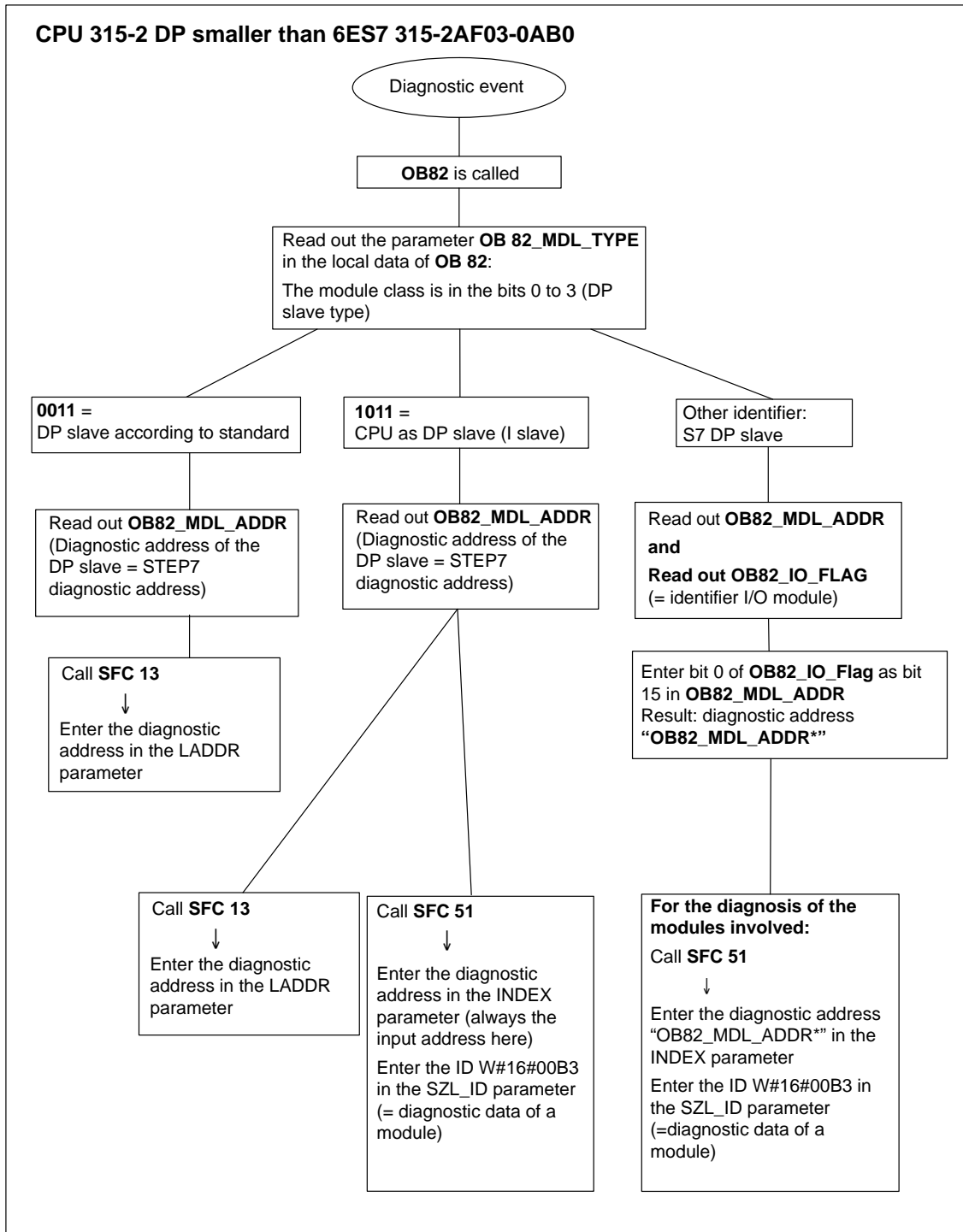| CPU 315-2 DP **<** 6ES7 315-2AF**03**-0AB0	CPU 315-2 DP as of 6ES7 315-2AF**03**-0AB0 CPU 316-2 DP as of 6ES7 316-2AG00-0AB0 CPU 318-2 as of 6ES7 318-2AJ00-0AB0
See Figure 9-1 on page 9-6	See Figure 9-2 on page 9-7

CPU 315-2 DP smaller than 6ES7 315-2AF03-0AB0

Diagnostic event

OB82 is called

Read out the parameter **OB 82_MDL_TYPE** in the local data of **OB 82**:

The module class is in the bits 0 to 3 (DP slave type)

0011 =
DP slave according to standard

1011 =
CPU as DP slave (I slave)

Other identifier:
S7 DP slave

Read out **OB82_MDL_ADDR**
(Diagnostic address of the DP slave = STEP7 diagnostic address)

Read out **OB82_MDL_ADDR**
(Diagnostic address of the DP slave = STEP7 diagnostic address)

Read out **OB82_MDL_ADDR**

and

Read out OB82_IO_FLAG
(= identifier I/O module)

Call **SFC 13**
↓
Enter the diagnostic address in the LADDR parameter

Enter bit 0 of **OB82_IO_Flag** as bit 15 in **OB82_MDL_ADDR**
Result: diagnostic address
"OB82_MDL_ADDR*"

Call **SFC 13**
↓
Enter the diagnostic address in the LADDR parameter

Call **SFC 51**
↓
Enter the diagnostic address in the INDEX parameter (always the input address here)
Enter the ID W#16#00B3 in the SZL_ID parameter (= diagnostic data of a module)

For the diagnosis of the modules involved:
Call **SFC 51**
↓
Enter the diagnostic address "OB82_MDL_ADDR*" in the INDEX parameter
Enter the ID W#16#00B3 in the SZL_ID parameter (=diagnostic data of a module)

Figure 9-1   Diagnostics with CPU 315-2 DP **<** 315-2AF**03**

CPU 315-2 DP as of 6ES7 315-2AF03-0AB0
CPU 316-2 DP;
318-2

(Diagnostic event)

OB82 is called

Read out **OB82_MDL_ADDR**

and

Read out OB82_IO_FLAG
(= identifier I/O module)

Enter bit 0 of **OB82_IO_Flag** as bit
15 in **OB82_MDL_ADDR**
Result: diagnostic address
"OB82_MDL_ADDR*"

For diagnosis of the whole DP slave:
Call **SFC 13**
↓
Enter the diagnostic address
"OB82_MDL_ADDR*" in the LADDR parameter

For the diagnosis of the modules involved:
Call **SFC 51**
↓
Enter the diagnostic address "OB82_MDL_ADDR*"
in the INDEX parameter

Enter the ID W#16#00B3 in the SZL_ID parameter
(=diagnostic data of a module)

Figure 9-2   Diagnostics with CPU 31x-2 (315-2 DP as of 315-2AF**03**)

Diagnostic Addresses

With the CPU 31x-2 you assign diagnostic addresses for the PROFIBUS-DP bus system. Make sure during configuration that DP diagnostic addresses are assigned to both the DP master and the DP slave.

CPU 31x-2 as DP Master　　　　　　　　**CPU 31x-2 as DP Slave**

PROFIBUS

During configuration you must specify two diagnostic addresses:

Diagnostic address　　　　　　　　　　　Diagnostic address

When you configure the DP master, you must specify (in the associated project of the DP master) a diagnostic address for the DP slave. In the following, this diagnostic address is referred to as *allocated to the DP master*.

The DP master receives information on the status of the DP slave or on a bus interruption via this diagnostic address (see also Table 9-3).

When you configure the DP slave, you must also specify (in the associated project of the DP slave) a diagnostic address that is allocated to the DP slave. In the following, this diagnostic address is referred to as *allocated to the DP slave*.

The DP slave receives information on the status of the DP master or on a bus interruption via this diagnostic address (see also Table 9-8 on page 9-20).

Figure 9-3　　Diagnostic Addresses for DP Master and DP Slave

Event Detection

Table 9-3 shows how the CPU 31x-2 as DP master recognizes status changes in a CPU as DP slave or interruptions in data transfer.

Table 9-3   Event Detection of the CPU 31x-2 as DP Master

Event	What Happens in the DP Master
Bus interruption (short-circuit, plug pulled)	• OB 86 is called and a *station failure* reported (incoming event; Diagnostic address of the DP slave, assigned to the DP master) • With I/O access: OB 122 is called up (I/O access error)
DP slave: RUN → STOP	• OB 82 is called and *Module fault* reported (incoming event; Diagnostic address of the DP slave assigned to the DP master; Variable OB82_MDL_STOP=1)
DP slave: STOP → RUN	• OB 82 is called and *Module ok* reported. (outgoing event; Diagnostic address of the DP slave assigned to the DP master; Variable OB82_MDL_STOP=0)

Evaluation in the User Program

Table 9-4 shows you how you can, for example, evaluate RUN-STOP transitions of the DP slave in the DP master (see Table 9-3).

Table 9-4   Evaluating RUN-STOP Transitions of the DP Slaves in the DP Master

In the DP Master	In the DP Slave (CPU 31x-2 DP)

Diagnostic addresses: (example)
    Master diagnostic address=**1023**
    Slave diagnostic address in the master system=**1022**
	Diagnostic addresses: (example)
	    Slave diagnostic address=**422**
	    Master diagnostic address=Irrelevant

The CPU calls OB 82 with the following information: • OB 82_MDL_ADDR:=**1022** • OB82_EV_CLASS:=B#16#39 (incoming event) • OB82_MDL_DEFECT:=Module fault Tip: This information is also in the CPU's diagnostic buffer In the user program, you should also include the SFC 13 "DPNRM_DG" to read out the DP slave diagnostic data.	←—— CPU: RUN → STOP CPU generates a DP slave diagnostic frame (see Section 9.5.4).

9.4 CPU 31x-2 as DP Slave

Introduction

This section lists the characteristics and technical specifications for the CPU when it is operated as a DP slave.

The characteristics and technical specifications of the CPU as the "standard" CPU can be found in Section 8.

Prerequisite

Should the MPI/DP interface be a DP interface? If so, you must then configure the interface as a DP interface.

Prior to start-up, the CPU must be configured as a DP slave. This means carrying out the following steps in *STEP 7*:

- "Switch on" the CPU as DP slave.
- Assign a PROFIBUS address.
- Assign a slave diagnostic address.
- Stipulate the address areas for data interchange with the DP master.

Device Master Files

You need a device master file to configure the CPU 31x-2 as a DP slave in a DP master system.
The device master file is included in *COM PROFIBUS* as of version 4.0.

If you are working with an older version or another configuration tool, you can get the device master file from the following sources:

- On the Internet at http://www.ad.siemens.de/csi_e/gsd

or

- Via modem from the **SSC** (Interface Center) Fuerth by calling +49/911/737972.

erhalten.

Configuration and Parameter Assignment Frame

When configuring/assigning parameters for the CPU 31x-2, you are given assistance by *STEP 7*. Should you require a description of the configuration and parameter assignment frame, in order to use a bus monitor for example, you can find it on the internet at http://www.ad.siemens.de/simatic-cs under article ID 996685.

Programming, Modifying and Monitoring via the PROFIBUS

As an alternative to the MPI interface, you can program the CPU or execute the PG's Monitor and Modify functions via the PROFIBUS-DP interface. To do so, you must enable these functions when configuring the CPU as a DP slave in *STEP 7*.

Note

The use of Monitor and Modify via the PROFIBUS-DP interface lengthens the DP cycle.

Data Transfer via an Intermediate Memory

The CPU 31x-2 provides an intermediate memory as DP slave for the PROFIBUS DP bus system. The data transfer between the CPU as DP slave and the DP master always takes place via this intermediate memory. You can configure up to 32 address areas for this.

This means that the DP master writes its data in these address areas in the intermediate memory and that the CPU reads this data in the user program and vice versa.
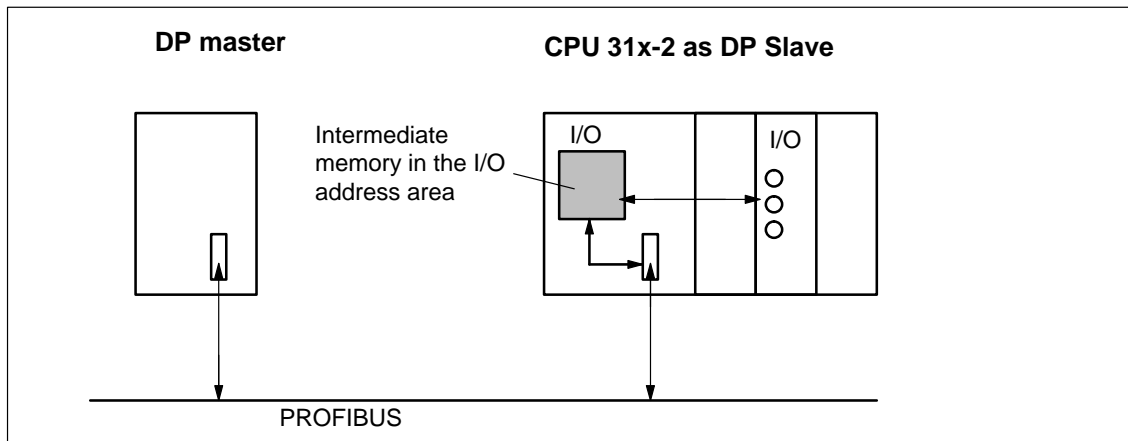
Figure 9-4   Intermediate Memory in the CPU 31x-2 as DP Slave

Address Areas of the Intermediate Memory

In *STEP 7* you configure input and output address areas:

- You can configure up to 32 input and output address areas.

- Each of these address areas can have up to 32 bytes.

- You can configure a maximum of 244 bytes for inputs and 244 bytes for outputs.

The following table shows the principle of address areas. You can also find this figure in the *STEP 7* configuration.

Table 9-5   Configuration Example for the Address Areas of the Intermediate Memory

	Type	Master Address	Type	Slave Address	Length	Unit	Consistency
1	E	222	A	310	2	Byte	Unit
2	A	0	E	13	10	Word	Total length
:							
32							
	Address areas in the DP master CPU		Address areas in the DP slave CPU		These address area parameters must be identical for DP master and DP slave		

Rules

The following rules must be followed when using the intermediate memory:

- Allocating the address areas:
    - Input data of the DP slave are **always** output data of the DP master
    - Output data of the DP slave are **always** input data of the DP master

- The addresses can be freely allocated. In the user program, access the data with Load/Transfer statements or with SFCs 14 and 15. You may also specify addresses from the process input or process output image (also see Section 3.2).

Note

You assign addresses for the intermediate memory from the DP address area of the CPU 31x-2.

You cannot assign addresses already allocated to the intermediate memory to the I/O modules in the CPU 31x-2!

- The lowest address in any given address area is that address area's start address.

- The length, unit and consistency of the address areas for DP master and DP slave must be identical.

S5 DP Master

If you are using an IM 308 C as a DP master and the CPU 31x-2 as a DP slave, the exchange of consistent data requires the following:

In the IM 308 C, you must program FB 192 to enable the exchange of consistent data between DP master and DP slave. With FB 192, the data of the CPU 31x-2 data is output or read out contiguously only in a single block.

S5-95 as a DP master

If you are using an AG S5-95 as a DP master, you must also set its bus parameters for the CPU 31x-2 as a DP slave.

Sample Program

Below you will see a small sample program for the exchange of data between DP master and DP slave. The addresses used in the example are those from Table 9-5.

In the DP Slave CPU	In the DP Master CPU
``L   2   Data
T   MB   6   preprocessing in
L   IB   0   DP slave
T   MB   7

L   MW   6   Forward data to
T   PQW   310   DP master
``` | |
| | ```L   PIB   222   Postprocess
T   MB   50   receive data in
L   PIB   223   DP master
L   B#16#3
+   I
T   MB   51

L   10   Data Processing
+   3   in DP master
T   MB   60

CALL   SFC   15   Send data to DP
 LADDR:= W#16#0   slave
 RECORD:= P#M60.0 Byte20
 RET_VAL:=MW 22
``` |
| ```CALL   SFC   14   Receive data
 LADDR:=W#16#D   from DP master
 RET_VAL:=MW 20
 RECORD:=P#M30.0 Byte20

L   MB   30   Postprocess
L   MB   7   receive data
+   I
T   MW   100
``` | |

Data Transfer in STOP Mode

The DP slave CPU goes into STOP mode: The data in the intermediate memory of the CPU is overwritten with "0". In other words, the DP master reads "0".

The DP master goes into STOP mode: The current data in the intermediate memory of the CPU is preserved and can still be read by the CPU.

PROFIBUS address

You cannot set the 126 as the PROFIBUS address for the CPU 31x-2.

9.5 Diagnostics of the CPU 31x-2 as DP Slave

In This Section

9.5.1   Diagnosis with LEDs

Diagnosis with LEDs – CPU 31x-2

Table 9-6 explains the meaning of the BUSF LEDs.
The BUSF LED assigned to the interface configured as the PROFIBUS-DP interface will always come on or flash.

Table 9-6   Meaning of the BUSF LEDs in the CPU 31x-2 as DP Slave

BUSF	Description	Remedy
LED off	Configuring OK.	–
LED flashes	The CPU 31x-2 is incorrectly parameterized. There is no data interchange between the DP master and the CPU 31x-2. Reasons: • Timeout. • Bus communication via PROFIBUS interrupted. • Incorrect PROFIBUS address.	• Check the CPU 31x-2. • Check to make sure that the bus connector is properly inserted. • Check for interruptions in the bus cable to the DP master. • Check configuring data and parameters.
LED on	• Short-circuit on bus.	• Check the bus configuration.

9.5.2   Diagnosis with *STEP 5* or *STEP 7*

Slave Diagnosis

The slave diagnosis complies with EN 50170, Volume 2, PROFIBUS. Depending on the DP master, the diagnosis can be read for all DP slaves that comply with the standard using *STEP 5* or *STEP 7*.

The following sections describe how the slave diagnosis is read and structured.

S7 Diagnosis

An S7 diagnosis can be requested for all the modules in the SIMATIC S7/M7 range of modules in the user program. The structure of the S7 diagnostic data is the same for both central and distributed modules.

The diagnostic data of a module is in data records 0 and 1 of the system data area of the module. Data record 0 contains 4 bytes of diagnostic data describing the current state of a module. The data record 1 also contains module-specific diagnostic data.

You can find out how to configure the diagnostic data in the *System and Standard Functions* Reference Manual.

9.5.3　Reading Out the Diagnostic Data

Table 9-7　Reading Out the Diagnostic Data with *STEP 5* and *STEP 7* in the Master System

Programmable Controller with DP Master	Block or Register in *STEP 7*	Application	See...
SIMATIC S7/M7	DP slave diagnosis register	Display slave diagnosis as plain text on the *STEP 7* user interface	See the section on hardware diagnostics in the *STEP 7* online help system and in the *STEP 7* User Manual
	SFC 13 "DP NRM_DG"	Read out slave diagnosis (store in the data area of the user program)	See Section 9.5.4; SFC: see *System and Standard Functions* Reference Manual
	SFC 51 "RDSYSST"	Read out system state sublists. In the diagnostic interrupt alarm with the system state list ID W#16#00B4, calling SFC 51 and reading out the system state list of the slave CPU.	*System and Standard Functions* Reference Manual
	SFC 59 "RD_REC"	Read out data records of the S7 diagnosis (store in the data area of the user program)	
	FB 99/FC 99	Evaluating slave diagnosis	On the Internet at http://www.ad.siemens.de/simatic-cs ID 387 257
SIMATIC S5 with IM 308-C as DP master	FB 192 "IM308C"	Reading out slave diagnosis (store in the data area of the user program)	Configuration – see Section 9.5.4 FBs – see *ET 200 Distributed I/O Device* Manual
SIMATIC S5 with S5-95U programmable controller as DP master	FB 230 "S_DIAG"		

Example of Reading Out the Slave Diagnosis with FB 192 "IM 308C"

Here you will find an example of how to use FB 192 to read out the slave diagnosis for a DP slave in the *STEP 5* user program.

Assumptions

The following assumptions are made for this *STEP 5* user program:

- As a DP master, the IM 308-C occupies the page frames 0... 15 (number 0 of the IM 308-C).
- The DP slave has the PROFIBUS address 3.
- The slave diagnosis should be stored in data block 20. You can also use any data block for this.
- The slave diagnosis consists of 26 bytes.

STEP 5 **User Program**

STL			Description
	:A	DB 30	
	:SPA	FB 192	
Name	:IM308C		
DPAD	:	KH F800	Default address area of the IM 308-C
IMST	:	KY 0, 3	IM no. = 0, PROFIBUS address of the DP slave = 3
FCT	:	KC SD	Function: Read slave diagnosis
GCGR	:	KM 0	Not evaluated
TYP	:	KY 0, 20	S5 data area: DB 20
STAD	:	KF +1	Diagnostic data as of data word 1
LENG	:	KF 26	Length of dignostic data = 26 bytes
ERR	:	DW 0	Error code storage in DW 0 of the DB 30

Example of Reading Out the S7 Diagnosis with SFC 59 "RD_REC"

Here you will find an example of how to use the SFC 59 to read out the data records of the S7 diagnosis for a DP slave in the *STEP 7* user program. Reading out the slave diagnosis with SFC 13 is similar.

Assumptions

The following assumptions are made for this *STEP 7* user program:

- The diagnosis for the input module with the address 200_H is to be read.
- Data record 1 is to be read out.
- Data record 1 is to be stored in DB 10.

STEP 7 User Program

STL	Description
CALL SFC 59	
REQ :=TRUE	Request to Read
IOID :=B#16#54	Identifier of the Address Area, here the I/O input
LADDR :=W#16#200	Logical address of the module
RECNUM :=B#16#1	Data record 1 is to be read out
RET_VAL :=	Errors result in the output of an error code
BUSY :=TRUE	Reading process is not finished
RECORD :=DB 10	Destination area for the read data record 1 is data block 10

Diagnostic Addresses

With the CPU 31x-2 you assign diagnostic addresses for the PROFIBUS-DP bus system. Make sure during configuration that DP diagnostic addresses are assigned to both the DP master and the DP slave.

CPU 31x-2 as DP Master   **CPU 31x-2 as DP Slave**

PROFIBUS

During configuration you must specify two diagnostic addresses:

Diagnostic address   Diagnostic address

When you configure the DP master, you must specify (in the associated project of the DP master) a diagnostic address for the DP slave. In the following, this diagnostic address is referred to as *allocated to the DP master*.

The DP master receives information on the status of the DP slave or on a bus interruption via this diagnostic address (see also Table 9-3 on page 9-9).

When you configure the DP slave, you must also specify (in the associated project of the DP slave) a diagnostic address that is allocated to the DP slave. In the following, this diagnostic address is referred to as *allocated to the DP slave*.

The DP slave receives information on the status of the DP master or on a bus interruption via this diagnostic address (see also Table 9-8).

Figure 9-5   Diagnostic Addresses for DP Master and DP Slave

Event Detection

Table 9-8 shows how the CPU 31x-2 as DP slave recognizes status changes or interruptions in the transfer of data.

Table 9-8   Event Detection of the CPU 31x-2 as DP Slave

Event	What Happens in the DP Slave
Bus interruption (short-circuit, plug pulled)	• OB 86 is called and a *station failure* reported (incoming event; diagnostic address of the DP slave assigned to the DP slave) • With I/O access: OB 122 is called up (I/O access error)
DP master: RUN → STOP	• OB 82 is called and *Module fault* reported (incoming event; diagnostic address of the DP slave assigned to the DP slave) Variable OB82_MDL_STOP=1)
DP master: STOP → RUN	• OB 82 is called and *Module ok* reported. (outgoing event; diagnostic address of the DP slave assigned to the DP slave) Variable OB82_MDL_STOP=0)

Evaluation in the User Program

Table 9-9 shows you how you can, for example, evaluate RUN-STOP transitions of the DP master in the DP slave (see Table 9-8).

Table 9-9   Evaluating RUN-STOP Transitions in the DP Master/DP Slave

In the DP Master	In the DP Slave

Diagnostic addresses: (example)
    Master diagnostic address=**1023**
    Slave diagnostic address in the master system=**1022**
	Diagnostic addresses: (example)
	    Slave diagnostic address=**422**
	    Master diagnostic address=Irrelevant

CPU: RUN → STOP $\longrightarrow$	The CPU calls OB 82 with the following information: • OB 82_MDL_ADDR:=**422** • OB82_EV_CLASS:=B#16#39 (incoming event) • OB82_MDL_DEFECT:=Module fault Tip: This information is also in the CPU's diagnostic buffer

9.5.4 Structure of the Slave Diagnostic Data

Structure of the Slave Diagnostic Data

Byte 0		
Byte 1		Station Status 1 to 3
Byte 2		
Byte 3		Master PROFIBUS Address
Byte 4		High byte ⎞ Manufacturer
Byte 5		Low byte ⎠ Identification
Byte 6 to Byte x		Module Diagnostics (the length depends on the number of address areas configured for the intermediate memory[1])
Byte x+1 to Byte y		Station Diagnostics (the length depends on the number of address areas configured for the intermediate memory)

[1] Exception: If the DP master is incorrectly configured, the DP slave interprets 35 configured address areas (46_H).

Figure 9-6   Format of the Slave Diagnostic Data

9.5.5   Station Status 1 to 3

Definition

Station status 1 to 3 provides an overview of the status of a DP slave.

Station Status 1

Table 9-10   Structure of Station Status 1 (Byte 0)

Bit	Description	Remedy
0	1: DP slave **cannot** be addressed by DP master.	• Is the correct DP address set on the DP slave? • Is the bus connector inserted? • Does the DP slave have power? • Is the RS 485 repeater correctly set? • Execute a Reset on the DP slave.
1	1: DP slave is not ready for data interchange.	• Wait; the DP slave is still doing its run-up.
2	1: The configuration data which the DP master sent to the DP slave do not correspond with the DP slave's actual configuration.	• Was the software set for the right station type or the right DP slave configuration?
3	1: Diagnostic interrupt, generated by a RUN/STOP transition on the CPU 0: Diagnostic interrupt, generated by a STOP/RUN transition on the CPU	• You can read out the diagnostic data.
4	1: Function is not supported, for instance changing the DP address at the software level.	• Check the configuring data.
5	0: This bit is always "0".	–
6	1: DP slave type does not correspond to the software configuration.	• Was the software set for the right station type? (parameter assignment error)
7	1: DP slave was parameterized by a different DP master to the one that currently has access to it.	• Bit is always "1" when, for instance, you are currently accessing the DP slave via the PG or a different DP master. The DP address of the master that parameterized the slave is located in the "Master PROFIBUS address" diagnostic byte.

Station Status 2

Table 9-11   Structure of Station Status 2 (Byte 1)

Bit	Description
0	1: DP slave must be parameterized again and reconfigured.
1	1: A diagnostic message has arrived. The DP slave cannot continue operation until the error has been rectified (static diagnostic message).
2	1: This bit is always "1" when there is a DP slave with this DP address.
3	1: The watchdog monitor has been activated for this DP slave.
4	0: This bit is always "0".
5	0: This bit is always "0".
6	0: This bit is always "0".
7	1: DP slave is deactivated, that is to say, it has been removed from the scan cycle.

Station Status 3

Table 9-12   Structure of Station Status 3 (Byte 2)

Bit	Description
0 to 6	0: These bits are always "0".
7	1: • More diagnostic messages have arrived than the DP slave can buffer. • The DP master cannot enter all the diagnostic messages sent by the DP slave in its diagnostic buffer.

9.5.6 Master PROFIBUS Address

Definition

The DP address of the DP master is stored in the master PROFIBUS address diagnostic byte:

- The master that parameterized the DP slave
- The master that has read and write access to the DP slave

Master PROFIBUS Address

Table 9-13   Structure of the Master PROFIBUS Address (Byte 3)

Bit	Description
0 to 7	DP address of the DP master that parameterized the DP slave and has read/write access to that DP slave.
	FF_H: DP slave was not parameterized by a DP master.

9.5.7 Manufacturer ID

Definition

The manufacturer identification contains a code specifying the DP slave's type.

Manufacturer Identification

Table 9-14   Structure of the Manufacturer Identification (Bytes 4 and 5)

Byte 4	Byte 5	Manufacturer Identification for
80_H	$2F_H$	CPU 315-2 DP
80_H	$6F_H$	CPU 316-2 DP
80_H	$7F_H$	CPU 318-2

9.5.8   Module Diagnosis

Definition

The module diagnosis specifies which of the configured address areas of the intermediate memory an input has been made for.

```
          7                   0    Bit No.
Byte 6   ┌─┬─┬─┬─┬─┬─┬─┬─┐
         │0│1│ │ │ │ │ │ │
         └─┴─┴─┴─┴─┴─┴─┴─┘
          ⏝ ╰───┬────╯
          │
          │         Length of the module diagnosis,
          │         including byte 6 (up to 6 bytes, depending on the number of configured
          │         address areas)
          Code for module diagnosis

          7 6 5 4 3   1        Bit No.
Byte 7   ┌─┬─┬─┬─┬─┬─┬─┬─┐
         │ │ │ │ │ │ │ │ │
         └─┴─┴─┴─┴─┴─┴─┴─┘
          │ │ │ │ │ │ │ └ Specified ≠ Actual configuration
          │ │ │ │ │ │ └ Preset configuration ≠ actual configuration or slave CPU in STOP mode
          │ │ │ │ │ └ Specified ≠ Actual configuration
          │ │ │ │ └ Entry for 1st configured address area
          │ │ │ └ Entry for 2nd configured address area
          │ │ └ Entry for 3rd configured address area
          │ └ Entry for 4th configured address area
          └ Entry for 5th configured address area

          7 6 5 4 3 2 1 0    Bit No.
Byte 8   ┌─┬─┬─┬─┬─┬─┬─┬─┐
         │ │ │ │ │ │ │ │ │
         └─┴─┴─┴─┴─┴─┴─┴─┘
          │ - - - - - - - - - │
                   Entry for 6th to 13th configured address area

          7 6 5 4 3 2 1 0    Bit No.
Byte 9   ┌─┬─┬─┬─┬─┬─┬─┬─┐
         │ │ │ │ │ │ │ │ │
         └─┴─┴─┴─┴─┴─┴─┴─┘
          │ - - - - - - - - - │
                   Entry for 14th to 21st configured address area

          7 6 5 4 3 2 1 0    Bit No.
Byte 10  ┌─┬─┬─┬─┬─┬─┬─┬─┐
         │ │ │ │ │ │ │ │ │
         └─┴─┴─┴─┴─┴─┴─┴─┘
          │ - - - - - - - - - │
                   Entry for 22nd to 29th configured address area
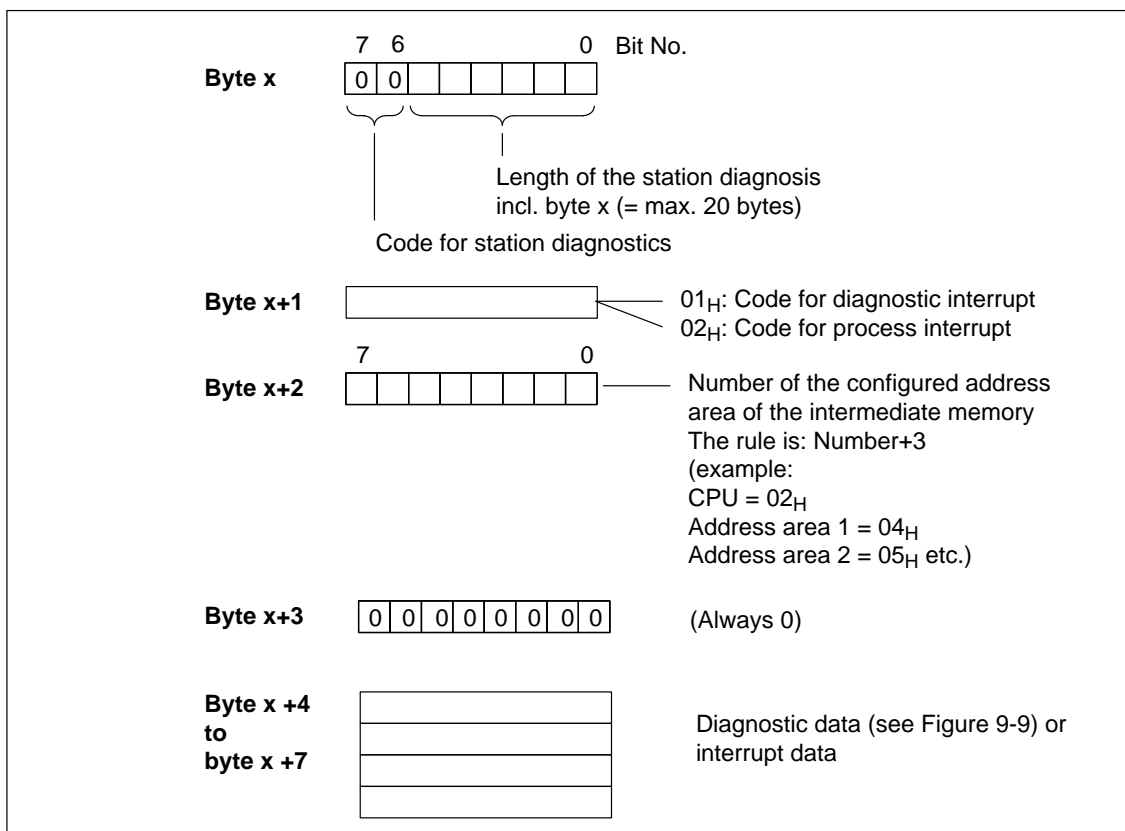
          7 6 5 4 3 2 1 0    Bit No.
Byte 11  ┌─┬─┬─┬─┬─┬─┬─┬─┐
         │0│0│0│0│0│ │ │ │
         └─┴─┴─┴─┴─┴─┴─┴─┘
                   │ │ └ Entry for 30th configured address area
                   │ └ Entry for 31st configured address area
                   └ Entry for 32nd configured address area
```

Figure 9-7   Structure of the Module Diagnosis of the CPU 31x-2

9.5.9   Station Diagnosis

Definition

The station diagnosis gives detailed information on a DP slave. The station diagnosis begins as of byte x and can have a maximum of 20 bytes.

Station Diagnostics

The following figure describes the structure and content of the bytes for a configured address area of the intermediate memory.

Figure 9-8   Structure of the Station Diagnosis

As of byte x +4

The purpose of the bytes beginning with byte x+4 depends on byte x+1 (see Figure 9-8).

Byte x+1 Contains the Code for...	
Diagnostic Interrupt (01$_H$)	**Process Interrupt (02$_H$)**
The diagnostic data contain the 16 bytes of status information from the CPU. Figure 9-9 shows the contents of the first four bytes of diagnostic data. The next 12 bytes are always 0.	For a process interrupt, you can program four bytes of interrupt information. These four bytes are forwarded to the DP master in *STEP 7* with the SFC 7 command "DP_PRAL" (see Section 9.5.10).

Bytes x+4 to x+7 for Diagnostic Interrupts

Figure 9-9 shows the configuration and contents of bytes x +4 to x +7 for diagnostic interrupt. The contents of these bytes correspond to the contents of data record 0 of the diagnostic data in *STEP 7* (in this case, not all bits are assigned).

Figure 9-9   Bytes +4 to +7 for Diagnostic and Process Interrupts

9.5.10   Interrupts

Interrupts with the S7/M7 DP Master

In the CPU 31x-2 as DP slave you can trigger a process interrupt in the DP master from the user program. OB 40 is called in the DP master's user program by calling SFC 7 "DP_PRAL". SFC 7 allows you to forward interrupt information in a doubleword to the DP master; this information can then be evaluated in OB 40 in variable OB40_POINT_ADDR. You can program the interrupt information as desired. A detailed description of SFC 7 "DP_PRAL" can be found in the reference manual entitled *System Software S7-300/400 - System and Standard Functions*.

Interrupts with Another DP Master

If you are running the CPU 31x-2 with another DP master, these interrupts are reflected in the station diagnosis of the CPU 31x-2. You must postprocess the relevant diagnostic events in the DP master's user program.

Note

Note the following in order to be able to evaluate diagnostic interrupts and process interrupts via the device-related diagnostics when using a different DP master:

- The DP master should be able to store the diagnostic messages, that is, the DP master should have a ring buffer in which to place these messages. If the DP master can not store diagnostic messages, only the last diagnostic message would be available for evaluation.
- You must scan the relevant bits in the device-related diagnostic data in your user program at regular intervals. You must also take the PROFIBUS-DP's bus cycle time into consideration so that you can scan the bits at least once in sync with the bus cycle time, for example.
- When using an IM 308-C as DP master, you can not utilize process interrupts in device-related diagnostics, as only incoming interrupts can be signaled, not outgoing interrupts.

9.6 Direct Communication

With *STEP 7* V 5.x or later, you can configure "Direct Communication" for PROFIBUS nodes. The CPU 31x-2 can take part in direct communication as the sender or receiver.

"Direct communication" is a special communication relationship between PROFIBUS-DP nodes.

Principle

Direct communication is characterized by the fact that the PROFIBUS-DP nodes "listen in" to find out which data a DP slave is sending back to its DP master. Using this function the eavesdropper (receiver) can directly access changes in the input data of remote DP slaves.

During configuration in *STEP 7*, in addition to defining the relevant I/O input addresses, you can also define which of the receiver's address areas the required data from the sender will be read to.

A CPU 31x-2 can be one of the following:
Sender   as DP slave
Receiver   as DP slave or DP master or as CPU not included in a
              master system (see Figure 9-10).

Example:

Figure 9-10 shows an example of the direct communication "relationships" you can configure. In the figure all the DP masters and DP slaves are CPU 31x-2s. Note that other DP slaves (ET 200M, ET 200X, ET 200S) can only be senders.

Figure 9-10   Direct Communication using CPU 31x-2

9.7 Diagnosis with Direct Communication

Diagnostic Addresses

With direct communication you allocate a diagnostic address on the receiver:

Figure 9-11   Diagnostic Address for Receiver with Direct Communication

Event Detection

Table 9-15 shows how the CPU 31x-2 acting as as receiver detects interruptions in the transfer of data.

Table 9-15   Event Detection by CPU 31x-2 Acting as Receiver in Direct Communication

Event	What Happens in the Receiver
Bus interruption (short-circuit, plug pulled)	• OB 86 is called and a *station failure* reported (incoming event; diagnostic address of the receiver, assigned to the sender) • With I/O access: OB 122 is called up (I/O access error)

Evaluation in the User Program

Table 9-16 shows you how you can, for example, evaluate the station failure of the sender in the receiver (see also Table 9-15).

Table 9-16   Evaluation of the Station Failure of the Sender During Direct Communication

In the Sender	In the Receiver
Diagnostic addresses: (example) 　　Master diagnostic address=**1023** 　　Slave diagnostic address in the master 　　system=**1022**	Diagnostic address: (example) 　　Diagnostic address=**444**
Station failure　　　　　　　　　　　→	The CPU calls OB 86 with the following information: • OB 86_MDL_ADDR:=**444** • OB86_EV_CLASS:=B#16#38 (incoming event) • OB86_FLT_ID:=B#16#C4 (failure of a DP station) Tip: This information is also in the CPU's diagnostic buffer

Cycle and Response Times of the S7-300 **10**

Introduction

In this section, we explain what the cycle time and the response time of the S7-300 consist of.

You can use the programming device to read the cycle time of your user program (see the *STEP 7 online help system*).

The example below shows you how to calculate the cycle time.

The response time is more important for the process. In this chapter we will show you in detail how to calculate the response time.

In This Section

Execution times

- for the *STEP 7* instructions processable by the CPUs

- for the SFCs/SFBs integrated in the CPUs

- for the IEC functions invokable in *STEP 7*

can be found in the *S7-300 Instruction List*

10.1 Cycle Time

Cycle Time – A Definition

The cycle time is the time that elapses during one program cycle.

Component Parts of the Cycle Time

The cycle time comprises:

Factors	Remarks
Operating system execution time	See Section 10.2
Process image transfer time (PII and PIQ)	
User program execution time	Can be calculated on the basis of the execution times of the individual instructions (see the *S7-300 Instruction List*) and a CPU-specific factor (see Table 10-3)
S7 timer (not in the case of the CPU 318-2)	See Section 10.2
PROFIBUS DP	
Integrated functions	
Communication via the MPI	You parameterize the maximum permissible cycle load produced by communication in percent in *STEP 7*
Loading through interrupts	See Sections 10.4 and 10.5

Figure 10-1 shows the component parts of the cycle time

Figure 10-1   Component Parts of the Cycle Time

Extending the Cycle Time

Note that the cycle time of a user program is extended by the following:

- Time-controlled interrupt handling

- Process interrupt handling (see also Section 10.4)

- Diagnostics and error handling (see also Section 10.4)

- Communication via MPI

10.2 Response Time

Response Time – A Definition

The response time is the time between detection of an input signal and modification of an associated output signal.

Factors

The response time depends on the cycle time and the following factors:

Factors	Remarks
Delay of the inputs and outputs	The delay times are given in the technical specifications • In the *Module Specifications* Reference Manual for the signal modules • In Section 8.4.1 for the integrated inputs/outputs of the CPU 312 IFM. • In Section 8.4.4 for the integrated inputs/outputs of the CPU 314 IFM.
Additional bus runtimes on the PROFIBUS subnet	CPU 31x-2 DP only

Range of Fluctuation

The actual response time lies between a shortest and a longest response time. You must always reckon on the longest response time when configuring your system.

The shortest and longest response times are considered below to let you get an idea of the width of fluctuation of the response time.

Shortest Response Time

Figure 10-2 shows you the conditions under which the shortest response time is reached.

Figure 10-2   Shortest Response Time

Calculation

The (shortest) response time consists of the following:

- 1 × process image transfer time for the inputs +

- 1 × operating system execution time +

- 1 × program execution time +

- 1 × process image transfer time for outputs +

- Execution time of S7 timer +

- Delay of the inputs and outputs

This corresponds to the sum of the cycle time and the delay of the inputs and outputs.

Longest Response Time

Figure 10-3 shows the conditions that result in the longest response time.

Figure 10-3   Longest Response Time

Calculation

The (longest) response time consists of the following:

- 2 × process image transfer time for the inputs +

- 2 × process image transfer time for the outputs +

- 2 × operating system execution time +

- 2 × program execution time +

- 2 × Bus runtime on the PROFIBUS-DP bus system (with CPU 31x-2 DP)

- Execution time of the S7 timer +

- Delay of the inputs and outputs

This corresponds to the sum of the double cycle time and the delay of the inputs and outputs plus the double bus runtime.

Operating System Processing Time

Table 10-1 contains all the times needed to calculate the operating system processing times of the CPUs.

The times listed do not take account of

- Test functions, e.g. monitor, modify

- Functions: Load block, delete block, compress block

- Communication

Table 10-1 Operating System Processing Times of the CPUs

Sequence	CPU 312 IFM	CPU 313	CPU 314	CPU 314 IFM	CPU 315	CPU 315-2 DP	CPU 316-2 DP	CPU 318-2
Cycle control	600 to 1200 μs	540 to 1040 μs	540 to 1040 μs	770 to 1340 μs	390 to 820 μs	500 to 1030 μs	500 to 1030 μs	200 μs

Process Image Update

Table 10-2 lists the CPU times for the process image update (process image transfer time). The times specified are "ideal values" which are prolonged by interrupts or by communication of the CPU.
(Process image = PI)

The CPU time for the process image update is calculated as follows:

K + number of bytes in the PI in rack "0" ×A
 + number of bytes in the PI in racks "1 to 3" B
 + number of bytes in the PI via DP D
 = Process image transfer time

Table 10-2   Process Image Update of CPUs

	Components	CPU 312 IFM	CPU 313	CPU 314	CPU 314 IFM	CPU 315	CPU 315-2 DP	CPU 316-2 DP	CPU 318-2
K	Base load	162 μs	142 μs	142 μs	147 μs	109 μs	10 μs	10 μs	20 μs
A	For each byte in rack "0"	14.5 μs	13.3 μs	13.3 μs	13.6 μs	10.6 μs	20 μs (per word)	20 μs (per word)	6 μs
B	For each byte in racks "1 to 3"	16.5 μs	15.3 μs	15.3 μs	15.6 μs	12.6 μs	22 μs (per word)	22 μs (per word)	12.4 μs
D	For each byte in DP area for integrated DP interface	–	–	–	–	–	12 μs (per word)	12 μs (per word)	1 μs

User Program Processing Time:

The user program processing time is made up of the sum of the execution times for the instructions and the SFB/SFCs called up. These execution times can be found in the Instruction List. Additionally, you must multiply the user program processing time by a CPU-specific factor. This factor is listed in Table 10-3 for the individual CPUs.

Table 10-3   CPU-specific Factors for the User Program Processing Time

Se-quence	CPU 312 IFM	CPU 313	CPU 314	CPU 314 IFM	CPU 315	CPU 315-2 DP	CPU 316-2 DP	CPU 318-2
Factor	1,23	1,19	1,15	1,15	1,15	1,19	1,19	1,025

S7 timers

In the case of the CPU 318-2, the updating of the S7 timers does not extend the cycle time.

The S7 timers are updated every 10 ms.
You can find out in Section 10.3 how to include the S7 timers in calculations of the cycle and response times.

Table 10-4   Updating the S7 Timers

Sequence	312 IFM	313	314	314 IFM	315	315-2 DP	316-2 DP
Updating the S7 timers (every 10 ms)	Number of si-multaneously active S7 tim-ers ×10 μs	Number of simultaneously active S7 timers × 8 μs					

PROFIBUS-DP interface

In the case of the CPU 315-2 DP/316-2 DP, the cycle time is typically extended by 5% when the PROFIBUS-DP interface is used.

In the case of the CPU 318-2, there is no increase in cycle time when the PROFIBUS-DP interface is used.

Integrated Functions

In the case of the CPU 312-IFM and the CPU 314-IFM, the cycle time is increased by a maximum of 10 % when integrated functions are used. In addition, you must, where applicable, take into account the update of the instance DB at the scan cycle checkpoint.

Table 10-5 shows the update times of the instance DB at the scan cycle checkpoint, together with the corresponding SFB runtimes.

Table 10-5   Update Time and SFB Runtimes

CPU 312 IFM/314 IFM	Update Time of the Instance DB at the Scan Cycle Checkpoint	SFB Runtime
IF Frequency measurement (SFB 30)	100 μs	220 μs
IF Counting (SFB 29)	150 μs	300 μs
IF Counting (Parallel counter) (SFB 38)	100 μs	230 μs
IF Positioning (SFB 39)	100 μs	150 μs

Delay of the Inputs and Outputs

You must take account of the following delay times, depending on the module:

- For digital inputs: The input delay time

- For digital outputs: Negligible delay times

- For relay outputs: Typical delay times of between 10 ms and 20 ms.
  The delay of the relay outputs depends, among other things, on the temperature and voltage.

- For analog inputs: Cycle time of the analog input

- For analog outputs: Response time of the analog output

Bus Runtimes in the PROFIBUS Subnet

When you have configured your PROFIBUS subnet using *STEP 7*, *STEP 7* will calculate the typical bus runtime to be expected. You can then display the bus runtime of your configuration on the programming device (see *STEP 7 User Manual*).

An overview of the bus runtime is provided in Figure 10-4. In this example, we assume that each DP slave has an average of 4 bytes of data.

Figure 10-4   Overview of the Bus Runtime on PROFIBUS-DP at 1.5 Mbps and 12 Mbps

If you run a PROFIBUS subnet with several masters, you must allow for the bus runtime of each master (i.e. total bus runtime = bus runtime $\times$ number of masters).

Extending the Cycle by Nesting Interrupts

Table 10-6 shows typical extensions of the cycle time through nesting of an interrupt. The program runtime at the interrupt level must be added to these. If several interrupts are nested, the corresponding times need to be added.

Table 10-6   Extending the Cycle by Nesting Interrupts

Interrupts	312 IFM	313	314	314 IFM	315	315-2 DP	316-2 DP	318-2
Process interrupt	approx. 840 µs	approx. 700 µs	approx. 700 µs	approx. 730 µs	approx. 480 µs	approx. 590 µs	approx. 590 µs	approx. to 340ms
Diagnostic interrupt	–	approx. 880 µs	approx. 880 µs	approx. 1000 µs	approx. 700 µs	approx. 860 µs	approx. 860 µs	approx. 450 µs
Time-of-day interrupt	–	–	approx. 680 µs	approx. 700 µs	approx. 460 µs	approx. 560 µs	approx. 560 µs	approx. 350 µs
Delay interrupt	–	–	approx. 550 µs	approx. 560 µs	approx. 370 µs	approx. 450 µs	approx. 450 µs	approx. 260 µs
Watchdog interrupt	–	–	approx. 360 µs	approx. 380 µs	approx. 280 µs	approx. 220 µσ	approx. 220 µσ	approx. 260 µs
Programming/ access error/ program execution error	–	approx. 740 µs	approx. 740 µs	approx. 760 µs	approx. 560 µs	approx. 490 µs	approx. 490 µs	approx. 130/ 155/ 285 µs

10.3   Calculation Examples for Cycle Time and Response Time

Component Parts of the Cycle Time

Remember: The cycle time consists of the following:

- Process image transfer time +
- Operating system processing time +
- User program processing time +
- Processing time of S7 timers

Sample Configuration 1

You have configured an S7-300 with the following modules on one rack:

- 1 CPU 314

- 2 SM 321 DI 32 $\times$ DC 24 V digital input modules (4 bytes each in the PI)

- 2 SM 322 DO 32 $\times$ DC 24 V/0.5A digital output modules (4 bytes each in the PI)

According to the Instruction List, the user program has a runtime of 1.5 ms.
There is no communication.

Calculation

In this example, the cycle time is calculated from the following times:

- Process image transfer time

  Process image of the inputs: 147 μs + 8 bytes $\times$ 13.6 μs = ca. **0.26 ms**

  Process image of the outputs: 147 μs + 8 bytes $\times$ 13.6 μs = ca. **0.26 ms**

- Operating system runtime

  Cyclic control: approx. **1 ms**

- User program processing time:

  approx. 1.5 ms $\times$ CPU-specific factor 1.15 = approx. **1.8 ms**

- Processing time of S7 timers

  Assumption: 30 S7 timers are in operation.

  For 30 S7 timers, the one-off update takes

  30 $\times$ 8 μs = 240 μs.

  Adding the process image transfer time, the operating system processing time and the user program processing time gives us the time interval:

  0.26 ms + 0.26 ms + 1 ms + 1.8 ms = 3.32 ms.

  Since the S7 timers are called every 10 ms, a maximum of one call can be made in this time interval, i.e. the cycle time can be increased by the S7 timers by a maximum of 240 μs (=0.24 ms)

The cycle time is calculated from the sum of the listed times:

Cycle time= 0.26 ms + 0.26 ms + 1 ms + 1.8 ms + 0.24 ms **= 3.56 ms.**

Parts of the Response Time

Remember: The response time is the sum of the following:

- 2 × process image transfer time for the inputs +

- 2 × process image transfer time for the outputs +

- 2 × operating system execution time +

- 2 × program execution time +

- Processing time of the S7 timers +

- Delay times of the inputs and outputs

Tip: Simple calculation: Calculated cycle time × 2 + delay times.

For sample configuration 1 the following therefore applies:
3.34 ms × 2 + delay times of the I/O modules.

Sample Configuration 2

You have configured an S7-300 with the following modules on two racks:

- 1 CPU 314

- 4 SM 321 DI 32×DC 24 V digital input modules (4 bytes each in the process image)

- 3 SM 322 DO 16×DC 24 V/0.5A digital output modules (2 bytes each in the PI)

- 2 SM 331 AI 8×12Bit analog input modules (not in the PI)

- 2 SM 332 AOI 4×12Bit analog output modules (not in the PI)

User program

According to the Instruction List, the user program has a runtime of 2 ms. By taking into account the CPU-specific factor of 1.15, the resulting runtime is approx. 2.3 ms. The user program employs up to 56 S7 timers simultaneously. No activities are required at the scan cycle checkpoint.

Calculation

In this example, the response time is calculated from the following times:

- Process image transfer time

  Process image of the inputs: 147 μs + 16 bytes × 13.6 μs = ca. **0.36 ms**

  Process image of the outputs: 147 μs + 6 bytes × 13.6 μs = ca. **0.23 ms**

- Operating system execution time

  Cyclic control: approx. **1 ms**

- User program processing time: **2.3 ms**

- **1st intermediate calculation** The time base for calculating the processing time of the S7 timers is the sum of all previously listed times:

2×0.36 ms	(process image transfer time of inputs)
$+ 2 \times 0.23$ ms	(process image transfer time of outputs)
$+ 2 \times 1$ ms	(operating system processing time)
$+ 2 \times 2.3$ ms	(user program processing time) $\approx$ **7.8 ms**.

- Processing time of S7 timers

  A one-off update of 56 S7 timers takes $56 \times 8 \ \mu s = 448 \ \mu s \approx 0.45$ ms.

  Since the S7 timers are called every 10 ms, a maximum of one call can be made in the cycle time, i.e. the cycle time can be increased through the S7 timers by a maximum of 0.45 ms.

- **2nd intermediate calculation:** The response time **excluding** the delay times of the inputs and outputs is calculated from the sum of:

8.0 ms	(result of the first subtotal)
+ 0.45 ms	(processing time of the S7 timers)
=8.45 ms.	

- Delay times of the inputs and outputs

  – The SM 321 DI $32 \times$ DC 24 V digital input module has an input delay of **4.8 ms** per channel.

  – The output delay of the SM 322; DO $16 \times$ DC 24 V/0.5A digital output group can be ignored.

  – The SM 331; AI $8 \times$ 12Bit analog input module was parameterized for interference frequency suppression of 50 Hz. This yields a conversion time of 22 ms per channel. Since 8 channels are active, the cycle time for the analog input module is **176 ms**.

  – The SM 332; AO $4 \times$ 12Bit analog output module was parameterized for the measurement range 0 ...10 V.The conversion time is **0.8 ms** per channel. Since 4 channels are active, a cycle time of 3.2 ms is obtained. A settling time of 0.1 ms for a resistive load must be added to this figure. This yields a response time of **3.3 ms** for an analog output.

- Response times with delay times for inputs and outputs:

- **Case 1:** An output channel of the digital output module is set when a digital input signal is read in. This results in a response time of:

  Response time = 4.8 ms + 8.45 ms **= 13.25 ms**.

- **Case 2:** An analog value is read in and an analog value is output. This results in a response time of:

  Response time = 176 ms + 8.45 ms + 3.3 ms **= 187.75 ms**.

10.4　　　　Interrupt Response Time

Interrupt Response Time – A Definition

The interrupt response time is the time that elapses between the first occurrence of an interrupt signal and the calling of the first instruction in the interrupt OB.

The following rule generally applies: High-priority interrupts are executed first. This means the interrupt response time is increased by the program processing time of the higher-priority interrupt OBs and the interrupt OBs of equal priority that have not yet been executed.

Calculation

The interrupt response time is calculated as follows:

Shortest interrupt response time =
　　　　　Minimum interrupt response time of the CPU +
　　　　　Minimum interrupt response time of the signal modules +
　　　　　Bus runtime on the PROFIBUS-DP

Longest interrupt response time =
　　　　　Maximum interrupt response time of the CPU +
　　　　　Maximum interrupt response time of the signal modules +
　　　　　2 × bus runtime on the PROFIBUS-DP bus system

Process Interrupt Response Time of the CPUs

Table 10-7 lists the process interrupt response times of the CPUs (without communication).

Table 10-7　Process Interrupt Response Times of the CPUs

CPU	Min.	Max.
312 IFM	0.6 ms	1.5 ms
313	0.5 ms	1.1 ms
314	0.5 ms	1.1 ms
314 IFM	0.5 ms	1.1 ms
315	0.3 ms	1.1 ms
315-2 DP	0.4 ms	1.1 ms
316-2 DP	0.4 ms	1.1 ms
318-2	0.23 ms	0.27 ms

Diagnostic Interrupt Response Times of the CPUs

Table 10-8 lists the diagnostic interrupt response times of the CPUs (without communication).

Table 10-8   Diagnostic Interrupt Response Times of the CPUs

CPU	Min.	Max.
312 IFM	–	–
313	0.6 ms	1.3 ms
314	0.6 ms	1.3 ms
314 IFM	0.7 ms	1.3 ms
315	0.5 ms	1.3 ms
315-2 DP	0.6 ms	1.3 ms
316-2 DP	0.6 ms	1.3 ms
318-2	0.32 ms	0.38 ms

Signal Modules

The process interrupt response time of the signal modules is composed of the following components:

* Digital input modules

  Process interrupt response time = internal interrupt preparation time + input delay

  You will find the times in the data sheet for the individual analog input module.

* Analog input modules

  Process interrupt response time = internal interrupt preparation time + conversion time

  The internal interrupt preparation time for the analog input modules is negligible. The conversion times can be found in the data sheet for the individual digital input modules.

The diagnostic interrupt response time of the signal modules is the time that elapses between the detection of a diagnostic event by the signal module and the triggering of the diagnostics interrupt by the signal module. This time is negligible.

Process Interrupt Handling

Process interrupt handling begins when the process interrupt OB 40 is called. Higher-priority interrupts cause the process interrupt handling routine to be interrupted. Direct accesses to the I/O are made at the execution time of the instruction. When the process interrupt handling routine has finished, either cyclic program execution continues or further same-priority or lower-priority interrupt OBs are called up and executed.

10.5   Calculation Example for the Interrupt Response Time

Parts of the Interrupt Response Time

Remember: The process interrupt response time consists of the following:

- The process interrupt response time of the CPU and

- The process interrupt response time of the signal module.

Example: You have configured an S7-300 with a CPU 314 and four digital modules. One digital input module is the SM 321; DI 16 $\times$ DC 24 V; with process and diagnostic interrupt. You have only enabled the process interrupt when setting the parameters for the CPU and the SM. You decided not to use time-controlled processing, diagnostics or error handling. You configured an input delay of 0.5 ms for the digital input module. No activities are necessary at the scan cycle checkpoint. There is no communication via the MPI.

Calculation

The process interrupt response time in this example is calculated from the following times:

- Process interrupt response time of the CPU 314: approx. 1.1 ms

- Process interrupt response time of the SM 321; DI 16 $\times$ DC 24 V;

    – Internal interrupt preparation time: 0.25 ms

    – Input delay   0.5 ms

The process interrupt response time is calculated from the sum of the listed times:

Process interrupt response time = 1.1 ms + 0.25 ms + 0.5 ms = **approx**. **1.85 ms**.

This process interrupt response time elapses from the time a signal is applied to the digital input until the first instruction in OB 40.

10.6   Reproducibility of Delay and Watchdog Interrupts

Definition of Reproducibility

Delay Interrupt:

The interval between the call-up of the first instruction in the OB and the programmed time of the interrupt.

Watchdog Interrupt:

The fluctuation of the time interval between two successive call-ups, measured in each case between the first instruction in the OB.

Reproducibility

Table 10-9 lists reproducibility of the delay and watchdog interrupts of the CPUs (without communication).

Table 10-9   Reproducibility of the Delay and Watchdog Interrupts of the CPUs

CPU	Reproducibility	
	Delay Interrupt	**Watchdog Interrupt**
314	approx. −1/+0.4 ms	approx. ±0.2 ms
314 IFM	approx. −1/+0.4 ms	approx. ±0.2 ms
315	approx. −1/+0.4 ms	approx. ±0.2 ms
315-2 DP	approx. −1/+0.4 ms	approx. ±0.2 ms
316-2 DP	approx. −1/+0.4 ms	approx. ±0.2 ms
318-2	approx. −0.8/+0.38 ms	approx. ±0.04 ms

CPU Functions Dependent on the CPU and *STEP 7* Version

11

In This Section

In this chapter we describe the functional differences between the various CPU versions.

These differences are determined by the following factors:

- By the performance features of the CPUs, especially the CPU 318-2 in comparison with other CPUs.

- By functionality of the CPUs described in this manual in comparison to previous versions.

Section	Contents	Page
11.1	The Differences Between the CPU 318-2 and the CPU 312 IFM to 316-2 DP	11-2
11.2	The Differences Between the CPUs and Their Previous Versions	11-5

11.1 The Differences Between the CPU 318-2 and the CPU 312 IFM to 316-2 DP

4 Accumulators with 318-2

CPU 318-2	CPUs 312 IFM to 316-2 DP
4 accumulators	2 accumulators

The following table shows you what to watch for if you want to use an STL user program of a CPU 312 IFM to a CPU 316-2 DP for the CPU 318-2.

Instructions	User Program from the CPU 312 IFM to 316-2 DP for the CPU 318
Double integer math (+I, –I, *I, /I; +D, –D, *D, /D,MOD; +R, –R, *R, /R)	The CPU 318 transfers the contents of accumulators 3 and 4 to accumulators 2 and 3 after these operations. If accumulator 2 is evaluated in the (accepted) user program, you now receive incorrect values with the CPU 318-2 because the value has been overwritten by the contents of accumulator 3.

Configuration

The CPU 318-2 only accepts a project from a CPU 312 IFM to 316-2 DP if it has been created for these CPUs with *STEP 7* V 5.x.

You cannot use programs that contain configuration data for FMs (FM 353/354, for example) or CPs (SDB 1xxx) for the CPU 318-2.
You must revise or recreate the relevant project.

Starting a Timer in the User Program

If you start a timer in the user program (with SI T, for example), there must be a number in BCD format in the accumulator of the CPU 318-2.

Forcing

The differences when forcing are described in Section 8.3.1.

Loading the User Program to the Memory Card

CPU 318-2	CPUs 312 IFM to 316-2 DP
... using the PD function **Load User Program**	... using the PD function **Copy RAM To ROM** or **Load User Program**

MPI Addressing

CPU 318-2	CPUs 312 IFM to 316-2 DP
The CPU addresses the MPI nodes within its configuration (FM/CP) via the **module start address**.	The CPUs address the MPI nodes within their configuration via the **MPI address**.
If FM/CP are in the central configuration of an S7-300 with their own MPI address, the CPU forms its own communication bus (via the backplane bus) with the FM/CP, separate from the other subnets. The MPI address of the FM/CP is no longer relevant for the nodes of other subnets. Communication to the FM/CP takes place via the CPU MPI address.	If FM/CP are in the central configuration of an S7-300 with their own MPI address, the FM/CP and CPU MPI nodes are in the same CPU subnet.

You have an S7-300 configuration with FM/CP addressed via the MPI and want to replace the CPU 312 IFM ... 316 with a CPU 318-2. Figure 11-1 on page 11-3 shows an example.

Figure 11-1   Sample Configuration

After the CPUs have been swapped, you must proceed as follows (based on the above example):

- Replace the CPU 316 with the CPU 318-2 in the STEP 7 project.
- Reconfigure the operator panel/programming device. This means reallocating the programmable controller and reassigning the destination address (= MPI address of the CPU 318-2 and the slot of the relevant FM)
- Reconfigure the configuration data for the FM/CP to be loaded onto the CPU.

This is necessary to ensure that the FM/CP in this configuration remain accessible to the operator panel/programming device.

Inserting and Removing a Memory Card (FEPROM)

If you remove a memory card in POWER OFF mode (CPU has power buffer) and insert another memory card with identical contents, the following happens after POWER ON:

CPU 318-2	CPUs 312 IFM to 316-2 DP
The CPU 318-2 goes into STOP mode and request a memory reset.	The CPU switches to the mode it was in prior to POWER OFF, i.e. RUN or STOP.

Connection resources

CPU 318-2	CPUs 312 IFM to 316-2 DP
The CPU 318-2 provides a total of 32 connection resources, 32 of them via the MPI/DP interface or 16 via the DP interface. Those connection resources are freely available for • PD/OP communication • S7 basic communication • S7 communication and • Routing of PD communication	The CPUs provide a specific number of connection resources. For • PD communication • OP communication and • S7 basic communication you can reservce connection resources which can then not be used by any other communication function. The remaining connection resources are then available for PD/OP/S7 basic and S7 communication. For routing, the CPUs 315-/316-2 provide additional connection resources for 4 routing connections.

11.2 The Differences Between the CPUs 312 IFM to 316 and Their Previous Versions

Memory Cards and Backing Up Firmware on Memory Card

As of the following CPUs:

CPU	Order No.	As of Version	
		Firmware	**Hardware**
CPU 313	6ES7 313-1AD**03-**0AB0	1.0.0	01
CPU 314	6ES7 314-1AE**04-**0AB0	1.0.0	01
CPU 315	6ES7 315-1AF**03-**0AB0	1.0.0	01
CPU 315-2	6ES7 315-2AF**03-**0AB0	1.0.0	01
CPU 316-2	6ES7 316-1AG**00-**0AB0	1.0.0	01

You can:

- Insert the 16 bit-wide memory cards:

    256 KB FEPROM   6ES7 951-1KH00-0AA0

    1 MB FEPROM   6ES7 951-1KK00-0AA0

    2 MB FEPROM   6ES7 951-1KL00-0AA0

    4 MB FEPROM   6ES7 951-1KM00-0AA0

- Back up the CPU firmware on memory card

MPI Addressing

You Have a CPU as of Order Number and Version:	You Have a CPU as of Order Number and Version:
6ES7 312-5AC01-0AB0, version 01	
6ES7 313-1AD02-0AB0, version 01	
6ES7 314-1AE03-0AB0, version 01	
6ES7 314-5AE02-0AB0, version 01	
6ES7 315-1AF02-0AB0, version 01	
6ES7 315-2AF02-0AB0, version 01	
6ES7 316-1AG00-0AB0, version 01	–
and STEP 7 V4.02 or later	and STEP 7 < V4.02
The CPU accepts the MPI addresses configured by you in *STEP 7* for the relevant CP/FM in an S7-300 or automatically determines the MPI address of the CP/FM in an S7-300 on the pattern MPI addr. CPU; MPI addr.+1 MPI addr.+2 etc.	The CPU automatically establishes the MPI address of the CP/FM in an S7-300 on the pattern MPI addr. CPU; MPI addr.+1 MPI addr.+2 etc.

MPI with 19.2 kbps

With STEP 7 as of V4.02 you can set a transmission rate for the MPI of 19.2 kbps.

The CPUs support 19.2 kbps as of the following order numbers:

6ES7 312-5AC01-0AB0, version 01
6ES7 313-1AD02-0AB0, version 01
6ES7 314-1AE03-0AB0, version 01
6ES7 314-5AE02-0AB0, version 01
6ES7 315-1AF02-0AB0, version 01
6ES7 315-2AF02-0AB0, version 01

CPU 315-2 DP

CPU 315-2 DP	≤ 6ES7 315-2AF03-0AB0 and *STEP 7* < V 5.x	As of 6ES7 315-2AF03-0AB0 and *STEP 7* as of V 5.x
Direct communication	No	Yes
Equidistance	No	Yes
Activation/deactivation of DP slaves	No	Yes
Routing	No	Yes
Reading out of slave diagnosis	See Figure 9-1 on page 9-6	See Figure 9-2 on page 9-7

Connection resources

From CPU	Order No.	As of Version	
		Firmware	**Hardware**
CPU 312 IFM	6ES7 312-5AC02-0AB0	1.1.0	01
CPU 313	6ES7 313-1AD03-0AB0	1.1.0	01
CPU 314	6ES7 314-1AE04-0AB0	1.1.0	01
CPU 314 IFM	6ES7 314-5AE03-0AB0	1.1.0	01
CPU 314 IFM	6ES7 314-5AE10-0AB0	1.1.0	01
CPU 315	6ES7 315-1AF03-0AB0	1.1.0	01
CPU 315-2 DP	6ES7 315-2AF03-0AB0	1.1.0	01
CPU 316-2 DP	6ES7 316-2AG00-0AB0	1.1.0	01

... can be reserved for PD communication, OP communication and S7 basic communication.
The unreserved connection resources then remain freely available for PD/OP/S7 basic or S7 communication (see also Section 8.2).

CPU versions earlier than those referred to above provide a fixed number of connection resources for the applicable communication functions.

Tips and Tricks

12

Tip on the "Monitoring Time for ..." Parameter in STEP 7

If you are not sure of the required times in the S7-300, parameterize the highest values for the parameters of "Monitoring Time for

- Transfer of parameters to modules"

- Ready message from modules"

CPU 31x-2 DP is DP Master	CPU 318-2 is DP Master
You can also set power-up time monitoring for the DP slaves with the "Transfer of parameters to modules" parameter.	You can set power-up time monitoring for the DP slaves with **both** of the above parameters.
This means that the DP slaves must be powered up and parameterized by the CPU (as DP master) in the set time.	

FM in a Distributed Configuration in an ET 200M (CPU 31x-2 is DP Master)

If you use the FM 353/354/355 in an ET 200M with the IM 153-2 and remove and insert the FM in the ET 200M, then you must subsequently turn the power supply of the ET 200M off and on.
The reason for this is that the CPU does not write the new parameters into the FM until power of the ET 200M is switched on.

The Retentive Feature of Data Blocks

You must note the following for the retentivity of data areas in data blocks:

With Backup Battery	Without Backup Battery	
	CPU program on Memory Card or in the integral EPROM of the 312 IFM/314 IFM	**Memory card not plugged in**
All DBs are retentive, whatever parameterization has been performed. The DBs generated using SFC 22 "CREAT_DB" are also retentive.	All DBs (retentive, non-retentive) are transferred from the memory card or from the integral EPROM into RAM on restart.	The DBs parameterized as retentive retain their contents
	• The DBs or data areas generated using SFC 22 "CREAT_DB" are not retentive. • After a power failure, the retentive data areas are retained. **Note:** These data areas are stored in the CPU, not on the memory card. The non-retentive data areas contain whatever has been programmed on EPROM.	

Watchdog Interrupt: Periodicity > 5 ms

For the watchdog interrupt, you should set periodicity > 5 ms. In the case of lower values, the danger of frequent occurrence of watchdog interrupt errors increases depending on, for example, the

- Program execution time of an OB 35 program

- Frequency and program execution time of higher priority classes

- Programming device functions.

Process Interrupt of I/O Modules

In the case of process interrupt-critical applications, insert the process interrupt-triggering modules as near as possible to the CPU.
The reason for this is that an interrupt is read most quickly by rack 0, slot 4 and then in ascending order of the slots.

CPU 312 IFM and 314 IFM: Erasing the Integral EPROM

If you wish to erase the contents of the integral EPROM, proceed as follows:

1. Use the menu command **View ▸ Online** to open a window for the active project in Online View, or

    open the **Accessible Nodes** window by clicking the **Accessible Nodes** button on the Toobar or by choosing the menu command **PLC ▸ Show Accessible Nodes**.

2. Select the MPI number of the target CPU (double-click).

3. Select the **Modules** container.

4. Choose the menu command **Edit ▸ Select All**.

5. Then choose the menu command **File ▸ Delete** or press the DEL key. This deletes all the selected blocks from the target memory.

6. Select the MPI number of the target CPU.

7. Choose the menu command **PLC ▸ Copy RAM To ROM**.

This command deletes all blocks online and overwrites the EPROM with the blank contents of the RAM.

SFB "DRUM" – Reversed Bytes in Output Parameter OUT-WORD

With the SFB "DRUM", the following CPUs return the the value with reversed bytes on the output parameter OUT_WORD.

CPU 312 IFM   up to and including 6ES7 312-5ACx2-0AB0, firmware V 1.0.0
CPU 313   up to and including 6ES7 313-1AD03-0AB0, firmware V 1.0.0
CPU 314   up to and including 6ES7 314-1AEx4-0AB0, firmware V 1.0.0
CPU 314 IFM   up to and including 6ES7 314-5AEx3-0AB0; firmware V 1.0.0
CPU 315   up to and including 6ES7 315-1AF03-0AB0, firmware V 1.0.0
CPU 315-2 DP up to and including 6ES7 315-2AFx2-0AB0
CPU 316   up to and including 6ES7 316-1AG00-0AB0

Consequently, the assignment as compared with the output parameter OUTj, $0 \leq j \leq 15$ is as follows:

Standards and Approvals

A

Introduction

This appendix provides the following information on the S7-300 modules and components:

- The most important standards and criteria met by S7-300 and

- Approvals that have been granted for the S7-300.

IEC 1131

The S7-300 programmable controller meets the requirements and criteria to standard IEC 1131, Part 2.

CE Symbol

Our products meet the requirements and protection guidelines of the following EC Directives and comply with the harmonized European standards (EN) issued in the Official Journal of the European Communities with regard to programmable controllers:

- 89/336/EEC "Electromagnetic Compatibility" (EMC Directive)

- 73/23/EEC "Electrical Equipment Designed for Use between Certain Voltage Limits" (Low-Voltage Directive)

The declarations of conformity are held at the address below, where they can be obtained if and when required by the respective authorities:

Siemens Aktiengesellschaft
Automation Group
A&D AS E 4
P.O. Box 1963
D-92209 Amberg
Federal Republic of Germany

EMC Guidelines

SIMATIC products have been designed for use in the industrial area.

Area of Application	Requirements:	
	Emitted interference	**Immunity**
Industry	EN 50081-2 : 1993	EN 50082-2 : 1995

If you use the S7-300 in residential areas, you must ensure emission of radio interference complies with Limit Class B as per EN 55011.

The following measures can be taken to achieve compliance with Limit Class B:

- Install the S7-300 in an earthed control/switchgear cabinet

- Fit filters to supply lines

UL Recognition

UL Recognition Mark
Underwriters Laboratories (UL) to
UL standard 508, Report 116536

CSA Certification

CSA Certification Mark
Canadian Standard Association (CSA) to
 Standard C22.2 No. 142, File No. LR 48323

FM Approval

FM Approval to Factory Mutual Approval Standard Class Number 3611, Class I, Division 2, Group A, B, C, D.

Warning

Personal injury or property damage can result.

In hazardous areas, personal injury or property damage can result if you withdraw any connectors while an S7-300 is in operation.

Always isolate the S7-300 in hazardous areas before withdrawing connectors.

PNO

CPU	Certificate No. As ...	
	DP Master	**DP Slave**
315-2 DP	Z00349	Z00258
316-2 DP	Yes *	Yes *
318-2	Yes *	Yes *

* Number was not available at time of going to press

Dimensioned Drawings

B

Introduction

In this appendix you will find dimensioned drawings of the CPUs for the S7-300. You need the specifications in these drawings in order to dimension the S7-300 configuration. The dimensioned drawings of the other S7-300 modules and components are contained in the *Module Specifications* Reference Manual.

CPU 312 IFM

Figure B-1 shows the dimensioned drawing of the CPU 312 IFM.

Figure B-1   Dimensioned Drawing of the CPU 312 IFM

CPU 313/314/315/315-2 DP/316-2 DP

Figure B-2 shows the dimensioned drawing of the CPU 313/314/315/315-2 DP/316-2 DP. The dimensions are the same for all the CPUs listed. Their appearance can differ (see Chapter 8). For example, the CPU 315-2 DP has two LED strips.

Figure B-2   Dimensioned Drawing of the CPU 313/314/315/315-2 DP/316-2 DP

CPU 318-2

Figure B-3 shows the dimensioned drawing of the CPU 318-2, front view. The side view is illustrated in Figure B-2

Figure B-3   Dimensioned Drawing of the CPU 318-2

CPU 314 IFM, Front View

Figure B-4 shows the dimensioned drawing of the CPU 314 IFM, front view. The side view is shown in Figure B-4.

Figure B-4   Dimensioned Drawing of the CPU 314 IFM, Front View

CPU 314 IFM, Side View

Figure B-5 shows the dimensioned drawing of the CPU 314 IFM, side view.

Figure B-5   Dimensioned Drawing of the CPU 314 IFM, Side View

Guidelines for Handling Electrostatic Sensitive Devices (ESD)

<div align="right">

C

</div>

Introduction

In this appendix, we explain

- what is meant by "electrostatic sensitive devices"

- the precautions you must observe when handling and working with electrostatic sensitive devices.

Contents

This chapter contains the following sections on electrostatic sensitive devices:

Section	Contents	Page
C.1	What is ESD?	C-2
C.2	Electrostatic Charging of Persons	C-3
C.3	General Protective Measures against Electrostatic Discharge Damage	C-4

C.1 What is ESD?

Definition

All electronic modules are equipped with large-scale integrated ICs or components. Due to their design, these electronic elements are very sensitive to overvoltages and thus to any electrostatic discharge.

Electrostatically **S**ensitive **D**evices are frequently referred to simply by the abbreviation **ESD**.

Electrostatic sensitive devices are labeled with the following symbol:

Caution

Electrostatic sensitive devices are subject to voltages that are far below the voltage values that can still be perceived by human beings. These voltages are present if you touch a component or the electrical connections of a module without previously being electrostatically discharged. In most cases, the damage caused by an overvoltage is not immediately noticeable and results in total damage only after a prolonged period of operation.

C.2   Electrostatic Charging of Persons

Charging

Every person with a non-conductive connection to the electrical potential of its surroundings can be charged electrostatically.

Figure C-1 shows you the maximum values for electrostatic voltages to which a person can be exposed by coming into contact with the materials indicated in the figure. These values are in conformity with the specifications of IEC 801-2.

Voltage in kV

(kV)

1 Synthetic material

2 Wool

3 Antistatic material, for example, wood or concrete

Relative air humidity in %

Figure C-1   Electrostatic Voltages which can Build up on a Person

C.3   General Protective Measures against Electrostatic Discharge Damage

Ensuring Sufficient Grounding

Make sure that the personnel, working surfaces and packaging are sufficiently grounded when handling electrostatic sensitive devices. You thus avoid electrostatic charging.

Avoiding Direct Contact

You should touch electrostatic sensitive devices only if it is unavoidable (for example, during maintenance work). Hold modules without touching the pins of components or printed conductors. In this way, the discharged energy cannot affect the sensitive devices.

If you have to carry out measurements on a module, you must discharge your body before you start the measurement by touching grounded metallic parts. Use grounded measuring devices only.

Replacement Parts and Accessories for the CPUs of the S7-300

D

Replacement Parts

Table D-1 lists all the parts you can order separately or later for the CPUs of the S7-300 programmable controllers.

Table D-1   Accessories and Replacement Parts

S7-300 Parts	Order No.	Acces-sories	Re-place-ment Parts
Bus connector	6ES7 390-0AA00-0AA0	–	X
Power connector between power supply unit and CPU	6ES7 390-7BA00-0AA0	–	X
2 × Key for CPU (for mode selector)	6ES7 911-0AA00-0AA0	–	X
Backup battery	6ES7 971-1AA00-0AA0	X	–
Accumulator for real-time clock	6ES7 971-5BB00-0AA0	X	–
Memory card **5 V - FEPROM**		X	
• 16 KB	6ES7 951-0KD00-0AA0		
• 32 KB	6ES7 951-0KE00-0AA0		
• 64 KB	6ES7 951-0KF00-0AA0		
• 128 KB	6ES7 951-0KG00-0AA0		
• 256 KB	6ES7 951-1KH00-0AA0		
• 512 KB	6ES7 951-0KJ00-0AA0		
• 1 MB	6ES7 951-1KK00-0AA0		
• 2 MB	6ES7 951-1KL00-0AA0		
• 4 MB	6ES7 951-1KM00-0AA0		
5 V RAM			
• 128 KB	6ES7 951-0KG00-0AA0		
• 256 KB	6ES7 951-1AH00-0AA0		
• 512 KB	6ES7 951-1AJ00-0AA0		
• 1 MB	6ES7 951-1AK00-0AA0		
• 2 MB	6ES7 951-1AL00-0AA0		
Labeling strip (Qty 10)	6ES7 392-2XX00-0AA0	–	X
Slot numbering label	6ES7 912-0AA00-0AA0	–	X

Table D-1   Accessories and Replacement Parts, continued

S7-300 Parts	Order No.	Acces- sories	Re- place- ment Parts
20-pin front connector		X	–
• Screw terminals	6ES7 392-1AJ00-0AA0		
• Spring-loaded terminals	6ES7 392-1BJ00-0AA0		
40-pin front connector		X	–
• Screw terminals	6ES7 392-1AM00-0AA0		
• Spring-loaded terminals	6ES7 392-1BM01-0AA0		
Shield contact element	6ES7 390-5AA00-0AA0	X	–
Shield terminals for		X	–
• 2 cables with a shield diameter of 2 to 6 mm (0.08 to 0.23 in.) each	6ES7 390-5AB00-0AA0		
• 1 cable with a shield diameter of 3 to 8 mm (0.12 to 0.31 in.)	6ES7 390-5BA00-0AA0		
• 1 cable with a shield diameter of 4 to 13 mm (0.16 to 0.51 in.)	6ES7 390-5CA00-0AA0		
Instruction List	6ES7 398-8AA03-8BN0	X	–

SIMATIC S7 Reference Literature

E

Introduction

This appendix contains references

- to manuals that you require for configuring and programming the S7-300,

- to manuals describing the components of a PROFIBUS-DP network,

- to technical books providing information beyond the S7-300.

Documentation Packs for *STEP 7* and Online Help

Table E-1 gives you an overview of the documentation for *STEP 7*.
Table E-2 details the Online Help for *STEP 7*.

Table E-1   Documentation Packs for *STEP 7*

Manuals	Purpose
Basic grounding in *STEP 7* • *Getting Started and Exercises with STEP 7 V5.0* • *Programming with STEP 7 V5.0* • *Configuring Hardware and Connections with STEP 7 V5.0* • *From S5 To S7, Conversion Guide*	The basic grounding for technical staff describing the procedures for implementing control tasks with *STEP 7* and the S7-300/400.
STEP 7 reference • *LAD/FBD/STL Manual for S7-300/400* • *Standard and System Functions for S7-300/400*	Reference works describing the programming languages LAD, FBD and STL as well as standard and system functions additional to the *STEP 7* basic grounding.

Table E-2   *STEP 7* Online Help

Online Help	Purpose
STEP 7 Help	The basic grounding in programming and hardware configuration with *STEP 7* in the form of Online Help
STL/LAD/FBD Reference Help SFB/SFC Reference Help Organisation Block Reference Help	Context-Sensitive Reference Help

Communication Manual

The *Communication with SIMATIC* manual gives you an introduction to and overview of the communication possible in SIMATIC.

Manuals for PROFIBUS-DP

For the configuration and startup of a PROFIBUS-DP network, you will need the descriptions of the other nodes and network components integrated in the network. To help you with this, you can order the manuals listed in Table E-3.

Table E-3   Manuals for PROFIBUS-DP

Manual
ET 200 Distributed I/O System
SIMATIC NET - PROFIBUS Networks
ET 200M Distributed I/O Station
SINEC L2-DP Interface of the S5-95U Programmable Controller
ET 200B Distributed I/O Station
ET 200C Distributed I/O Station
ET 200U Distributed I/O Station
ET 200 Handheld Unit
Technical Overviews
S7/M7 Programmable Controllers *Distributed I/O with PROFIBUS-DP and AS-I*

Technical Literature

Table E-4 lists a selection of technical literature which you can obtain directly from Siemens or from book retailers.

Table E-4   List of Books You Can Order

Title	Siemens Order Number	Book Retailers' Order Number
Speicherprogrammierbare Steuerungen, Grundbegriffe Siemens-AG, Berlin and Munich, 1989	A19100-L531-F913	ISBN 3-8009-8031-2
SPS Speicherprogrammierbare Steuerungen vom Relaisersatz bis zum CIM-Verbund Eberhardt E. Grötsch Oldenbourg Verlag; Munich, Vienna 1989	A19100-L531-G231	ISBN 3-486-21114-5
Speicherprogrammierbare Steuerungen SPS; Band 1: Verknüpfungs- und Ablaufsteuerungen; von der Steuerungsaufgabe zum Steuerungsprogramm Günter Wellenreuther, Dieter Zastrow Braunschweig (3rd edition) 1988	–	ISBN 3-528-24464-X
Steuern und Regeln mit SPS Andratschke, Wolfgang Franzis-Verlag	–	ISBN 3-7723-5623-0
Dezentralisieren mit PROFIBUS DP *Aufbau, Projektierung und Einsatz des PROFIBUS DP mit SIMATIC S7* Josef Weigmann, Gerhard Kilian Publicis MCD Verlag, 1998	A19100-L531-B714	ISBN 3-89578-074-X

Safety of Electronic Control Equipment   **F**

Introduction

The information provided here is of a predominantly fundamental nature and applies regardless of the type of electronic control system and its manufacturer.

Reliability

Maximum reliability of the SIMATIC systems and components is achieved by implementing the following extensive and cost-effective measures during the development and manufacture:

This includes the following:

- Use of high-quality components;

- Worst-case design of all circuits;

- Systematic and computer-controlled testing of all components supplied by subcontractors;

- Burn-in of all LSI circuits (e.g. processors, memories, etc.);

- Measures to prevent static charge building up when handling MOS ICs;

- Visual checks at different stages of manufacture;

- Continuous heat-run test at elevated ambient temperature over a period of several days;

- Careful computer-controlled final testing;

- Statistical evaluation of all returned systems and components to enable the immediate initiation of suitable corrective measures;

- Monitoring of the most important control components using on-line tests (watchdog for the CPU, etc.).

These measures are basic measures. They prevent or rectify a large proportion of possible faults.

Risks

In all cases where the occurrence of failures can result in material damage or injury to persons, special measures must be taken to enhance the safety of the installation – and therefore also of the situation. For this type of application, relevant, plant-specific regulations exist that must be observed on installing the control systems (e.g. VDE 0116 for burner control systems).

For electronic control equipment with a safety function, the measures that have to be taken to prevent or rectify faults are based on the risks involved in the installation. Above a certain potential danger, the basic measures listed above are no longer sufficient. In such cases, additional measures (e.g. redundant configurations, tests, etc.) must be implemented for the control equipment and certified (DIN VDE 0801). The S5-95F fail-safe programmable controller has been prototype tested by the German Technical Inspectorate, BIA and GEM III and several certificates have been granted. It is, therefore, just as able as the S5-115F fail-safe PLC that has already been tested to control and monitor safety-related areas of the installation.

Subdivision into Safety-Related and Non-Safety-Related Areas

In almost every installation there are sections that perform safety-related tasks (e.g. Emergency Stop pushbuttons, protective guards, two-hand-operated switches). To avoid the need to examine the entire controller from the aspect of safety, the controller is usually divided into a **safety-related** and **non-safety-related area**. In the non-safety-related area, no special demands are placed on the safety of the control equipment because any failure in the electronics will have no effect on the safety of the installation. In the safety-related area, however, the only control systems and switchgear that are permitted to be used are those that comply with the relevant regulations.

The following divisions are common in practical situations:

1. For control equipment with few safety-related functions (e.g. machine controls)

   The conventional PLC is responsible for machine control and the safety-related functions are implemented with the fail-safe S5-95F mini PLC.

2. For control equipment with a medium degree of safety-related functionality (e.g. chemical installations, cable cars)

   The non-safety-related area is also implemented here with a conventional PLC and the safety-related area is implemented with a tested fail-safe PLC (S5-115F or several S5-95Fs).

   The entire installation is implemented with a fail-safe control system.

3. For control equipment with mainly safety-related functions (e.g. burner control systems)

   The entire control system is implemented with fail-safe technology.

Important Information

Even when electronic control equipment has been configured for maximum design safety, for example using multi-channel setups, it is still of the utmost importance that the instructions given in the operating manual are followed exactly. Incorrect handling can render measures intended to prevent dangerous faults ineffective, or generate additional sources of danger.

Siemens Worldwide

G

In This Appendix

In this appendix you will find a list of the following:

- Siemens offices in the Federal Republic of Germany

- All European and non-European offices and representatives of Siemens AG.

SIMATIC Partners in the Federal Republic of Germany

N Branch

N 52066 Aachen
AUT P 13, Mr Georgens
Kurbrunnenstr. 22

☎ (02 41) 4 51-2 52
Fax (02 41) 4 51-3 98

N 86159 Augsburg
AUT S11, Mr Hirth
Werner-von-Siemens Str. 6

☎ (08 21) 25 95-4 50
Fax (08 21) 25 95-4 08

N 95448 Bayreuth
AUT P/S 11, Ms Hösl
Weiherstr. 25

☎ (09 21) 2 81-3 41
Fax (09 21) 2 81-4 44

N 10587 Berlin
AUT P 1, Mr Liebner
Salzufer 6-8

☎ (0 30) 39 93-23 97
Fax (0 30) 39 93-23 02

N 33605 Bielefeld
AUT P 12, Ms Schlüpmann
Schweriner Str. 1

☎ (05 21) 2 91-5 21
Fax (05 21) 2 91-5 90

N 38126 Braunschweig
AUT P 11, Mr Pelka
Ackerstr. 20

☎ (05 31) 27 12-3 05
Fax (05 31) 27 12-4 16

N 28195 Bremen
AUT P 12, Ms Ulbrich
Contrescarpe 72

☎ (04 21) 3 64-24 27
Fax (04 21) 3 64-28 42

N 09114 Chemnitz
AUT P 11, Ms Aurich
Bornaer Str. 205

☎ (03 71) 4 75-35 10
Fax (03 71) 4 75-35 25

ZN 01189 Dresden
AUT 1, Mr Lehmann
Karlsruher Str. 111

☎ (03 51) 40 22-2 77
Fax (03 51) 40 22-2 74

ZN 40219 Düsseldorf
AUT P 15, Mr Becker
Lahnweg 10

☎ (02 11) 3 99-16 64
Fax (02 11) 3 99-18 48

ZN 99097 Erfurt
AUT P 22, Mr Skudelny
Haarbergstr. 47

☎ (03 61) 4 25-23 51
Fax (03 61) 4 25-23 50

ZN 45128 Essen
AUT P 14, Mr Klein
Kruppstr. 16

☎ (02 01) 8 16-24 28
Fax (02 01) 8 16-23 31

ZN 60329 Frankfurt
AUT P 25, Mr W. Müller
Rödelheimer Landstr. 1-3

☎ (0 69) 7 97-34 18
Fax (0 69) 7 97-34 42

ZN 79104 Freiburg
AUT P, Mr Thoma
Habsburgerstr. 132

☎ (07 61) 27 12-2 38
Fax (07 61) 27 12-4 46

ZN 20099 Hamburg
AUT 1, Mr Rohde
Lindenplatz 2

☎ (0 40) 28 89-30 03
Fax (0 40) 28 89-32 09

ZN 30519 Laatzen (Hannover)
AUT P 10, Ms Hoffmann
Hildesheimer Str. 7

☎ (05 11) 8 77-23 19
Fax (05 11) 8 77-27 39

ZN 74076 Heilbronn
AUT P/S, Mr Gaul
Neckarsulmer Str. 59

☎ (0 71 31) 1 83-2 03
Fax (0 71 31) 1 83-3 20

ZN 76185 Karlsruhe
AUT 14 P, Mr Boltz
Bannwaldallee 48

☎ (07 21) 9 92-24 13
Fax (07 21) 9 92-25 85

ZN 34117 Kassel
AUT P 13, Mr Uhlig
Bürgermeister-Brunner-Str.15

☎ (05 61) 78 86-3 32
Fax (05 61) 78 86-4 48

ZN 87439 Kempten
AUT P, Mr Fink
Lindauer Str. 112

☎ (08 31) 58 18-2 25
Fax (08 31) 58 18-2 40

ZN 24109 Kiel
AUT 1, Ms Drews
Wittland 2-4

☎ (04 31) 58 60-3 26
Fax (04 31) 58 60-2 48

ZN 56068 Koblenz
AUT P 11, Mr Ricke
Frankenstr. 21

☎ (02 61) 1 32-2 44
Fax (02 61) 1 32-2 55

ZN 50823 Köln
AUT P 14, Mr Prescher
Franz-Geuer-Str. 10

☎ (02 21) 5 76-27 62
Fax (02 21) 5 76-27 95

ZN 78416 Konstanz
AUT P, Ms Wiest
Fritz-Arnold-Str. 16

☎ (075 31) 988-2 02
Fax (075 31) 988-1 40

ZN 04105 Leipzig
AUT P 2, Ms Kiesewetter
Springerstr. 15

☎ (03 41) 2 10-30 07
Fax (03 41) 2 10-30 63

ZN 39106 Magdeburg
AUT VG 33, Mr Ganschinietz
Sieverstorstr. 32-33

☎ (03 91) 5 88-17 21
Fax (03 91) 5 88-17 22

ZN 68165 Mannheim
AUT 16 P, Mr Sulzbacher
Dynamostr. 4

☎ (06 21) 4 56-28 43
Fax (06 21) 4 56-25 45

ZN 81679 München
AUT P 14, Mr Schäfer
Richard-Strauss-Str. 76

☎ (0 89) 92 21-30 64
Fax (0 89) 92 21-43 99

ZN 48153 Münster
AUT S 13, Mr Schlieckmann
Siemensstr. 55

☎ (02 51) 76 05-4 25
Fax (02 51) 76 05-3 36

ZN 90439 Nürnberg
AUT P 11, Mr Glas
Von-der-Tann-Str. 30

☎ (09 11) 6 54-35 87
Fax (09 11) 6 54-73 84

ZN 49090 Osnabrück
AUT S 13, Mr Pöhler
Eversburger Str. 32

☎ (05 41) 12 13-2 73
Fax (05 41) 12 13-3 50

ZN 93053 Regensburg
AUT P/S 12, Mr Rewitzer
Hornstr. 10

☎ (09 41) 40 07-1 97
Fax (09 41) 40 07-2 36

ZN 18069 Rostock
AUT, Ms Langhammer
Industriestr. 15

☎ (03 81) 78-21 71
Fax (03 81) 78-21 75

ZN 66111 Saarbrücken
AUT, Mr Müller
Martin-Luther-Str. 25

☎ (06 81) 3 86-22 89
Fax (06 81) 3 86-21 11

ZN 57072 Siegen
AUT P 11, Mr Patz
Sandstr. 42-48

☎ (02 71) 23 02-2 40
Fax (02 71) 23 02-2 38

ZN 70499 Stuttgart
AUT P 11, Mr Müller
Weissacherstr. 11

☎ (07 11) 1 37-26 44
Fax (07 11) 1 37-29 46

ZN 54292 Trier
AUT VG 14 P, Mr Baldauf
Löbstr. 15

☎ (06 51) 20 09-23
Fax (06 51) 20 09-24

ZN 89079 Ulm
AUT ZR, Mr Birk
Nikolaus-Otto-Str. 4

☎ (07 31) 94 50-3 28
Fax (07 31) 94 50-3 34

ZN 97084 Würzburg
AUT PIS 13, Mr Vogt
Andreas-Grieser-Str. 30

☎ (09 31) 61 01-4 59
Fax (09 31) 61 01-5 42

ZN 42103 Wuppertal
siehe ZN 45128 Essen
AUT P 14, Mr Klein
Kruppstr. 16

☎ (02 01) 8 16-24 28
Fax (02 01) 8 16-23 31

SIMATIC Partners in Europe (excluding the Federal Republic of Germany)

Belgium

1060 Bruessel
Siemens S.A., VP4, Mr Gmuer
Chaussee de Chaleroi 116
☎ 00 32 (2) 5 36 25 33
Fax 00 32 (2) 5 36 23 87

Bulgaria

1113 Sofia
Siemens AG, Ms Kirova
Blvd. Dragan Zankov Nr. 36
☎ 0 03 59 (2) 70 85 21
Fax 0 03 59 (2) 68 50 51

Denmark

2750 Ballerup
Siemens A/S, IP, Mr Hansen
Borupvang 3
☎ 00 45 (44) 77 42 90
Fax 00 45 (44)77 40 16

Finland

02601 Espoo
Siemens Osakeyhtioe,
OEM/AUT 1, Mr Saarelainen
Majurinkatu, P.O.B. 60
☎ 0 03 58 (0) 51 05 36 70
Fax 0 03 58 (0) 51 05 36 56

France

69641 Caluire-et-Cuire/Lyon
Siemens S.A., AUT 1, Leifstelle
9-11, Chemin des Petites Brosses
BP 39
☎ 00 33/ 78 98 60 08
Fax 00 33/ 78 98 60 18

59812 Lesquin, Cedex/Lille
Siemens S.A., AUT 1, Leitstelle
78, Rue de Gustave Delroy
BP 239
☎ 00 33/ 20 95 71 91
Fax 00 33/ 20 95 71 86

33694 Merignac/Bordeaux
Siemens S.A., AUT 1,
Leitstelle, Parc Cadera Sud
36, Avenue Ariane, BP 351
☎ 00 33/ 56 13 32 66
Fax 00 33/ 56 55 99 59

44300 Nantes
Siemens S.A., AUT 1,
Leitstelle, Zac du Perray
9, Rue du Petit Chatelier
☎ 00 33/ 40 18 68 30
Fax 00 33/ 40 93 04 83

93527 Saint Denis, Cedex 2/Paris
Siemens S.A., AUT 1, Mr Granger
39/47, Bd Ornano
☎ 00 33 (1) 49 22 33 18
Fax 00 33 (1) 49 22 32 05

67016 Strasbourg, Cedex
Siemens S.A., AUT 1, Leistelle
2, Rue du Rhin-Napoleon
BP 48
☎ 00 33/ 88 45 98 22
Fax 00 33/ 88 60 08 40

31106 Toulouse
Siemens S.A., AUT 1, Mr Huguet
ZAC de Basso Cambo
Avenue du Mirail, BP 1304
☎ 00 33/ 62 11 20 15
Fax 00 33/ 61 43 02 20

Greece

15110 Amaroussio/Athen
Siemens A.E., HB 3 AUT,
Mr Antoniou; Paradissou &
Artemidos, P.O.B. 6 10 11
☎ 00 30 (1) 68 64-5 15
Fax 00 30 (1) 68 64-5 56

54110 Thessaloniki
Siemens A.E., VB 3 AUT,
Mr Passalidis
Georgikis Scholis 89, P.O.B. 10290
☎ 00 30 (31) 47 92 12
Fax 00 30 (31) 47 92 65

Great Britain

Manchester M20 2UR
Siemens PLC, Control Systems,
Mr Hardern
Sir William Siemens House,
Princess Road
☎ 00 44 (61) 4 46 52 33
Fax 00 44 (61) 4 46 52 32

Ireland

Dublin 11
Siemens Ltd., Power & Automa-
tion Division, Mr Mulligan
8-11 Slaney Road
Dublin Industrial Estate
☎ 0 03 53 (1) 8 30 28 55
Fax 0 03 53 (1) 8 30 31 51

Iceland

121 Reykjavik
Smith & Norland H/F,
Mr Kjartansson,
Noatuni 4, P.O.B. 519
☎ 0 03 54 (1) 62 83 00
Fax 0 03 54 (1) 62 83 40

Italy

40127 Bologna
Siemens S.p.A., AUT R10A,
Mr Tosatti
Via Casciarolo, 8
☎ 00 39 (51) 6 38 45 09
Fax 00 39 (51) 24 32 13

25128 Brescia
Siemens S.p.A., AUT R10A,
Mr Gaspari, Via della Volta, 92
☎ 00 39 (30) 3 53 05 26
Fax 00 39 (30) 34 66 20

20124 Milano
Siemens S.p.A., AUT R10A,
Mr Berti, Via Lazzaroni, 3
☎ 00 39 (2) 66 76 28 36
Fax 00 39 (2) 66 76 28 20

35129 Padova
Siemens S.p.A., AUT R10A,
Mr Millevoi, Viale dell'Industria, 19
☎ 00 39 (49) 8 29 13 11
Fax 00 39 (49) 8 07 00 09

00142 Roma
Siemens S.p.A., AUT R10A,
Mr Vessio, Via Laurentina, 455
☎ 00 39 (6) 5 00 95-1
Fax 00 39 (6) 5 00 95 20

10127 Torino
Siemens S.p.A., AUT R10A,
Mr Montoli, Via Pio VII, 127
☎ 00 39 (11) 6 17 3-1
Fax 00 39 (11) 61 61 35

Croatia

41000 Zagreb
Siemens d.o.o., Mr Culjak
Trg Drazena Petrovica 3 ("Cibona")
☎ 0 03 85 (41) 33 88 95
Fax 0 03 85 (41) 32 66 95

Luxembourg

1017 Luxemburg-Hamm
Siemens S.A., AUT, Mr Nockels
20, Rue des Peupliers
B.P. 1701
☎ 0 03 52/ 4 38 43-4 21
Fax 0 03 52/ 4 38 43-4 15

Netherlands

2595 AL Den Haag
Siemens Nederland N.V., IPS/APS,
Mr Penris, Prinses Beatrixlaan 26
☎ 00 31 (70) 3 33 32 74
Fax 00 31 (70) 3 33 34 96

Norway

5033 Fyllingsdalen
Siemens A/S Bergen,
Mr Troan, Bratsbergveien 5
Postboks 36 60
☎ 00 47 (55) 17 67 41
Fax 00 47 (55) 16 44 70

0518 Oslo 5
Siemens A/S, AUT Produkter,
Mr Eggen, Ostre Aker vei 90
Postboks 10, Veitvet
☎ 00 47 (22) 63 34 09
Fax 00 47 (22) 63 33 90

7004 Trondheim
Siemens A/S Trondheim,
Mr Thorsen, Spelaugen 22
☎ 00 47 (73) 95 96 69
Fax 00 47 (73) 95 95 04

Austria

6901 Bregenz
Siemens AG, AUT, Mr Madlener
Josef-Huter-Straße 6,
Postfach 347
☎ 00 43 (55 74) 41 92 72
Fax 00 43 (55 74) 41 92 88

8054 Graz
Siemens AG, AUT, Mr Jammernegg
Strassganger Straße 315
Postfach 39
☎ 00 43 (3 16) 2 80 42 80
Fax 00 43 (3 16) 2 80 42 85

6040 Innsbruck/Neu-Rum
Siemens AG, AUT, Mr Mayr
Siemensstraße 2, Postf. 9 04
☎ 00 43
(5 12) 23 12 60
Fax 00 43 (5 12) 23 15 30

9020 Klagenfurt
Siemens AG, AUT, Mr Weber
Werner von Siemens Park 1
☎ 00 43
(4 63) 3 88 32 43
Fax 00 43 (4 63) 3 88 34 49

4020 Linz
Siemens AG, AUT, Mr Schmidt
Wolfgang-Pauli-Straße 2
Postfach 563
☎ 00 43
(7 32) 3 33 02 95
Fax 00 43 (7 32) 3 33 04 93

5020 Salzburg
Siemens AG, AUT, Mr Mariacher Jun.
Innsbrucker Bundesstraße 35
Postfach 3
☎ 00 43 (6
62) 4 48 83 35
Fax 00 43 (6 62) 4 48 83 09

1211 Wien
Siemens AG, AUT 1, Mr Strasser,
Siemensstraße 88-92,
Postfach 83
☎ 00 43
(1) 25 01 37 88
Fax 00 43 (1) 25 01 39 40

Poland

40-931 Katowice
Siemens Sp. z.o.o., Niederlassung
Katowice, Mr Krzak
Ul. Kosciuszki 30
☎ 00 48 (3) 157 32 66
Fax 00 48 (3) 157 30 75

60-815 Poznan
Siemens Sp. z.o.o., Niederlassung
Poznan, Mr Weiss
Ul. Gajowa 6
☎ 00 48 (61) 47 08 86
Fax 00 48 (61) 47 08 89

03-821 Warszawa
Siemens Sp. z.o.o., Mr Cieslak
Ul. zupnicza 11,
☎ 00 48 (2) 6 70 91 47
Fax 00 48 (2) 6 70 91 49

53-332 Wroclaw
Siemens Sp. z.o.o., Niederlassung
Wroclaw, Mr Wojniak
Ul. Powstancòw Slaskich 95
☎ 00 48 (71) 60 59 97
Fax 00 48 (71) 60 55 88

Portugal

2700 Amadora
Siemens S.A., Dep. Energia e
Industria, Mr Eng. C. Pelicano
Estrada Nacional 117 ao
km 2,6 Alfragide, Apartado 60300
☎ 0 03 51 (1) 4 17 85 03
Fax 0 03 51 (1) 4 17 80 71

4450 Matosinhos-Porto
Siemens S.A., Dep. Energia e
Industria, Mr Eng. A. Amaral,
Estrada Nacional 107,
No. 3570 Freixieiro, Apartado 5145
☎ 0 03 51 (2) 9 99 21 11
Fax 0 03 51 (2) 9 99 20 01

Rumania

76640 Bucuresti
Siemens, Birou de consultatii
tehnice, Mr Fritsch
Str. Zarii No. 12, sector 5
☎ 00 40 (1) 2 23 47 95
Fax 00 40 (1) 2 23 45 69

Russia

113043 Moskau
Siemens AG, Mr Engelhard/
Mr Michailow, Ul. Dubininskaja 98
☎ 0 07 (0 95) 2 36 75 00
Fax 0 07 (0 95) 2 36 62 00

Sweden

40020 Göteborg
Siemens AB, ASP, Mr Ohlsson
Ostergardsgatan 2-4
Box 1 41 53
☎ 00 46 (31) 7 76 86 53
Fax 00 46 (31) 7 76 86 76

55111 Jönköping
Siemens AB, ASP, Mr Jonsson
Klubbhusgatan 15, Box 10 07
☎ 00 46 (36) 15 29 00
Fax 00 46 (36) 16 51 91

20123 Malmö
Siemens AB, ASP, Mr Jämtgren
Grimsbygatan 24, Box 326
☎ 00 46 (40) 17 46 14
Fax 00 46 (40) 17 46 17

85122 Sundsvall
Siemens AB, ASP, Mr Sjöberg
Lagergatan 14, Box 766
☎ 00 46 (60) 18 56 00
Fax 00 46 (60) 61 93 44

19487 Upplands Väsby/Stockholm
Siemens AB, ASP-A1, Mr Persson
Johanneslandsvägen 12-14
☎ 00 46 (8) 7 28 14 64
Fax 00 46 (8) 7 28 18 00

Switzerland

1020 Renens/Lausanne
Siemens-Albis SA, Systemes
d'automation, VHRL, Ms Thevenaz
5, Av. des Baumettes
Case postale 1 53
☎ 00 41 (21) 6 31 83 09
Fax 00 41 (21) 6 31 84 48

8047 Zürich
Siemens-Albis AG, VHR 3,
Mr Engel, Freilagerstraße 28-40
☎ 00 41 (1) 4 95 58 82
Fax 00 41 (1) 4 95 31 85

Slovakian Republic

81261 Bratislava
Siemens AG, Mr Sykorcin,
Tovarenska 11
☎ 00 42 (7) 31 21 74
Fax 00 42 (7) 31 63 32

Slovenia

61000 Ljubljana
Siemens Slovenija, Mr Lavric
Dunajska C47
☎ 0 03 86 (61) 1 32 60 68
Fax 0 03 86 (61) 1 32 42 81

Spain

48011 Bilbao
Siemens S.A., AUT 1, Mr Tapia
Maximo Aguirre, 18
☎ 00 34 (4) 4 27 64 33
Fax 00 34 (4) 4 27 82 39

08940 Cornella de Llobregat/
Barcelona
Siemens S.A., AUT 1, Mr Ortiz
Joan Fernandez Vallhonrat, 1
☎ 00 34 (3) 4 74 22 12
Fax 00 34 (3) 4 74 42 34

33206 Gijon
Siemens S.A., AUT 1, Mr Huchet
Corrida, 1
☎ 00 34 (85) 35 08 00
Fax 00 34 (85) 34 93 10

15005 La Coruna
Siemens S.A., AUT 1, Mr Pereira
Linares Rivas, 12-14
☎ 00 34 (81) 12 07 51
Fax 00 34 (81) 12 03 60

30008 Murcia
Siemens S.A., AUT 1, Mr Martinez
Marques de los Velez, 13
☎ 00 34 (68) 23 36 62
Fax 00 34 (68) 23 52 36

41092 Sevilla
Siemens S.A., AUT 1,
Mr de la Fuente
ISLA DE LA CARTUJA
Paseo de la Acacias, s/n
(Edificio Siemens)
☎ 00 34 (5) 4 46 30 00
Fax 00 34 (5) 4 46 30 46

28760 Tres Cantos (Madrid)
Siemens S.A., AUT 1,
Mr Olaguibel, Ronda de Europa, 5
☎ 00 34 (1) 8 03 12 00
Fax 00 34 (1) 8 03 22 71

46021 Valencia
Siemens S.A., AUT 1, Mr Albors
Avda. Aragon, 30 (Ed. Europa)
☎ 00 34 (6) 3 69 94 00
Fax 00 34 (6) 3 62 61 19

36204 Vigo
Siemens S.A., AUT 1, Mr Garrido
Pizarro, 29
☎ 00 34 (86) 41 60 33
Fax 00 34 (86) 41 84 64

50012 Zaragoza
Siemens S.A., AUT 1, Mr Aliaga
Avda. Alcalde Gomez Laguna, 9
☎ 00 34 (76) 35 61 50
Fax 00 34 (76) 56 68 86

Czech Republic

60200 Brno
Siemens AG, Kancelar Brno,
Mr Tucek, Vinarska 6
☎ 00 42 (5) 43 21 17 49
Fax 00 42 (5) 43 21 19 86

14000 Praha 4
Siemens AG, Zastoupeni v CR,
Mr Skop, Na strzi 40
☎ 00 42 (2) 61 21 50 33 6
Fax 00 42 (2) 61 21 51 46

80040 Findliki-Istanbul
SIMKO A.S., AUT ASI 1, Ms Yargic
Meclisi Mebusan Cad. 125
☎ 00 90 (1) 25 10 90 01 706
Fax 00 90 (1) 25 10 90 07 09

Turkey

06680 Ankara-Kavaklidere
SIMKO-ANKARA, Mr Ensert,
Atatürk Bulvari No. 169/6
☎ 00 90 (312) 4 18 22 05

80040 Findikli-Istanbul
SIMKO TIC. ve SAN. A. S.,
AUT 1, Ms Yargic
Meclisi Mebusan Cad. No 125
☎ 00 90 (212) 2 51 17 06
Fax 00 90 (212) 2 52 39 16

Ukraine

252054 Kiew 54
Siemens-Vertretung, AUT,
Mr Liebschner,
Ul. Worowskowo 27
☎ 0 07 (044) 2 16 02 22
Fax 0 07 (044) 2 16 94 92

Hungary

1036 Budapest
Siemens GmbH, AUT 1, Mr Turi
Lajos utca 103
☎ 00 36 (1) 2 69 74 55
Fax 00 36 (1) 2 69 74 54

SIMATIC Partners Outside of Europe

Afrika

Ägypten

Zamalik/EGY-Cairo
ELETECH, AUT, Mr W. Y. Graiss
6 Zarkaria Rizk Street,
P.O.B. 90
☎ +20 (2) 3 42 03 71
Fax +20 (2) 3 42 03 76

Algeria

16035 Hydra/Alger
Siemens, Bureau d'Alger, Division
Energie, Mr Bennour,
44, rue Abri Areski , B.P. 112
☎ +213 (2) 60 40 88
Fax +213 (2) 60 65 98

Ivory Coast

Abidjan 15/R. C. I.
Siemens AG, SEMEN, Mr. Hellal,
16 B.P. 1062
☎ +2 25 (37) 46 57
Fax +2 25 (27) 10 21

Libya

Tripoli/Libya S.P.L.A.J.
Siemens AG, Branch Libya,
Mr Wahab, Zat-EL-Imad-
Building Tower No. 5, Floor No. 9
P.O.B. 91 531
☎ +218 (21) 4 15 34
Fax +218 (21) 4 79 40

Morocco

Casablanca 05
SETEL S.A., AUT, Mr El Bachiri,
Immeuble Siemens,
km 1, Route de Rabat,
Ain Sebaa
☎ +212 (2) 35 10 25
Fax +212 (2) 34 01 51

Namibia

Windhoek 9000
Siemens (Pty) Ltd., Mr Jürgen Hoff
9 Albert Wessels Street
Industries North, P.O.B. 23125
☎ +2 64 (61) 6 13 58/59
Fax +2 64 (61) 6 13 77

South Africa

RSA-2001 Braamfontein
Siemens Ltd., AUT, Mr E. Hillermann
Siemens House SH 401
Corner Wolmarans & Biccard
Streets, P.O. Box 4583
2000 Johannesburg
☎ +27 (11) 4 07 41 11
☎ +27 (11) 4 07 48 15
Fax +27 (11) 4 07 46 82

Tunisia

TN-2062 Romana-Le Bardo
FAZE Sarl Electrotechnique,
Mr Fantar, Immeuble Cham
☎ +2 16 (1) 51 90 91
Fax +2 16 (1) 50 19 32

TN-2035 Charguia II Tunis
SITELEC S.A. Mr Mouelhi
16, Rue de l'Usine
Zone industrielle (Aéroport),
BP 115, 1050 Tunis Cedex
☎ +2 16 (1) 70 00 99
Fax +2 16 (1) 71 70 10

Zimbabwe

Electro Technologies Corp. (Pvt.) Ltd./
Siemens Zimbabwe,
Mr Ron Claassens, Savoy House
cnr. Inez Terrace/J. Moyo Ave
P.O. Box 46 80
☎ +263 (4) 79 18 66
Fax +263 (4) 75 44 06

America

Argentina

8000 Bahia Blanca,
Prov. de Buenos Aires
Siemens S.A., Mr S.Duran,
Rudriguez 159
☎ +54 (91) 55-61 41
Fax +54 (91) 55-61 71

(1650) San Martin,
Prov. de Buenos Aires
Siemens S.A., PEI-AUT,
Mr Rudriguez Juis/Mr Roland Herron,
Gral. Roca 1865, Ruta 8, km 18 C.C.
☎ +54 (1) 7 38 71 92/7 15
☎ +54 (1) 7 38 71 85
Fax 254 (1) 7 38 71 71

5000 Cordoba, Prov. de Cordoba
Siemens S.A., Mr S. Garcia,
Campillo 70
☎ +54 (51) 73-9940/994
Fax +54 (51) 72-97 14

5539 Las Heras, Prov. de Mendoza
Siemens S.A., Mr S. Suarez,
Acceso Norte 379
☎ +54 (61) 30-00 22/0 37
Fax +54 (61) 30-00 22/0 37

2000 Rosario, Prov. de Santa Fe
Siemens S.A., Mr R. Stiza,
Ricchieri 750
☎ +54 (1) 41 37-03 21/0
Fax +54 (1) 41 37-07 87

Bolivia

La Paz
Sociedad Comercial e Industrial
Hansa Ltda., E & A, Mr Beckmann
Calle Mercado esq. Yanacocha
C. P. 10 800
☎ +591 (2) 35 44 45
Fax +591 (2) 37 03 97

Brazil

05110-900 Sao Paulo, SP, Pinituba
MAXITEC S.A., AUT-PA, Mr F. Rocco,
Avenida Mutinga, 3650
☎ +55 (11) 8 36 29 99
Fax +55 (11) 8 36 29 50

Chile

Santiago de Chile
INGELSAC,Div. Energia, Mr Browne
Avda. Holanda 64, Cas. 242-V
☎ +56 (2) 2 31 00 00
Fax +56 (2) 2 32 66 88

Costa Rica

San Jose 1000
Siemens S.A. San Jose, Division
Energia y Automatizacion, VAT,
Mr Ferraro,
La Uruca, Apartado 100 22
☎ +5 06 87 50 50
Fax +5 06 21 50 50

Ecuador

Quito
Siemens S.A., Dept. DEA,
Mr J. Guerra
Calle Manuel Zambrano y
Panamericana Norte km 2 1/2
Casilla de Correos 17-01-3580
☎ +5 93 (2) 47 40 60
Fax +5 93 (2) 40 77 38

El Salvador

San Salvador
Siemens S.A., E/A, Mr M. Dubon
43, Calle Siemens
Parque Industrial Sta. Elena
Apartado 1525
☎ +5 03 78 33 33
Fax +5 03 78 33 34

Guatemala

Ciudad de Guatemala
Siemens S.A., EA/AUT, Mr Godoy
2a Calle 6-76
Zona 10, Apartado 1959
☎ +5 02 (2) 32 44 44
Fax +5 02 (2) 34 36 70

Canada

Mississauga, ON L5N 7AG
Siemens Electric Ltd., Dept. SL 20,
Mr Fred Leon, 2185 Derry Road
West
☎ +1 (905) 7 92 81 95 82
Fax +1 (905) 58 19 58 12

Point Claire, QUE H9R-4R6
Siemens Electric Ltd., Mr D. Goulet
7300 Trans Canada Highway
☎ +1 (514) 4 26 60 99
Fax +1 (514) 4 26 61 44

Burnaby, B. C. V5J 5J1
Siemens Electic Ltd., Mr A. Mazurek
Marine Way Business Park
8875 Northbrook Court
☎ +1 (604) 4 35 08 80
Fax +1 (604) 4 35 10 23

Columbia

Baranquilla
Siemens S.A., EA, Mr C. Perez,
Carrera 58 No. 709-40
☎ +57 (958) 56 11 48
Fax +57 (958) 56 11 48

Bogota 6
Siemens S.A., Division Energia,
Mr M. Jaramillo
Carrera 65, No. 11-83
Apartado 80150
☎ +57 (1) 2 94 22 66
Fax +57 (1) 2 94 24 98

Cali
Siemens S.A., Barranquilla,
Mr Guido Hernandez
Carrera 40, No. 13-05
☎ +57 (92) 66-4 44 00
Fax +57 (92)66-5 30 56

Cali
Siemens S.A. Cali Mr C. A. Naranjo
Carrera 48 A, 15 Sur 92
☎ +57 (94) 2 66-30 66
Fax +57 (94) 2 68-25 57

Mexico

02300 Mexico, D.F.
Siemens S.A. de C.V., EI-AUT,
Mr Gregorio Sanchez
Delegacion Azcapotzalco
Poniente 116, No. 590
Colonia Industrial Vallejo
Apartado Postal
15-064, 02600 mexico
☎ +52 (5) 3 28 20 00
Fax +52 (5) 3 28 21 92
Fax +52 (5) 3 28 21 93

Peru

Lima 13
ESIM S.A., Dept. AUT,
Mr Paz-Soldan
Avda. N. Arriola 385 4to Piso
☎ +51 (14) 71 46 61
Fax +51 (14) 71 09 93

USA

Alpharetta, GA 30202
SIA Inc., Regional Sales Manager
Sautheast, Mr Mich Gunyon,
Technology Drive
☎ +1 (4 04) 7 40 36 60
Fax +1 (4 04) 7 40 36 96

Andover, MA 01810
SIA Inc., North East Region,
Mr Mark Fondl, One Tech Drive,
Suite 310
☎ +1 (5 08) 6 85 60 77
Fax +1 (5 08) 6 86 88 72

Houston, TX 77040
SIA Inc., SouthWest Region,
Mr Wade Bradford
13100 Northwest Freeway, Suite 210
☎ +1 (713) 6 90 03 33
Fax +1 (713) 4 60 44 50

Mason, OH 45040-9011
SIA Inc., Central Region,
Mr Luther Crouthamel,
4770 Duke Drive suite 381
☎ +1 (5 13) 3 98 96 91
Fax +1 (5 13) 3 98 98 39

Mukilteo, WA 98275
SIA Inc., MidwWest Region,
Mr Earl Haas, 8412 54th Avenue West
☎ +1 (7 14) 9 79 66 00
Fax +1 (7 14) 5 57 90 61

Plymouth, MN 55442
SIA Inc., MidWest Region,
Mr Greg Jaster,
13235 45th Avenue No.
☎ +1 (7 08) 6 40 15 95
Fax +1 (7 08) 6 40 80 26

Venezuela

1071 Caracas
Siemens S.A., AUT-ASI,
Mr Jesus Cavada
Avda. Don Diego Cisneros
Urbanizacion Los Ruices,
Ap. 3616, Caracas 1010 A
☎ +58 (2) 2 39 07 33
Fax +58 (2) 2 03 82 00

Asia

China

510064 Guangzhou
Siemens Ltd. China, Guangzhou
Office, Mr Peter Chen,
Room 1134-1157 GARDEN Hotel
Garden Tower,
368 Huanshi Dong Lu
☎ +86 (20) 3 85 46 88
Fax +86 (20) 3 34 74 54

100015 Beijing
Siemens Ltd. China, Beijing Office,
Mr Wolfgang Söllner
7, Wangjing Zhonghuan Nan Lu
Chaoyang District
P.O. Box 8543
☎ +86 (10) 4 36 18 88
Fax +86 (10) 4 36 32 13

200090 Shanghai
Siemens Ltd. China, Shanghai
Office, Mr William Cui,
450, Lin Quing Lu
☎ +86 (21) 5 39 54 10
Fax +86 (21) 5 39 54 21

110001 Shenyang
Siemens Ltd. China, Shenyang
Office, Mr Ren Qi, Sakei Torch
Building 23rd Fl. 262A Shifu Da Lu
Shen He District
☎ +86 (24) 2 79 02 87
Fax +86 (24) 2 79 02 86

Hongkong

Hong Kong
Siemens Ltd. Hang Kong A. R. O.,
Automation System ,
Division , Mr Keiren Lake,
7th Floor, Regency Centre,
39 Wong Chuk Hang Road
☎ +85 (2) 28 70 76 11
Fax +85 (2) 25 18 04 11

India

Bangalore 560 001
Siemens Ltd., BAN/AUT-MAP,
Mr B. Sunderram
Jyoti Mahal, 3rd Floor
49, St. Marks Road, P.O.B. 5212
☎ +91 (80) 2 21 21 01
Fax +91 (80) 2 21 24 18

Bombay 400 018
Siemens Ltd., AUT/M-AP,
Mr S. Mistry
Head Office B Building
130, Ganpat Jahav Marg. Worli
☎ +91 (22) 4 93 13 50/60
Fax +91 (22) 4 95 08 22

Calcutta 700 071
Siemens Ltd., CAL/AUT-MAP,
Mr D. K. Ganguli
6, Little Russel Street, P.O.B. 715
☎ +91 (33) 2 47 83 74/-80
Fax +91 (33) 2 47 47 83

S7-300 Programmable Controller Hardware and Installation
EWA 4NEB 710 6084-02 01

SIMATIC Partners Outside of Europe

New Delhi 110 002
Siemens Ltd., DEL/AUT-MAP,
Mr R. Narayanan
4A, Ring Road, I.P. Estate,
P.O.B. 7036
☎ +91 (11) 3 31 81 44
Fax +91 (11) 3 31 41 78

Indonesia

Jakarta 12870
Dian Graha Elektrika, Jakarta, Power
Eng. & Autom. Div., Mr M. Zafrullah
Jl. Gatot Subroto Kov. 74-75,
Mustika centre Building Floor 2a.,
P.O. Box 4267
☎ +62 (21) 8 30 65 74
Fax +62 (21) 8 30 74 02

Iran

15914 Teheran
Siemens S.S.K., Mr Din-Payuh
Khiabane Ayatollah Taleghani 32
Siemenshouse, P.O.B. 15875-4773, 15
Teheran
☎ +98 (21) 61 41
Fax +98 (21) 6 40 23 89

Japan

Tokyo 141-00
Siemens K.K., ATT, Mr Nakamichi
Siemens Fujikara Building, 8F
11-20, Nishí-Gotanda 2-chome
Shinagawa-ku
☎ +81 (3) 34 90 44 37
Fax +81 (3) 34 95 97 92

Pakistan

Karachi - 74400
Siemens Pakistan Eng. Co. Ltd.,
Power Division, Mr Ilyas
ILACO House
Abdullah Haroon Road
P.O. Box 7158
☎ +92 (21) 51 60 61
Fax +92 (21) 5 68 46 79

Philippines

Metro Manila
Siemens Inc., Mr B. Bonifacio
2nd & 4th Fl., Sterling Centre Bldg.
Esteban cor. de la Rosa
Legaspi Village
☎ +63 (2) 8 18 48 18
Fax +63 (2) 8 18 48 22

Saudi Arabia

Jeddah - 21412
Arabia Electric Ltd. Service Center,
Mr Kobeissi, P.O.B. 4621
☎ +9 66 (2) 6 65 84 20
Fax +9 66 (2) 6 65 84 90

Singapore

Singapore 1334
Siemens (Pte) Ltd. Singapore, AUT,
Mr Ulf Bexell,
2 Kallang Sector
☎ +65 8 41 35 28
Fax +65 8 41 35 29

South Korea

Seoul
Siemens Ltd., E+A, Mr Kang W. S.
Asia Tower Building, 9th Floor
726 Yeoksam-dong, Kang-nam-ku,
C.P.O. Box 3001
☎ +82 (2) 5 27 77 62
Fax +82 (2) 5 27 77 19

Taiwan

Taipei 106
Siemens Ltd., AUT 1, Mr Gulden
6th Fl., Cathy Life Insurance Bldg.
296, Jen Ai Road, Sec. 4
☎ +8 86 (2) 3 25 48 88
Fax +8 86 (2) 7 05 49 75

Thailand

Bangkok 10110
Berli Jucker Co. Ltd., Mr Narong
Berli Jucker House
99, Soi Rubia, Sukhumvit 42 Road
P.O. Box 173 BMC, Bangkok 1000
☎ +66 (2) 3 67 11 11
Fax +66 (2) 3 67 10 00

Vietnam

Hanoi
Siemens AG, Representation Office
Mr Nguyen Huang Giang
18, Phan Boi Chau Street
☎ +84 (4) 25 60 61
Fax +84 (4) 26 62 27

Australia

Adelaide
Siemens Ltd. Adelaide Office, CS/I.A.,
Mr J. Weiss, 315 Glen Osmond Road
Glenunga, S.A. 5064
☎ +61 (8) 3 79 66 66
Fax +61 (8) 3 79 08 99

Melbourne
Siemens Ltd., CS/I.A., Mr N. Gilholm,
544 Church Street
Richmond, Victoria 3121
☎ +61 (3) 4 20 75 20
Fax +61 (3) 4 20 75 00

Perth
Siemens Ltd., CS/I.A., Mr A. Lostrom
153, Burswood Road
Victoria Park, W.A. 6100
☎ +61 (9) 3 62 01 42
Fax +61 (9) 3 62 01 47

Sydney, N.S.W. 2064
Siemens Ltd. Sidney, Industrial
Automation, Mr Stephen Coop,
383 Pacific Highway, Artamon
☎ +61 (2) 4 36 78 04
Fax +61 (2) 4 36 86 24

New Zealand

Greenlane, Auckland 5
Siemens Ltd. Auckland Office,
CS/I.A., Mr A. Richmond
300 Great South Road
P.O.B 17-122
☎ +64 (9) 5 20 30 33
Fax +64 (9) 5 20 15 56

List of Abbreviations

<div style="text-align:right">

H

</div>

Abbrevia-tions	Description
CP	Communication processor
CPU	Central processing unit
DB	Data block
FB	Function block
FC	Function
FM	Function module
FO	Fiber-optic cable
GD	Global data communication
IM	Interface module
IP	Intelligent I/O
LAD	Ladder logic (programming language representation in STEP 7)
M	Chassis ground
MPI	Multipoint Interface
OB	Organization block
OP	Operator panel
PIQ	Process-image output table
PII	Process-image input table
PG	Programming device
PS	Power supply
SFB	System function block
SFC	System function
SM	Signal module
STL	Statement List (programming language representation in STEP 7)

Glossary

Accumulator

The accumulators are registers in the → CPU and are used as intermediate memory for loading, transfer, comparison, calculation and conversion operations.

Address

An address is the identifier for a specific operand or operand area (e.g. input I 12.1, memory word MW 25, data block DB 3).

Analog module

Analog modules convert process values (e.g. temperature) into digital values, so that they can be processed by the central processing unit, or convert digital values into analog manipulated variables.

Automation system

An automation system is a → programmable controller in the context of SIMATIC S7.

Backplane bus

The backplane bus is a serial data bus over which the modules communicate and over which the necessary power is supplied to the modules. The connection between the modules is established by bus connectors.

Backup battery

The backup battery ensures that the → user program in the → CPU is stored in the event of a power failure and that defined data areas and bit memories, timers and counters are retentive.

Backup memory

The backup memory provides a backup of memory areas for the
→ CPU without a backup battery. A configurable number of timers, counters, memories and data bytes (retentive timers, counters, memories and data bytes) is backed up.

Bit memory

Bit memories are part of the → system memory of the CPU for storing interim results. They can be accessed in units of a bit, byte, word or doubleword.

Bus

A bus is a communication medium connecting several nodes. Data transmission can be serial or parallel across electrical conductors or fiber-optic cables.

Bus segment

A bus segment is a self-contained section of a serial bus system. Bus segments are interconnected using repeaters.

Chassis ground

Chassis ground is the totality of all the interconnected inactive parts of a piece of equipment on which a hazardous touch voltage cannot build up even in the event of a fault.

Clock memories

Memories that can be used for clocking purposes in the user program (1 memory byte).

Note

Note in the case of S7-300 CPUs that the clock memory byte is not exceeded in the user program.

Code block

A code block in SIMATIC S7 is a block which contains a section of the *STEP 7* user program (in contrast to a → data block which only contains data).

Communication processor

Communication processors are modules for point-to-point and bus links.

Compress

The programming device online function "Compress" is used to align all valid blocks contiguously in the RAM of the CPU at the start of the user memory. This eliminates all gaps which arose when blocks were deleted or modified.

Configuration

Assignment of modules to racks/slots and (e.g. for signal modules) addresses.

Consistent data

Data whose contents are related and which should not be separated are known as consistent data.

For example, the values of analog modules must always be handled consistently, that is the value of an analog module must not be corrupted by reading it out at two different times.

Counter

Counters are part of the → system memory of the CPU. The content of the "counter cells" can by modified by *STEP 7* instructions (e.g. count up/down).

CP

→ Communication processor

CPU

Central processing unit of the S7 programmable controller with open and closed-loop control systems, memory, operating system and interface for programming device.

Cycle time

The scan time is the time taken by the → CPU to scan the → user program once.

Data block

Data blocks (DB) are data areas in the user program which contain user data. Global data blocks can be accessed by all code blocks while instance data blocks are assigned to a specific FB call.

Data, static

Static data is data which can only be used within a function block. The data is saved in an instance data block belonging to the function block. The data stored in the instance data block is retained until the next function block call.

Data, temporary

Temporary data is local data of a block which is stored in the L stack during execution of a block and which is no longer available after execution.

Delay Interrupt

→ Interrupt, time-delay

Device master file

All slave-specific characteristics are stored in a device master file (GSD file). The format of the device master file is defined in the EN 50170, Volume 2, PROFIBUS standard.

Diagnostics

→ System diagnostics

Diagnostic interrupt

Diagnostics-capable modules use diagnostic interrupts to report system errors which they have detected to the → CPU.

Diagnostic buffer

The diagnostic buffer is a buffered memory area in the CPU in which diagnostic events are stored in the order of their occurrence.

DP master

A → master which behaves in accordance with EN 50170, Part 3 is known as a DP master.

DP slave

A → slave which is operated in the PROFIBUS bus system using the PROFIBUS-DP protocol and which behaves in accordance with EN 50170, Part 3 is known as a DP slave.

Equipotential bonding

Electrical connection (equipotential bonding conductor) which gives the bodies of electrical equipment and external conducting bodies the same or approximately the same potential, in order to prevent disturbing or dangerous voltages from being generated between these bodies.

Error display

The error display is one of the possible responses of the operating system to a → runtime error. The other possible responses are: → error response in the user program, STOP status of the CPU.

Error handling via OB

If the operating system detects a specific error (e.g. an access error with *STEP 7*), it calls the organization block (error OB) which is provided for this event and which specifies the subsequent behavior of the CPU.

Error response

Response to a → runtime error. The operating system can respond in the following ways: conversion of the programmable controller to the STOP mode, call of an organization block in which the user can program a response or display of the error.

External power supply

Power supply for the signal and function modules and the process peripherals connected to them.

FB

→ Function block

FC

→ Function

Flash EPROM

FEPROMs are the same as electrically erasable EEPROMS in that they can retain data in the event of a power failure, but they can be erased much more quickly (FEPROM = Flash Erasable Programmable Read Only Memory). They are used on → memory cards.

Force

The "Force" function overwrites a variable (e.g. memory marker, output) with a value defined by the S7 user. At the same time the variable is assigned write protection so that this value cannot be modified from any point (including from the STEP 7 user program). The value is retained after the programming device is disconnected. The write protection is not canceled until the "Unforce" function is called and the variable is written again with the value defined by the user program. During commissioning, for example, the "Force" function allows certain outputs to be set to the "ON" state for any length of time even if the logic operations of the user program are not fulfilled (e.g. because inputs are not wired).

Function

A function (FC) in accordance with IEC 1131-3 is a → code block without → static data. A function allows parameters to be passed in the user program. Functions are therefore suitable for programming complex functions, e.g. calculations, which are repeated frequently.

Function block

A function block (FB) in accordance with IEC 1131-3 is a → code block with → static data. An FB allows parameters to be passed in the user program. Function blocks are therefore suitable for programming complex functions, e.g. closed-loop controls, mode selections, which are repeated frequently.

Functional grounding

Grounding which has the sole purpose of safeguarding the intended function of the electrical equipment. Functional grounding short-circuits interference voltage which would otherwise have an impermissible impact on the equipment.

GD element

A GD element is generated by assigning the → global data to be shared and is identified by the global data identifier in the global data table.

GD circle

A GD circle encompasses a number of CPUs which exchange data by means of global data communication and which are used as follows:

* One CPU sends a GD packet to the other CPUs.

* One CPU sends and receives a GD packet from another CPU.

A GD circle is identified by a GD circle number.

GD packet

> A GD packet can consist of one or more → GD objects which are transmitted together in a frame.

Global data

> Global data is data which can be addressed from any → code block (FC, FB, OB). In detail, this refers to memories M, inputs I, outputs Q, timers, counters and data blocks DB. Absolute or symbolic access can be made to global data.

Global data communication

> Global data communication is a procedure used to transfer → global data between CPUs (without CFBs).

Ground

> The conducting earth whose electrical potential can be set equal to zero at any point.
>
> In the vicinity of grounding electrodes, the earth can have a potential different to zero. The term "reference ground" is frequently used to describe these circumstances.

Ground (to)

> To ground means to connect an electrically conducting component to the grounding electrode (one or more conducting components which have a very good contact with the earth) across a grounding system.

Instance data block

> A data block, which is generated automatically, is assigned to each function block call in the *STEP 7* user program. The values of the input, output and in/out parameters are stored in the instance data block, together with the local block data.

Interface, multipoint

> → MPI

Interrupt

> The → operating system of the CPU recognizes 10 different priority classes which control the execution of the user program. These runtime levels include interrupts, e.g. process interrupts. When an interrupt is triggered, the operating system automatically calls an assigned organization block in which the user can program the desired response (for example in an FB).

Interrupt, delay

> The time-delay interrupt belongs to one of the priority levels for program execution in the SIMATIC S7 system. The interrupt is generated after expiry of a time delay started in the user program. A corresponding organization block is then executed.

Interrupt, diagnostic

> → Diagnostic interrupt

Interrupt, process

> → Process interrupt

Interrupt, time-of-day

> The time-of-day interrupt belongs to one of the runtime levels for program execution on the SIMATIC S7 system. The interrupt is generated on a certain date (or daily) at a certain time (e.g. 9:50 or every hour, every minute). A corresponding organization block is then executed.

Interrupt, watchdog

> A watchdog interrupt is generated periodically by the CPU in configurable time intervals. A corresponding → organization block is then executed.

Isolated

> On isolated I/O modules, the reference potentials of the control and load circuits are galvanically isolated, for example by optocoupler, relay contact or transformer. Input/output circuits can be connected to a common potential.

Load memory

> The load memory is part of the central processing unit. It contains objects generated by the programming device. It is implemented either as a plug-in memory card or a permanently integrated memory.

Local data

> → Data, temporary

Master

> When they are in possession of the → token, masters can send data to other nodes and request data from other nodes (= active node).

Memory card

> Memory cards are memory media in smart card format for CPUs and CPs. They are implemented as → RAM or → FEPROM.

Module parameters

> Module parameters are values which can be used to control the response of the module. A distinction is made between static and dynamic module parameters.

MPI

> The multipoint interface (MPI) is the programming device interface of SIMATIC S7. It enables the simultaneous operation of several stations (programming devices, text displays, operator panels) on one or more central processing units. Each station is identified by a unique address (MPI address).

MPI address

> → MPI

Nesting depth

> One block can be called from another by means of a block call. Nesting depth is the number of → code blocks called at the same time.

Non-isolated

> On non-isolated input/output modules, there is an electrical connection between the reference potentials of the control and load circuits.

OB

> → Organization block

OB priority

The → operating system of the CPU distinguishes between various priority classes, such as cyclic program scanning, process interrupt-driven program scanning, etc. Each priority class is assigned → organization blocks (OB) in which the S7 user can program a response. The OBs have different standard priorities which determine the order in which they are executed or interrupted in the event that they are activated simultaneously.

Operating mode

The SIMATIC S7 programmable controllers have the following operating modes: STOP, → START-UP, RUN.

Operating system of the CPU

The operating system of the CPU organizes all functions and processes of the CPU which are not associated with a special control task.

Organization block

Organization blocks (OBs) represent the interface between the operating system of the CPU and the user program. The processing sequence of the user program is defined in the organization blocks.

Parameter

1. Variable of a *STEP 7* code block
2. Variable for setting the behavior of a module (one or more per module). Each module is delivered with a suitable default setting, which can be changed by configuring the parameters in *STEP 7*.
Parameters can be → static parameters or → dynamic parameters

Parameters, dynamic

Unlike static parameters, dynamic parameters of modules can be changed during operation by calling an SFC in the user program, for example limit values of an analog signal input module.

Parameters, static

Unlike dynamic parameters, static parameters of modules cannot be changed by the user program, but only by changing the configuration in *STEP 7*, for example the input delay on a digital signal input module.

PG

> → Programming device

PLC

> → Programmable controller

Priority class

> The operating system of an S7-CPU provides up to 26 priority classes (or "runtime levels") to which various organization blocks are assigned. The priority classes determine which OBs interrupt other OBs. If a priority class includes several OBs, they do not interrupt each other, but are executed sequentially.

Process image

> The process image is part of the → system memory of the CPU. The signal states of the input modules are written into the process-image input table at the start of the cyclic program. At the end of the cyclic program, the signal states in the process-image output table are transferred to the output modules.

Process interrupt

> A process interrupt is triggered by interrupt-triggering modules on the occurrence of a specific event in the process. The process interrupt is reported to the CPU. The assigned → organization block is then processed in accordance with the priority of this interrupt.

Product version

> The product version differentiates between products which have the same order number. The product version is increased with each upwardly compatible function extension, production-related modification (use of new components) or bug-fix.

PROFIBUS-DP

> Digital, analog and intelligent modules of the programmable controller as well as a wide range of field devices to EN 50170, part 3, such as drivers or valve terminals, are installed in a distributed configuration in the direct vicinity of the process – across distances of up to 23 km (14.375 miles).

> The modules and field devices are connected to the programmable controller via the PROFIBUS-DP fieldbus and addressed in the same way as centralized I/Os.

Programmable controller

Programmable controllers (PLCs) are electronic controllers whose function is saved as a program in the control unit. The configuration and wiring of the unit are therefore independent of the function of the control system. The programmable controller has the structure of a computer; it consists of a → CPU (central processing unit) with memory, input/output groups and an internal bus system. The I/Os and the programming language are oriented to control engineering needs.

Programming device

Programming devices are essentially personal computers which are compact, portable and suitable for industrial applications. They are equipped with special hardware and software for SIMATIC programmable controllers.

RAM

A RAM (random access memory) is a semiconductor read/write memory.

Reference ground

→ Ground

Reference potential

Potential with reference to which the voltages of participating circuits are observed and/or measured.

Restart

When a central processing unit is started up (e.g. by switching the mode selector from STOP to RUN or by switching the power on), organization block OB 100 (complete restart) is executed before cyclic program execution commences (OB 1). On a complete restart, the process-image input table is read in and the *STEP 7* user program is executed starting with the first command in OB 1.

Retentivity

A memory area is retentive if its contents are retained even after a power failure and a change from STOP to RUN. The non-retentive area of memory markers, timers and counters is reset following a power failure and a transition from the STOP mode to the RUN mode.

The following can be made retentive:

- Bit memories
- S7 timers (**not** for CPU 312 IFM)
- S7 counters
- Data areas (only with memory card or integral EPROM)

Runtime error

Error which occurs during execution of the user program on the programmable controller (and not in the process).

Scan rate

The scan rate determines the frequency with which → GD packets are transmitted and received on the basis of the CPU cycle.

Segment

→ Bus segment

SFB

→ System function block

SFC

→ System function

Signal module

Signal modules (SM) represent the interface between the process and the programmable controller. Input and output modules can be digital (input/output module, digital) or analog (input/output module, analog).

Slave

A slave can only exchange data with a → master when so requested by the master.

Start-up

> RESTART mode is activated on a transition from STOP mode to RUN mode.
> Can be triggered by the → mode selector or after power on or an operator action
> on the programming device. In the case of the S7-300 a → restart is carried out.

STEP 7

> Programming language for developing user programs for SIMATIC S7 PLCs.

Substitute value

> Substitute values are configurable values which output modules transmit to the
> process when the CPU switches to STOP mode.
>
> In the event of an input access error, a substitute value can be written to the
> accumulator instead of the input value which could not be read (SFC 44).

System diagnostics

> System diagnostics is the term used to describe the detection, evaluation and
> signaling of errors which occur within the programmable controller. Examples of
> such errors are program errors or module failures. System errors can be displayed
> with LED indicators or in *STEP 7*.

System function

> A system function (SFC) is a → function integrated in the operating system of the
> CPU that can be called, as required, in the STEP 7 user program.

System function block

> A system function block (SFB) is a → function block which is integrated in the
> operating system of the CPU and which can be called in the STEP 7 user program
> as required.

System memory

> The system memory is integrated on the central processing unit and implemented
> as a RAM memory. The system memory includes the operand areas (for example
> timers, counters, bit memories, etc.) as well as the data areas (for example
> communication buffers) required internally by the → operating system.

System state list

The system status list contains data describing the current status of an S7-300. You can use it to gain an overview of the following at any time:

- The S7-300 configuration

- The current parameterization of the CPU and the parameterizable signal modules

- The current statuses and sequences in the CPU and the parameterizable signal modules.

Terminating resistor

A terminating resistor is a resistor used to terminate a data communication line in order to prevent reflection.

Time-of-day interrupt

→ Interrupt, time-of-day

Timer

→ Times

Times (timer cells)

Times are part of the → system memory of the CPU. The contents of the "timer cells" are updated automatically by the operating system asynchronously to the user program. *STEP 7* instructions are used to define the exact function of the timer cells (for example on-delay) and initiate their execution (e.g. start).

Token

Access right on bus

Transmission rate

Rate of data transfer (bps)

Ungrounded

Having no galvanic connection to ground

User memory

The user memory contains the → code and → data blocks of the user program. The user memory can be integrated in the CPU or can be provided on plug-in memory cards or memory modules. The user program is always executed in the → working memory of the CPU, however.

User program

The SIMATIC system distinguishes between the → operating system of the CPU and user programs. The latter are created with the programming software → *STEP 7* in the available programming languages (ladder logic and statement list) and saved in code blocks. Data are stored in data blocks.

Varistor

Voltage-independent resistor

Watchdog Interrupt

→ Interrupt, watchdog

Working memory

The working memory is a random-access memory in the → CPU which the processor accesses during program execution.

Index

To

Siemens AG

A&D AS E 82

Postfach 1963

D–92209 Amberg

From

Your Name: _

Your Title: _

Company Name: _

Street: _

City, Zip Code: _

Country: _

Phone: _

Please check any industry that applies to you:

❐ Automotive ❐ Pharmaceutical

❐ Chemical ❐ Plastic

❐ Electrical Machinery ❐ Pulp and Paper

❐ Food ❐ Textiles

❐ Instrument and Control ❐ Transportation

❐ Nonelectrical Machinery ❐ Other _ _ _ _ _ _ _ _ _ _ _ _ _

❐ Petrochemical

Remarks Form

Your comments and recommendations will help us to improve the quality and usefulness of our publications. Please take the first available opportunity to fill out this questionnaire and return it to Siemens.

Please give each of the following questions your own personal mark within the range from 1 (very good) to 5 (poor).

1. Do the contents meet your requirements? ☐
2. Is the information you need easy to find? ☐
3. Is the text easy to understand? ☐
4. Does the level of technical detail meet your requirements? ☐
5. Please rate the quality of the graphics/tables: ☐

Additional comments:

_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _

To

Siemens AG

A&D AS E 82

Postfach 1963

D–92209 Amberg

From

Your Name: _

Your Title: _

Company Name: _

 Street: _

 City, Zip Code: _

 Country: _

 Phone: _

Please check any industry that applies to you:

❐   Automotive   ❐   Pharmaceutical

❐   Chemical   ❐   Plastic

❐   Electrical Machinery   ❐   Pulp and Paper

❐   Food   ❐   Textiles

❐   Instrument and Control   ❐   Transportation

❐   Nonelectrical Machinery   ❐   Other _ _ _ _ _ _ _ _ _ _ _ _ _ _

❐   Petrochemical

Remarks Form

Your comments and recommendations will help us to improve the quality and usefulness of our publications. Please take the first available opportunity to fill out this questionnaire and return it to Siemens.

Please give each of the following questions your own personal mark within the range from 1 (very good) to 5 (poor).

1. Do the contents meet your requirements? ☐
2. Is the information you need easy to find? ☐
3. Is the text easy to understand? ☐
4. Does the level of technical detail meet your requirements? ☐
5. Please rate the quality of the graphics/tables: ☐

Additional comments:

_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _
_ _