

SIMATIC

C7-633 / C7-634 Control Systems

Manual

This manual is part of the documentation package with the order number:

6ES7633-1AF01-8BA0

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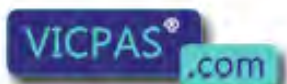
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10/98

C79000-G7076-C634

Release 01



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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:



Warning

indicates that death, severe personal injury or substantial 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

The device/system may only be set up and operated in conjunction with this manual.

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 description, 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.



Caution

UL + CSA: Lithium Battery Replacement

Danger of explosion if battery is incorrectly replaced. Replace only with same or equivalent type recommended by the manufacturer. Dispose of used batteries according to the manufacturer's instructions.



Warning

FM WARNING - DO NOT DISCONNECT WHILE CIRCUIT IS LIVE UNLESS LOCATION IS KNOWN TO BE NON-HAZARDOUS

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We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcomed.

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Preface

Purpose of the Manual

This manual provides you with a complete overview of the **C7-633 P, C7-633 DP, C7-634 P and C7-634 DP control systems**. It offers support for the installation and commissioning of these systems, outlines the possibilities for connecting other devices, and introduces the components required for this.

Where is this Manual Valid?

This manual is valid for the following device variants:

C7	Order Number
C7-633 P	6ES7633-1DF00-0AE3
C7-633 DP	6ES7633-2BF00-0AE3
C7-634 P	6ES7634-2DBF00-0AE3
C7-634 DP	6ES7634-2BF00-0AE3

Audience and Requirements

This manual is intended for personnel with the necessary qualifications for commissioning, operating, and programming the hardware product described.

You should be familiar with the use of computers or devices with similar functions to a PC (for example, programming devices) under the operating system Windows 95 / NT 4.0 and have some knowledge of the STEP 7 Standard software and the ProTool configuration software and the relevant documentation.

C7 Documentation Package

The control systems comprise the following individual components:

- SIMATIC S7-300
- SIMATIC Operator Panel

You will find information on these individual components in the version of the C7 documentation package valid for your control systems. This documentation package comprises four manuals and an instruction list. You will find the contents listed in Table 1-1:

Manual 6 5 311 6 5 312 6 7 8	Manual Operator Panel OP7, OP17	
Manual S7-300 Programmable Controller Hardware and Installation	Reference Manual Module Specifications	Instruction List S7-300 Programmable Controller, CPU 312 IFM, 314 IFM, 313, 314, 315, 315-2 DP

Table 1-1 C7 Documentation Package

Manual	Contents
Manual <i>C7-633/C7-634 Control Systems</i>	Provides information on the topics: <ul style="list-style-type: none"> • Installation and installation guidelines for the C7-633 and C7-634 • Connecting the C7 systems to a programming device and other devices • Connecting an IM 361 interface module • Features of the C7 and differences from SIMATIC S7-300 and SIMATIC Operator Panels • Communication between the CPU and the OP
Manual <i>Operator Panel OP7, OP17</i>	Provides information on: <ul style="list-style-type: none"> • Functionality • Device description • Operating modes and how to operate the OP
Manual <i>S7-300 Programmable Controller, Hardware and Installation</i>	Detailed description of: <ul style="list-style-type: none"> • Configuring the mechanical and electrical structure • Installation and wiring • Preparing the S7-300 for commissioning • Features and technical specifications of the S7-300 CPUs
Reference Manual: <i>S7-300 and M7-300 Programmable Controllers, Module Specifications</i>	Describes the hardware of the S7-300 modules: <ul style="list-style-type: none"> • Analog modules • Digital modules • Interface modules • Characteristics and technical specifications of the S7-300 modules
Instruction List <i>S7-300 Programmable Controller CPU 312 IFM, 314 IFM, 313, 314, 315-2DP</i>	<ul style="list-style-type: none"> • List of instructions for the CPUs • Brief description of the instructions and the execution times

Further Documentation

There is a range of user manuals which are intended to be used selectively to support you with the programming, expansion, and configuration of a C7 control system. The figure below and the explanations which follow should make it easier to use the documentation.

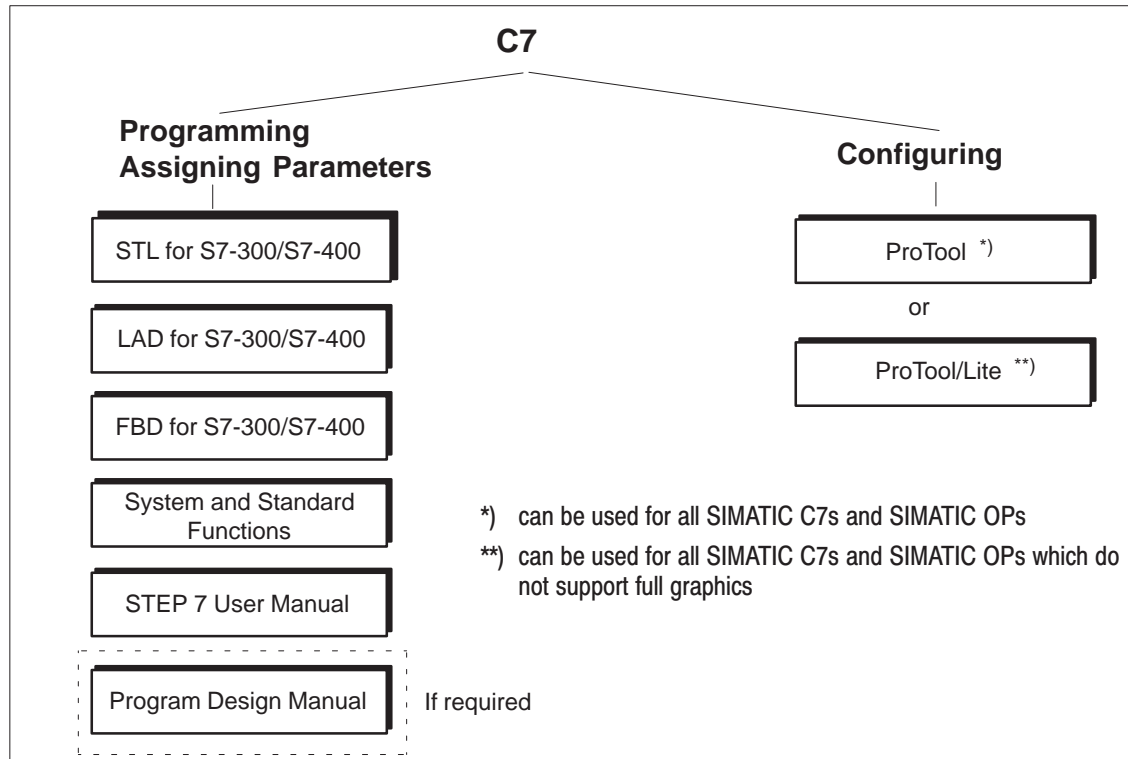


Table 1-2 STEP 7 Documentation Package, Order Number, see Catalog ST 70

Manual	Contents
User Manual: <i>Standard Software for S7 and M7</i>	Provides information on working with the STEP 7 applications: <ul style="list-style-type: none"> • Installing and starting up STEP 7 on a PC/programming device • Handling the applications with the following contents: <ul style="list-style-type: none"> – Managing projects and files – Configuring and assigning parameters to the S7-300 – Assigning symbolic names for user programs – Creating and debugging the user program in STL/LAD – Creating data blocks • Configuring communications between several CPUs: <ul style="list-style-type: none"> – Downloading/uploading, storing, and deleting the user program – Monitoring and modifying the user program (for example, variables) – Monitoring and modifying the CPU (for example, operating state, memory reset, compressing memory, protection levels)
Manual: <i>Statement List (STL) for S7-300/400, Programming</i> or Manual: <i>Ladder Logic (LAD) for S7-300/400, Programming</i> or Manual: <i>Function Block Diagram (FBD) for S7-300/400, Programming</i>	Reference manuals for programming with STL, LAD, or FBD: <ul style="list-style-type: none"> • Basics of working with STL/LAD/FBD (for example, structure of STL/LAD/FBD, number formats, syntax) • Description of all instructions in STEP 7 (with sample programs) • Description of the various methods of addressing in STEP 7 (with examples) • Description of all integrated functions of the CPUs • Description of the CPU-internal registers
Reference Manual: <i>System Software for S7-300/400, System and Standard Functions</i>	Detailed description of: <ul style="list-style-type: none"> • All organization blocks (OB) and their priority classes • All standard functions (FC) integrated in STEP 7 • All system functions (SFC) integrated in the operating system of a CPU
Programming Manual: <i>System Software for S7-300/400, Program Design</i>	Teaches the basic requirements for creating STEP 7 programs: <ul style="list-style-type: none"> • Guide to the efficient solution of the programming task using a PC/programming device and STEP 7 • How the CPUs work (for example, memory concept, access to inputs/outputs, addressing, blocks, data types, data management) • Description of STEP 7 data management • Using the STEP 7 data types • Using linear and structured programming (with program samples) • Using block call instructions • Overview of using the STEP 7 applications for developing projects (with detailed example) • Using test and diagnostics functions of the CPUs in the user program (for example, error OBs, status word)

Table 1-3 Other Manuals that Provide Helpful Information on How to Operate the C7 Control System

Manual	Contents
<i>PG 7xx</i>	Describes the programming device (PG) hardware: <ul style="list-style-type: none"> • Setting up and starting up the programming device • Expansion possibilities • Configuration • Error diagnostics
ProTool / ProTool/Lite	Manual for creating configurations with ProTool or ProTool/Lite: <ul style="list-style-type: none"> • Using ProTool/ProTool/Lite • Configuring • Displays and messages • Loading the configuration into the C7
Manual: <i>Communication with SIMATIC</i>	Describes communication in the SIMATIC S7/M7/C7: <ul style="list-style-type: none"> • Introduction to the theory of communications • Communication utilities • Structure and configuration of communication networks • Examples of the various communication possibilities

Conventions

To make it easier to read this manual, we have used **C7** throughout the manual to stand for the device types C7-633 P, C7-633 DP, C7-634 P, and C7-634 DP.

Other Sources of Information

In the literature list at the end of the manual you will find a list of other sources of information on S7-300 and programmable logic controllers.

Structure of This Manual

To make it easier for you to locate specific information, the manual has been structured as follows:

- At the beginning of the manual, you will find a complete table of contents for the manual.
- In the individual chapters, the information in the left margin gives an overview of the contents of each section.
- Following the appendices, there is a glossary containing definitions of the important technical terms used in the manual.
- At the end of the manual, you will find a detailed index giving you fast access to the information you seek.

Standards

The C7 control system conforms to the standards listed in Appendix B.1.

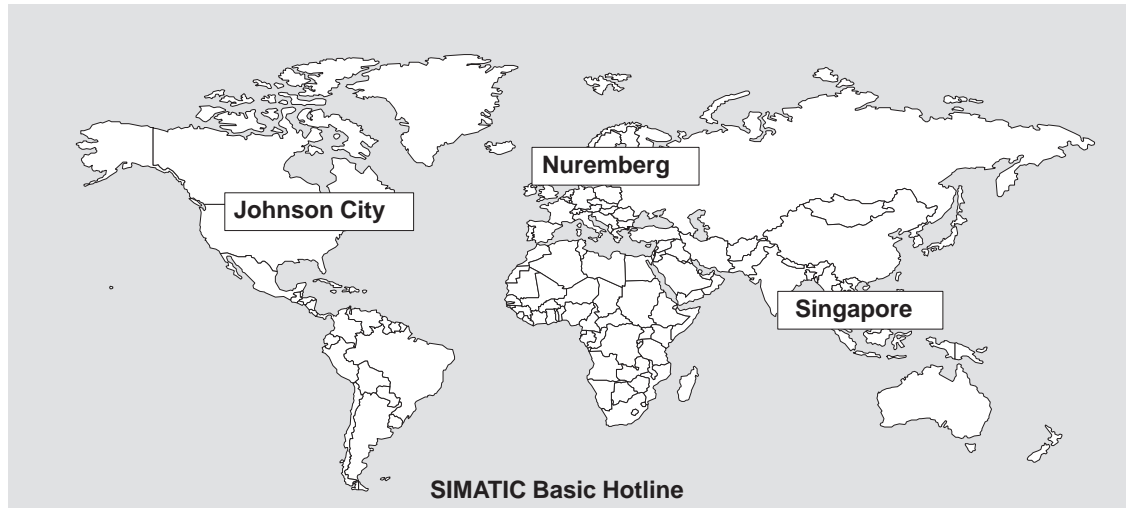
Further Support

If you have any questions about using the C7 control systems described in this manual and cannot find an answer here, please contact the Siemens representative in your area. You can obtain a list of addresses of Siemens representatives worldwide from the SIMATIC Customer Support Hotline.

If you have any questions or comments on this manual, please fill out the remarks form at the end of the manual and return it to the address shown on the form. We would be grateful if you could also take the time to answer the questions giving your personal opinion of the manual.

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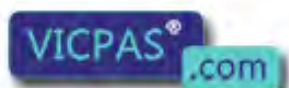
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 - On the **Internet** under
<http://www.ad.siemens.de/support/html-00/>
 - Via the **Bulletin Board System (BBS)** in Nuremberg (*SIMATIC Customer Support Mailbox*) under the number +49 (911) 895-7100.

To access the mailbox, use a modem with V.34 (28.8 Kbps) capability whose parameters you should set as follows: 8, N, 1, ANSI, or dial in using ISDN (x.75, 64 Kbps).



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C7-633/C7-634 Control Systems
C79000-G7076-C634-01

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Product Overview

1

In This Chapter...

This chapter introduces the different variants of the device. A brief overview of the scope of functions of the device helps to give you a first impression of the C7 control systems.

In addition, this chapter also explains which other components you can connect to a C7 control system.

Accessories for Operating a C7 Control System

To operate a C7 control system you will require the following accessories:

- Programming device (PG) or PC with multipoint interface (MPI),
- An MPI cable
- A serial cable (RS 232/TTY),
- A 24-V power supply
- The following programs must be loaded on the programming device or PC:
 - The STEP 7 or STEP 7-Mini applications
 - The configuration tool ProTool or ProTool/Lite

1.1 Product Variants

Overview

The C7 devices are available in the following variants:

- C7-633 P, C7-633 DP
- C7-634 P, C7-634-DP

C7-633 P/ C7-633 DP

The C7-633 and C7-633 DP control systems have a SIMATIC S7-300 CPU 315 or CPU 315-2 DP as the C7 CPU and an OP 7 with **extended** function keys as the C7 OP (see Section 3.1).

The screen display comprises four lines of 20 characters with a character height of 8 mm.

The C7-633 P is fitted with an integrated I/O module and has no DP interface.



Figure 1-1 C7-633 P

The C7-633 DP does not have an integrated on-board I/O.



Figure 1-2 C7-633 DP

C7-634 P/ C7-634 DP

The C7-634 P and C7-634 DP control systems have a SIMATIC S7-300 CPU 315 or CPU 315-2 DP as the C7 CPU and an OP 17 as the C7 OP.

The screen display can be configured as follows:

- Four lines of 20 characters with 11 mm character height or
- Eight lines of 40 characters with 6 mm character height.

The different character heights can also be combined with the basic configuration of 8*40 in a display.

The C7-634 P is fitted with an integrated I/O module and has no DP interface.



Figure 1-3 C7-634 P

The C7-634 DP has no integrated on-board I/O.



Figure 1-4 C7-634 DP

PROFIBUS DP Bus Connection

The C7-633 DP and C7-634 DP control systems can be connected via the integrated DP interface to a PROFIBUS DP network.

Scope of Functions

With the C7 devices you can:

- Download user programs to the C7 CPU and run them.
- Communicate with other nodes in an MPI or PROFIBUS DP network via an integrated MPI or DP interface.
- Process digital and analog signals using the C7's integral I/O.
- Use interrupt inputs or counters (for purposes including frequency metering, period duration measurement).
- Load and execute operator interface configurations you created with the configuration tools "ProTool" or "ProTool/Lite."
- Using these configurations you can monitor and influence the process which you control with the user program.
- Connect other S7 modules via the IM 361 interface module.
- Output data to a connected printer.

C7 Components

The C7 contains two units that work independently of each other and communicate via an internal multipoint interface:

- C7 CPU: controls
- C7 Operator Panel: operates and monitors

The C7 CPU is independent of the C7 OP. The C7 OP continues to run, for example, when the C7 CPU goes into STOP.

Note

The C7 CPU and the C7 OP each have an MPI address. You therefore configure these components exactly the same as the stand-alone components CPU and OP.

These components are discussed explicitly in the manual as necessary.

1.2 Scope of Supply and Accessories for C7

Parts Supplied

The following components are included in the scope of supply of a C7 device:

- C7-633 P, C7-633 DP, C7-634 P, or C7-634 DP
- Battery (integrated in the device)
- One grounding bar (C7-633 P and C7-634 P only)
- Six shielding clips (C7-633 P and C7-634 P only)
- Seal and four screw-in tensioners
- Power supply connector (4-pin)
- Product Information (as required)
- Connector set (C7-633 P and C7-634 P only)

Accessories

The following components can be ordered as important **C7 standard accessories**:

Component	Identifying Data	Order Number
PG cable (MPI) (connects C7 to PG)		See catalog ST 70
PG cable (TTY) (serial transfer (ProTool))		
PC/MPI cable	5 m	
Printer cable for RS 232 serial interface (max. 16 m)		

Spare Parts

The following components can be ordered as **spare parts for the C7**:

Component	Identifying Data	Order Number
Service package	Seal and 4 screw-in tensioners	See catalog ST 70
Backup battery		
Connector set for C7 I/Os with solid and profiled coding keys		

1.3 Components for Connection to a C7

In addition to the connections to the process, you can also connect different components to the C7. The most important components and their functions are listed in Table 1-1:

Table 1-1 Connectable Components of a C7

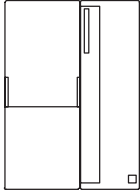
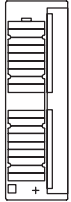
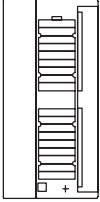
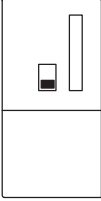
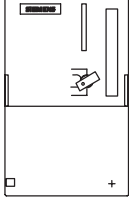

Component	Function	Illustration
Interface module (IM 361)	... connects a C7 to an expansion rack for S7-300 modules via an IM 361 connecting cable	
Signal modules (SM) (digital input modules, digital output modules, analog input modules, analog output modules, analog I/O modules)	... adapt different process signal levels to the C7 CPU. They can be connected to the C7 via an IM 361	
Function modules (FM)	... for time-critical and memory-intensive process signal processing tasks, for example, positioning or closed-loop control	
Communications processors (CP)	... relieves the CPU of communication tasks, for example, CP 342-5 DP for supporting FMS services, point-to-point connections, S5 connections, etc.	
S7-300 (CPU)	... communicates via the MPI/DP interface with the C7 and/or other nodes in an MPI network	
S7-400 (CPU)	... communicates via the MPI/DP interface with the C7 and/or other nodes in an MPI/DP network	

Table 1-1 Connectable Components of a C7

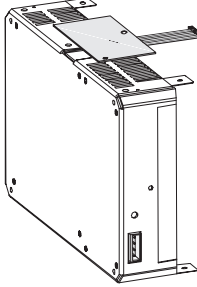
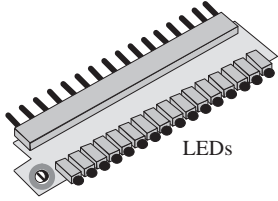

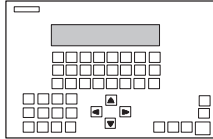
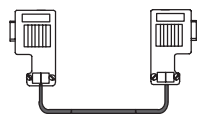
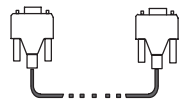
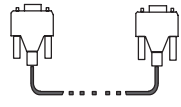

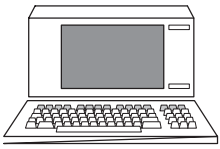

Component	Function	Illustration
C7 I/O module (expansion I/Os)	... is used for expanding the integrated I/Os by 16 digital inputs, 16 digital outputs, 4 analog inputs, 4 analog outputs, and 4 universal inputs directly on the device	
C7 simulator modules	... with switches and LEDs to allow simulation of 16 digital inputs and 16 digital outputs. It can be connected to the C7 via an IM 361	
SIMATIC TOP Connect	... permits easy, fast, and reliable wiring of the I/O and power supply connectors	
OP (operator panel)	... executes operator interface functions	
PROFIBUS bus cable with bus connector	... connects nodes of an MPI network or L2-DP network together	
Programming device cable (MPI)	... connects a programming device/PC to a C7	
Programming device cable (serial)	... connects a programming device/PC to a C7 (RS 232/TTY). Serial transfer with ProTool	
Printer	... prints out operator interface messages for the C7	

Table 1-1 Connectable Components of a C7

Component	Function	Illustration
Programming device (PG) or PC with the STEP 7 and ProTool software packages	... configures, assigns parameters, programs, and tests the C7	
RS 485 repeater	... for amplifying the signals in an MPI network or L2-DP network, and for linking segments of an MPI or L2-DP network	

Example

Figure 1-5 shows some possible connections to other devices.

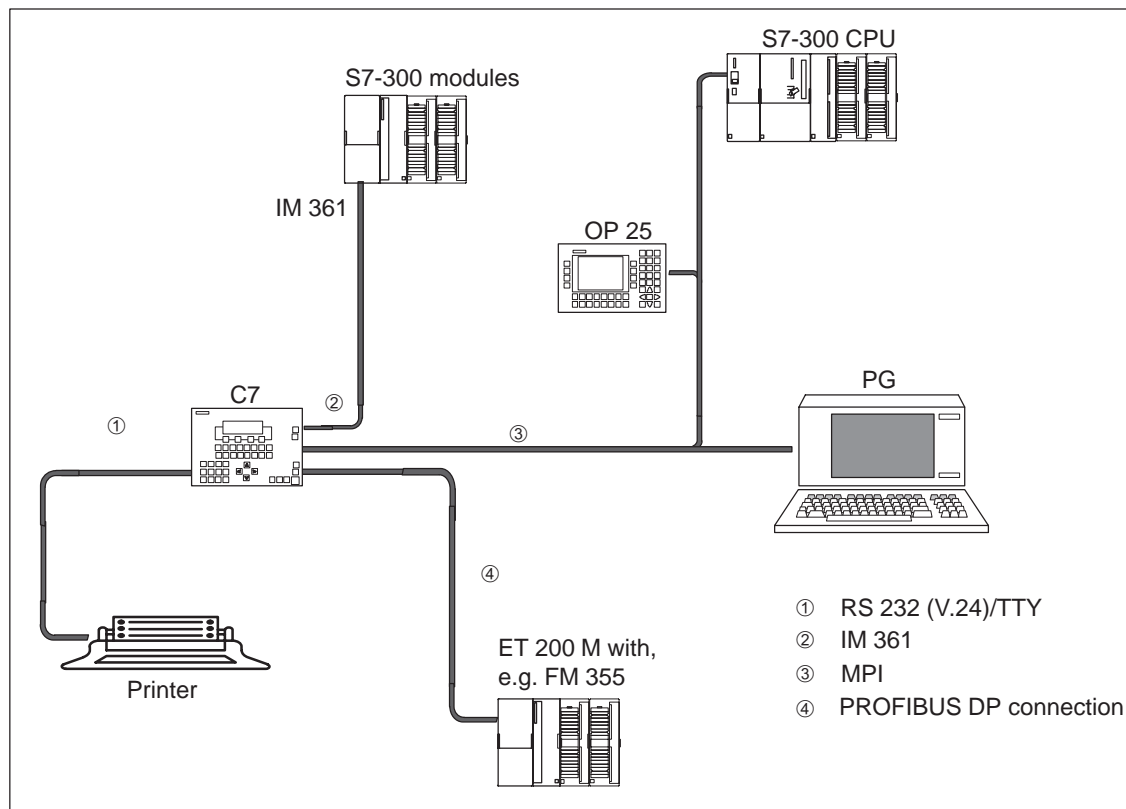
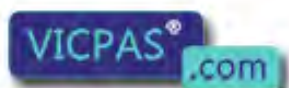


Figure 1-5 Some C7 Connection Possibilities



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C7-633/C7-634 Control Systems
C79000-G7076-C634-01

Installation and Setup Guidelines for the C7

2

Chapter Overview

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2.4	Connector Assignments	2-13
2.5	Connecting a Programming Device/PC to a C7	2-17
2.6	Connecting a Programming Device/PC to Several Nodes	2-18
2.7	Setup Guidelines for Interference-Free Installation	2-20
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2.9	Encoding Connectors	2-23
2.10	Expanding the C7 with S7-300 Modules	2-24
2.11	Configuring an MPI and PROFIBUS DP Network	2-26

2.1 Labeling Strips

Plant-Specific Labeling

The function keys are labeled using labeling strips which are inserted into the keypad from the side. When shipped, the function keys are labeled as follows:

C7-633: F1 to F4, K1 to K8, and K9 to K16.

C7-634: F1 to F8, K1 to K8, and K9 to K16.

By exchanging the labeling strips, you can label the function keys of your C7 specifically for your plant.

Making Labeling Strips

To make your own labeling strips, use transparent foil so that the LEDs in the function keys remain visible. Label the foil using either a printer or an indelible pen so it cannot be erased. Cut the strips out using the templates shown in Figures 2-1 (C7-633) and 2-2 (C7-634).

Note

Laser printouts are not indelible. You should therefore protect the printed sheet with transparent adhesive foil.

Shipped with the ProTool configuration software are the Word® files SLIDE633.DOC and SLIDE634.DOC. The files contain formatted templates for labeling the function keys of C7-633 and C7-634 and can also be used to edit and print your own individual labeling strips with a minimum of effort. You will find the SLIDE63x.DOC and SLIDE634.DOC files in the ProTool directory "Utility."

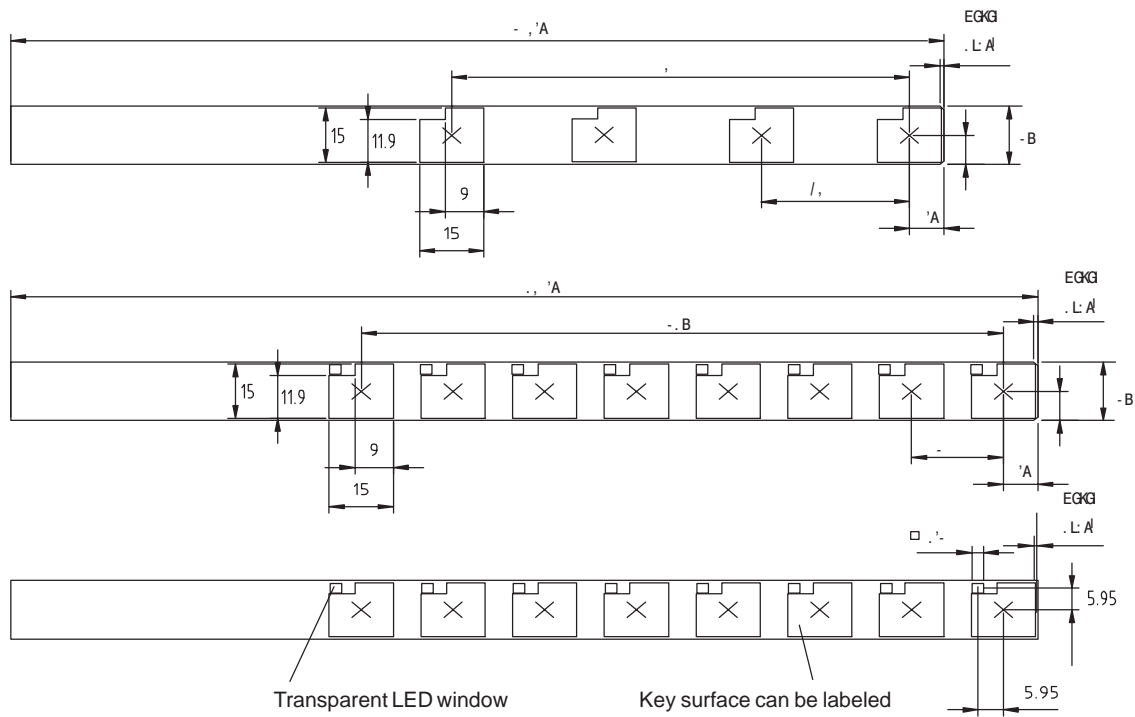


Figure 2-1 Dimensions of the Labeling Strips for the C7-633

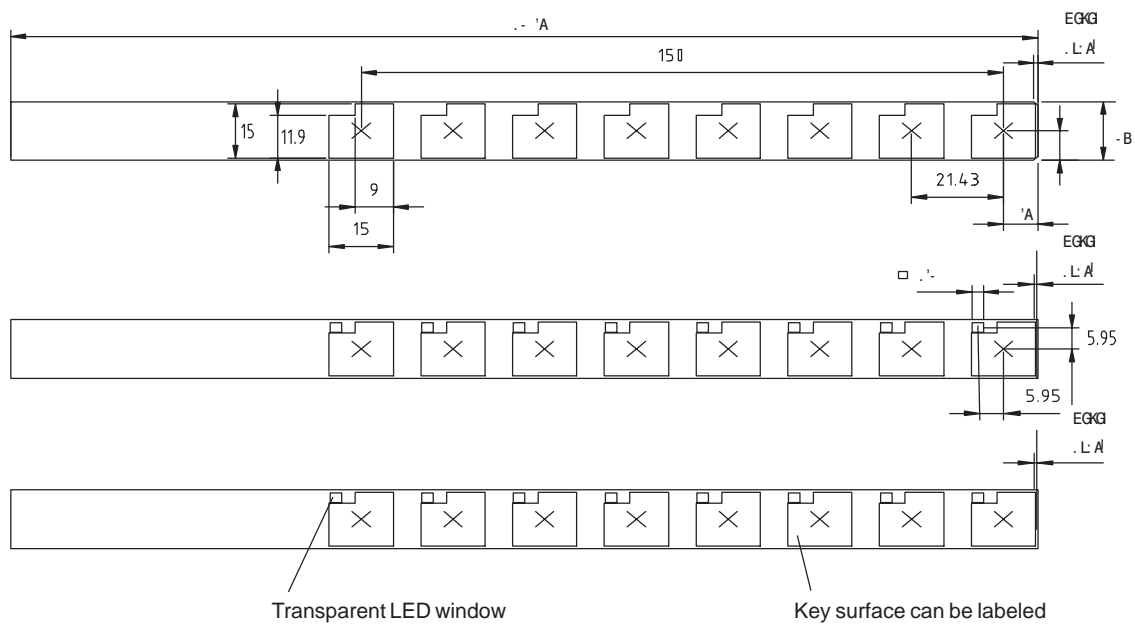


Figure 2-2 Dimensions of the Labeling Strips for the C7-634

Changing Labeling Strips

The C7 is designed for user-friendly insertion of the labeling strips. The labeling strips should only be changed when the C7 is not installed. Proceed as follows to change the strips:

1. Pull the labeling strips you want to replace out of the device.
2. From the rear of the device, push the new strips into the relevant slots on the side.

Note

The labels on the strips must be indelible before the strips are inserted. If the keypad membrane is dirtied or smudged from the inside, it cannot be cleaned and can only be replaced at the factory of origin.

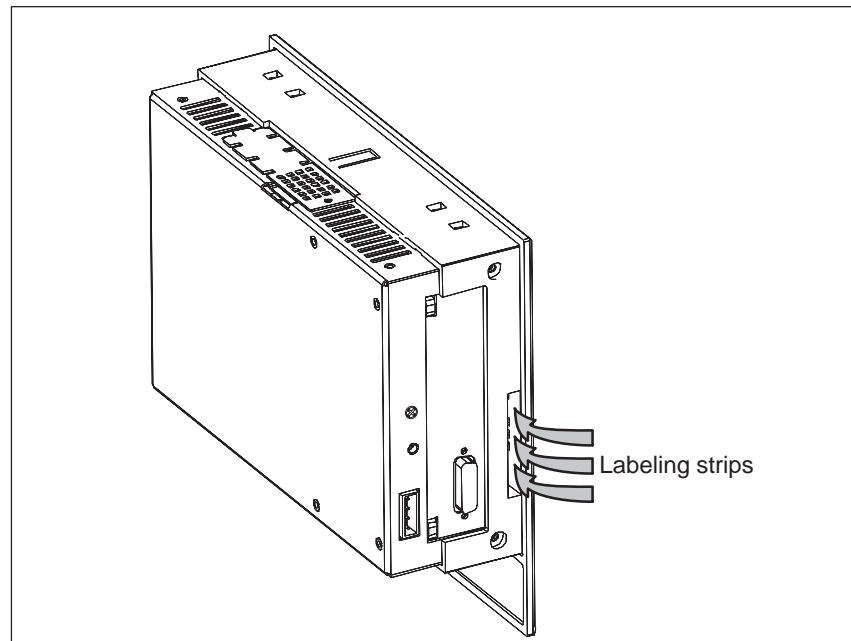


Figure 2-3 Inserting Labeling Strips

2.2 Mechanical Installation

Installing the Device

The C7 control system has been prepared for fixed installation in a control panel or cabinet door. Proceed as follows to install the C7:

1. Make a cutout in the control panel dimensions 230.5 x 158.5 mm (same size for all device variants). See Figure 2-5.
2. Push the enclosed seal over the casing from behind.
3. Insert the C7 into the prepared cutout.
4. Guide the fixing hooks of the enclosed screw-in tensioner 1 into the appropriate recesses in the casing of the C7.
5. Tighten the C7 using a screwdriver from the rear of the control panel 2.

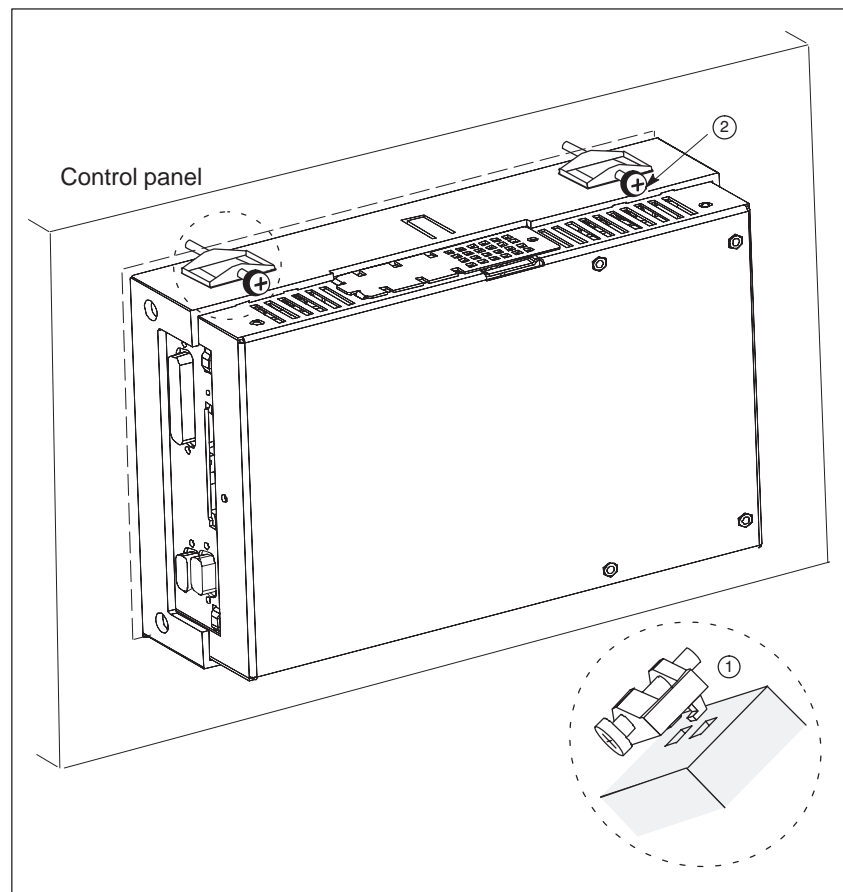


Figure 2-4 C7-633 DP with Screw-In Tensioners

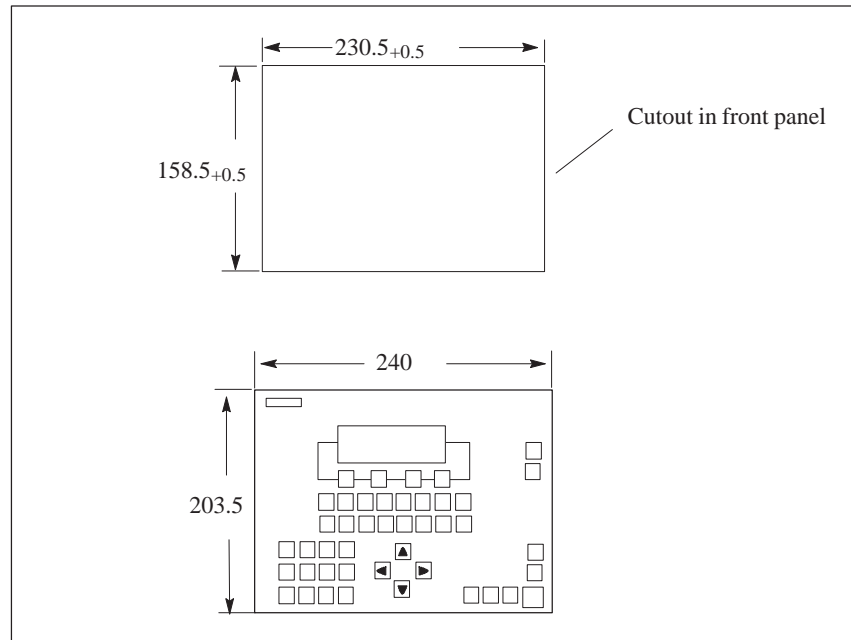


Figure 2-5 Dimension Drawings for Cutout in Control Panel (All Device Variants)

Installation Guidelines

When installing a C7, please note the following:

The plate of a control panel may be 2 to 4 mm thick. Make sure the seal ring fits tightly in all places.

When you tighten the fixings, the seal ring should be visible (min. 0.5 mm).

Gaps of at least 50 and 70 mm must be left on the sides of the C7 for outgoing cables and air circulation as shown in Figure 2-6.

The seal ring on the front panel must sit perfectly.

The tabs of the insertion strips must not be trapped.

The C7 must be protected from direct sunlight.

Note

The C7 can be mounted and operated in different positions, whereby horizontal mounting is preferable.

It is also possible to mount the system rotated around a horizontal axis (see Appendix B.1 Technical Specifications “Operational ambient temperature”).

Operation is not permissible in a position that is tilted around a vertical axis.

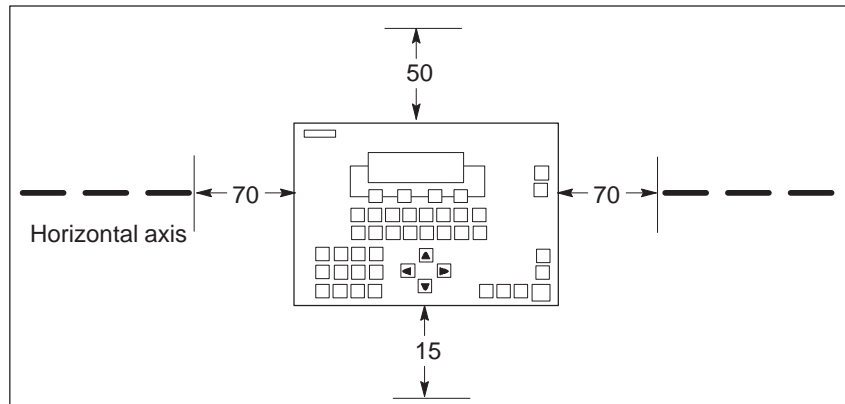


Figure 2-6 Gap Dimensions to be Observed when Installing the C7

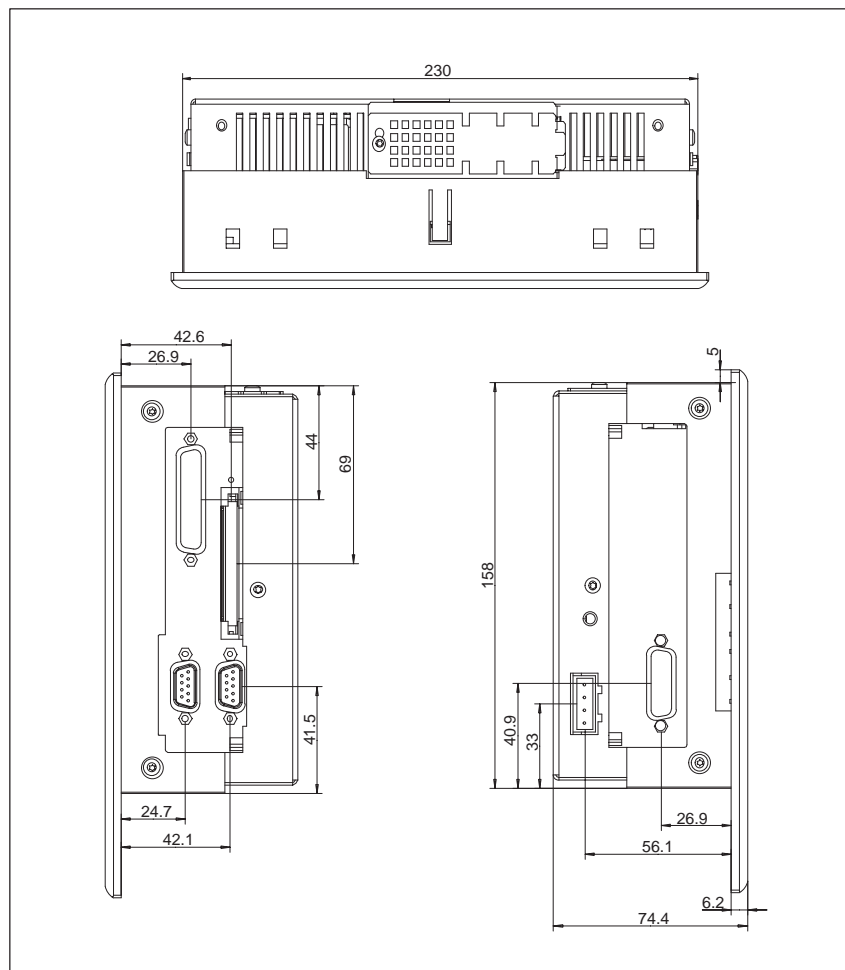


Figure 2-7 Dimension Drawings for the C7-633 DP/C7-634 DP

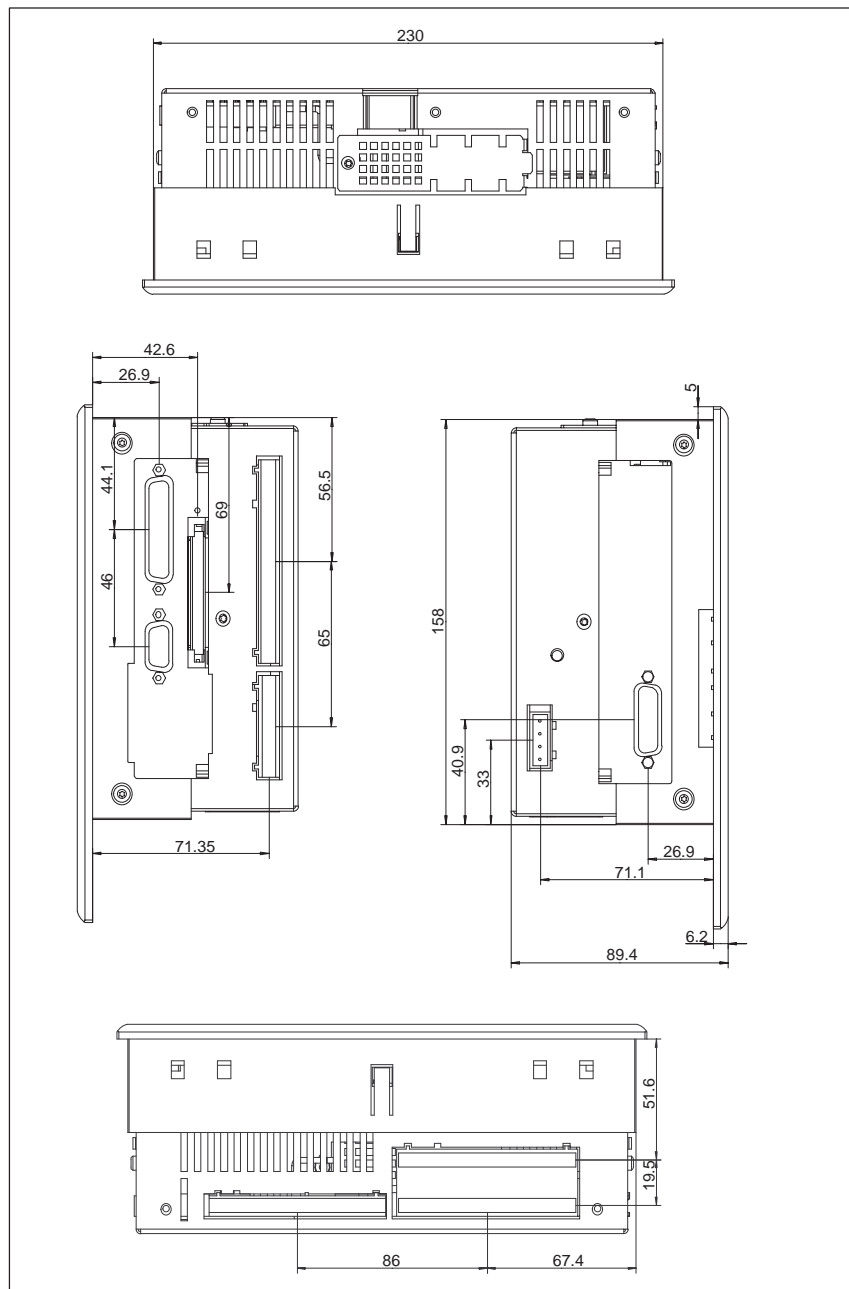


Figure 2-8 Dimension Drawings for the C7-633 P/C7-634 P

2.3 Electrical Installation

Overview

The following plug and socket connectors (interfaces) required for connecting the various inputs and outputs of the on-board I/O of the C7-633 P or C7-634 P are provided.

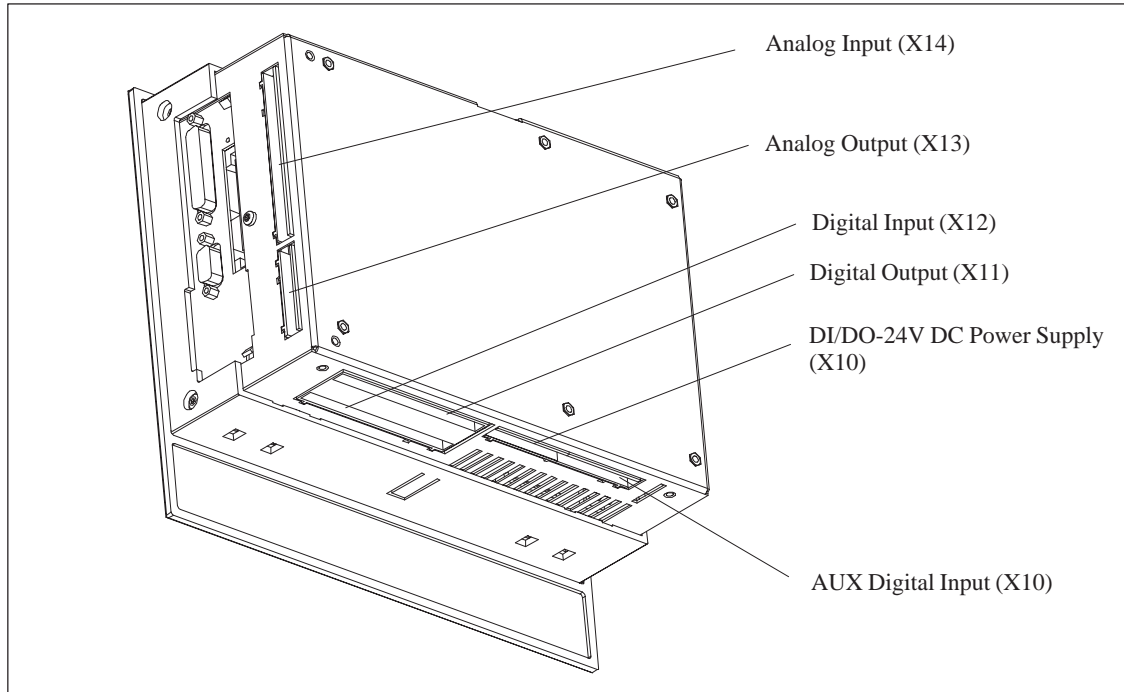


Figure 2-9 A View of the C7-633 P with On-Board I/O Interfaces

Digital Inputs (X12)

Table 2-1 Pin Assignments of the Digital Inputs

Pin No.	Signal	Explanation
0.0	I0.0	Digital input 0
0.1	I0.1	Digital input 1
0.2	I0.2	Digital input 2
0.3	I0.3	Digital input 3
0.4	I0.4	Digital input 4
0.5	I0.5	Digital input 5
0.6	I0.6	Digital input 6
0.7	I0.7	Digital input 7
1.0	I1.0	Digital input 8
1.1	I1.1	Digital input 9
1.2	I1.2	Digital input 10
1.3	I1.3	Digital input 11

Table 2-1 Pin Assignments of the Digital Inputs

Pin No.	Signal	Explanation
1.4	I1.4	Digital input 12
1.5	I1.5	Digital input 13
1.6	I1.6	Digital input 14
1.7	I1.7	Digital input 15

Digital Outputs (X11)

Table 2-2 Pin Assignments of the Digital Outputs

Pin No.	Signal	Explanation
0.0	Q0.0	Digital output 0
0.1	Q0.1	Digital output 1
0.2	Q0.2	Digital output 2
0.3	Q0.3	Digital output 3
0.4	Q0.4	Digital output 4
0.5	Q0.5	Digital output 5
0.6	Q0.6	Digital output 6
0.7	Q0.7	Digital output 7
1.0	Q1.0	Digital output 8
1.1	Q1.1	Digital output 9
1.2	Q1.2	Digital output 10
1.3	Q1.3	Digital output 11
1.4	Q1.4	Digital output 12
1.5	Q1.5	Digital output 13
1.6	Q1.6	Digital output 14
1.7	Q1.7	Digital output 15

Analog Inputs X14

Table 2-3 Pin Assignments of the Analog Inputs

Pin No.	Explanation
AI1-U	Analog input 1, signal input for voltage
AI1-I	Analog input 1, signal input for current
AI1-M	Analog input 1, reference potential
AI2-U	Analog input 2, signal input for voltage
AI2-I	Analog input 2, signal input for current
AI2-M	Analog input 2, reference potential
AI3-U	Analog input 3, signal input for voltage
AI3-I	Analog input 3, signal input for current
AI3-M	Analog input 3, reference potential
AI4-U	Analog input 4, signal input for voltage
AI4-I	Analog input 4, signal input for current
–	Not connected
–	Not connected
–	Not connected

Analog Outputs X13

Table 2-4 Pin Assignments of the Analog Outputs

Pin No.	Explanation
AO1	Analog output, signal output for voltage/current
MANA	Analog output, reference potential
AO2	Analog output, signal output for voltage/current
MANA	Analog output, reference potential
AO3	Analog output, signal output for voltage/current
MANA	Analog output, reference potential
AO4	Analog output, signal output for voltage/current
MANA	Analog output, reference potential

AUX Digital Inputs X10 (Universal Inputs)

Table 2-5 Pin Assignments of the Universal Inputs

Pin No.	Explanation
M	Relevant ground
DI-X1	Universal input 1 (digital input, interrupt input or counter input)
DI-X2	Universal input 2 (digital input, interrupt input or counter input)
DI-X3	Universal input 3 (digital input, interrupt frequency or period duration counter input)
DI-X4	Universal input 4 (interrupt input or digital input)
Gate1	Gate for counter input DI-X1
Gate2	Gate for counter input DI-X2
Gate3	Gate for counter input DI-X3

DI/DO 24 VDC X10 Power Supply

Table 2-6 Pin Assignments of the Power Supply DI/DO

Pin No.	Explanation
1L+	24-volt supply for DI 0.0...1.7
1M	Relevant ground for DI 0.0...1.7
2L+	24-volt supply for DO0.0...DO0.7 (approx. 2 A)
2L+	24-volt supply for DO0.0...DO0.7 (approx. 2 A)
2M	Relevant ground for DO0.0...DO0.7
3L+	24-volt supply für DO1.0...DO1.7 (approx. 2 A)
3L+	24-volt supply for DO1.0...DO1.7 (approx. 2 A)
3M	Relevant ground for DO1.0...DO1.7

2.4 Connector Assignments

Overview

The following interfaces and connectors are present on the C7 for connecting it to other devices. The connector assignments are listed in the following tables.

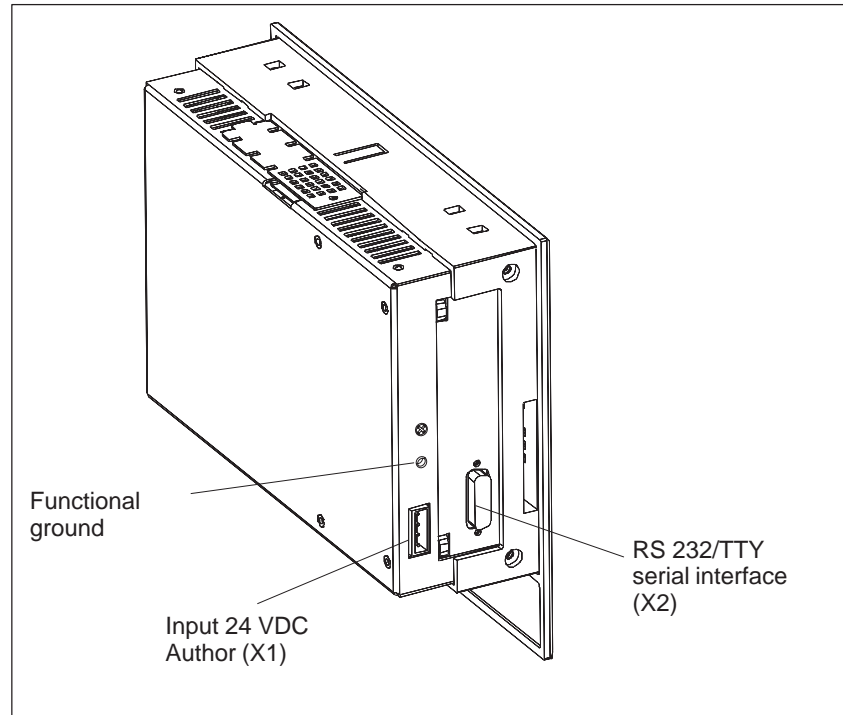


Figure 2-10 C7-633 DP and C7-634 DP: View with Power Supply and RS 232/TTY Serial Interface

24 VDC Input X1 (C7 Power Supply)

Pin No.	Explanation
1	L+
2	M (ground M24V)
3	A+ (authorization input)
4	AI ground (authorization input)


Note

When connecting the power supply, observe the information on the 24 V DC power supply listed in the Technical Specifications in Appendix B.1

RS 232/TTY (X2) Serial Interface

Pin No.	Explanation
1	C7 ground (reference potential)
2	DRxM
3	RxD
4	TxD
5	CTS
6	DTxP
7	DTxM
8	C7 ground (reference potential)
9	DRxP
10	RTS
11	--
12	C7 ground (reference potential)
13	--
14	--
15	C7 ground (reference potential)

Functional Ground

Connect the functional ground terminal  (see Figure 2-10) to the cabinet ground using a cable lug and a cable with a minimum cross-section of 4 mm², taking the shortest route.

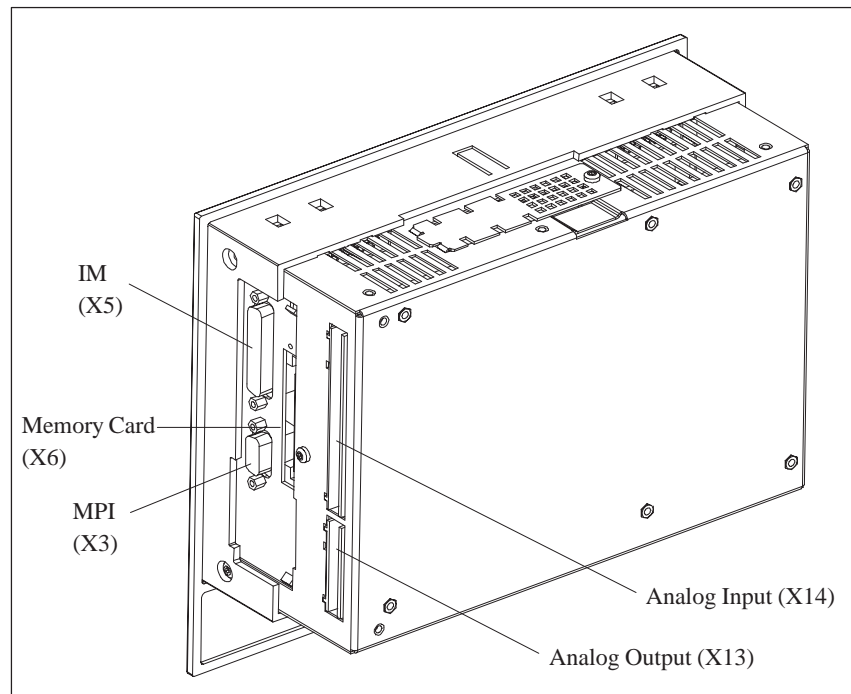


Figure 2-11 C7-633 P and C7-634 P: View with IM, MPI Interface, Memory Card, and I/O Interface

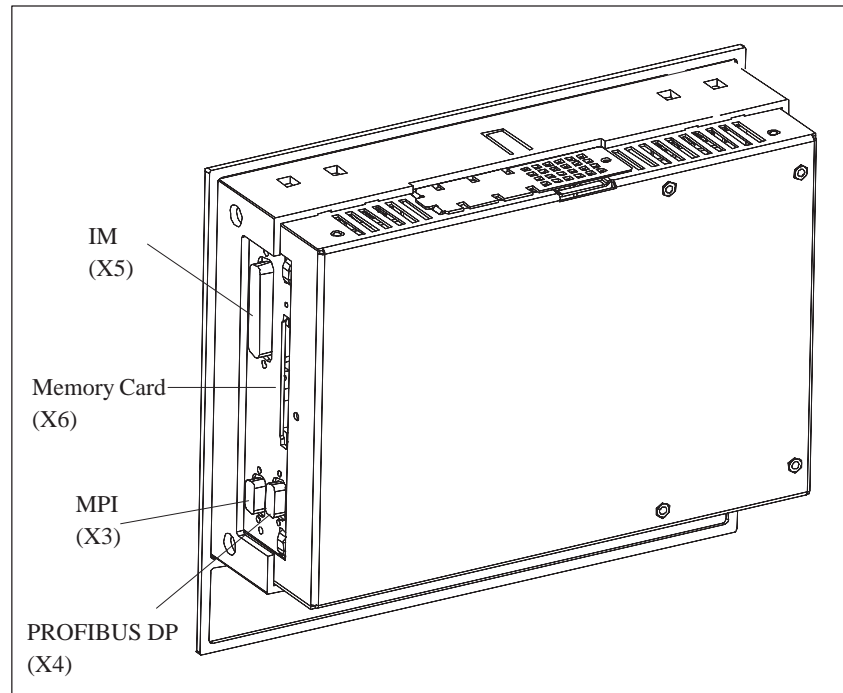


Figure 2-12 C7-633 DP and C7-634 DP: View with IM, MPI, and DP Interfaces, and Memory Card

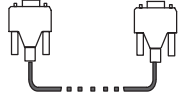
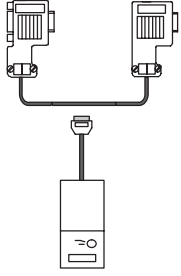
**MPI Interface
(X3) and
PROFIBUS DP
Interface (X4)**

Pin No.	Explanation
1	NC
2	M24V
3	RS485 line B
4	RTSAS
5	M5V
6	P5V
7	P24V
8	RS485 line A
9	NC

C7 Device Connections

You can use the following cables to connect the C7 to other devices:

Table 2-7 Cables for Connecting to the C7 (see also Section 1.2)

Connecting Cable	Length	Special Features	Illustration	Connection between...
MPI				
Programming device cable	5 m	-		C7 ↔ PG/PC
PROFIBUS bus cable Interior cable, Direct-buried cable and bus connector, without PG-type socket, with PG-type socket and PROFIBUS bus terminal RS 485, with 1.5 m, with 3 m cable, with PG-type socket and 1.5 m cable	-	User must make own cable		C7 ↔ PG/PC C7 ↔ C7 C7 ↔ S7-300 C7 ↔ S7-400
RS 232/TTY serial interface				
Serial cable (printer cable)		See catalog ST80.1		C7 → Printer
Serial cable (transfer ProTool)		See catalog ST80.1		C7 ↔ PG/PC
IM 361				
IM 361 cable		-		C7 ↔ additional I/O (S7-300)

2.5 Connecting a Programming Device/PC to a C7

Procedure

You can connect the programming device or a PC to the multipoint interface (MPI) of the C7 using a preassembled programming device cable.

Alternatively, you can make up the connecting cable yourself using the PROFIBUS bus cable and bus connectors.

Figure 2-13 shows the components required for connecting a programming device/PC to a C7.

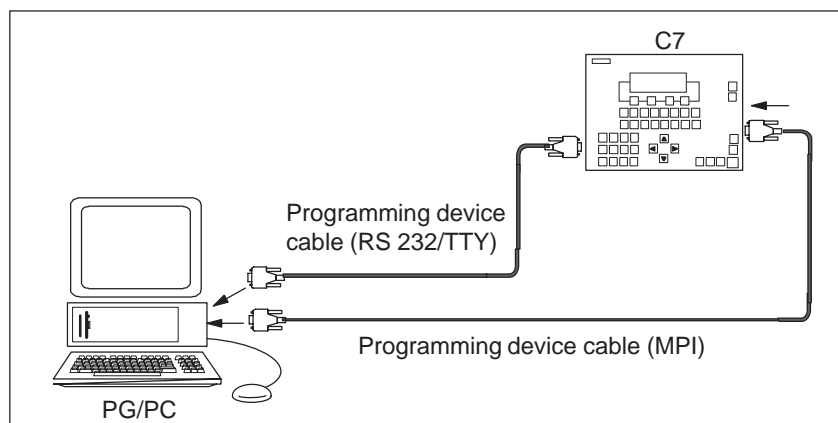


Figure 2-13 Connecting a Programming Device/PC to a C7

The C7 operator panel is loaded via the RS 232/TTY interface. The connection to the C7 CPU is made via the multipoint interface.

Cable Lengths

You will find information on the possible cable lengths and what you should observe when setting up an MPI or PROFIBUS DP network in the manual [/10/](#).

2.6 Connecting a Programming Device/PC to Several Nodes

Overview

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

Fixed installation of the programming device or PC in the MPI network

A programming device or PC connected for startup and maintenance purposes.

Depending on the type you require, connect the programming device or PC to the other nodes as follows:

Configuration Type	Connection
Fixed installation of the programming device/PC in the network	The programming device/PC is linked directly into the MPI network
Programming device/PC connected for startup and maintenance	The programming device/PC is connected to one node via a spur line

Fixed Installation of Programming Device/PC

With fixed installation of a programming device or PC in the MPI network, you connect the programming device/PC via bus connectors directly to the other nodes in the MPI network.

Figure 2-14 shows a C7 network with two C7s. The C7 devices are connected together by means of a PROFIBUS bus cable.

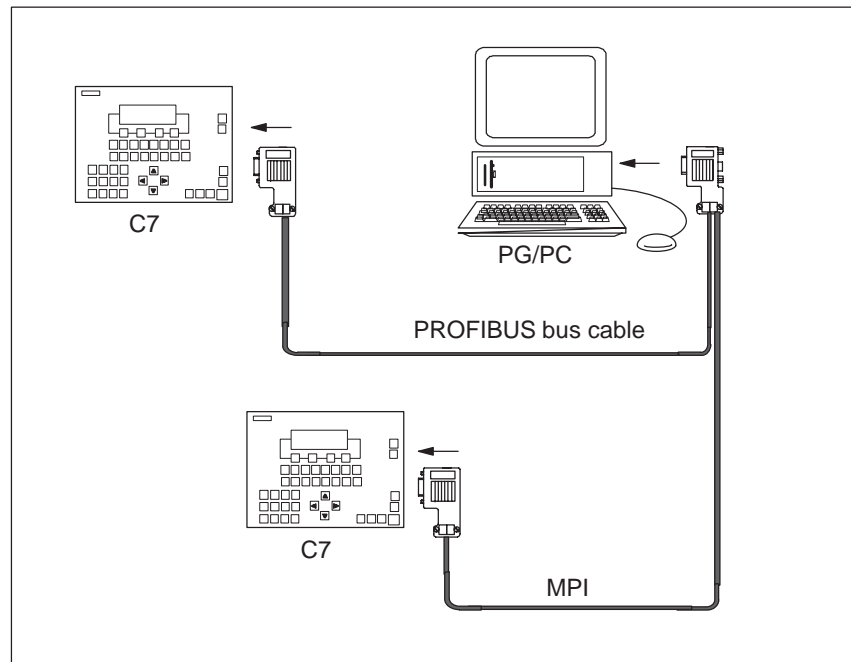


Figure 2-14 Connecting a Programming Device/PC to Several C7 Devices

Connecting a Programming Device/PC for Service Purposes

If there is no stationary programming device or PC available, we recommend the following procedure:

In order to connect a programming device or PC for service purposes to an MPI network with “unknown” node addresses, we recommend you set the following address on the service programming device/PC:

MPI address: 0

Highest MPI address: 126.

Then work out the highest MPI address in the MPI network using the STEP 7 application *Configuring Hardware* and adjust the highest MPI address on the programming device or PC to match the highest address of the MPI network.

Programming Device/PC for Startup and Maintenance

For startup and maintenance purposes, you connect the programming device/PC via a spur line to a node in the MPI network. To do this, the bus connector of this node must have a PG-type socket.

Figure 2-15 shows two networked C7s to which a programming device/PC is connected.

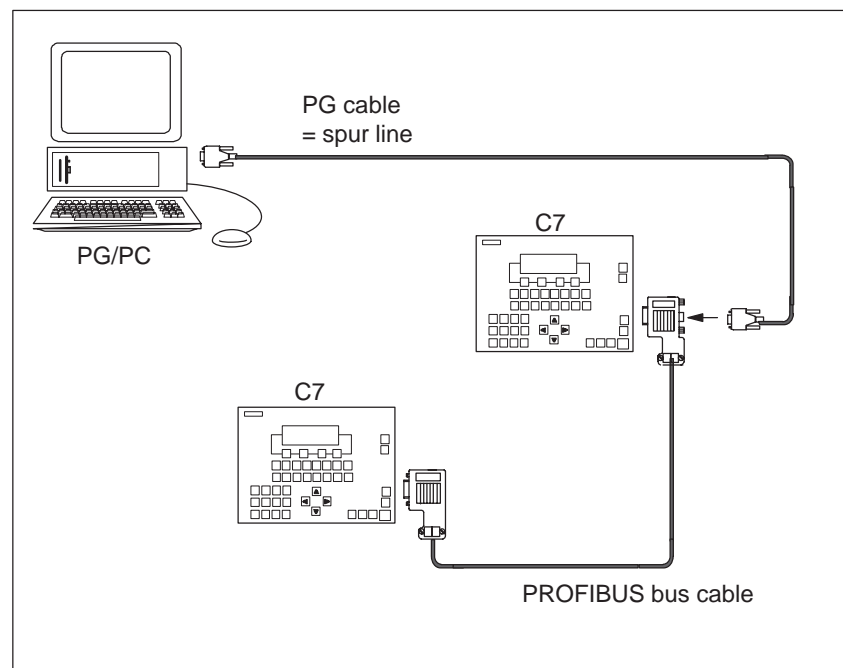


Figure 2-15 Connecting a Programming Device/PC to an MPI Network

2.7 Setup Guidelines for Interference-Free Installation

Overview

An automation system must be shielded to prevent interference.

When a system is poorly grounded or not shielded, low-frequency or high-frequency interference signals can penetrate through to the internal bus of the controller and cause malfunctions.

Interference signals can also be caused when relays or contactors switch (very rapid changes in current or voltage; high-frequency interference signals) or when two parts of a system have different grounding potentials (low-frequency interference signals).

Use and Installation of Interference-Free Cables

Use only shielded cables for all signal lines.

Ground cable shields on both sides for:

- Cables to the programmable controller
- Bus cables
- Cables to I/O devices.

The standard cables specified in the *ST80.1* catalog meet these requirements.

Screw or lock all plug-type connections.

Do not install signal lines parallel to power lines. Use a separate cable duct located at least 50 cm from the power lines.

Cabinet Installation

Devices which could bring in interference signals from outside should be installed at the bottom of the cabinet. Place the grounding rail immediately at the cabinet entrance so that cables which could be carrying interference signals can be placed directly on the grounding potential. Place all shielded lines with their shielding here. With double-shielded signal lines, place only the outer shield on the grounding potential.

Install long signal lines along the cabinet walls. Cabinet design in accordance with EMC guidelines is an important factor in the reduction of interference. All grounding connections in the cabinet must have large cable cross-sections and be laid over a large area.

Insulate analog devices in the switching cabinet and ground them to a single point in the cabinet using copper tape.

Always use equivalent metals for the materials. Never use aluminum (danger of oxidation).

Connect all doors and metal parts (sides, back panel, and cover) of the cabinet at least three times to the cabinet frame (short, paint-free, and large-area connections).

Note

If your system generates high electrostatic voltages (for example, textile machines, special construction machines), run the grounding lines of the machine parts carrying interference signals to a separate operating ground isolated from the central grounding point of the cabinet (surface grounding with building construction, reinforcement).

**Protection Against
Overvoltage**

Observe the guidelines in Section 4.11 of the manual **/10/** to protect against overvoltage and lightning strikes.

Observe the guidelines in Section 4.8 of the manual **/10/** for laying cables within buildings.

2.8 Connecting Shielded Cables

Overview

This section describes how to connect the shield of shielded signal lines to ground. The ground connection is made by directly connecting the shield with the ground terminal of the C7-633 P or C7-634 P.

Procedure

Proceed as follows to install the grounding bar and shielding clips supplied with the C7-633 P and C7-634 P:

1. Position the grounding bar as shown in Figure 2-16 and fix this in place with the screw you removed earlier.
2. Attach the shielding clips to the grounding bar as shown in Figure 2-16.
3. Press the insulated cable into these shielding clips in such a way as to achieve optimal contact of the cable shield.

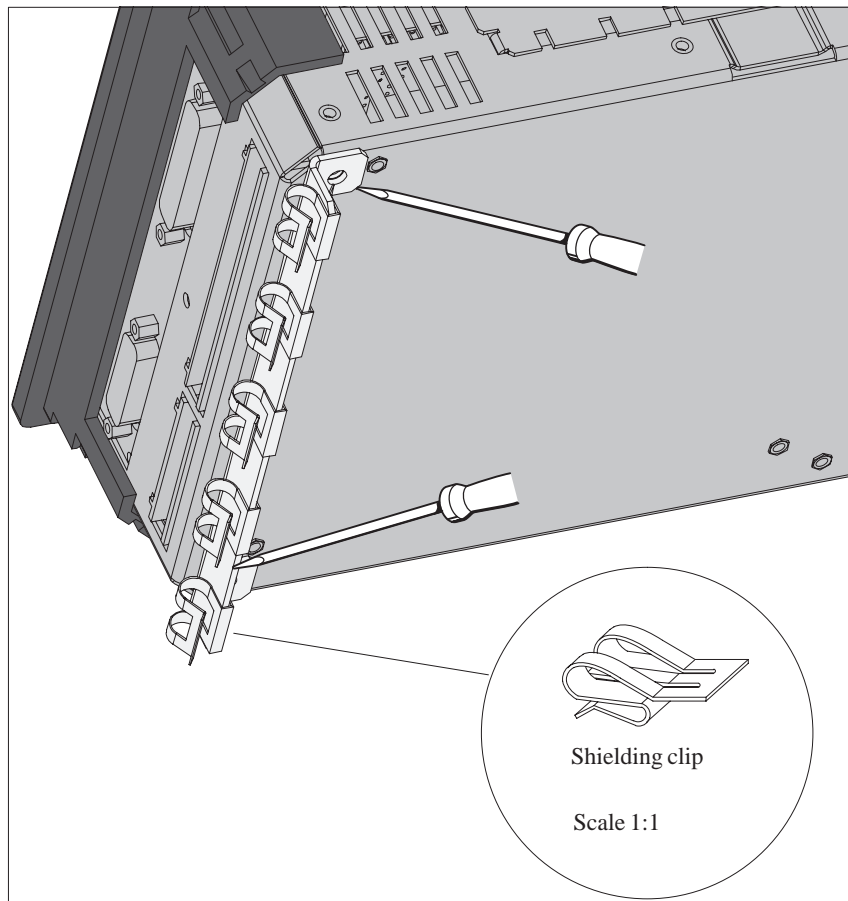


Figure 2-16 C7-633 P with Grounding Bar and Shielding Clips

2.9 Encoding Connectors

Overview

A set of connectors with solid and profiled coding keys can be ordered as C7-633 P or C7-634 P accessories (see Section 1.2 under Accessories). The keying of connectors will be described in the following:

Keying Connectors

The solid coding keys ① and profiled coding keys ② (see Figure 2-17) prevent a connector from being confused with another without polarity reversal.

Proceed as follows:

1. Insert the solid coding key ① into the notches provided on the connector part ①.
2. Insert the profiled coding key ② into the respective cutouts on the housing part ②.

Solid and profiled coding keys that face each other prevent the connector from being plugged in.

The connector can be plugged in if solid and profiled coding keys do not face each other.

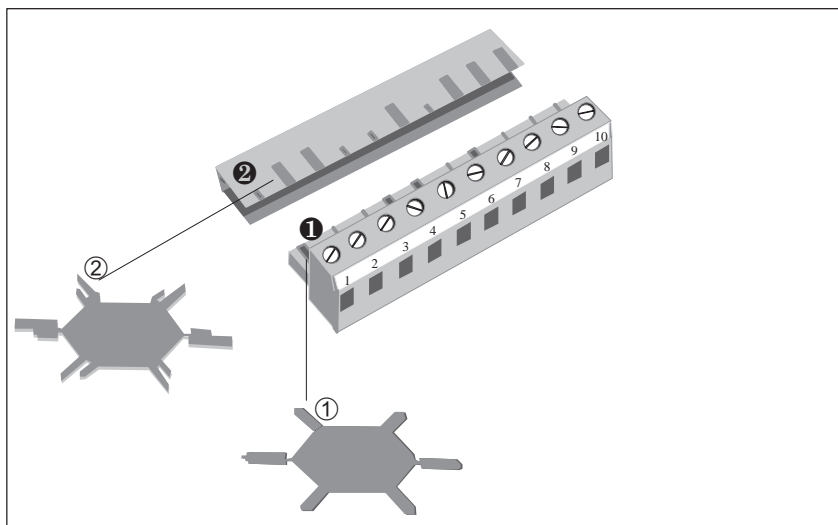


Figure 2-17 The Coding Ensures that the Correct Connector is Inserted

2.10 Expanding the C7 with S7-300 Modules

IM 360 Interface Module

The C7 has an integrated IM 360 interface module for I/O expansion with an external S7 standard I/O. This interface module has the following characteristics:

Data transmission from the IM 360 to the IM 361 of the first rack expansion via a 368 connecting cable

Maximum distance between IM 360 and IM 361 is 10 m.

You can expand your C7 by up to three racks using the integrated IM 360 interface module.

Connecting Additional Modules

You can connect the additional modules as follows:

1. Install the modules as described for racks 1 to 3 in the manual /10/.
2. Connect the C7 to the IM 361 via a standard IM cable (see also Figure 2-12 for connecting the C7).

When the C7 is first started up, it detects any additional connected modules.

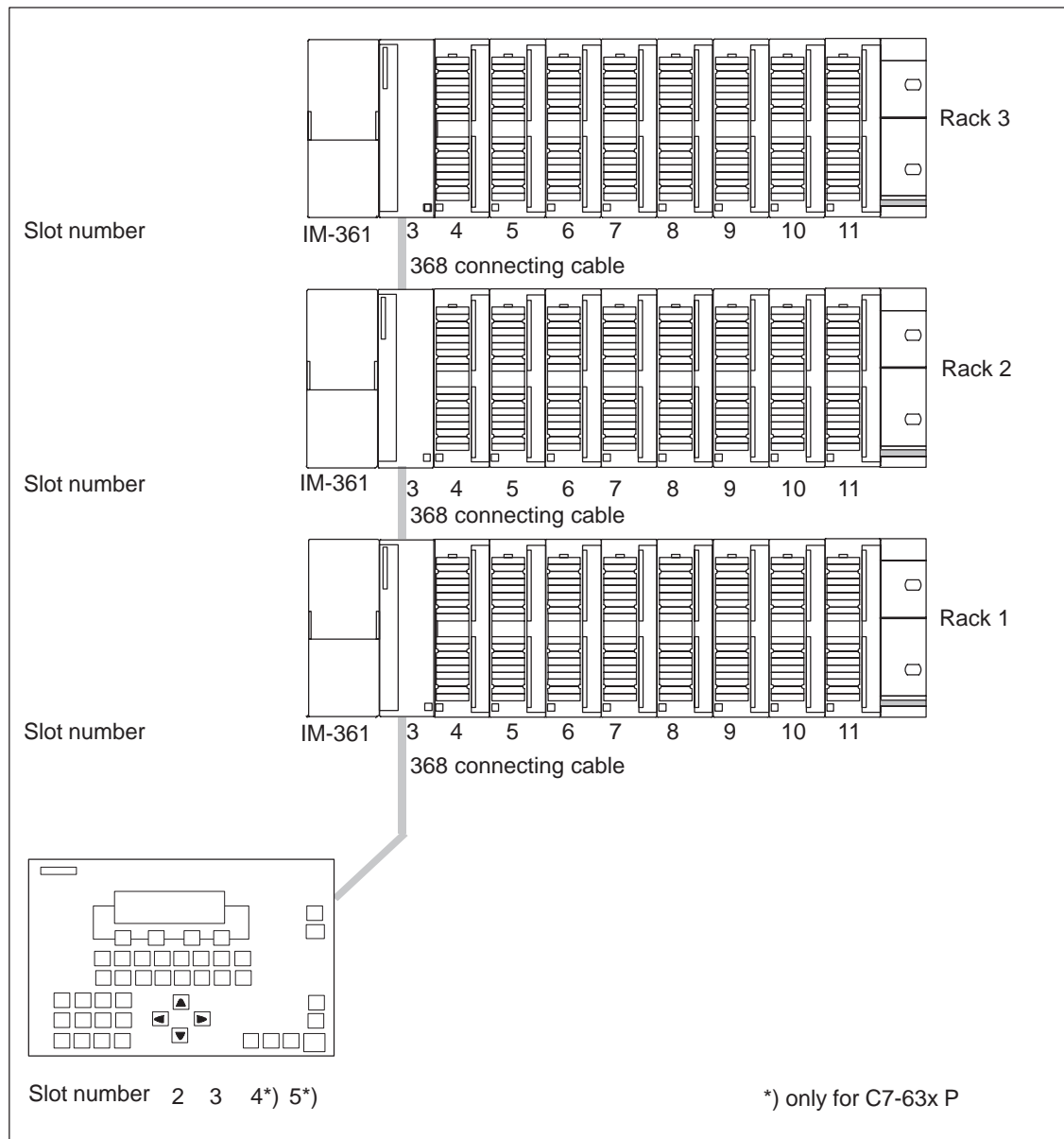


Figure 2-18 Maximum Configuration of the Slots of a C7

2.11 Configuring an MPI and PROFIBUS DP Network

You can integrate the C7 devices in an MPI network via the MPI and configure a PROFIBUS DP network via the PROFIBUS DP interface (only for C7-633 DP or C7-634 DP).

You will find the procedures for configuring an MPI network and PROFIBUS DP network in the manual **/10/**.

Special Features of C7

3

Chapter Overview

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3.1 Variations from the Individual Components CPU and OP

Keyboard

The arrangement and color of the keys on the C7-633 and C7-634 corresponds mainly to those of the OP 7 and OP 17 operator panels (see the *OP7, OP17 Control Panels* manual).



Extended OP function keys on the C7-633:

The C7-633 and the OP 7 differ in their number of function keys:

C7-633: F1 to F4 and K1 to K16

OP 7: F1 to F4 and K1 to K4

Selecting a CPU Operating Mode Using Keys

A CPU is set to the modes MRES, STOP, RUN, and RUN-P using a mechanical keyswitch. On both C7 devices, this keyswitch is emulated as an electronic keyswitch by means of the keys  and .

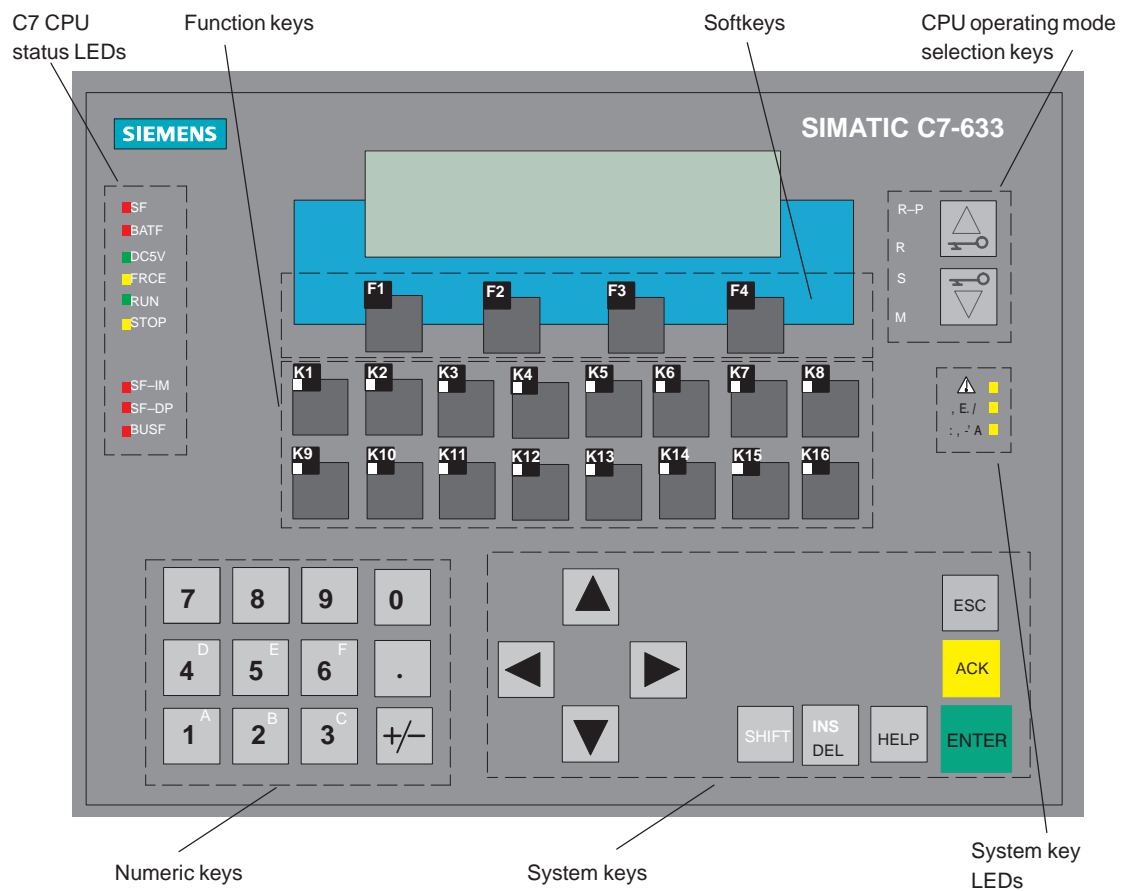


Figure 3-1 C7-633 with Keyboard and Display

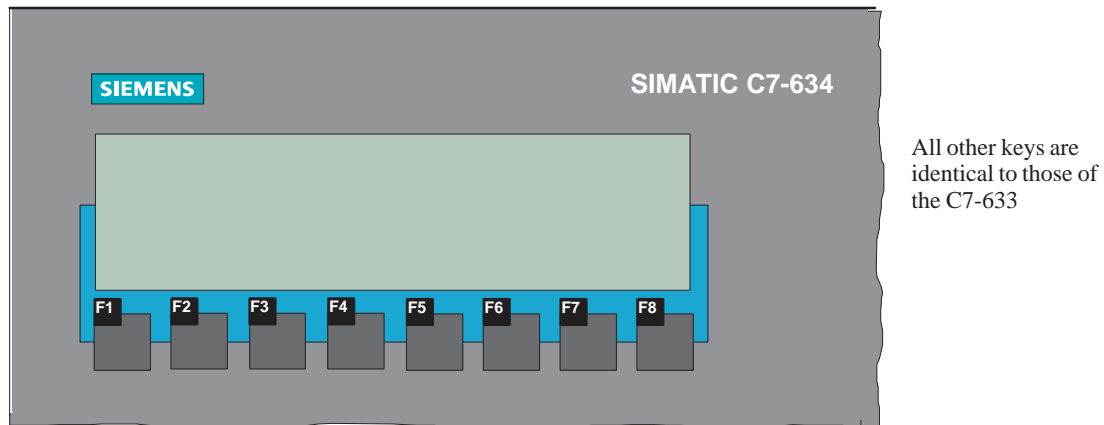


Figure 3-2 C7-634 with Keyboard and Display

3.2 Selecting a C7 CPU Operating Mode

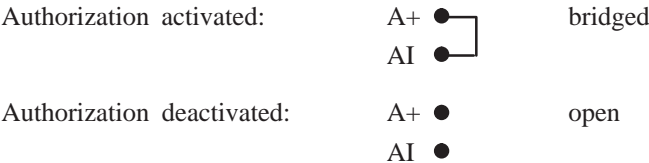
**Changing the
C7 CPU Operating
Mode**






You select the CPU operating modes RUN-P, RUN, STOP, and MRES as follows:

Each time the mode selector key is pressed, the CPU mode changes. The key must remain pressed for at least 500 ms for the mode change to take place and the corresponding LED to light up.

To prevent an uncontrolled C7 CPU operating mode transition during control operation, the key function can be activated or deactivated via an external authorization input. When the authorization input is activated, operating mode selection is active and the current CPU mode is displayed by an LED. When the authorization input is deactivated, all status LEDs are off.

The authorization input is located on the same connector as the C7 power supply (see Section 2.4).



Mode	Key	Explanation / Procedure
RUN-P (R-P)		<p>The C7 CPU processes the user program.</p> <p>Programs and data can be:</p> <ul style="list-style-type: none"> Read out from the C7 CPU with the programming device (C7 → PG) Downloaded to the C7 CPU and changed there (PG → C7).
RUN (R)	 or 	<p>The C7 CPU processes the user program.</p> <p>Programs and data can be:</p> <ul style="list-style-type: none"> Read out from the C7 CPU with the programming device (C7 → PG). cannot be downloaded to the C7 CPU and changed there (PG → × C7).
STOP (S)		<p>The C7 CPU does not process the user program.</p> <p>Programs can be:</p> <ul style="list-style-type: none"> Read out from the C7 CPU with the programming device (C7 → PG) Downloaded to the C7 CPU and changed there (PG → C7). <p>Note:</p> <p>The STOP mode is only valid for the C7 CPU and not for the C7 OP. It is possible to continue working with the C7 OP.</p>
MRES (M)		<p>Memory Reset</p> <p>Executing a memory reset on the C7 CPU (clear memory, reload user program from flash memory if a memory card is inserted) requires a special sequence of operations with the modes STOP and MRES:</p> <ol style="list-style-type: none"> Select STOP mode by pressing the DOWN key. The key must remain pressed for at least 300 ms for the transition to take place. The key LED “S” and the CPU status LED “STOP” light up. Select the mode MRES by keeping the DOWN key depressed. The key LED “M” lights up. Immediately after the second time the CPU status LED “STOP” lights up, release the key briefly and press it again. After flashing briefly, it then remains lit. <p>Note:</p> <p>If data were deleted during the memory reset which were required by the C7 OP configuration, the C7 OP reports this using an error message.</p>

3.3 DI/DO Status Displays

Configuring the DI/DO Status Display

The DI/DO status display is not a system function but a configured image of the C7 OP. You can create the DI/DO status display image yourself or copy it from the standard configuration supplied with ProTool (image name: Z_DI_DO).

The values represented are read as a direct **process image** of the digital inputs and an internal process image of the digital outputs of the digital C7 I/O and displayed in binary format (BIN).

Note that the last state set by the program is displayed, although the real process state of the digital outputs is 0 when the C7 CPU is in STOP mode.

The following data are supplied:

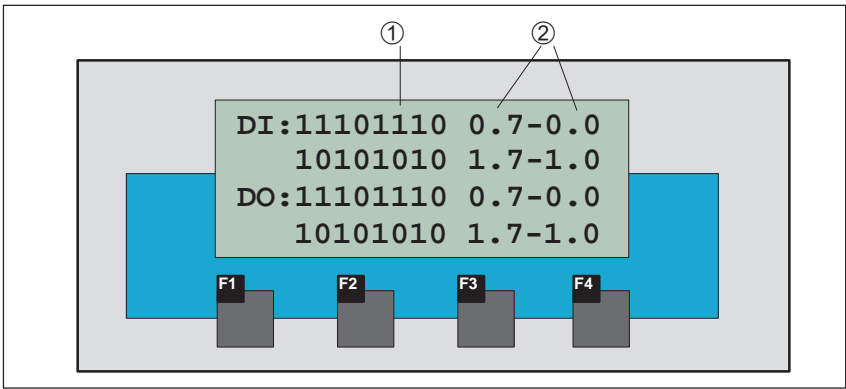


Figure 3-3 DI/DO Status Display on a C7-633 P

Table 3-1 Explanation of the DI/DO Display in Figure 3-3

Position	Explanation
①	Signal status of the DI/DO <ul style="list-style-type: none">• 1 DI/DO set• 0 DI/DO reset
②	Pin no. from - to

Note

The values of the digital I/O are read in and displayed every 400 ms. Any changes which occur between these times are not displayed.

C7 CPU Access

The DI/DO image of the standard configuration accesses the digital I/Os of the first configured programmable controller. Therefore, the first programmable controller in the list should always be the C7 CPU. Otherwise it is necessary to adapt the programmable controller access for the image.

3.4 Status and Error Indicators on the C7 CPU

Status and Error Indicators

The C7 has the following status and error indicators:

■	SF
■	BATF
■	DC5V
■	FRCE
■	RUN
■	STOP
■	SF-IM
■	SF-DP
■	BUSF

Figure 3-4 Status and Error Indicators on the C7

Meaning of the Status and Error Indicators

The status and error indicators are explained in the order in which they are positioned on the C7.

LED	Meaning	Explanations
SF (red)	C7 CPU group error	Lights up for <ul style="list-style-type: none"> • Hardware faults • Firmware faults • Programming errors • Parameter assignment errors • Math errors • Time errors • Faulty internal memory • Battery failure or backup missing on POWER ON • I/O error in the internal I/O functions To determine the error/fault more exactly, you must use the programming device and display the diagnostic buffer.
BATF (red)	Battery fault	Lights up if the battery <ul style="list-style-type: none"> • Has too low voltage • Is defective • Is missing
DC5V (green)	5 VDC supply for C7	Lights up if the internal 5 VDC supply is functioning correctly
FRCE (yellow)	Force job	Lights up when a force job is active
RUN (green)	RUN mode for the C7 CPU	Lights up when the C7 CPU user program is being processed. Flashes (2 Hz) during C7 CPU startup (then the STOP LED also lights up; when the STOP LED goes out, the outputs are enabled). Flashes (2 Hz) when the CPU is in HOLD mode.

LED	Meaning	Explanations
STOP (yellow)	STOP mode for the C7 CPU	Lights up when the C7 is not processing a CPU user program. Flashes in 1-second intervals if the C7 CPU requires a memory reset (MRES).
SF-IM (red)	Interface module group error	Lights up when the connection between the C7 and the expansion rack is faulty.

Display Elements for PROFIBUS

The following table explains the meaning of the LEDs which are assigned to the PROFIBUS DP. Refer also to Chapter 11 in the manual /70/.

SF-DP (red)	BUSF (green)	Meaning	Remedy
On	On	• Bus fault (physical fault)	• Check the bus cable for short circuit or wire break
		• DP interface fault • Different transmission rates in multi-master operation	• Evaluate diagnostics, reconfigure or correct errors if necessary
On	Flashing	• Station failed	• Check the bus cable is connected correctly, check for short circuits or wire breaks
		• At least one of the assigned slaves cannot be addressed	• Wait until the C7 has completed its startup • If flashing does not cease, check the DP slaves and evaluate diagnostics
On	Off	• DP configuration missing or faulty (also if CPU was not set as DP master)	• Evaluate diagnostics, reconfigure or correct errors if necessary
Off	Off	• No error	

Communication between the CPU and the Operator Panel

4

In This Chapter

This chapter provides you with information on configuration parameters that are necessary for the communication between the C7 OP and the C7 CPU.

The communication is achieved using two data areas:

- The user data area
and/or
- The interface area.

The functions, structure, and special features of the various user data areas and the interface areas are described in this chapter.

For those who are not yet familiar with OPs, we recommend the manual *First Steps with ProTool/Lite*.

Chapter Overview

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4.1 Configured Communications Parameters

Parameters

In the configuration software, the following parameters are to be set for communication via the MPI:

Note

The following parameters are already assigned generally applicable default values and need not be modified unless the C7 is used in connection with any other S7, C7, or OP units in a network.

Parameter	Explanation
CPU type	CPU in programmable controller The S7-300 is to be set for the C7 CPU. If further CPUs are connected, they must be set with S7-300 or S7-400.
CPU address	MPI address of the C7 CPU in the network configuration. The default address is 2. The address can be freely assigned. It must be unique in a network.
Slot/rack	Here you must set the slot and rack. For the C7 CPU, the setting is: Slot 2 Rack 0
C7 OP address	MPI address of the C7 OP in the network configuration. The address can be freely assigned. It must be unique in the network configuration. The default value is address 1.
Interface	Here, you determine which interface of the OP the C7 CPU is connected to.
Transmission rate	The data transfer rate between the C7 OP and the C7 CPU can be set between 19.2 Kbps and 1.5 Mbps.

Configuration Tool

All settings can be made with ProTool and ProTool/Lite under the menu command *System* → *PLC* .

4.2 Overview of User Data Areas

User Data Areas

User data areas are used to exchange data between the C7 CPU and the C7 OP. It is by means of these data areas that the C7 CPU and the C7 OP communicate.

The communication process consists of the C7 OP and the user program alternately writing and reading information into and out of the data areas. Upon evaluation of the data, the C7 CPU and the C7 OP are triggered into the various actions.

The user data areas can reside in any required memory area in the C7 CPU.

Functionality

The following user data areas are possible:

- Event messages
- Alarm messages
- Control jobs
- Recipes
- System keyboard image
- Function keyboard image
- LED image
- Cyclic intervals (C7-634 only)
- Date and time
- Screen number area
- User version

4.3 Event and Alarm Messages

Message Triggering

Messages are triggered by setting a bit in one of the message areas in the C7 CPU. The location of the message area is defined by the configuration tool. The corresponding area must also be defined in the C7 CPU.

As soon as the bit in the event or alarm message area of the C7 CPU is set and transferred to the C7 OP, the message is recognized as having “arrived”.

Conversely, after resetting the same bit in the C7 CPU, the message is registered in the C7 OP as having “departed”.

Message Areas

Table 4-1 represents the number of message areas for event and alarm messages and alarm acknowledgement areas, as well as the total length of all areas, for both the C7-633 and the C7-634.

Table 4-1 Message Areas of the C7 OP

Device	Event message area		Alarm message area and alarm message acknowledgement area	
	Number	Length (words)	Number of each type	Total length of each type (words)
C7-633	4	32	4	32
C7-634	4	64	4	64

Message Bit and Message Number Assignment

A message can be configured for every bit in the configured message area. The bits are assigned to the message numbers in ascending sequence.

Example:

The following event message area is configured for the C7 CPU:

DB 60 Address 42 Length 5 (in words)

Figure 4-1 shows the assignment of all 80 (5 x 16) message numbers to the individual bit numbers in the control event message area.

The assignment follows automatically in the C7 OP.

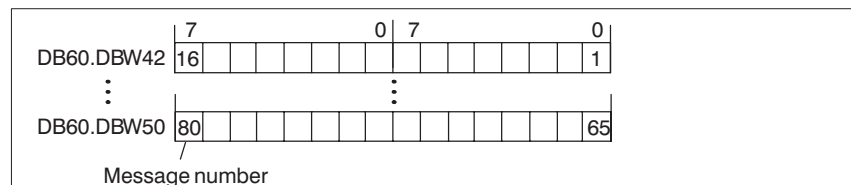


Figure 4-1 Assignment of Message Bit and Message Number

Acknowledgement

As alarm messages indicate faulty behavior of some sort, these must be acknowledged. Acknowledgement follows either by:

- Taking appropriate action on the C7 or
- Setting a bit in the acknowledgement area of the C7 CPU.

Acknowledgement Area

If the C7 CPU is to be informed about an acknowledgement of an alarm message at the C7 OP itself, or if the acknowledgement should be given by the C7 CPU, the corresponding acknowledgement areas are to be configured in the C7 CPU:

- **Acknowledgement area C7 OP → C7 CPU:**
The programmable controller is informed when an alarm message is acknowledged by an operation at the OP.
- **Acknowledgement area C7 CPU → C7 OP:**
The alarm message is acknowledged via the C7 CPU.

These acknowledgement areas are to be allocated in the configuration; - when using ProTool and ProTool/Lite, under “area pointers”. Figure 4-2 shows schematically the individual alarm message and acknowledgement areas

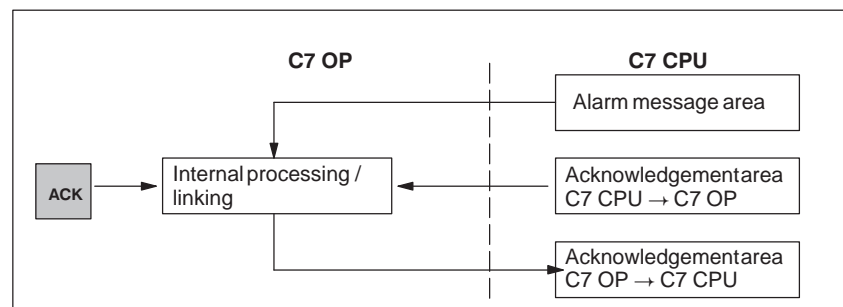


Figure 4-2 Alarm Message and Acknowledgement Areas

Assignment of Acknowledgement Bit to Message Number

Every alarm message has a message number. To this message number, the same bit of the alarm message area and the bit multiplying of the acknowledgement area are assigned. This is also valid for more than one acknowledgement area, if the length of the previous acknowledgement area does not encompass the entire length of the alarm message area. Figure 4-3 clarifies this situation.

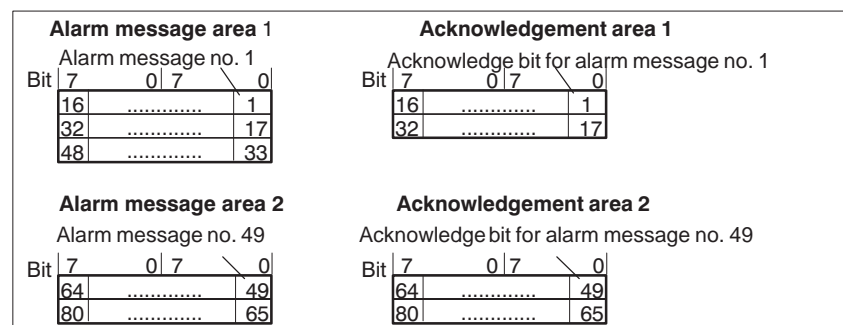


Figure 4-3 Assignment of Acknowledge Bit and Message Number

Acknowledgement Area C7 CPU → C7 OP

One of the bits set in the C7 CPU area, causes the acknowledgement of the corresponding alarm message at the C7 OP. Reset this bit when you reset the bit in the alarm message area. Figure 4-4 shows the timing diagram.

The acknowledgement area C7 CPU → C7 OP

- Must be immediately connected to the relevant alarm message area
- Must have exactly the same polling time and
- Can have the same maximum length as the corresponding alarm message area.

If the acknowledgement area C7 CPU → C7 OP is not physically located behind the alarm message area, the system message \$655 is issued when the device starts up.

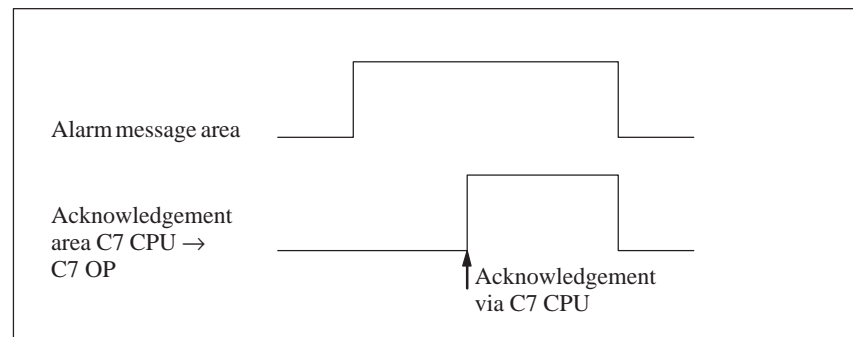


Figure 4-4 Pulse Diagram for Acknowledgement Area C7 CPU → C7 OP

Acknowledgement Area C7 OP → C7 CPU

If a bit is set in the alarm message area, the CP OP sets the corresponding bit in the acknowledgement area. If an alarm message is acknowledged at the C7 OP, the corresponding bit is set in the acknowledgement area C7 OP → C7 CPU. In this way, the S7 can recognize that the alarm message has been acknowledged.

The acknowledgement area C7 OP → C7 CPU can have the same maximum length as the corresponding alarm message area.

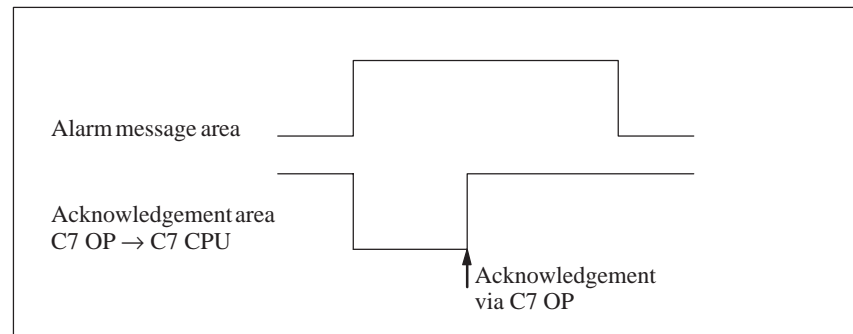


Figure 4-5 Pulse Diagram for Acknowledgement Area C7 OP → C7 CPU

Size of the Acknowledgement Areas

The acknowledgement areas may not be larger than the corresponding alarm message area. It can, however, be configured to be smaller if it is not necessary to acknowledge every alarm message. Figure 4-6 clarifies this case.

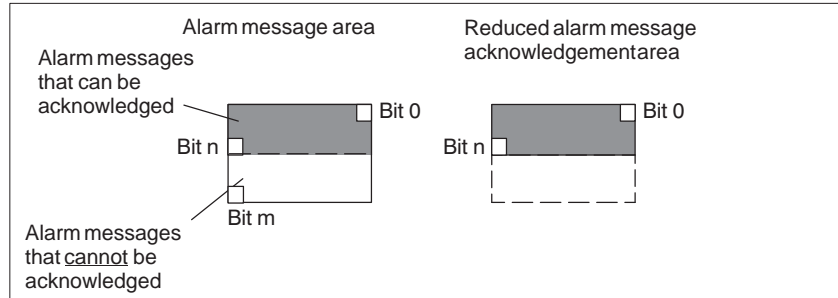


Figure 4-6 Reduced Acknowledgement Area

Note

Allocate important alarm messages, whose acknowledgement is to be signaled to the C7 CPU in the alarm message area from bit 0 in ascending order!

The two related bits in the alarm message area and the acknowledgement area must not be set simultaneously.

4.4 Keyboard and LED Image

Application

Key actions on the C7 OP can be transferred to the C7 CPU and evaluated there. In this way, actions can be triggered in the C7 CPU (for instance, switching on a motor).

The LEDs in the C7's function keys can be controlled from the C7 CPU. In this way, active LEDs can be used in different situations to signal to the operator which key they should press.

Prerequisite

In order to make use of this function, you must:

- Set up corresponding data areas (images) in the C7 CPU
- Specify these data areas as “area pointers” during the configuration
- Assign the bits from the “area pointers” to these data areas on configuring the function keys.

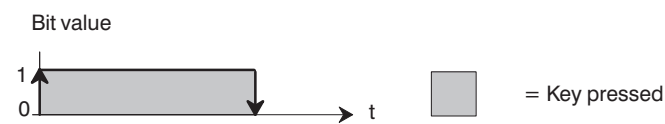
Transfer

The keyboard images are transferred spontaneously to the C7 CPU. That means the transfer always happens if a change is registered at the C7 OP. In this case you do not need to configure a polling time. A maximum of two simultaneous key actions can be transferred at one time.

Value Allocation

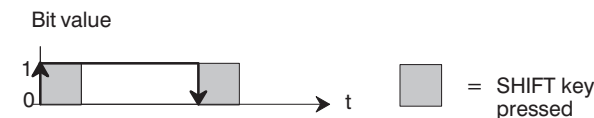
- **All keys (except SHIFT key)**

As long as the corresponding key is pressed, the assigned bit in the keyboard image has the value 1, otherwise it has the value 0.



- **SHIFT key**

When the SHIFT key is first pressed, the assigned bit in the keyboard image receives the value 1. This state remains even after releasing the key until the SHIFT key is pressed again.



4.4.1 System Keyboard Image

Layout

The system keyboard image is a data area with a fixed length of **two** data words.

Every key of the system keyboard is assigned exactly one bit in the system keyboard image, with the exception of the cursor keys.

The system keyboard image must also be specified as “area pointer, type: system keyboard” in the configuration. This image can be assigned **once** only and in **one** CPU.

Keyboard image:

Bit number															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		+/-	.	SHIFT		INS DEL		ENTER			ESC		ACK	HELP	
						9	8	7	F 6	E 5	D 4	C 3	B 2	A 1	0

1st word

2nd word

Keyboard group bit

Note

Unused bits may not be overwritten by the user program.

Keyboard Group Bit

The keyboard group bit serves as the control bit. It is set to the value 1 for each transfer of the keyboard image from the C7 OP to the C7 CPU. After evaluation of the data area by the user program, it should be reset.

You can determine whether a block has been transferred again by regularly reading the group bits with the user program.

4.4.2 Function Keyboard Image

Data Areas

The image of the function keyboard can be categorized into separate data areas:

- Maximum number of data areas - 4
- Total length of all data areas (words) - 4

Key Assignment

The assignment of the individual keys to the data area bits is defined when the function keys are configured. The number within the image area is declared for every key.

The function keyboard image must also be specified in the configuration, under “area pointer, type: function keyboard”.

Keyboard Group Bit

The most significant bit in the last data word of **every** data area is the keyboard group bit. It serves as a control bit. This bit is set to 1 for every transfer of the keyboard image. After evaluation of the data area by the user program, the keyboard group bit should be reset.

You can determine whether a block has been transferred again by regularly reading the group bits with the user program.

4.4.3 LED Image

Data Areas

The LED image can be categorized into separate data areas.

- Maximum number of data areas: 4 (for example, 4 different data areas in various CPUs)
- Total length of all data areas (words) 8:

The LED image must also be specified under “area pointer, type: LED image” in the configuration.

LED Assignment

The assignment of the individual LEDs to the data area bits is defined when the function keys are configured. The bit number within the image area is declared for every LED.

The K keys in the C7 OPs have two-colored LEDs (red and green).

The bit number (n) denotes the first of two consecutive bits, which can control four different LED states in total:

Bit n + 1	Bit n	LED Function
0	0	Off
0	1	Flashing red
1	0	Permanently red
1	1	Permanently green

4.5 Screen Number Area

Application

The C7 OP stores information concerning the image displayed on the C7 OP in the screen area number.

It is thus possible to transfer information about the current display contents from the C7 OP to the C7 CPU, and from there, to trigger certain reactions, for example, displaying another image.

Requirement

If the screen number area is to be used, it must be specified as an “area pointer” in the configuration. It can only be stored **once** and in **one** C7 CPU.

The screen number area is transferred spontaneously to the controller. That means the transfer always happens if a change is registered at the C7 OP. In this case you do not need to configure a polling time.

Layout

The screen number area is a data area with a fixed length of 2 data words.

The layout of the screen number area for the C7 OP in the memory of the controller is represented below.

	7	0	7	0
1st word	Current screen type		Current screen number	
2nd word	Current entry number		Current input field number	

Entry	Assignment
Current screen type	1: Image 2: Recipe 3: Special image
Current screen/recipe number	1 to 99
Current entry number	1 to 99
Current input field number	0 to 8 0: Entry number

All bytes of the screen number area are assigned with FF_H in the message level and for the display of a contents directory.

For **special screens** the screen number area is assigned as follows:

	7	0	7	0
1st word	3		Special screen number	
2nd word	FF _H		Current input field number	

4.6 User Version

Verwendung

You can check whether the C7 OP is connected to the right controller on startup.

The C7 OP compares a value stored in the C7 CPU with the configured value. This ensures that the configuration data are compatible with the C7 CPU. If the values do not match, the system message \$653 is displayed on the C7 OP and the device is restarted.

To use this function, preset the following values when configuring the C7 OP:

- Version number of the configuration (value between 1 and 255) under *System → Settings*
- Data type and address of the value stored in the controller for the version:
System → Area Pointers,
Select *User Version* in the *Type:* field.

4.7 Interface Area

Overview

The interface area is only necessary for the C7 CPU if its functions are to be used or evaluated by the C7 CPU.

The interface area must be configured if you want to use the following functions:

- Send control jobs to the C7 OP
- Synchronize date and time between the C7 CPU and the C7 OP
- Evaluate coupling identifier
- Recipes (transferring data records)
- Recognize C7 OP startup in the C7 CPU program
- Evaluate the C7 OP operating mode in the C7 CPU program
- Evaluate the C7 OP's ready bit in the C7 CPU program
- Set cyclic interrupts (C7-634 only)

Layout of the Interface Area

Figure 4-7 shows the layout of the interface area. You can define the interface area in a data block or a memory area. The address of the interface area should be specified in the configuration. This is necessary so that the OP knows where to put the data.

The interface area should be created once per CPU.

Interface area:

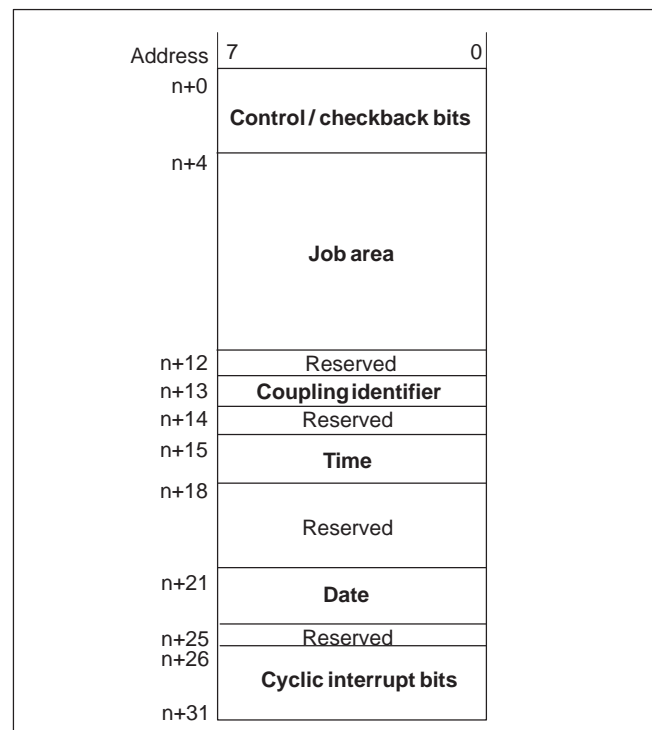


Figure 4-7 Layout of the Interface Area for the C7 CPU

4.7.1 Control and Checkback Bits

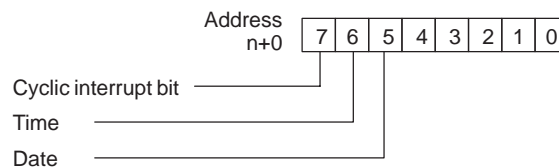
Introduction

Three bytes are available in the interface area for the control and checkback bits. Bytes n+0 and n+1 are used to coordinate between the C7 OP and the C7 CPU. Byte n+3 is required for the transfer of data records and indirect variables.

Byte n+0, n+1, and n+3 are described below.

Description of Byte n+0

The structure of byte n+0 is shown below. The diagram is followed by a description of the individual bits.



Bits 5-6 Date/time 1 = New

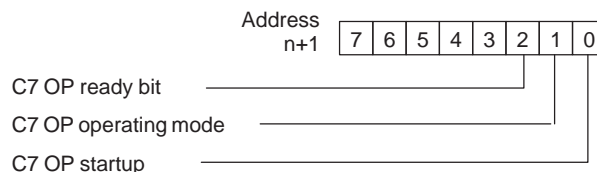
The transfer of the date and time from the C7 OP to the C7 CPU can be initiated by means of control job 41. These bits are set by the C7 OP if a new date or a new time is transferred. The bits must be reset in the control program after the date or time has been evaluated.

Bit 7 Cyclic interrupt bit: 1 = New

The cyclic interrupt bit is possible only for the C7-634. If the C7-634 has set a new cyclic interrupt bit in the interface area, it also sets the corresponding bit in the control and checkback bits. You therefore need only scan this bit to detect a change in the cyclic interrupt bit. Following evaluation, the bit has to be reset in the S7 program.

Description of Byte n+1

The following diagram shows the layout of byte n+1. Afterwards follows the description of the individual bits.



- Bit 0** C7 OP startup
1 = C7 OP has been started
- Bit 0 is reset by the C7 OP following startup. You can reset the bit in the C7 CPU program and thus recognize when the C7 OP is being restarted.
- Bit 1** C7 OP operating mode
1 = C7 OP in offline mode
0 = C7 OP in normal mode
- Bit 1 is set if the operator switches the C7 OP to offline. The bit has a value 0 in an online condition.
- Bit 2** C7 OP ready bit
The C7 OP inverts the ready bit within 1 second. In the C7 CPU program, you can recognize whether a connection to the C7 OP exists.

Description of Byte n+3

Byte n+3 serves to synchronize the transfer of data records and indirect variables. The meanings of the individual bits are described below. Exactly how the transfer works is described in Section 4.8.3.

- Bit 0** 1 = Data mailbox is disabled (set only by the C7 OP)
0 = Data mailbox is enabled
- Bit 1** 1 = Data record/variable is faulty
- Bit 2** 1 = Data record/variable is correct
- Bit 3** 1 = Data transfer completed
- Bit 4** 1 = Request data record/variable
- Bit 5** 1 = C7 OP should read data mailbox
- Bit 6** 1 = Request data mailbox disable
- Bit 7** 1 = C7 OP has read data mailbox
(with transfer C7 CPU→C7 OP)

4.7.2 Data Areas in the Interface Area

Overview

In this section, the structure and use of the interface data areas are described.

The C7 CPU initiates an action to be carried out on the C7 OP by means of the job area. All other bytes are areas in which the C7 OP writes data. These areas can be evaluated by the C7 CPU program. The individual bytes are described below.

Job Area

Bytes n+4 to n+11:

Control jobs can be passed on to the C7 OP via the job area. The actions on the C7 OP are initiated in this way.

The job area consists of four words. In the first word of the job area is the job number. In the other words, the job parameters are to be entered (maximum 3). Figure 4-8 shows the general structure of a control job.

If the first word of the job area is not equal to zero, the C7 OP evaluates the control job. After that, the C7 OP sets this data word to zero again. For this reason, the parameters must first be entered in the job area and only then the job number.

The possible control jobs are listed with job numbers and parameters in Section 4.10.

Coupling Identifier

Byte n+13:

The C7 OP enters the coupling identifier 0 for the multipoint interface in byte 13.

Date and Time

Time = bytes n+15 to n+17

Date = bytes n+21 to n+24

The date and time can be transferred from the C7 OP to the C7 CPU via control job 41.

The following screens show the structure of the data area. All inputs are coded in Binary Coded Decimal (BCD).

Time:

Address	7	0
n+15	Hours (0...23)	
n+16	Minutes (0...59)	
n+17	Seconds (0...59)	

Date:

Address	7	0
n+21	Weekday (1...7)	
n+22	Day (1...31)	
n+23	Month (1...12)	
n+24	Year (0...99)	

Cyclic Interrupt Bits (C7-634 only)

Bytes n+26 to n+31:

A cyclic interrupt is a periodically recurring point in time (hourly, daily, weekly, annually) at which a predefined function is executed - for example:

- Print message buffer or screen
- Select screen.

When a cyclic interrupt is reached on the C7 OP, the corresponding bit is set in this area:

Address	7	0	7	0
n + 26	16			1
	32			17
n + 30	48			33

Cyclic Interrupt No.

4.8 Recipes

Overview

A recipe is a group of variables for a fixed data structure. You set this structure in your configuration and assign data to it on the C7 OP. You cannot modify the structure on the C7 OP later.

Since the data structure can be assigned several times, we refer to data records. These data records are stored (created), loaded, deleted, and modified on the C7 OP. The data are stored on the C7 OP, thus saving memory on the C7 CPU.

Using recipes insures that, when a data record is transferred to the C7 CPU, several items of data are transferred to the C7 CPU **together** and in a **synchronized** fashion.

Transferring Data Records

Data records can be transferred from the C7 OP to the C7 CPU or from the C7 CPU to the C7 OP. You transfer data records from the C7 OP to the C7 CPU to set specific values on the C7 CPU - for example, to produce orange juice. In the same way, you can fetch data from the C7 CPU and store them on the C7 OP as a data record to save, say, a favorable assignment of values.

Note

Only variables are used to transfer data records. In order to transfer a data record from the data medium (flash) of the C7 OP to the C7 CPU, it must first be loaded into the variables.

Synchronization

A special feature of recipes is that the data are transferred synchronously and cannot be inadvertently overwritten. To insure a coordinated procedure for transferring data records, bits are set in the control and checkback byte 2 of the interface area.

4.8.1 Transferring Data Records

Definition

When a data record is written, the variables in the data record are written directly to the defined addresses concerned. With direct reading, the variables are read into the C7 OP from the target memories of the C7 CPU.

With ProTool, the variables must have a direct link to the C7 CPU for direct transfer. Variables not having an assigned address on the C7 CPU are not transferred.

4.8.2 Addressing Recipes and Data Records, and the Requisite Data Areas

Addressing/ Data areas

During configuration, the recipe is given a name and a number. Both the recipe name and the recipe number can be seen on the C7 OP.

The data records you create on the C7 OP are similarly given a name and a number.

When a data record transfer is initiated from the C7 OP to the C7 CPU, the recipe name and the data record number are transferred to the controller together with the data. For this, you have to create a data mailbox in the controller. Use the same specifications as were set in the configuration under *Area Pointer*. The values of the data record are written directly to the addresses in the controller.

Data mailbox:

1st word	Recipe number
2nd word	Reserved
3rd word	Reserved
4th word	Data record number
5th word	Reserved

4.8.3 Synchronization during Transfer - Normal Case

Transferring Data Records

The control and checkback bits in the interface area synchronize data record transfer. A transfer is normally initiated by an operator input on the C7 OP.

- Bit 0** 1 = Data mailbox is disabled (set only by the C7 OP)
 0 = Data mailbox is enabled
- Bit 1** 1 = Data record/variable is faulty
- Bit 2** 1 = Data record/variable is correct
- Bit 3** 1 = Data transfer completed
- Bit 4** 1 = Request data record/variable
- Bit 5** 1 = C7 OP should read data mailbox
- Bit 6** 1 = Request data mailbox disable
- Bit 7** 1 = C7 OP has read data mailbox
 (with transfer C7 CPU → C7 OP)

Description:

Byte n + 3 = Control and checkback bits in the interface area

Transfer C7 OP → C7 CPU (Initiated on C7 OP)

The following description shows the procedure by which the C7 OP sets synchronizing bits and the manner in which the C7 CPU program has to react to them.

Table 4-2 Procedure for Transmission

Step	Explanation
1	Bit 0 is checked by the C7 OP. If bit 0 is set to 1 (= data mailbox disabled), the transfer is terminated with a system error message. If bit 0 is set to 0, the C7 OP sets the bit to 1.
2	The C7 OP enters the identifications in the data mailbox. With an indirectly transferred data record, the data record values are also written to the data mailbox. With a directly transferred data record, the values of the variables are written to the configured address.
3	The OP sets bit 3 to 1 (= data transfer terminated).
4	The data record or the variable can be evaluated in the control program. You then have to acknowledge in the control program whether the transfer was correct or faulty. Correct: bit 2 is set to 1 Faulty: bit 1 is set to 1
5	Reset bit 0 in the control program.
6	The C7 OP resets the bits set in step 3 and step 4.

4.8.4 Synchronization during Transfer - Special Cases

Transfer C7 OP → C7 CPU (Initiated by C7 CPU)

Make sure that the values of the data record are only read by the internal data medium. The current values are not relevant to the data record transfer.

Step	Explanation
1	In the control program, request the data mailbox disable by setting bit 6 to 1.
2	If a disable is possible, the C7 OP sets bit 0 to 1 and simultaneously resets bit 6 to 0.
3	In the control program, inform the C7 OP via the data mailbox which data record it should transfer. To do this, enter the identifications of the data record in the data mailbox.
4	Set bit 4 to 1 (= request data via data mailbox) in the control program.
5	The C7 OP reads the data mailbox.
6	The C7 OP resets bit 4 and transfers the data record or the variable as described for case 1 from step 2 onwards.

Transfer C7 CPU → C7 OP (Initiated by C7 OP)

Direct transfer from the C7 CPU to the C7 OP always takes place without coordination. The values are read directly from the address. Variables without addresses are ignored.

Transfer C7 CPU → C7 OP (Initiated by C7 CPU)

The values are written from the C7 CPU into the internal data medium.

Step	Explanation
1	In the S7 program, request the data mailbox disable by setting bit 6 to 1.
2	If a disable is possible, the C7 OP sets bit 0 to 1 and simultaneously resets bit 6 to 0.
3	In the S7 program, inform the C7 OP via the data mailbox which data record it should fetch by entering the recipe number and data record number in the mailbox.
4	Set bit 5 to 1 (= C7 OP is to read data mailbox).
5	When the C7 OP has fetched the data record, it sets bit 7 to 1 (= C7 OP has read data mailbox). By setting bit 7, the C7 OP specifies that the read process is terminated.
6	Set bit 7 to 0.

Transfer Using Control Jobs

A data record can be transferred from the C7 OP to the C7 CPU via control job No. 70. Control job 69 initiates transfer from the C7 CPU to the C7 OP.

4.9 Notes on Optimization

Decisive Factors

The structure of the user data areas described in Section 4.3 and the configured polling times in the **area pointers** are significant factors for the update times that can **actually** be achieved. The update time is the polling time plus the transfer time plus the processing time.

To achieve an optimal update time, the following points should be observed during configuration:

- Configure the individual data areas as large as necessary, but as small as possible.
- Define the data areas which belong together contiguously. The actual update time improves if you configure **one** large area as opposed to several small areas.
- The total performance is unnecessarily compromised if the polling times are too small. Set the polling time according to the changing speed of the process values. The change in temperature of an oven for example, is significantly more sluggish than the change of rotary speed in an electrical drive.
- The approximate value for the polling time is around 1 second.
- Avoid cyclic transfer of the user data areas (polling time 0) if necessary in order to improve the update time. Instead of this use the control jobs to transfer the user data areas as required according to events.
- Place the variables of a message or a screen without gaps in one data area.
- In order that changes in the C7 CPU are recognized by the C7 OP, they must at least be pending during the actual polling time.

4.10 Control Jobs and Their Parameters

Description

Using control jobs, functions on the C7 OP can be triggered by the control program, such as:

- Displaying screens
- Setting the time and date
- Changing general settings

A control job is identified by its job number. Up to three parameters can be transferred depending on the control job.

Control Job

A control job comprises four data words. The first data word contains the job number. Depending on the function, up to three parameters can be passed in data words 2 to 4. Figure 4-8 shows the general structure of a control job.

Address	Left byte (LB)	Right byte (RB)
Word 1	0	Job no.
Word 2	Parameter 1	
Word 3	Parameter 2	
Word 4	Parameter 3	

Figure 4-8 Structure of a Control Job

No.	Function
	System messages 50 Output system message buffer Passwords 55 Login 56 Password input Parameters 2, 3 -
12	Message log on/off Parameter 1 0: Off 1: On Parameters 2, 3 -
13	Change language Parameter 1 0: 1st language 1: 2nd language 2: 3rd language Parameters 2, 3 -
14	Set time (BCD-coded) Parameter 1 LB: - RB: Hours (0 to 23) Parameter 2 LB: Minutes (0 to 59) RB: Seconds (0 to 59) Parameter 3 -
15	Set date (BCD-coded) Parameter 1 LB: - RB: Weekday (1 to 7: Sunday to Saturday) Parameter 2 LB: Date (1 to 31) RB: Month (1 to 12) Parameter 3 LB: Year
16	Parameters for internal interface (C7-633:RS 232; C7-634: IF1) Parameter 1 Value for parameter 2 Transmission rate (only for printer) 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps Data bits (only for printer) 0: 7 data bits 1: 8 data bits Stop bits (only for printer) 0: 1 stop bit 1: 2 stop bits Parity (only for printer) 0: Even 1: Odd 2: None

No.	Function
Parameter 2	Interface parameters to be set 0: Transmission rate 1: Data bits 2: Stop bits 3: Parity
Parameter 3	-
19	Printer parameters
Parameter 1	Value for parameter 2 Number of characters per line 0: 20characters/line 1: 40characters/line 2: 80characters/line Number of lines per page 0: 60 lines/page 1: 61 lines/page : 12: 72 lines/page
Parameter 2	Printer parameters to be set 0: Number of characters per line 1: Number of lines per page
Parameter 3	-
21	Display mode for alarm messages
Parameter 1	0: First value (oldest message) 1: Last value (newest message)
Parameters 2, 3	-
22	Set display contrast
Parameter 1	0 to 15
Parameters 2, 3	-
23	Set password level
Parameter 1	0 to 9 0 = lowest password level 9 = highest password level
Parameters 2, 3	-
24	Password logout
Parameters 1, 2, 3	-
31	Print alarm message buffer
Parameter 1	0: Print chronologically 1: Print together
Parameters 2, 3	-
32	Print event message buffer
Parameter 1	0: Print chronologically 1: Print together
Parameters 2, 3	-

No.	Function
37	Overflow warning for event messages on/off
	Parameter 1 0: Off 1: On
	Parameters 2, 3 -
38	Overflow warning for alarm messages on/off
	Parameter 1 0: Off 1: On
	Parameters 2, 3 -
41	Transfer date/time to C7 CPU
	At least 5 seconds should lie between two jobs otherwise the C7 OP will be overloaded.
	Parameters 1, 2, 3 -
43	Fetch C7 CPU event message bit area
	Parameter 1 Area pointer no.: 1 to 4
	Parameters 2, 3 -
44	Fetch C7 CPU alarm message bit area
	Parameter 1 Area pointer no.: 1 to 4
	Parameters 2, 3 -
45	Fetch C7 CPU acknowledgement area
	Parameter 1 Area pointer no.: 1 to 4
	Parameters 2, 3 -
47	Transfer LED area directly to C7 OP
	Parameter 1 Area pointer no.: 1 to 4
	Parameter 2 LED image: 1st word
	Parameter 3 LED image: 2nd word
	In contrast to control job no. 42 (fetch LED area from C7 CPU), the LED image is directly transferred with the control job here, thus achieving faster control of the LEDs.
	The specified LED area must not be configured larger than 2 DW.
48	Menu selection
	Parameter 1 Menu number in the standard menu 1 Message level
	Parameter 2 Menu item number 0: First menu item 1 to 20 Other menu items
	Parameter 3 -
49	Delete event message buffer
	Parameters 1, 2, 3 -
50	Delete alarm message buffer
	Parameters 1, 2, 3 -

No.	Function
51	Screenselection
Parameter 1	LB: Cursor lock (0: off; 1: on) RB: Screen number 1 to 99
Parameter 2	Entry number: 0 to 99 (0 = cursor set to the first available entry)
Parameter 3	Field number: 1 to 8 for C7-633 1 to 32 for C7-634 Output fields are ignored in the serial numbering system. Note: The input fields of an entry are numbered consecutively: 0 Entry number field 1 First input field : n Last input field The numbering of the input fields starts from 1 again for each entry.
52	Print screen
Parameter 1	Screen number (1 to 99) in byte format
Parameters 2, 3	-
53	Select recipe
Parameter 1	LB: Cursor lock (0: off; 1: on) RB: Recipe number (1 to 99)
Parameter 2	Data record number (1 to 99)
Parameter 3	LB: Entry number (0 to 99) RB: Field number (0/1)
54	Print recipe
Parameter 1	Recipe number (1 to 99)
Parameter 2	Data record number (1 to 99)
Parameter 3	-
69	Transfer recipe data record from C7 CPU to C7 OP
Parameter 1	Recipe number (1 to 99)
Parameter 2	Data record number (1 to 99)
Parameter 3	0, 1 0: Data record is not overwritten 1: Data record is overwritten
70	Transfer recipe data record from C7 OP to C7 CPU
Parameter 1	Recipe number (1 to 99)
Parameter 2	Data record number (1 to 99)
Parameter 3	-
71	Partial screen updating
Parameter 1	0: Off 1: On
Parameters 2, 3	-
This job must only be triggered if no screen is selected.	

No.	Function
72	Cursor positioning in current screen or recipe
Parameter 1	Entry number: 0 to 99
Parameter 2	Field number: 1 to 8 for C7-633 1 to 32 for C7-634
Parameter 3	Cursor lock (0: off; 1: on)
73	Cursor positioning in current special screen
Parameter 1	Field number (0 to 8)
Parameter 2	Cursor lock (0: off; 1: on)
Parameter 3	-
74	Keyboard simulation
Parameter 1	LB: Keyboard number 1 Internal function keypad 2 System keypad RB: Password level 0: Will be evaluated 1: Will not be evaluated
Parameter 2	LB: Key code
Parameter 3	-
<p>For keyboard simulation via a control job, take note of the transfer time from the C7 CPU to the C7 OP. For example, the acknowledgement of an alarm message by keyboard simulation on the C7 CPU can lead to an undesired result if:</p> <ul style="list-style-type: none"> - The alarm message in question has already been acknowledged by an operation on the C7 or - A new alarm message or system message arrives before the control job has been evaluated. 	

Jobs with Cursor Lock

If the “cursor lock” parameter is equal to 1 in one of the jobs 11, 51, 53, 72, and 73, the selected input field can no longer be exited using the cursor keys or the ESC key. The cursor lock will only be disabled again by:

- Repeating the job with the cursor lock = 0,
- Another job which causes a change to the display on the screen.

If you try to exit the input field with the cursor lock activated, the system message “\$400 Invalid key pressed” is displayed.

4.10.1 Example of How to Activate a Control Job

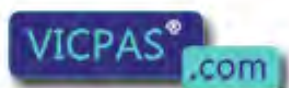
Procedure for Control Job

The following describes the procedure for activating a control job:

1. Set up the interface block (contains the interface area) in the C7 CPU (for example, DB52).
2. In the configuration, enter the interface block (DB52) in the “area pointer”. This informs the C7 OP that this block exists.
3. The job is entered in the interface block by means of a C7 CPU program (see Figure 4-9).
4. The C7 OP reads the interface block and executes the job.

Program for control job 51 “Screen selection”		
CALL	DB52	Call the interface block
L	ScreenNo	Enter parameter 1 (screen number) in the
T	DBW6	job area of the interface block,
L	EntryNo	Enter parameter 2 (entry number) in the
T	DBW8	job area of the interface block
L	FieldNo	Enter parameter 3 (field number) in the
T	DBW10	job area of the interface block
L	51	Enter the job number in the job area of the
T	DBW4	interface block to activate the job

Figure 4-9 Example of a C7 CPU Program



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Communication Functions

5

Chapter Overview

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5.1 Introduction

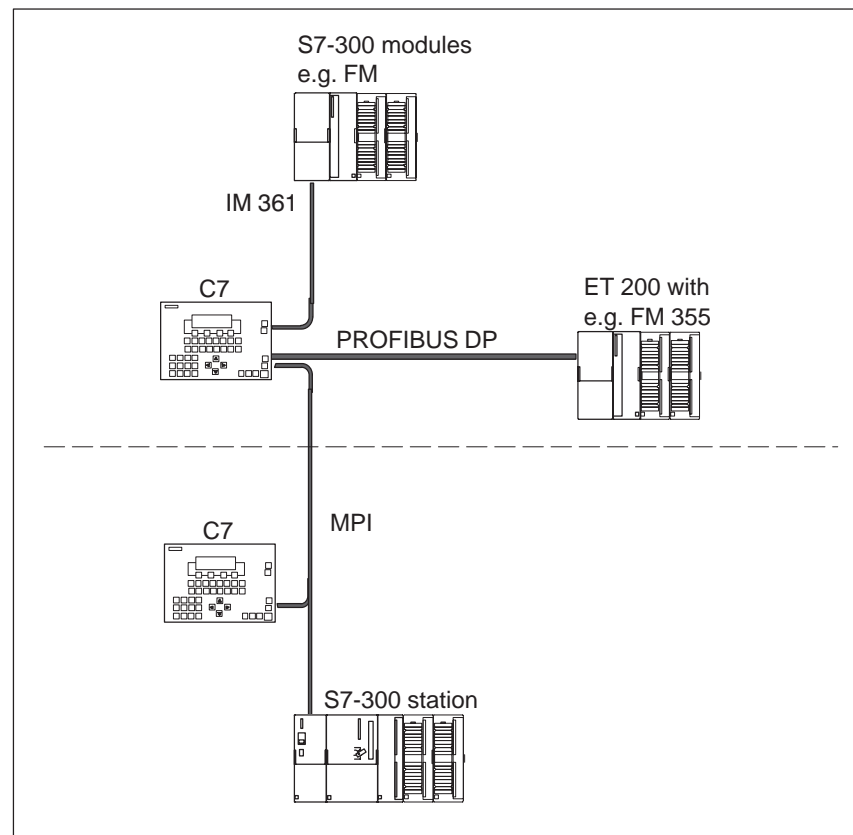
The C7 offers the following methods of communication:

- Communication between C7/S7 stations

The controller can exchange data with other stations in the MPI subnet via the multipoint interface and the communication functions X_SEND/X_RCV, X_GET, X_PUT (SFC65, SFC66, SFC67, SFC68) and global data.

- Communication within a C7 station

The controller can read or write data to and from intelligent modules via the PROFIBUS-DP interface or IM interface and the communication functions I_GET (SFC72) and I_PUT (SFC73).



These communication system functions (SFCs) are described below. You will find a detailed description in [/71/](#).

5.2 Communication between C7/S7 Stations (MPI Subnet)

Properties

The communication SFCs offer the possibility of acknowledged data exchange via non-configured S7 connections to other C7/S7 stations. Using these communication SFCs, you can reach all communication partners on the MPI subnet and transfer small quantities of data (max. 76 bytes).

From S7/M7/C7 CPUs you can also access variables in another C7/S7 CPU (X_PUT/X_GET).

The connections to the communication partners are established dynamically when the SFC is called. A free connection resource in each of the communication partners will be required for this.

If there are no free connections resources available on the communication partners, no new connections can be established (temporary lack of resources, indicated as SFC error class in RET_VAL).

The communication SFCs must not be deleted in RUN mode, otherwise any connection resources in use may not be able to be freed up (program changes only in STOP).

The number of communication partners that can be reached one after the other is greater than the number of connections that can be set up simultaneously (corresponds to a CPU-specific quantity, see **70**).

Communication is also possible if the communication partners are in other S7 projects.

Blocks

The communication SFCs do not require any additional user memory (for example, in the form of instance data blocks).

The SFCs can have parameters assigned which means the block parameters can be changed dynamically during program processing. This means different communication partners can be reached in succession using one SFC.

On the server side, no SFCs are required in the user program for specific functions as these communication functions are already being dealt with by the operating system.

The following SFCs are available for communication via MPI subnet:

Blocks		Description
SFC65 SFC66	X_SEND X_RCV	Safe transfer of a data field to a communication partner, meaning the data exchange is only complete when the receive function (X_RCV) has accepted the data in the communication partner.
SFC67	X_GET	With this SFC you can read a variable from a communication partner without having to place a corresponding SFC on the communication partner. This function is performed in the communication partner by the operating system.
SFC68	X_PUT	With this SFC you can write a variable to a communication partner without having to place a corresponding SFC on the communication partner. This function is performed in the communication partner by the operating system.
SFC69	X_ABORT	With this SFC you can cancel an existing connection explicitly without transferring data. This frees up the corresponding connection resources again on both sides.

Addressing

For the above blocks, addressing the communication partner is done via the MPI address configured in STEP 7. The communication partner can also be in another S7 project.

Data Consistency

The maximum data area which can be read/written as a contiguous field of data by the operating system in the S7-300/S7-400 CPUs (X_PUT/X_GET) is shown in the table below.

An array of the data types Byte, Word, and Double Word can be transferred consistently up to a CPU-specific maximum length (see table).

CPU 31x (C7)	CPU 412	CPU 413	CPU 414	CPU 416
8 bytes	32 bytes	32 bytes	32 bytes	32 bytes

If larger amounts of user data are transferred using X_PUT/X_GET, inconsistencies may arise.

5.3 Communication within a C7 Station (PROFIBUS DP or IM)

Properties

The communication SFCs offer the possibility of acknowledged data exchange via non-configured S7 connections to PROFIBUS DP partners.

Using these communication SFCs, you can reach all communication partners which can be addressed via the I/O addresses of a station (for example, function modules (FMs)).

The connections to the communication partners are established dynamically when the SFC is called. A free connection resource in each of the communication partners will be required for this.

The number of communication partners that can be reached in succession within the station is not restricted.

Blocks

The following SFCs are available for communication within a station:

Block		Description
SFC72	I_GET	With this SFC you can read a variable from a communication partner without having to place a corresponding SFC on the communication partner. This function is performed in the communication partner by the operating system.
SFC73	I_PUT	With this SFC you can write a variable to a communication partner without having to place a corresponding SFC on the communication partner. This function is performed in the communication partner by the operating system.
SFC74	I_ABORT	With this SFC you can cancel an existing connection explicitly without transferring variables. This frees up the corresponding connection resources again on both sides.

Addressing

For the above blocks, addressing the communication partner is done via the module start address (I/O address) configured in STEP 7.

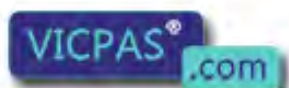
Data Consistency

The maximum data area which can be read/written as a contiguous field of data by the operating system in the S7-300 CPUs (I_PUT/I_GET) is shown in the table below.

An array of the data types Byte, Word, and Double Word can be transferred consistently up to a CPU-specific maximum length (see table).

CPU 31x (C7)	CPU 412	CPU 413	CPU 414	CPU 416
8 bytes	32 bytes	32 bytes	32 bytes	32 bytes

If larger amounts of user data are transferred using I_PUT/I_GET, inconsistencies may arise.



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C7 Digital I/O

6

Chapter Overview

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6.4	Addressing the C7 Digital I/O	6-9

6.1 Digital Inputs

Introduction The C7 has different digital inputs for connecting sensors.

Digital Inputs This chapter lists the technical specifications of the digital inputs in the C7. In addition to the technical specifications of the digital inputs, this chapter also describes

- The characteristics
- The special features
- The terminal connection and block diagrams of the digital inputs

Characteristics The digital input function has the following characteristics:

- 16 inputs, isolated as a group
- Nominal input voltage: 24 VDC
- Suitable for switches and 2-wire proximity switches (BEROs), for example.

Terminal Connection and Block Diagram

Figure 6-1 shows the terminal connection and the block diagram of the digital inputs.

The pages following contain detailed technical specifications of the digital inputs.

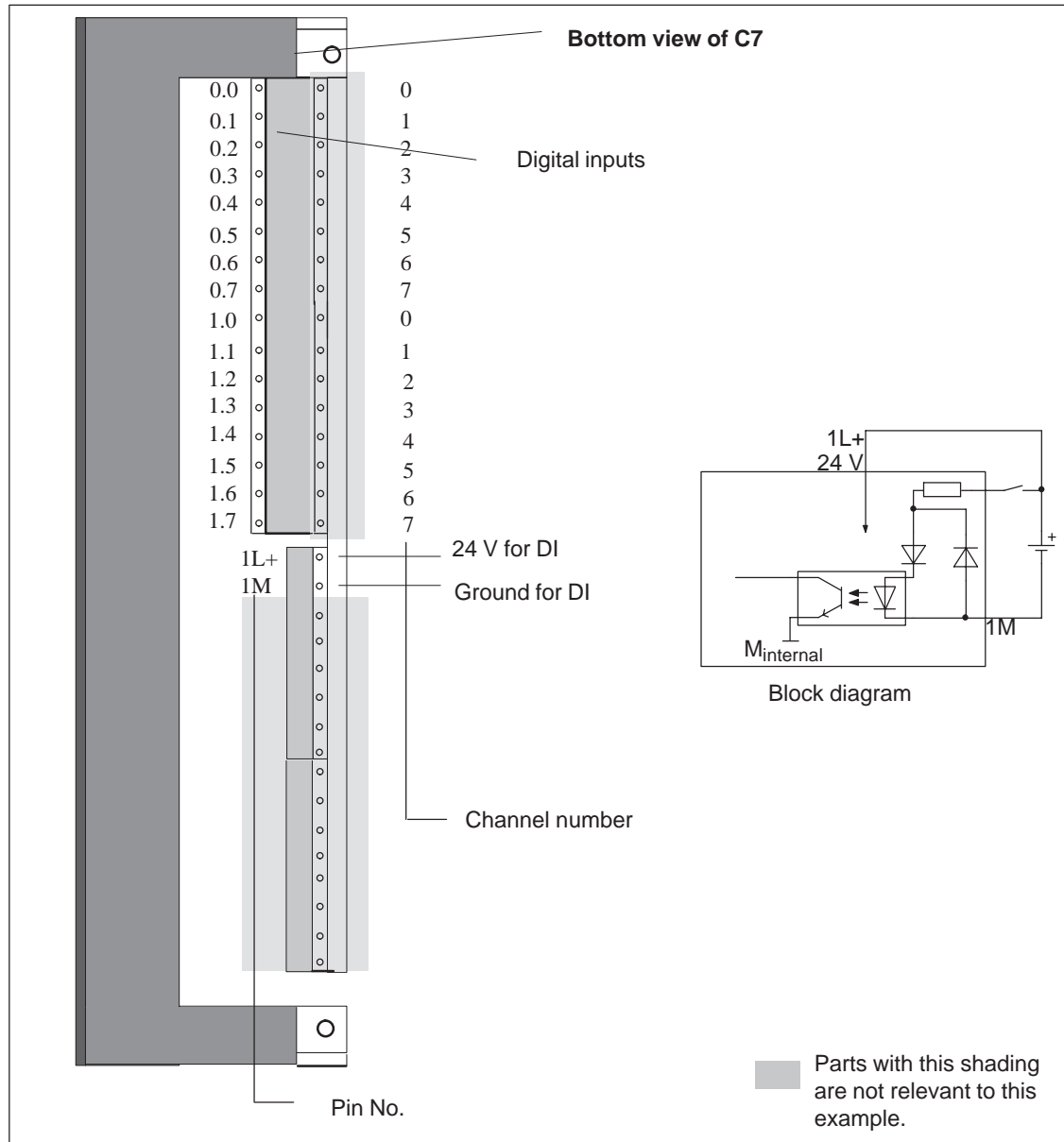


Figure 6-1 Terminal Connection and Block Diagram of the Digital Inputs

Specific Data of the Digital Input		Data for Selecting a Sensor	
Number of inputs	16	Input voltage	
Cable length		• Nominal voltage	24 VDC
• Unshielded	600 m	• For “1” signal	from 11 to 30 V
• Shielded	1000 m	• For “0” signal	from -3 to 5 V
Voltages, Currents, Potentials		Input current	
Nominal load voltage L +	24 VDC	• For “1” signal	from 6 to 11.5 mA
Number of simultaneously energizable inputs	16	Input delay time	
Galvanic isolation	Yes (optocoupler)	• Programmable	No
• In groups of	16	• At “0” to “1”	from 1.2 to 4.8 ms
Permissible potential difference		• At “1” to “0”	from 1.2 to 4.8 ms
• Between the M terminals of the groups	-	Input characteristic	In accordance with EN 61131-2 (IEC 1131, Part 2)
• Insulation resistance	$U_{ISO} = 500 \text{ VDC}$	Type of input in accordance with IEC 1131	Type 2
Status, Interrupts, Diagnostics		Connection of 2-wire BEROs	Possible
Interrupts	No	• Permissible quiescent current	$\leq 2 \text{ mA}$
Diagnostic functions	No		

6.2 Digital Outputs

Characteristics

The digital outputs have the following characteristics:

- 16 outputs, isolated
- Output current: 0.5 A
- Nominal load voltage: 24 VDC
- Suitable for solenoid valves and d.c. contactors.

Special Feature

When the supply voltage is switched on, the digital outputs send a pulse to the outputs. A pulse can be approximately 50 μ s within the permissible output current range.

Terminal Connection and Block Diagram

Figure 6-2 shows the terminal connection and the block diagram of the digital outputs.

The pages following contain detailed technical specifications of the digital outputs.

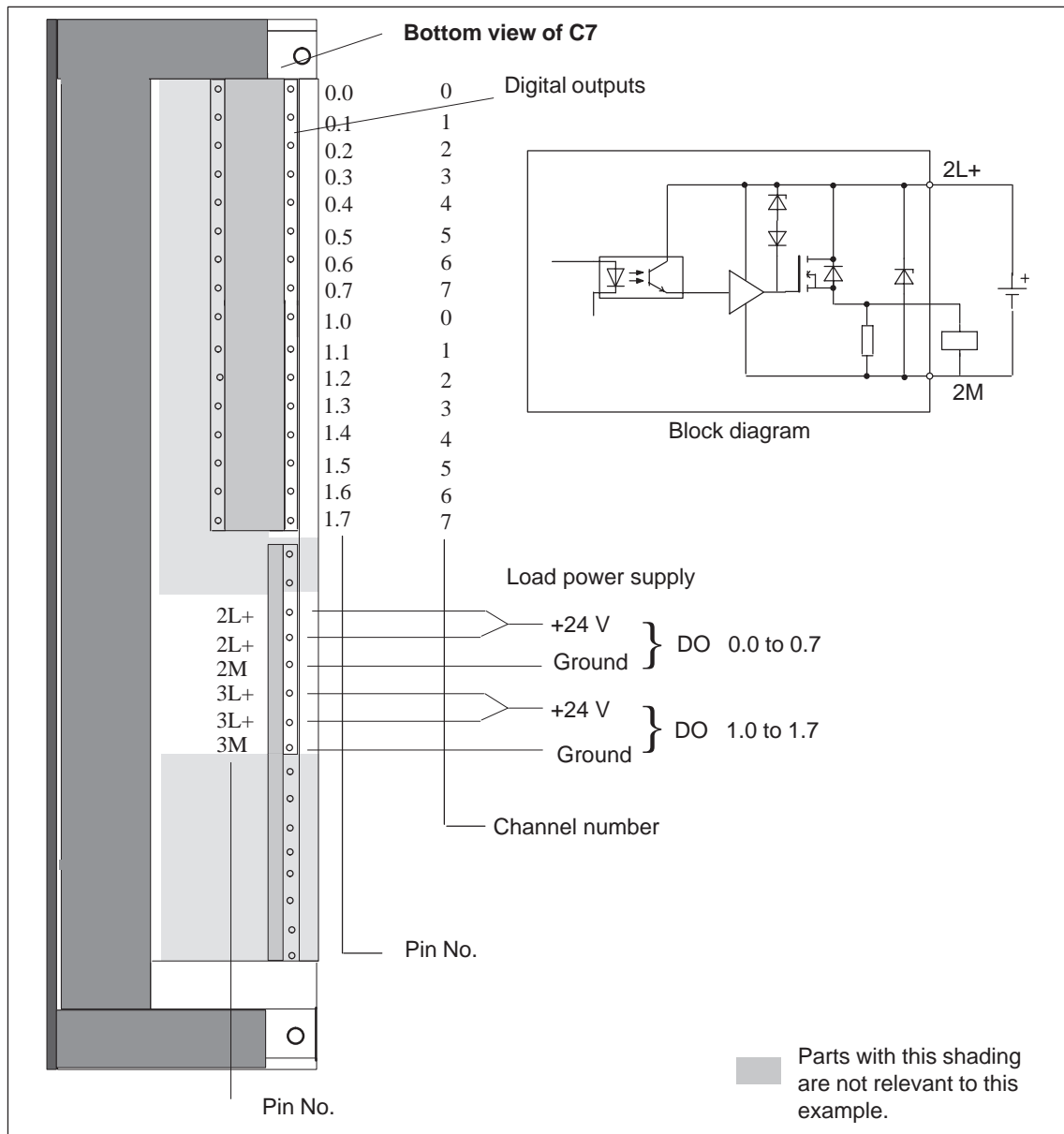


Figure 6-2 Terminal Connection and Block Diagram of the Digital Outputs

Connection of Load Power Supply

If the maximum permissible current is utilized for the load power supply, both pins should be wired to avoid overloading of the contacts. For relatively low currents, wiring of only one +24V pin is sufficient.

Specific Data of the Digital Output Function		Data for Selecting an Actuator	
Number of outputs	16	Output voltage	
Cable length		• At "1" signal	L + (- 0.8 V)
• Unshielded	600 m	Output current	
• Shielded	1000 m	• At "1" signal nominal value	0.5 A
Voltages, Currents, Potentials		Permissible range	5 mA to 0.5 mA
Nominal load voltage L +	24 VDC/0.5A	• At "0" signal (quiescent current)	max. 0.5 mA
Total current of the outputs (per group)		Lamp load	max. 5 W
• Up to 20 °C	4 A	Parallel switching of 2 outputs	
• Up to 45 °C	2 A	• For logic operations	Possible (outputs of the same group only)
Galvanic isolation	Yes (optocoupler)	• For enhancing performance	Not possible
• In groups of	8	Activating a digital input	Yes
Insulation resistance	U _{ISO} = 500 VDC	Max. switching frequency	
Status, Interrupts, Diagnostics		• With resistive load/lamp load	100 Hz
Interrupts	No	• With inductive load	0.5 Hz
Diagnostic functions	No	Inductive cutoff voltage limited (internally) to	L + (- 48 V)
		Short-circuit protection of the outputs	Yes, electronically timed
		• Operating point	1 A

6.3 DI/DO Status Displays

Configuring the DI/DO Status Display

The DI/DO status display is not a system function but a configured image of the C7 OP. You can create the DI/DO status display image yourself or copy it from the standard configuration supplied with ProTool (image name: Z_DI_DO).

The values represented are read as a direct **process image** of the digital inputs and an internal process image of the digital outputs of the digital C7 I/O and displayed in binary format (BIN).

Note that the last state set by the program is displayed, although the real process state of the digital outputs is 0 when the C7 CPU is in STOP mode.

The following data are displayed:

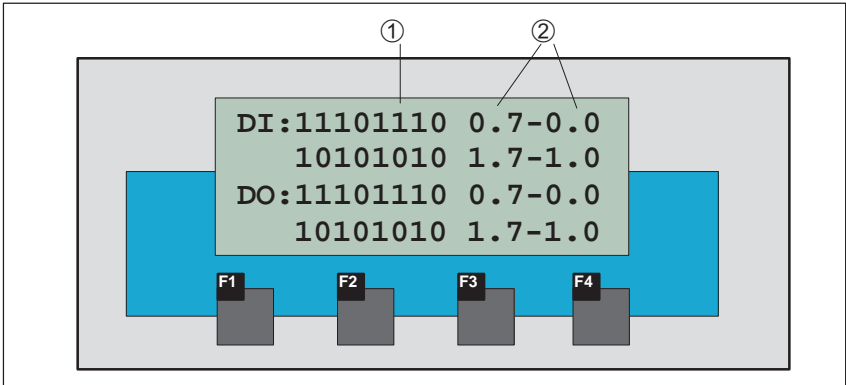


Figure 6-3 DI/DO Status Display on a C7-633/P

Table 6-1 Explanation of the DI/DO Display in Figure 6-3

Position	Explanation
①	Signal status of the DI/DO <ul style="list-style-type: none">• 1 DI/DO set• 0 DI/DO reset
②	Pin no. from - to

Note

The values of the digital I/O are read in and displayed every 400 ms. Any changes which occur between these times are not displayed.

C7 CPU Access

The DI/DO image of the standard configuration accesses the digital I/Os of the first configured programmable controller. Therefore, the first programmable controller in the list should always be the C7 CPU. Otherwise it is necessary to adapt the programmable controller access for the image.

6.4 Addressing the C7 I/O

Overview

The following section describes the addressing of the digital I/O. You require this information to be able to address the channels for the digital inputs and outputs in the user program.

Figure 6-4 shows the diagram for addressing the individual channels of the digital I/O.

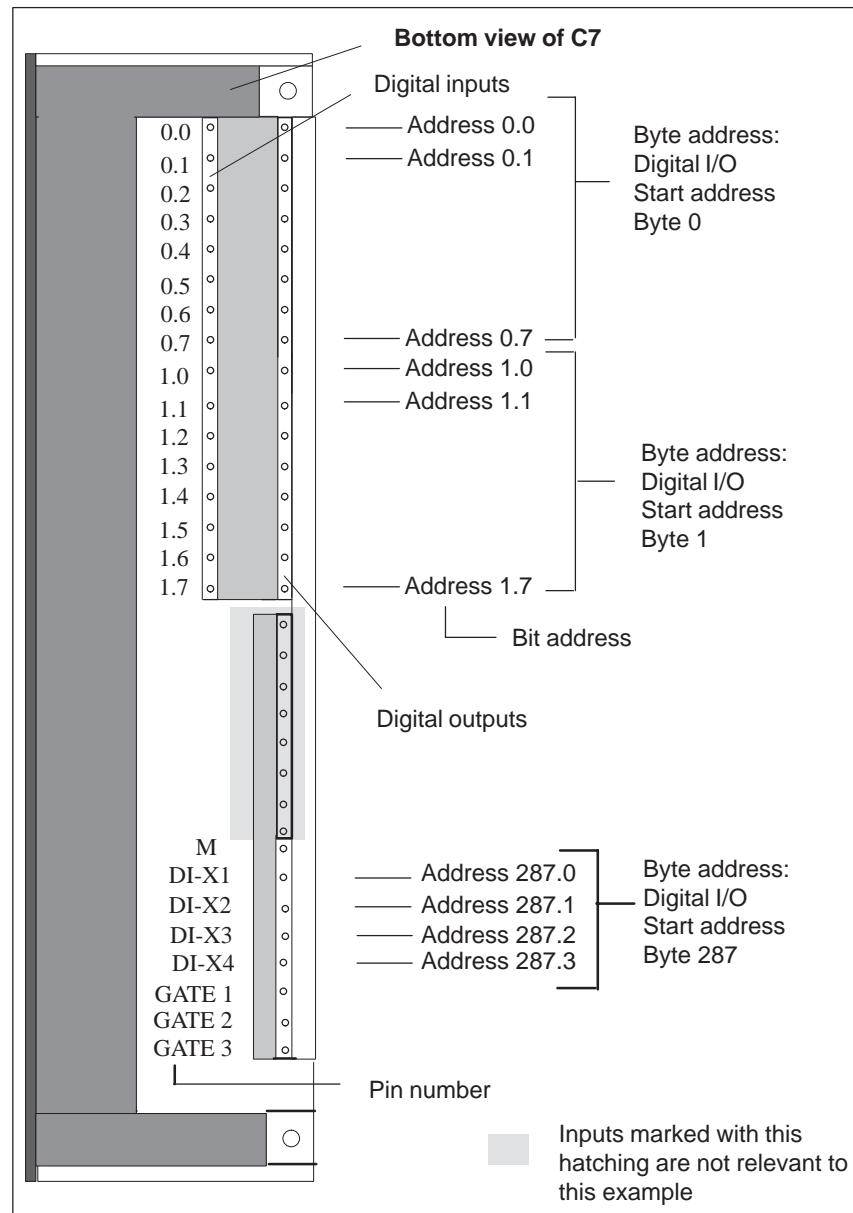
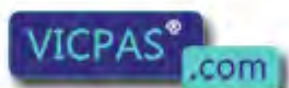


Figure 6-4 Digital I/O Addresses



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C7 Analog I/O

7

Chapter Overview

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7.1 Analog Technology

Introduction

There are different analog inputs and outputs available to you in the C7 for connecting sensors and/or loads/actuators.

Analog I/O

This section covers the following:

- A description of analog value representation, the measuring types, measuring ranges, and output ranges in the C7
- A description of how to connect the sensors or loads/actuators to the analog I/O
- The principles of using analog I/Os
- Behavior of the analog I/O

Ungrounded Configuration

The C7 cannot be installed in an ungrounded configuration.

7.2 Connecting Transducers to Analog Inputs

Overview

You can connect various types of transducers to the analog inputs:

- Voltage transducers
- Current transducers

This section tells you how to connect up your transducers and what precautions you have to take when doing so.

Cables for Analog Signals

To reduce electrical interference, you should use twisted-pair shielded cables for the analog signals. The shield of the analog signal cables should be grounded at both cable ends. If there are potential differences between the cable ends, an equipotential bonding current can flow over the shield. This can interfere with the analog signals. In such a case, you should ground the shield at one end of the cable only.

Isolated Analog Input

The analog input is isolated and so there is no electrical connection between the reference point of the measuring circuit M_{ANA} and the M terminal of the C7 power supply (see Figure 7-1).

A potential difference U_{ISO} can occur between the reference point of the measuring circuit M_{ANA} and the M terminal of the C7. Make sure that U_{ISO} does not exceed the permissible value. Where it is possible that the permissible value might be exceeded (see technical specifications), establish a connection between the M_{ANA} terminal and the M terminal of the C7.

Connecting Transducers to Analog Inputs

A potential difference U_{CM} (common mode voltage) may occur between the measuring line $AIx-M$ of the input channels and the reference point of the measuring circuit M_{ANA} . However, this potential difference must not exceed the permissible value (see technical specifications). Where it is possible that the permissible value for U_{CM} might be exceeded, or where you cannot determine the difference in potential accurately, you must connect $AIx-M$ to M_{ANA} . Please observe this also for the unused inputs.

Abbreviations

The abbreviations used in Figures 7-1 to 7-3 have the following meanings:

- AIx-X: Measuring line AIx-U or AIx-I
- AIx-M: Reference potential of the measuring line
- M_{ANA}: Reference potential of the analog measuring circuit
- M: Ground terminal of the C7
- U_{CM}: Potential difference between inputs and M_{ANA}
- U_{ISO}: Potential difference between M_{ANA} and the M terminal of the C7

Isolated Transducers

The isolated transducers are not connected with the local ground potential. They can be operated free of potential. Local conditions or interference can cause potential differences U_{CM} (static or dynamic) to occur between the measuring lines M of the input channels and the reference point of the measuring circuit M_{ANA}. However, this potential difference must not exceed the permissible value. Where it is possible that the permissible value for U_{CM} might be exceeded, or where you cannot determine the difference in potential accurately, you must connect AIx-M to M_{ANA}.

Figure 7-1 shows the principle of connecting isolated transducers to an isolated analog input.

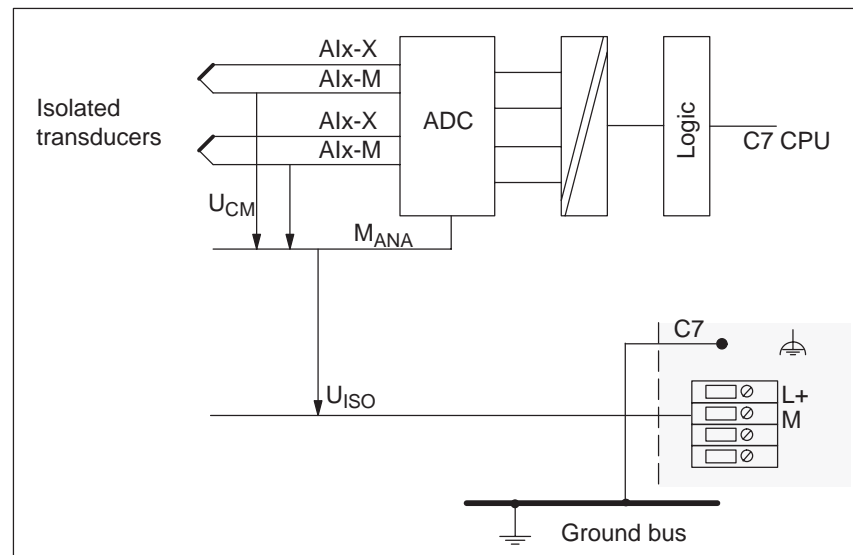


Figure 7-1 Connecting Isolated Transducers to an Isolated Analog Input

Non-Isolated Transducers

The non-isolated transducers are connected on-site with the ground potential. Depending on local conditions or interference, potential differences (static or dynamic) can occur between the locally distributed measuring points. To prevent these potential differences, you must provide equipotential bonding conductors between the measured value points.

In addition, potential differences U_{CM} (static or dynamic) can arise between the measuring lines AIx-M of the input channels and the reference point of the measuring circuit M_{ANA} . However, these potential differences must not exceed the permitted value. Where it is possible that the permissible value for U_{CM} might be exceeded, or where you cannot determine the difference in potential accurately, you must connect AIx-M to M_{ANA} .

Figure 7-2 shows the principle of connecting non-isolated transducers to an isolated analog input.

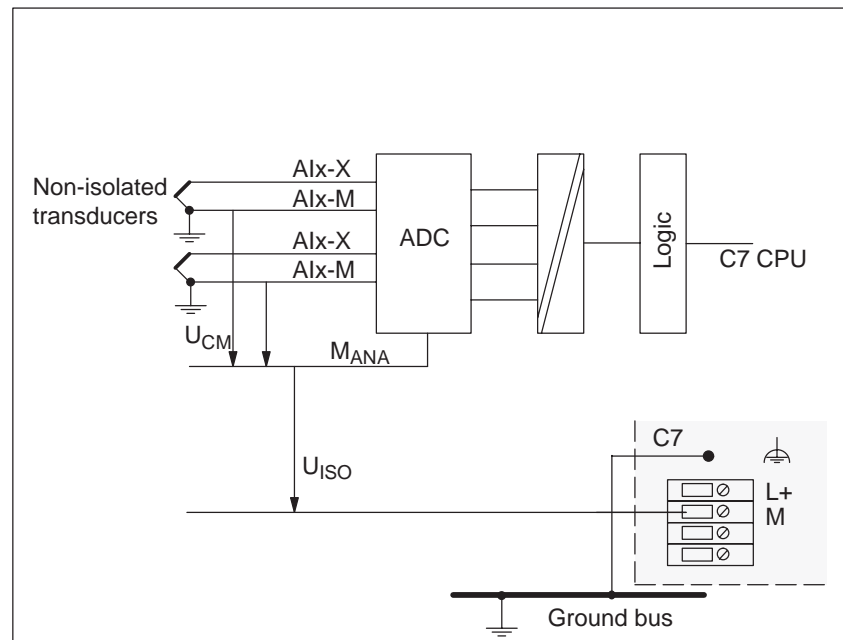


Figure 7-2 Connecting Non-Isolated Transducers to an Isolated Analog Input

7.2.1 Connecting Voltage and Current Transducers

Abbreviations and Mnemonics

The abbreviations and mnemonics used in Figures 7-3 to 7-4 have the following meanings:

AIx-X: Measuring line AIx-I or AIx-U

AIx-M: Reference potential of the measuring line

M_{ANA}: Reference potential of the analog measuring circuit

Connecting Voltage Transducers

Figure 7-3 shows the connection of voltage transducers to an isolated analog input.

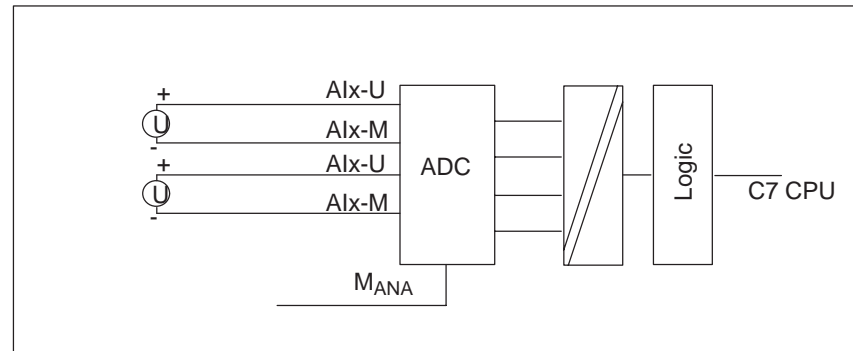


Figure 7-3 Connecting Voltage Transducers to an Isolated Analog Input

Connecting Current Transducers as 4-Wire Transducers

4-wire transducers possess a separate voltage supply. Figure 7-4 shows the connection of current transducers as 4-wire transducers to a non-isolated analog input.

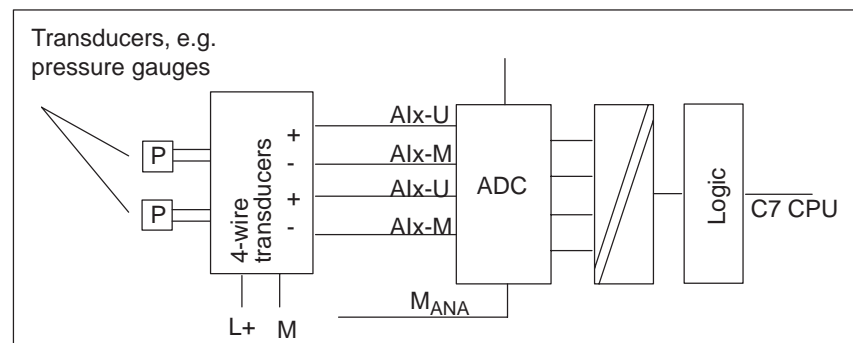


Figure 7-4 Connecting 4-Wire Transducers to a Non-Isolated Analog Input

7.3 Connecting Loads/Actuators to the Analog Output

Overview	You can provide loads/actuators with current or voltage using the analog output.
Cables for Analog Signals	To reduce electrical interference, you should use twisted-pair shielded cables for the analog signals. The shield of the analog signal cables should be grounded at both cable ends. If there are potential differences between the cable ends, an equipotential bonding current can flow over the shield. This can interfere with the analog signals. In such a case, you should ground the shield at one end of the cable only.
Isolated Analog Output	<p>The analog output is isolated and so there is no electrical connection between the reference point of the AO-M analog circuit and the M terminal of the C7.</p> <p>A potential difference U_{ISO} can occur between the reference point of the analog circuit M_{ANA} and the M terminal of the C7. Make sure that U_{ISO} does not exceed the permissible value. Where it is possible that the permissible value might be exceeded (see technical specifications), establish a connection between the AO-M terminal and the M terminal of the C7.</p>
Abbreviations and Mnemonics	<p>The abbreviations and mnemonics in the Figures 7-5 to 7-6 have the following meanings:</p> <p>AOx: Analog output (current (AO-I) and voltage (AO-U) can be assigned)</p> <p>R_L: Load/actuator</p> <p>AO-M : Ground terminal (reference potential of the analog output)</p> <p>L+: Terminal for 24 VDC supply voltage</p> <p>U_{ISO}: Potential difference between M_{ANA} and the M terminal of the C7.</p> <p>Figures 7-5 to 7-6 show you how to connect loads/actuators to the current and/or voltage outputs of the analog output module.</p>

Connecting Loads to a Current Output

You must connect loads to a current output at AO-I and the reference point of the analog circuit AO-M.

Figure 7-5 shows the principle of connecting loads to a current output of an isolated analog output module.

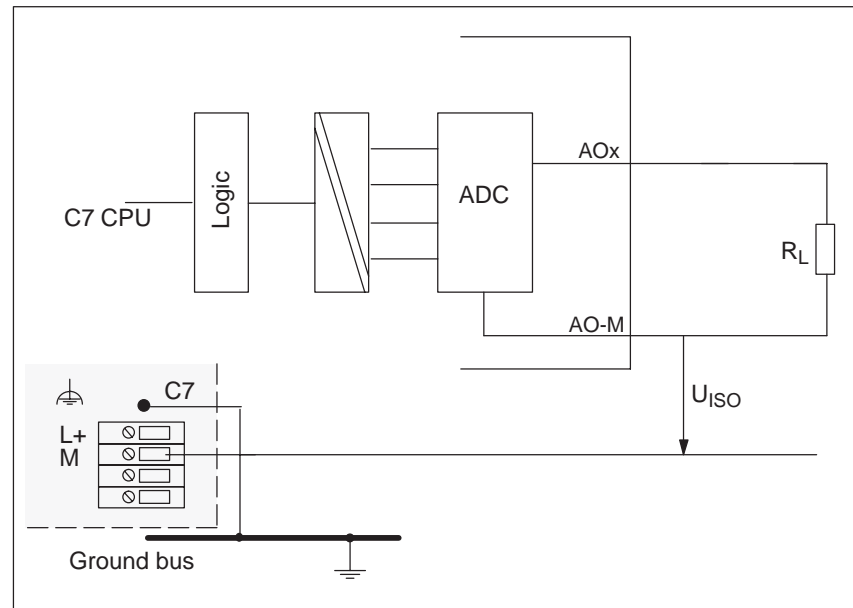


Figure 7-5 Connecting Loads to a Current Output of an Isolated Analog Output

Connecting Loads to a Voltage Output

Connection of loads to a voltage output is only possible in 2-wire circuits as there is only one output.

2-wire connection of loads to a voltage output is carried out at terminal AOx and the reference point of the measuring circuit AO-M.

Figure 7-6 shows the principle of connecting loads to a voltage output of a non-isolated analog output module with 2-wire connection.

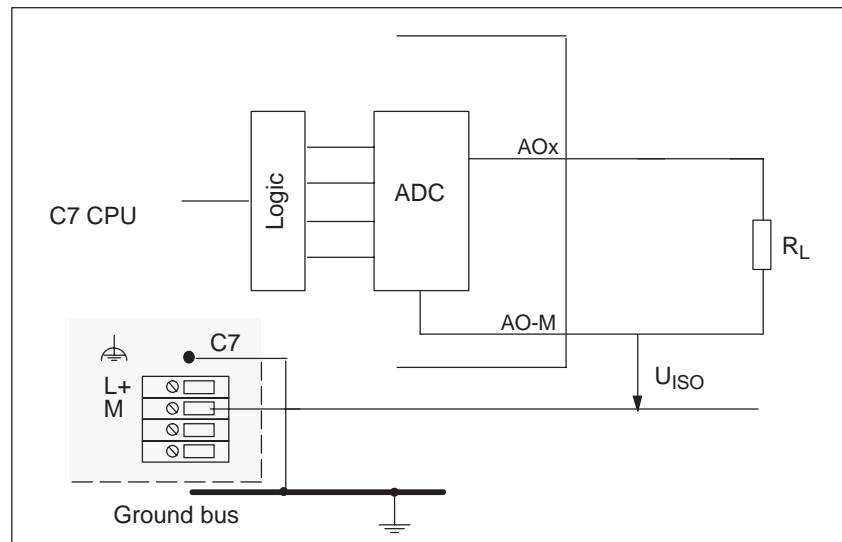


Figure 7-6 2-Wire Connection of Loads to a Voltage Output of an Analog Output

7.4 Analog Input Function

This Section

This section contains

- The characteristics of the analog input module
- The technical specifications of the analog input module

You will learn

- How to start up the analog input module
- The measuring ranges provided by the analog input module
- The parameters you can use to influence the characteristics of the analog input module.

Available Measurement Types

The following measurement types are available on the analog input module:

- Voltage measurement
- Current measurement

Measurement Ranges

The measurement ranges are:

- Voltage: $\pm 10\text{V}$
- Current: $\pm 20\text{mA}$, 4 to 20mA

Wire Break Check

For the current range 4 to 20 mA, a current of $< 1.6\text{ mA}$ is interpreted by the software as a wire break.

Measurement Ranges for 4-Wire Transducers

Measurement ranges for current measurement with 4-wire transducers:

- $\pm 20\text{mA}$
- 4 to 20mA

7.4.1 Characteristics and Technical Specifications of the Analog Input Module

Characteristics

The analog input module has the following characteristics:

- 4 inputs
- Measured value resolution
 - 12 bits incl. sign
- Measurement type selectable:
 - Voltage
 - Current
- Choice of measurement range per input
- Configurable diagnostics
- Configurable diagnostic interrupt
- Configurable interrupt cycle
- Isolated

**Terminal
Connection
Diagram**

Figure 7-7 shows the terminal connection diagram of the analog inputs.

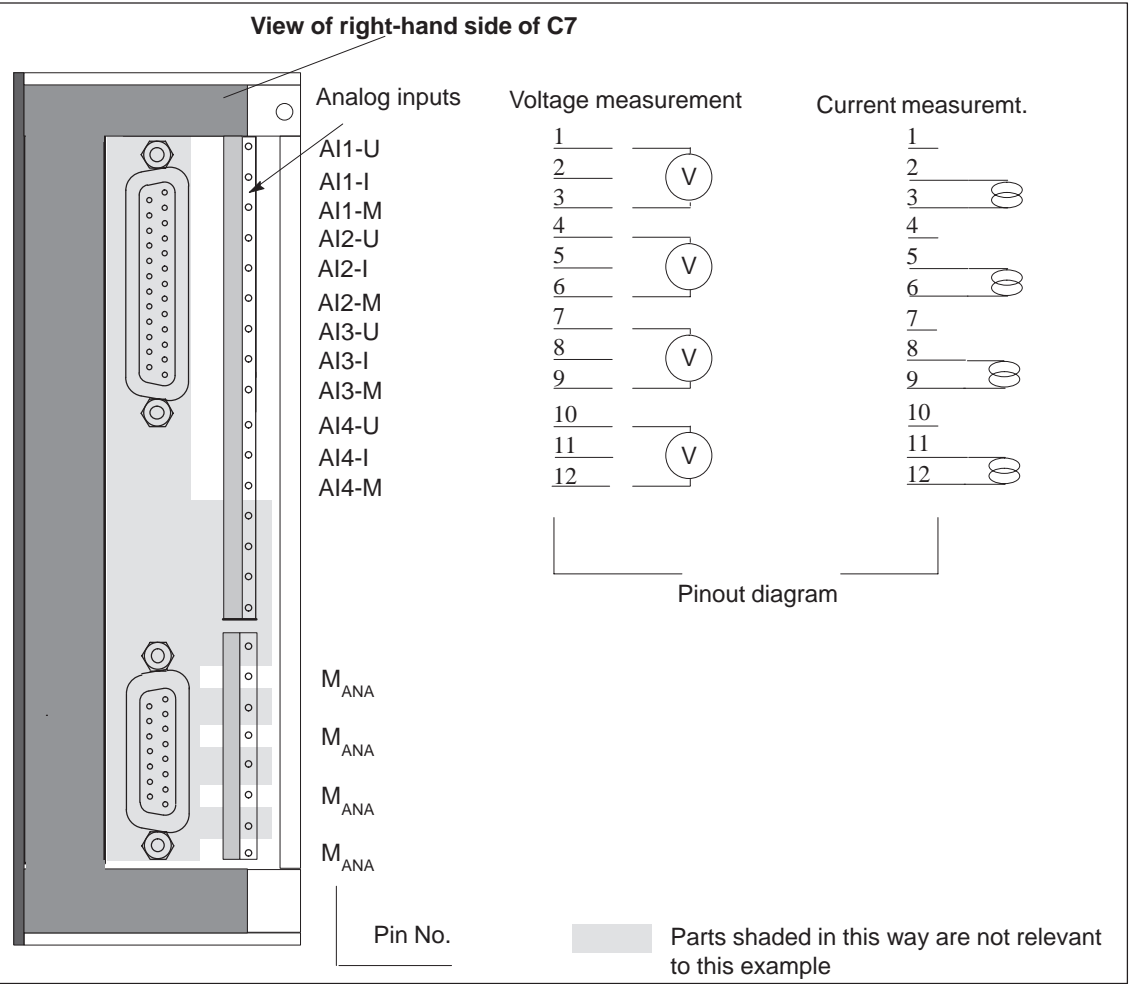


Figure 7-7 Terminal Connection Diagram of the Analog Inputs

**Connecting a
Power/Voltage
Sensor**

You can connect either a power sensor or a voltage sensor to an analog input, but never both at the same time.

**Unused Analog
Inputs**

To prevent interference from occurring, all unused analog inputs should be short-circuited.

Channels

Three pins are combined to form a channel.

Table 7-1 Channels of the Analog Input Module

Pin No.	Value	Channel
AI1-U	Voltage input	Channel 1 (AI1)
AI1-I	Current input	
AI1-M	Reference potential	
AI2-U	Voltage input	Channel 2 (AI2)
AI2-I	Current input	
AI2-M	Reference potential	
AI3-U	Voltage input	Channel 3 (AI3)
AI3-I	Current input	
AI3-M	Reference potential	
AI4-U	Voltage input	Channel 4 (AI4)
AI4-I	Current input	
AI4-M	Reference potential	

Block Diagram

Figure 7-8 shows the block diagram of the analog input module. The next page contains detailed technical specifications of the analog input module.

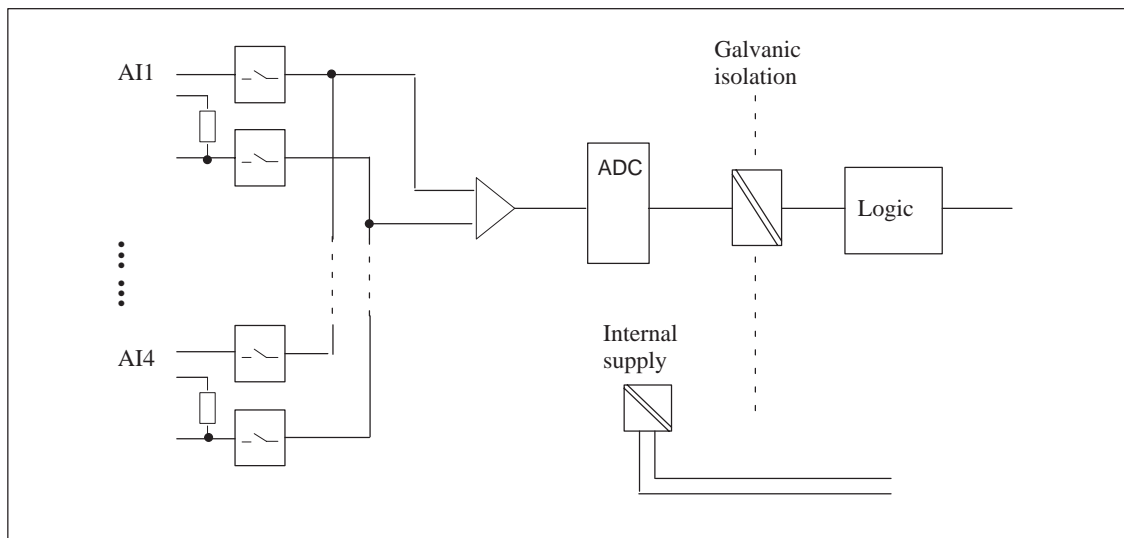


Figure 7-8 Block Diagram of the Analog Input Module

Technical Specifications

Data Specific to Analog Inputs		Data for Selecting a Sensor	
Number of inputs	4	Input ranges (rated values)/input resistance	
Cable length, shielded	200 m	<ul style="list-style-type: none"> Voltage $\pm 10 \text{ V}; \quad /50 \text{ k}\Omega$ 	
Voltages, Currents, Potentials		<ul style="list-style-type: none"> Current $\pm 20 \text{ mA}; \quad /105.5\Omega$ 	
Isolation (analog I/Os to electronics)	yes	4 - 20 mA; $/105.5\Omega$	
Isolation resistance	$U_{\text{ISO}} = 500 \text{ V DC}$	Permitted input voltage for voltage input (destruction limit)	
Permitted potential difference		Max. 30 V permanent, 38 V for max. 1 s (pulse duty ratio 1:20)	
<ul style="list-style-type: none"> Between reference potential of the inputs A_{IX-M} and M_{ANA} for signal = 0V 	$U_{\text{CM}} = 2.5 \text{ V DC}$	Permitted input current for current input (destruction limit)	
Analog Value Formation		30 mA	
Measurement principle	Instantaneous value	Connection of signal sensors	
<ul style="list-style-type: none"> Cycle time (all channels) 	2 ms	<ul style="list-style-type: none"> For voltage measurement Possible 	
Cycle time (per channel)	0.5 ms	<ul style="list-style-type: none"> For current measurement as 4-wire transducer Possible 	
<ul style="list-style-type: none"> Resolution in bits incl. sign (incl. overflow range) 	12	as 2-wire transducer Not directly possible	
Measurement ranges:	Measurement range selected by connection to different pins	Status, Interrupts, Diagnostics	
Voltage	$\pm 10 \text{ V}$	Interrupts	
Current	$\pm 20 \text{ mA}, 4 \text{ to } 20 \text{ mA}$	<ul style="list-style-type: none"> Hardware interrupt as cyclic interrupt yes, selectable 	
Noise Suppression, Error Limits		<ul style="list-style-type: none"> as cycle end interrupt yes, selectable 	
Noise voltage suppression		<ul style="list-style-type: none"> Diagnostic interrupt yes, selectable 	
<ul style="list-style-type: none"> Common mode noise ($U_{\text{CM}} < 1.0 \text{ V}$) 	$> 40 \text{ dB}$	Diagnostic functions yes, selectable	
Crosstalk between the inputs	$> 60 \text{ dB}$	<ul style="list-style-type: none"> Diagnostic information can be read out yes 	
Error limit (in entire temperature range, relative to input range)		Time intervals yes, selectable	
<ul style="list-style-type: none"> Voltage 	$\pm 0.8 \%$	Wire break detection In measurement range 4 to 20 mA, selectable	
<ul style="list-style-type: none"> Current 	$\pm 0.8 \%$		
Basic error limit (error limit at 25 °C, relative to the input range)			
<ul style="list-style-type: none"> Voltage 	$\pm 0.6 \%$		
<ul style="list-style-type: none"> Current 	$\pm 0.6 \%$		
Reproducibility in settled state at 25 °C related to range	0.05 %		

7.5 Analog Output Function

This Section

This section contains

- The characteristics of the analog output function
- The technical specifications of the analog output function

You will learn

- How to start up the analog output function
- The various ranges of the analog output function
- The parameters you can use to influence the characteristics of the analog output function
- The technical specifications of the analog output function.

Characteristics

The output function has the following characteristics:

- 4 outputs
- The outputs can be selected either as
 - Voltage output or
 - Current output
- 12-bit resolution incl. sign
- Configurable diagnostics
- Isolated

Note

If you modify the output ranges while the analog output module is active, intermediate values can arise at the output!

Terminal Connection Diagram

Figure 7-9 shows the terminal connection diagram of the analog output module.

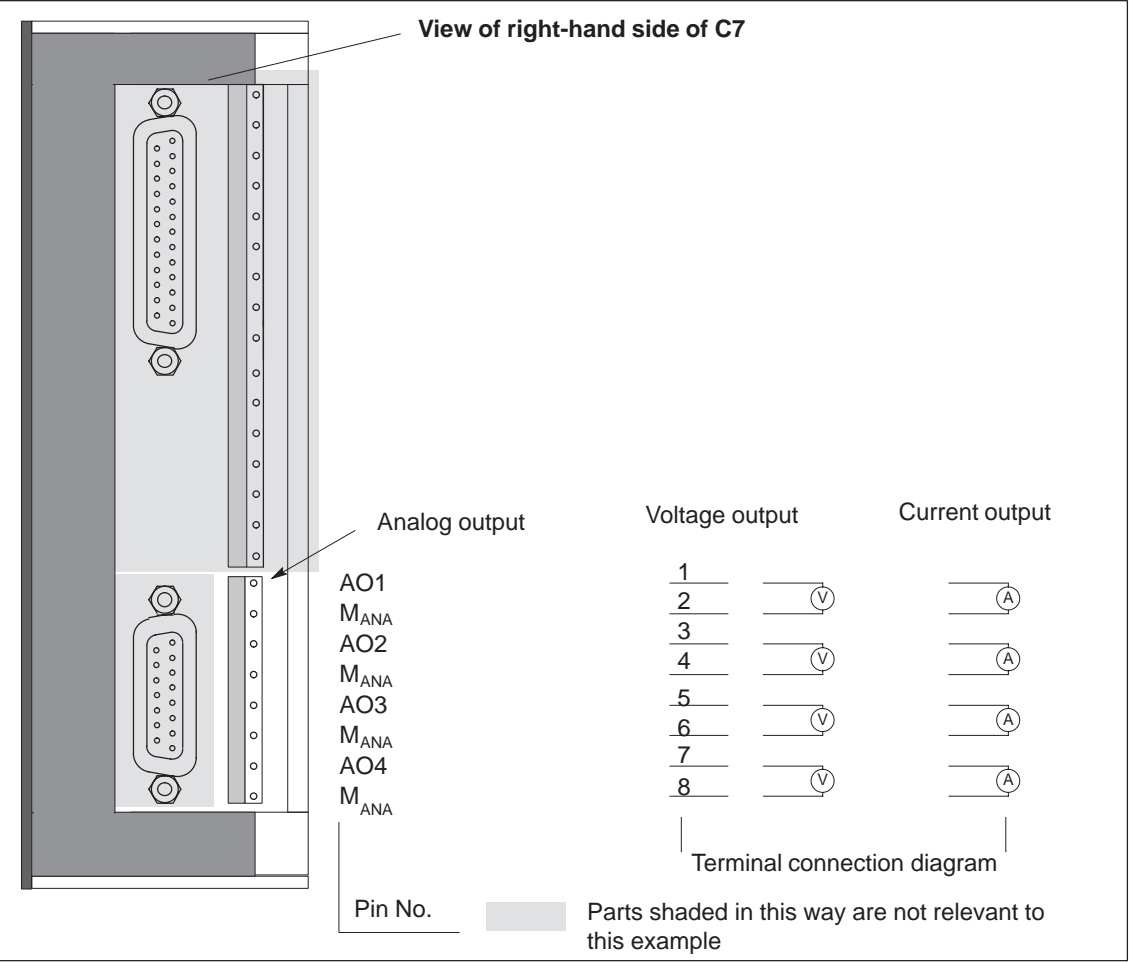


Figure 7-9 Terminal Connection Diagram of the Analog Output Module

Block Diagram

Figure 7-10 shows the block diagram of the analog output module. You will find detailed technical specifications of the analog output module on the following pages.

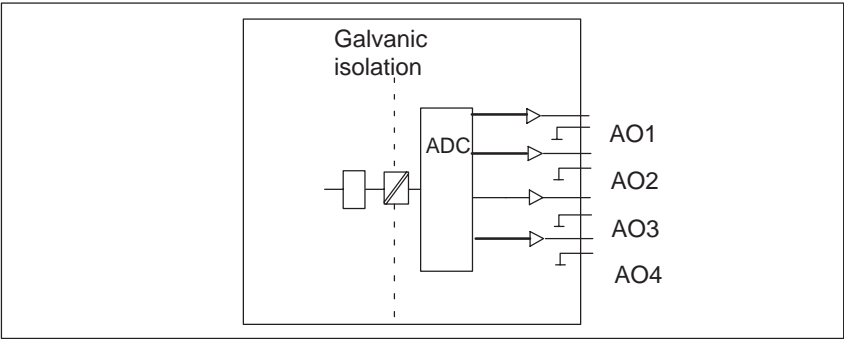


Figure 7-10 Block Diagram of the Analog Output Module

Technical Specifications

Data Specific to Analog Outputs	Status, Interrupts, Diagnostics
Number of outputs 4	Interrupts
Cable length, shielded 200 m	<ul style="list-style-type: none"> Diagnostic interrupt yes, selectable
Voltages, Currents, Potentials	Diagnostic functions yes, selectable
Isolation yes	<ul style="list-style-type: none"> Diagnostic information can be read out yes, group error
Dielectric strength $U_{ISO} = 500 \text{ V DC}$	Data for Selecting an Actuator
Measurement ranges: Voltage or current selectable	Output ranges (rated values) $\pm 10 \text{ V}$ $\pm 20 \text{ mA}$ From 4 to 20 mA
Voltage $\pm 10 \text{ V}$	Load resistance
Current $\pm 20 \text{ mA}$, 4 to 20 mA	<ul style="list-style-type: none"> For voltage outputs min. $2 \text{ k } \Omega$ For current outputs max. $500 \text{ } \Omega$ Capacitive load max. $1 \text{ } \mu\text{F}$ Inductive load max. 1 mH
Analog Value Formation	Voltage output
Resolution (incl. overflow range)	<ul style="list-style-type: none"> Short-circuit protection Short-circuit proof yes Short-circuit current approx. 25 mA
<ul style="list-style-type: none"> $\pm 10 \text{ V}$; $\times \geq 20 \text{ mA}$; 4 to 20 mA 	12 bits incl. sign
Conversion time (all active channels) max. 4 ms typ. 2 ms	Current output
Settling time	<ul style="list-style-type: none"> Idle voltage max. $\pm 15 \text{ V}$
<ul style="list-style-type: none"> For resistive load 0.1 ms For capacitive load 3.3 ms For inductive load 0.5 ms 	Connecting actuators
Substitute value	<ul style="list-style-type: none"> For voltage output 2-wire connection possible For current output 2-wire connection possible
Idle power and voltage yes, selectable	Destruction limits for voltages/currents applied externally
Global value can be substituted (one value for all channels) yes, selectable	<ul style="list-style-type: none"> Voltage at the outputs against M_{ANA} max. 20 V DC Current max. 40 mA DC
Retain last value yes, selectable	
Noise Suppression, Limit Values	
Crosstalk attenuation between outputs $> 40 \text{ dB}$	
Error limit (in the entire temperature range, relative to the output range)	
<ul style="list-style-type: none"> Voltage $\pm 0.8 \%$ Current $\pm 1 \%$ 	
Basic error limit (error limit at $25 \text{ } ^\circ\text{C}$ relative to the output range)	
<ul style="list-style-type: none"> Voltage $\pm 0.5 \%$ Current $\pm 0.6 \%$ 	
Output ripple (relative to the output range) $\pm 0.05 \%$	
Reproducibility (in settled state at $25 \text{ } ^\circ\text{C}$ relative to the output range) $\pm 0.06 \%$	

7.6 Use and Function of the C7 Analog I/O

In This Section

This section contains:

- Descriptions of the basic terms in analog value processing
- How to address and assign parameters to the analog I/O
- How you allocate measurement ranges to analog input channels
- The behavior of the individual analog input and output channels.

7.6.1 Addressing the Analog I/O

Analog Function Addresses

The address of an analog channel is always a word address.

An analog input/output has the same start address for the analog input and output channels (see Figure 7-11).

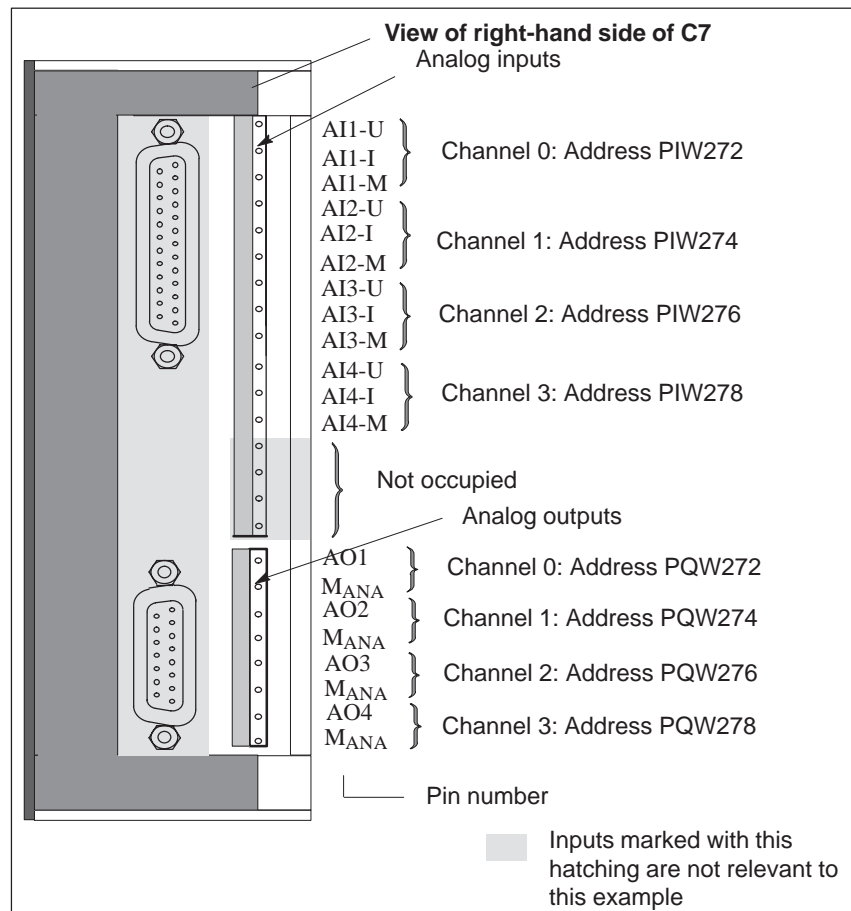


Figure 7-11 Analog Input/Output Addresses

7.6.2 Timing of the Analog I/Os

Analog Inputs

The timing of the analog inputs depends on the current parameter assignment of the analog I/Os (see Section 7.6.3). The duration of the measuring cycle depends on the number of activated analog input channels. Deactivated channels reduce the length of the measuring cycle.

The measuring cycle is the sum of the conversion times of the activated analog inputs.

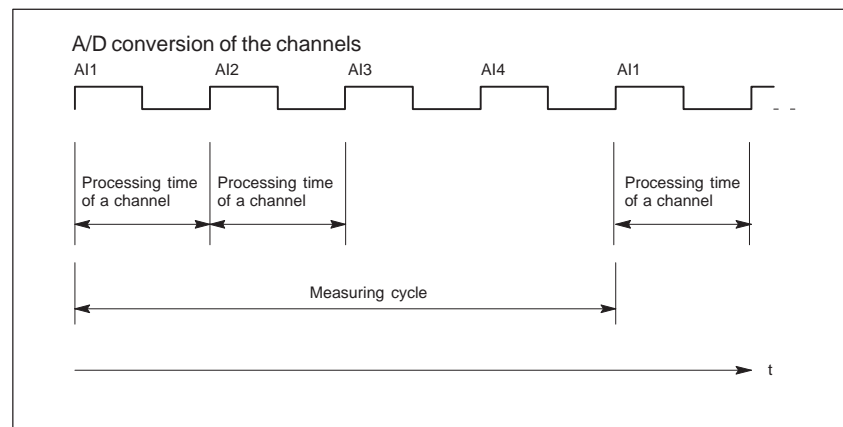


Figure 7-12 Measuring Cycle when All Analog Input Channels are Activated

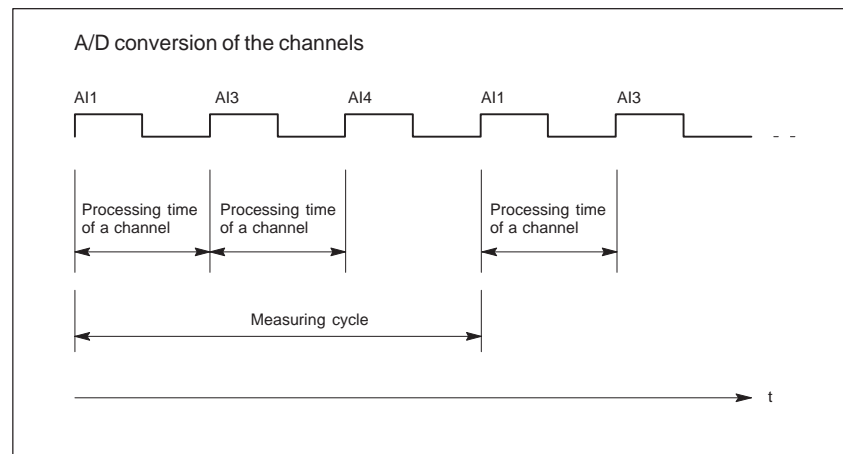


Figure 7-13 Measuring Cycle when Analog Input Channel 2 is Deactivated

Analog Outputs

The duration of the output cycle does **not** depend on the number of activated analog output channels. This is always constant and deactivated channels do not reduce the output cycle.

$$t_{\text{output cycle}} = 4 \times t_{\text{conversion time of a channel}} = \text{const.}$$

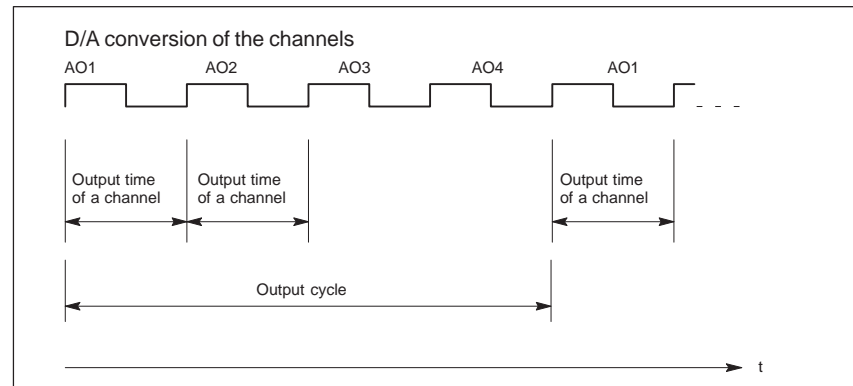


Figure 7-14 Output Cycle when All Analog Output Channels are Activated

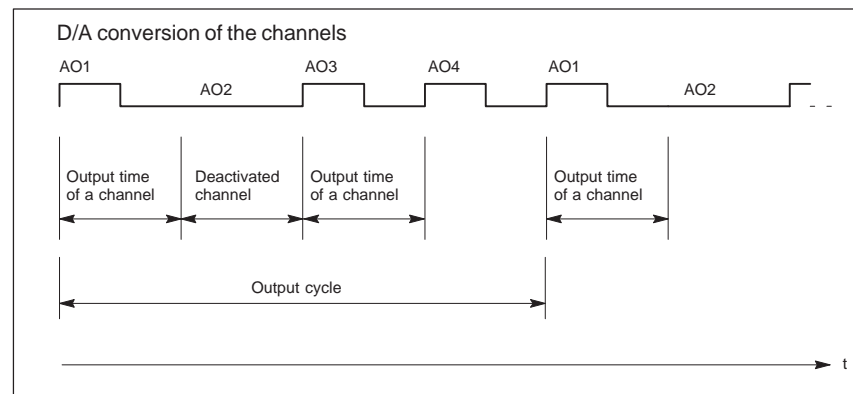


Figure 7-15 Output Cycle when Analog Output Channel 2 is Deactivated

7.6.3 Assigning Parameters to the Analog I/O

Overview

This chapter contains an overview of the analog I/O and their parameters.

Parameter Assignment

You set the parameters for the analog I/O using the S7 application *Configuring Hardware*. A parameter block is generated that contains all the currently selected I/O parameters. After loading this parameter block, the parameters are not immediately transferred to the analog I/O. The C7 CPU then transfers the parameters to the analog I/O after every operating mode change from STOP→RUN.

Alternatively, you can also change some parameters in the user program with SFCs 55 to 57 (see Reference Manual /235/).

We subdivide the parameters for the two configuration alternatives into:

- Static parameters and
- Dynamic parameters

The following table explains when the static and dynamic parameters are adopted.

Table 7-2 Time of Transfer of the Parameters from the C7 CPU to the Analog I/O

Parameter	Set with	Time of Parameter Transfer
Static	<i>Configuring Hardware</i>	STOP -> RUN
Dynamic	<i>Configuring Hardware</i>	STOP -> RUN
	SFCs 55 to 57	RUN

Assignment of Parameters for Characteristics

The following parameter blocks permit the assignment of parameters in *Configuring Hardware* to define the following characteristics of the analog I/O:

- For inputs
 - Basic settings
 - Diagnostics
 - Measurement
 - Interrupt cycle
- For outputs
 - Basic settings
 - Diagnostics
 - Substitute values
 - Output range

Analog Input Parameters

Table 7-3 provides an overview of the analog input parameters.

Table 7-3 Analog Input Parameters

Parameter	Analog Inputs	
	Value Range	Preset Value
Basic settings		
<ul style="list-style-type: none"> • Enable diagnostic interrupt 	Yes/No	No
Diagnostics		
<ul style="list-style-type: none"> • Enable <ul style="list-style-type: none"> – Configuration/parameter assignment error – Wire break (only 4 to 20 mA) – Range undershoot – Range overshoot • Wire break test (only for measurement range 4 to 20 mA) 	Yes/No	No
Measurement		
<ul style="list-style-type: none"> • Type of measurement 	Deactivated Voltage Current	Voltage
<ul style="list-style-type: none"> • Measurement range 	± 10 V ± 20 mA 4 to 20 mA	± 10 V
Interrupt cycle		
<ul style="list-style-type: none"> • Interrupt • Interrupt time 	Yes/No Unsolicited, 3ms, 3.5 ms, 4 ms, 4.5 ms to 16 ms	No Unsolicited

Hardware Interrupt

You can operate the inputs of the analog I/Os in three ways:

- Without hardware interrupt

A free measuring cycle of all activated channels without generating hardware interrupts.

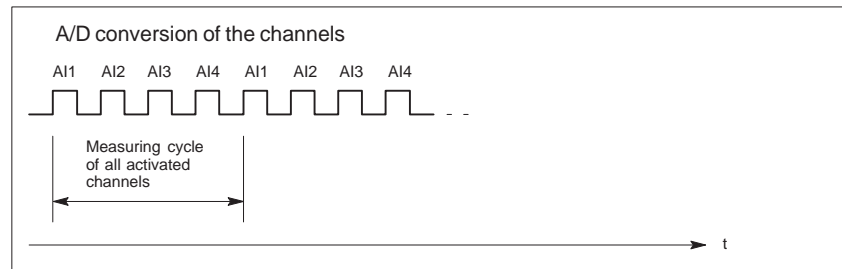


Figure 7-16 Sequence of the Measurement with Four Analog Input Channels without Generating Hardware Interrupts

- Hardware interrupt as a cyclic interrupt

Free measuring cycle of all activated channels with generation of a non measuring cycle-dependent hardware interrupt as a time interrupt with a configurable interrupt time.

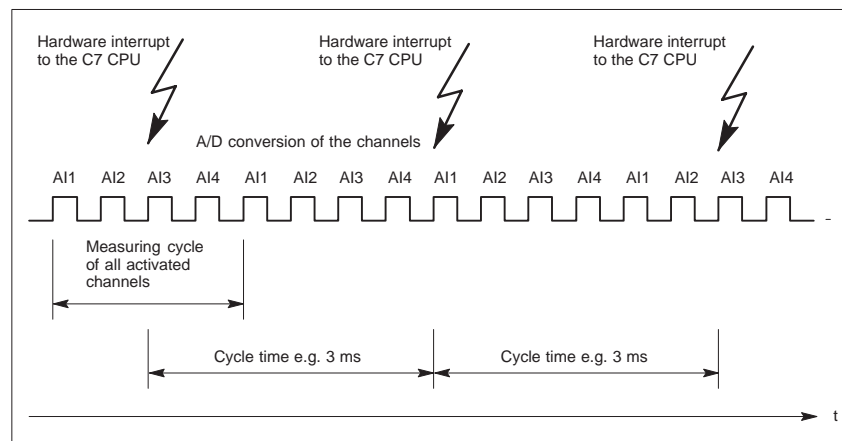


Figure 7-17 Sequence of the Measurement with Four Analog Input Channels and Generation of Hardware Interrupts as Cyclic Interrupts

- Hardware interrupt as cycle end interrupt

A measuring cycle with a configurable cycle time and generation of a hardware interrupt as a cycle end interrupt.

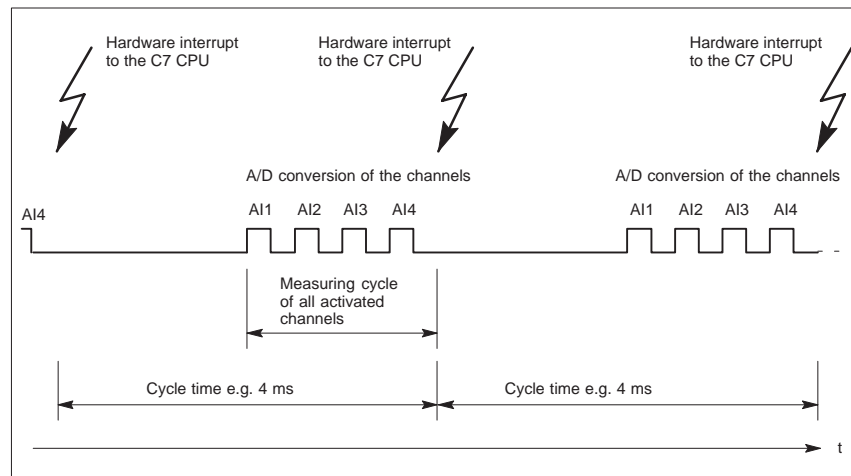


Figure 7-18 Sequence of the Measurement with Four Analog Input Channels with Generation of Hardware Interrupts as Cycle End Interrupts

A hardware interrupt from the I/Os triggers the start of OB40 (hardware interrupt OB) on the C7 CPU. In this case, the process variable OB40_POINT_ADDR supplies the value DW#16#10000000.

Parameter Characteristics of Analog Inputs

Table 7-4 shows which parameters

- Are static or dynamic
- Can be set for all or individual analog inputs.

Table 7-4 Parameter Characteristics of Analog Inputs

Parameter	Static/Dynamic	Effective Range
Enable diagnostic interrupt	Static	Analog inputs/ Analog outputs/ Universal inputs
Enable diagnostics	Static	Channel
Wire break test	Static	Channel
Type of measurement	Dynamic	Channel
Measurement range	Dynamic	Channel
Interrupt cycle	Dynamic	Analog inputs

Analog Output Parameters

Table 7-5 provides an overview of the analog output parameters.

Table 7-5 Analog Output Parameters

Parameter	Analog Output	
	Value Range	Preset Value
Basic setting		
• Enable diagnostic interrupt	Yes/No	No
Diagnostics		
• Enable	Yes/No	No
– Configuration/parameter assignment error		
– Substitute value switched on		
Substitute value		
• Idle power and voltage (value 0)	Yes/No	Yes
• Retain last value	Yes/No	No
• Global substitute value	9400 _H ...6C00 _H	0
Output range		
• Type of output	Deactivated Voltage Current	Voltage
• Output range	± 10 V ± 20 mA 4 to 20 mA	± 10 V

Parameter Characteristics of Analog Outputs

Table 7-6 shows which parameters

- Are static or dynamic
- Can be set.

Table 7-6 Parameter Characteristics of Analog Outputs

Parameter	Static/Dynamic	Effective Range
Enable diagnostic interrupt	Static	Analog inputs / Analog outputs/ Universal inputs
Enable diagnostics	Static	Outputs
Substitute value		
• Idle power and voltage (value 0)	Dynamic	Outputs
• Retain last value	Dynamic	Outputs
• Global substitute value	Dynamic	Outputs
Type of output	Dynamic	Outputs
Output range	Dynamic	Outputs

7.6.4 Representation of Analog Values

Overview

The representation of analog values, or an analog value in binary form, is the same for all C7 analog inputs and analog outputs.

This section describes the analog values for **all** measurement ranges or output ranges that can be used with the C7 analog I/O.

Representation of Analog Values

The digitalized analog value is the same for input and output values of the same nominal range.

The representation of analog values is performed as a two's complement

Table 7-7 illustrates the representation of the analog I/O:

Table 7-7 Representation of Analog Values

Resolution	Analog Value															
Bit number	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Weighting of the bits	S	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Sign Conventions

The sign (S) of the analog value is always contained in bit number 15:

- “0” → +
- “1” → –

12-Bit Resolution

The resolution is 12 bit. The analog value is entered into the ACCU left justified. The unoccupied low significance places are written with “0”.

Table 7-8 contains an example of a bit pattern showing how the unoccupied places for 12-bit resolution are filled with “0”.

Table 7-8 Bit Pattern of a 12-Bit Analog Value (Example)

Resolution	Analog Value															
Bit number	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
12-bit analog value (incl. sign)	0	1	0	0	0	1	1	0	0	1	1	1	0	0	0	0

7.6.5 Representation of Analog Values for the Measurement Ranges of the Analog Inputs

Overview

The tables in this section contain the digitalized analog values for the measurement ranges of the analog inputs.

In Table 7-9, you will find the representation of the binary analog values and the associated decimal or hexadecimal representation of the units of the analog values.

How to Read the Measured Value Tables

Table 7-10 contains the digitalized analog values for the various measurement ranges.

Since the binary representation of the analog values is always the same, this table contains only the comparison of the measurement ranges to the units.

This table is therefore clearer and easier to read. The corresponding binary representation of the measured values can be referred to in Table 7-9.

Measured Value Resolution

The bits identified with “x” are not relevant to a resolution of 12 bits.

Table 7-9 Possible Resolutions of Analog Values

Resolution in Bits (incl. Sign)	Units		Analog Value	
	Decimal	Hexadecimal	High Byte	Low Byte
12	16	10 _H	S 0 0 0 0 0 0 0	0 0 0 1 x x x x

Voltage and Current Measurement Ranges

Table 7-10 contains the representation of the digitized voltage measurement ranges for ± 10 V and the digitized current measurement ranges ± 20 mA, 4 to 20 mA.

Table 7-10 Representation of the Digitalized Measured Value of the Analog Inputs (Voltage and Current Measurement Ranges)

Measuring Range ± 10 V	Measuring Range ± 20 mA	Measuring Range 4 to 20mA	Units		Range
			Decimal	Hexadecimal	
≥ 11.759	≥ 23.516	0	≥ 32512	$\geq 7F00_H$	Overflow
11.7589	23.515	22.81	32511	7EFF _H	
:	:	:	:	:	Upper range
10.0004	20.0007	20.005	27649	6C01 _H	
10	20.000	20.000	27648	6C00 _H	Nominal range
7.500	14.998	:	20736	5100 _H	
:0	:0	4.000	:0	:0 _H	
- 7.500	- 14.998	3.9995	-20736	AF00 _H	
- 10	- 20.000	0	-27648	9400 _H	
- 10.0004	- 20.0007	Underflow range	-27649	93FF _H	Lower range
:	:		:	:	
- 11.759	- 23.516		-32512	8100 _H	
$\leq - 11.76$	$\leq - 23.517$		$\leq - 32513$	$\leq 80FF_H$	Underflow

7.6.6 Representation of Analog Values for the Output Range of the Analog Outputs

Table for Output Ranges

Table 7-11 contains the analog output ranges of the analog outputs.

Voltage /Current Output Ranges

Table 7-11 contains the representation of the voltage output range ± 10 V and the current output ranges ± 20 mA, 4 to 20 mA

Table 7-11 Representation of the Analog Output Range of the Analog Outputs (Voltage/Current Output Ranges)

Output Range ± 10 V	Output Range 4 to 20 mA	Output Range ± 20 mA	Units		Range	
			Decimal	Hexadecimal		
0	0	0	≥ 32512	≥ 7F00 _H	Overflow	
11.7589	22.81	23.515	32511	7EFF _H	Upper range	
:	:	:	:	:		
10.0004	20.005	20.0007	27649	6C01 _H		
10.0000	20.000	20.000	27648	6C00 _H	Nominal range	
:	:	:	:	:		
0	4.000	0	0	0 _H		
0	3.9995	:	:	:		
:	0		- 6912	E500 _H		
-10.0000			- 6913	E4FF _H		
			:	:		
-10.0000		- 20.000	- 27648	9400 _H		
10.0004		- 20.0007	- 27649	93FF _H	Lower range	
:		:	:	:		
-11.7589		23.515	- 32512	8100 _H		
0		0	≤ - 32513	≤ 80FF _H	Underflow	

7.6.7 Conversion and Cycle Time of the Analog Inputs

Introduction

You can find the definitions and relationships between conversion time and cycle time for the analog inputs in this section.

Conversion Time

The conversion time consists of the basic conversion time and an additional conversion time necessary for the input calibration.

Cycle Time

The analog-digital conversion and the transfer of the digitalized measured values to the C7 CPU is performed sequentially, i.e. the analog input channels are converted one after the other. The cycle time, i.e. the elapsed time before an analog input value is converted again, is the sum of all conversion times (0.5 ms/channel) of all activated analog input channels. Unused analog input channels should be deactivated in the *Configuring Hardware* application in order to reduce the cycle time.

Figure 7-19 illustrates an overview of how the cycle time for a 4-channel analog input is composed.

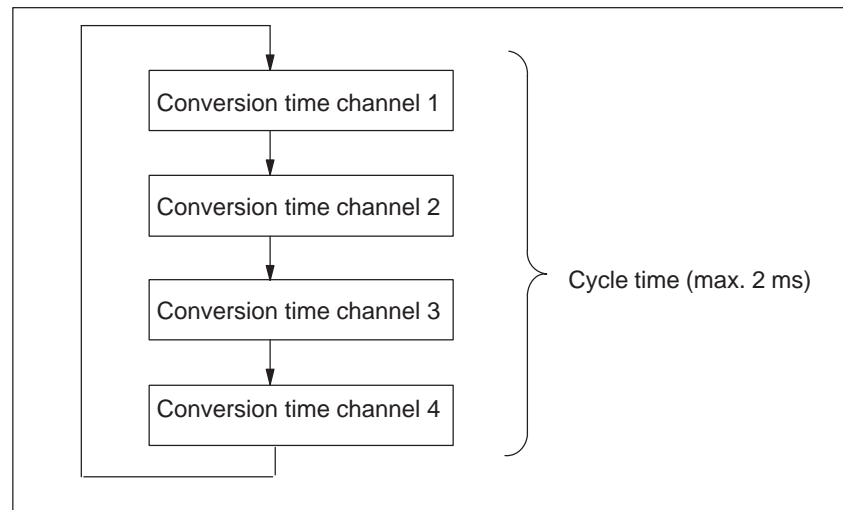


Figure 7-19 Cycle time of an Analog Input

Interrupt Cycle

If the interrupt cycle mode is assigned parameters, the new measuring cycle is not started unless the time interrupt is initiated (see Section 7.6.3).

7.6.8 Conversion, Cycle, Settling and Response Times of Analog Outputs

Introduction	This section contains the definitions and relationships between relevant times for the analog outputs.
Conversion Time	The conversion time includes the acceptance of the digitalized output values from the internal memory and the digital-analog conversion.
Cycle Time	The cycle time, i.e. the elapsed time before an analog output value is next converted is equal to the time for the conversion of the analog outputs.
Settling Time	The settling time (t_2 to t_3), that is the elapsed time between the creation of the converted value and the attainment of the specific value at the analog output, is load-dependent. You must differentiate between resistive, capacitive, and inductive load.
Response Time	The response time, that is the interval between providing the digital output value and attaining the specified value at the analog output, is between 100 μ s and 2 ms.

7.6.9 Behavior of the Analog I/O

Overview

This section describes:

- The dependency of the analog input and output values on the supply voltages of the analog I/O and the operating modes of the C7.
- The behavior of the analog I/O depending on the position of the analog values in the respective value range.
- The influence of errors on the analog I/O.

Influence of the Supply Voltage and the Operating Mode

The input and output values of the analog I/O are dependent upon the supply voltage of the analog I/O and the operating mode of the C7.

The triggering of a diagnostic interrupt is dependent upon the parameter assignment.

Table 7-12 gives an impression of these inter-relationships.

Table 7-12 Dependencies Between Analog Input and Output Values upon the Operating State of the C7 and upon the Supply Voltage L+

Operating state of C7		Input value of the analog input	Output value of the analog output
POWER ON	RUN	Process value	C7 value
	STOP	Process value	Substitute value or Retain last value (configurable)
POWER OFF	STOP	–	0 signal

Influence of the Value Range on the Input

The behavior of the analog input is dependent upon the position of the input values within the value range. Table 7-13 illustrates this dependency for the analog input values.

Table 7-13 Behavior of the Analog Input Depending on the Position of the Analog Input Value in the Value Range

Process Value lies in	Input Value	Diagnostics	Interrupt
Nominal range	Process value	–	–
Upper range/lower range	Process value	–	–
Overflow/underflow	7FFF _H	Message ¹	Diagnostic interrupt ¹

¹ According to parameter assignment

Influence of the Value Range for the Output

The behavior of the analog output is dependent upon the position of the output values within the value range. Table 7-14 illustrates this dependency for the analog output values.

Table 7-14 Behavior of the Analog Input in Relation to the Position of the Analog Input Value in the Value Range

Output Value lies in	Output Value	Diagnostics	Interrupt
Nominal range	C7 value	–	–
Upper range/lower range	C7 value	–	–
Overflow/underflow	0 signal	–	–

Influence of Errors

Errors lead to a diagnostic message and diagnostic interrupt if diagnostic parameters have been assigned (see Section 10.2).

7.6.10 Time Interrupt/Interrupt Cycle

Interrupt Cycle	If the interrupt cycle mode is assigned parameters, the new measuring cycle is not started unless the time interrupt is initiated (see Section 7.6.3).
Configurable Events	Use the STEP 7 application <i>Configuring Hardware</i> for parameter assignment.
Hardware Interrupt OB	If a hardware interrupt is transferred from the I/O to the C7 CPU, the hardware interrupt OB (OB40) is called in the C7 CPU. The event which called OB40 is stored in the start information (declaration section) of OB40. You have to evaluate the additional information Z1 to Z3 in the start information.
Declaration Section of OB40	The entries in the declaration section of OB40 are listed in Table 7-15. The bytes relevant to the user are hatched in the table.

Table 7-15 Declaration Section of OB40

Byte	Meaning		Meaning	Byte
0	Class	Identifier	Event number	1
2	Priority class		Current OB number	3
4	Data identifiers Z2/3		Data identifier Z1	5
6	Additional information Z1			7
8	Additional information Z2			9
10	Additional information Z3			11
12	Time stamp of event			13
14				15
16				17
18				19

Additional Information Z1 Additional information Z1 contains the start address of the C7 I/O module (bytes 6/7).
Address: 272 or 0110_H

Additional Information Z2 Bit 4 of byte 8 = 1 in the case of an end-of-cycle interrupt.

Additional Information Z3 Additional information Z3 is not used and assigned the value 0000_H.

Evaluation in the User Program The evaluation of hardware interrupts in the user program is described in the manual /234/.

7.7 Examples for Programming the Analog I/O

Overview

The following examples for programming the analog I/O will help to familiarize you with the principles of programming the C7 I/O.

7.7.1 Block for Scaling Analog Input Values

Function of Block

The FC126 block is used to convert the actual value entered as a hexadecimal number in a peripheral input word into a corresponding-point number (=analog value) to be output to a memory double word. For this purpose, a simple calculation using the rule of three is programmed.

1. First, the actual value is related to the total range (RANGE_HEX) resulting from the difference (UL - LL).

The result is a percentage of the absolute actual value. This is identical in the floating-point number and in the hexadecimal representation.

2. Then the total range resulting from the difference (UL - LL) is calculated in floating-point number representation, depending on whether the measuring range is unipolar or bipolar.
3. Now the percentage (PERCENT) calculated before is related to the total floating-point number range.

The result is the absolute read-in value.

4. Finally, the lower limit (LL) is added to this value as the offset.
5. The resulting floating-point number is output.

Summary of Formulae

$$\text{PERCENT} = (\text{channel} - \text{LL}) / (\text{UL} - \text{LL})$$
$$\text{RANGE_HEX} = \text{UL} - \text{LL}$$
$$\text{actual value} = \text{PERCENT} * (\text{upper limit} - \text{lower limit}) + \text{lower limit}$$

FC126 Sequence of Statements

The FC126 function contains the following statement lines:

```

FUNCTION FC 126: void

var_input
    lower limit: DWORD;
    upper limit: DWORD;
    channel: DWORD;

end_var

var_output
    actual value : DWORD;

end_var

var_temp
    LL:DWORD;
    RANGE_HEX:DWORD;
    PERCENT:DWORD;

end_var

BEGIN

    /***Case: unipolar or bipolar measuring range***
    L lower limit;           // lower limit negative?
    L 0.0;                   // yes=> bipolar measuring range
    <R;
    JC bipo;

    L DW#16#000_00000;      // unipolar range lower limit
    T LL
    JU comp;

    bipo: NOP 0;
    L W#16#9400;            // bipolar range lower limit
    ITD;
    T LL;

    /***Computing the range (hexadecimal)***
    comp:NOP 0;

    L W#16#6C00;            // upper limit for unipolar and bipolar
                                //range identical

    ITD;
    L LL;
    -D;
    T RANGE_HEX;           // buffer difference
  
```

```
**** Relating actual value to total measuring range****
L channel;                                // relate input value to total
                                           // range

ITD;
L LL;
-D;
DTR;
L RANGE_HEX;
DTR;
/R;
T PERCENT;

****Computing floating point number****
L upper limit;                            // calculate floating point number range
L lower limit;
-R;
L PERCENT;
*R;
L lower limit;
+R;
T actual value;

END_FUNCTION
```

Calling FC126 in OB1

An example for calling FC126 is described below.

Before calling the function, the range limits must be reassigned to memory double words. This is necessary to enable using variable values. Normally, “upper limit” and “lower limit” are fixed values.

This can be achieved by setting the “upper limit” and “lower limit” parameters in the declaration section of FC126 to “REAL”. To enhance flexibility in a test environment, this variant has been omitted.

Sequence of Statements in OB1

```
ORGANIZATION_BLOCK OB1
var_temp
                                start_info:array [0..19] of byte;

end_var;
BEGIN;

L10.0;
T MD4;

L -10.0;
T MD0;

CALL FC 126 (
                                lower limit:=MD0,
                                upper limit:=MD4,
                                channel:=PIW272
                                actual value:=MD8
                                );
END_ORGANIZATION_BLOCK
```

7.7.2 Block for Scaling Analog Output Values

Function of Block

The FC127 block is used to convert the setpoint to be specified in a memory double word as a floating-point number to the corresponding hexadecimal pattern (=analog value) which must be output to a peripheral output word. For this purpose, a simple calculation using the rule of three is programmed.

1. First, the setpoint is related to the total range (RANGE_DEC) resulting from the difference (upper limit - lower limit).

The result is a percentage of the absolute setpoint value. This is identical in the floating-point number and in the hexadecimal representation.

2. Then the total range (RANGE_HEX), resulting from the difference (UL - LL) is calculated in hexadecimal representation, depending on whether the measuring range is unipolar or bipolar.

3. Now the percentage (PERCENT) calculated before is related to the total hexadecimal range (RANGE_HEX).

The result is the absolute value to be output.

4. Finally, the lower limit (LL) is added to this value as the offset.
5. The resulting bit pattern is output.

Summary of Formulae

$$\text{PERCENT} = (\text{setpoint} - \text{lower limit}) / (\text{upper limit} - \text{lower limit})$$

$$\text{RANGE_DEC} = \text{upper limit} - \text{lower limit}$$

$$\text{RANGE_HEX} = \text{UL} - \text{LL}$$

$$\text{Channel} = \text{PERCENT} * \text{RANGE_HEX} + \text{LL}$$

FC127 Sequence of Statements

The FC127 function contains the following statement lines:

FUNCTION FC 127: void

var_input

lower limit: DWORD;
upper limit: DWORD;
setpoint: DWORD;

end_var

var_temp

LL : DWORD;
UL : DWORD;
RANGE_DEC : DWORD;
RANGE_HEX : DWORD;
PERCENT : DWORD;

end_var

```
BEGIN

/**Case: unipolar or bipolar measuring range?*/
L lower limit;           // lower limit negative?
L 0.0;                   // yes => bipolar measuring range
<R;
JC bipo;

L DW#16#0000_0000;       //unipolar range lower limit
T LL
JU comp;

bipo NOP 0
L W#16#9400;             // bipolar range lower limit
ITD;
T LL;

/**Calculating the range (hexadecimal)*/
comp: NOP 0;

L W#16#6C00;             // upper limit for unipolar and bipolar
                        // range identical
ITD;
L LL;
-D;
T RANGE_HEX;            // buffer difference

/** Relating setpoint to total measuring range*/
L upper limit;          // compute range
L lower limit
-R;
T RANGE_DEC;

L setpoint;              // relate setpoint to total
                        // range
L lower limit;
-R;
L RANGE_DEC;
/R;
T PERCENT;

/**Computing hex pattern to be output*/
L RANGE_HEX;            // relate hex value to total range
DTR;
L PERCENT;
*R;
L LL;                   // add offset
DTR;
+R;
RND;                    // convert floating-point number to
                        // 32-bit integer
T channel;              // output result
```

Calling FC127 in OB1

An example for calling FC127 is described below.

Before calling the function, the range limits and the setpoint must be reassigned to memory double words. This is necessary to enable using variable values. Normally, “upper limit” and “lower limit” are fixed values; the “setpoint” is variable.

This can be achieved by setting the “upper limit” and “lower limit” parameters in the declaration section of FC127 to “REAL”. To enhance flexibility in a test environment, this variant has been omitted.

Sequence of Statements in OB1

ORGANIZATION_BLOCK OB1

var_temp

start_info:array [0..19] of byte;

end_var

BEGIN

L -10.0;

T MD0;

L 10.0;

T MD4;

L 2.2;

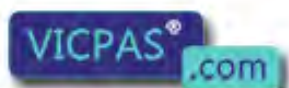
T MD8;

CALL FC 127 (

lower limit:=MD0,
upper limit:=MD4,
setpoint:=MD8,
channel:=PQW272

);

END_ORGANIZATION_BLOCK



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C7 Universal Inputs

8

Chapter Overview

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8.1 Universal Inputs

Overview

The C7 has 4 digital universal inputs that provide the following functionality:

- Interrupt input
- Counter input
- Frequency/period duration counter input
- Digital input
- External gate counter input

These input functions can be set by assigning them parameters; this determines how the inputs are used.

Terminal Connection Diagram

Figure 8-1 shows the pin assignments of the universal inputs

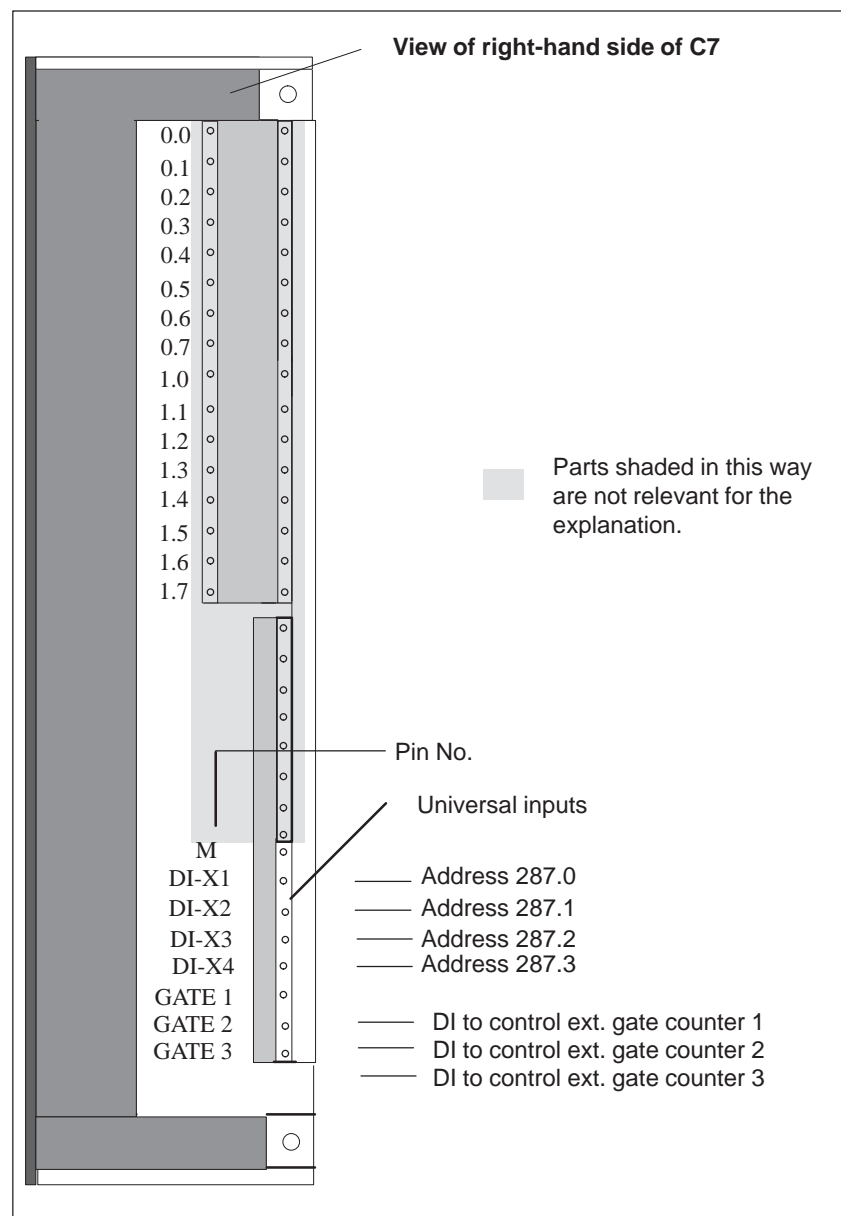


Figure 8-1 Pin Assignments of the Universal Inputs

Pin Assignments of the Universal Inputs

The pin assignments of the universal inputs are as follows:

Table 8-1 Assignments of the Universal Inputs

Pin No.	Function
M	Associated ground
DI-X1	Universal input 1 (interrupt, digital and counter input, external gate counter 16 bit)
DI-X2	Universal input 2 (interrupt, digital and counter input, external gate counter 16 bit)
DI-X3	Universal input 3 (interrupt, digital, counter, frequency counter and period duration counter input, external gate counter 24 bit)
DI-X4	Universal input 4 (interrupt or digital input)
GATE 1	External gate pin for DI-X1
GATE 2	External gate pin for DI-X2
GATE 3	External gate pin for DI-X3

Assigning Parameters to the Inputs

The universal inputs are set using software. This is done using the *Configuring Hardware* application. You use this application to determine which function the individual input is to execute (see Table 8-1).

Interrupt Input

If this function is set, the input responds like a normal interrupt input, that is, a hardware interrupt is triggered in the C7 CPU as a response to the assigned edge.

Digital Input

If this function is set, the input responds like a normal digital input (see Section 6.1). The only difference here is that the current process signal is not automatically given to the control program but must first be read in from the I/O.

Counter Input

These universal inputs enable you to capture counter pulses up to a frequency of 10 kHz. The counter can count either up or down. You can also assign parameters to the count edge.

Frequency Counter

This enables you to count pulses within a programmed length of time. From this you can calculate a frequency ≤ 10 kHz.

Period Duration Counter

This function enables you to count fixed timer ticks between two positive edges. From this you can calculate the duration of an interval period.

External Gate Counter

This function enables you to count pulses within a gate time that starts with a rising edge on the external gate pin and ends with a falling edge.

Technical Specifications of the Universal Inputs

Specific Data of the Universal Inputs		External Gate Counter	
Number of inputs	4 + 3 (gate pins)	• Principle	Max. 3 Edge counting via external pin
Cable length, shielded	1000 m	• Counter range C1/C2	0 to $2^{16}-1$
unshielded	600 m	• Counter range C3	0 to $2^{24}-1$
Voltages, Currents, Potentials		Data for Selecting a Sensor	
Nominal load voltage L +	24 VDC	Input voltage	
Number of simultaneously energizable inputs	4 + 3 (gate pins)	• Nominal voltage	24 VDC
Galvanic isolation	No	• For "1" signal	from 11 to 30 V
		• For "0" signal	from -3 to 5 V
Function, Interrupts, Diagnostics		Input current	
Interrupts } Counter functions } Max. counter frequency Diagnostic function	Can be assigned parameters 10 kHz Module standard diagnostics in conjunction with analog I/O. No channel-specific diagnostics Max. 3	• At "1" signal	from 2 to 8 mA
Counters		Input delay time	
• Principle	Edge counting	• Configurable	No
• Counter range C1/C2	up 0 to $2^{16}-1$ down $2^{16}-1$ to 0	• From "0" to "1"	approx. 0.01 ms
• Counter range C3	up 0 to $2^{24}-1$ down $2^{24}-1$ to 0	• From "1" to "0"	approx. 0.01 ms
• Limit value (setpoint) specification	1 value per counter	Input characteristic	In accordance with IEC 1131, Part 2
• Counter interrupt of up counter	When limit value is reached	Type of input in accordance with IEC 1131	Type 2
• Counter interrupt of down counter	When "0" is reached	Input current	
• Enable	In the program	• At "1" signal	From 6 to 11.5 mA
Period Duration Counter	Max. 1		
• Principle	Counting fixed time units between two positive edges		
• Counter range	0 to $2^{24}-1$		
• Max. period duration	8.395 s or 0.119 Hz		
Frequency Counter	Max. 1		
• Principle	Counting of pulses within a time period		
• Counter range	0 to $2^{24}-1$		
• Gate width	0, 1 s, 10 s (can be set)		
• Max. frequency	10 kHz; limited by input filter		

8.2 Use and Function of the Universal Inputs

In This Section

In this section you can find:

- Basic terminology about the function of the universal inputs
- How you can use the universal inputs
- How you can address and assign parameters to the universal inputs

8.2.1 Addressing Universal Inputs

Overview

You can select the following functions by assigning the appropriate parameters to the universal inputs:

- Digital input
- Interrupt input
- Counter
- Frequency counter
- Period time counter
- External gate counter

Universal Input Addresses

The addresses for the universal inputs are default addresses which cannot be changed. According to the application of the universal inputs, the results occupy differing addresses.

For the address allocation, a distinction is made between:

- The input range PIW280 to PIB287 for count values or signal state of the digital inputs, and
- The output/control range PQW 280 to PQB287 for counters

Input Range

The 4 universal inputs of the input range (see Figure 8-1) have the following addresses and weightings:

Table 8-2 Input Address of the Universal Inputs

Address		Designation
PIB280 PIB281		CI1: Counter input
PIB282 PIB283		CI2: Counter input
PIB284 PIB285 PIB286		CI3: Counter input Frequency/period time counter
PIB287	Bit 7	—
	Bit 6	
	Bit 5	States of the count inputs see Table 8-3
	Bit 4	
	Bit 3	Current state of universal input 4
	Bit 2	Current state of universal input 3
	Bit 1	Current state of universal input 2
	Bit 0	Current state of universal input 1

States of the Inputs

The state of the individual inputs is stored as a bit pattern in PIB287:

Table 8-3 State of the Inputs

Address PIB287	Status Display of Universal Inputs
Bit7	—
Bit 6*)	Bit = 1: Counter 3 enabled Bit = 0: Counter 3 disabled
Bit 5*)	Bit = 1: Counter 2 enabled Bit = 0: Counter 2 disabled
Bit 4*)	Bit = 1: Counter 1 enabled Bit = 0: Counter 1 disabled
Bit 3	Bit = 1: universal input 1 set. Bit = 0: universal input 1 reset.
Bit 2	Bit = 1: universal input 2 set. Bit = 0: universal input 2 reset
Bit 1	Bit = 1: universal input 3 set. Bit = 0: universal input 3 reset.
Bit 0	Bit = 1: universal input 4 set. Bit = 0: universal input 4 reset.

*) Only relevant if universal input was assigned as count input

Output Range

If the universal inputs are used as counters, then the behavior of the counters is controlled via the output range.

Table 8-4 Addresses and Weighting of the Output Range of the Count Inputs

Address	Control of Counters 1 to 3
PQW280	Start/comparison value counter 1 [*]
PQB287: Bit 0 Bit 1	0 = Counter 1 disabled 1 = Counter 1 enabled 0 = Do not accept new start/comparison value 1 = Set new start/comparison value
PQW282	Start/comparison value counter 2 [*]
PQB287: Bit 0 Bit 1	0 = Counter 2 disabled 1 = Counter 2 enabled 0 = Do not accept new start/comparison value 1 = Set new start/comparison value
PQB284 PQB285 PQB285	Start/comparison value counter 3 [*]
PQB287 Bit 4 Bit 5	0 = Counter 3 disabled 1 = Counter 3 enabled 0 = Do not accept new start/comparison value 1 = Set new start/comparison value

^{*}) Initial value for down counter, comparison value for up counter

Note

Please note that no direct read-in function is available for reading in the complete counter status of counter 3.

When counting in the 0 to 65535 value range (2 bytes), the counter values are stored in PQW285.

8.2.2 Assigning Parameters to the Universal Inputs

Parameter Block Universal Inputs

In the parameter block “universal inputs” you set the parameters for:

- The interrupt inputs
- The counters
- The frequency meter/period time counter
- The digital inputs
- The external gate counter

Assigning Parameters

You set the parameters for the universal inputs using the STEP 7 application *Configuring Hardware*. A parameter block is generated which contains all currently selected parameters of the universal inputs. After loading this parameter block, the C7 CPU then transfers the parameters to the appropriate universal inputs at every operating mode change from STOP → RUN.

Interrupt Inputs

If the universal inputs are used as interrupt inputs, a hardware interrupt will be triggered on the C7 CPU for the assigned rising or falling edge at the input. The default is the rising edge.

Counter Inputs

The universal inputs 1 to 3 can be assigned as:

- Counter input, 16 bit (counters 1 and 2)
- Counter input, 24 bit (counter 3)
- Frequency counter (input 3 only)
- Period time counter (input 3 only)
- External gate counter, 16 bit (inputs 1 and 2 only)
- External gate counter, 24 bit (input 3 only)

The counter values are made available to the user program as 16-bit or 24-bit values and the frequency and period time counter values as 24-bit values. The counter values of the external gate counter are either 16-bit or 24-bit values, depending on the input.

Table 8-5 lists the parameters for the above-mentioned functions:

Table 8-5 Parameter Block of the Count Inputs

Parameter	Explanation	Value Range	Default Setting
Count input 1	Activate the count input and define the type of counting	Standard Interrupt Counter HW gate counter	Standard
	Define the count direction	Up Down	Up
	Set edge to be used for counting	Rising edge Falling edge	Rising edge
	Counter can trigger a hardware interrupt after reaching the comparison value (when counting up) or on zero transition (when counting down)	Yes No	No
	No further parameters for external gate counter (16 bit)	—	—
Count input 2	Activate the count input and define the type of counting	Standard Interrupt Counter HW gate counter	Standard
	Define the count direction	Up Down	Up
	Set edge to be used for counting	Rising edge Falling edge	Rising edge
	Counter can trigger a hardware interrupt after reaching the comparison value (when counting up) or on zero transition (when counting down)	Yes No	No
	No further parameters for external gate counter (16 bit)	—	—

Table 8-5 Parameter Block of the Count Inputs

Parameter	Explanation	Value Range	Default Setting
Count input 3	Activate the count input and define the type of counting	Standard Interrupt Counter Frequency counter Period duration counter HW gate counter	Standard
	If counter activated then define the count direction	Up Down	Up
	If counter activated then define the edge to be used for counting	Rising edge Falling edge	Rising edge
	If counter activated, then the counter can trigger a hardware interrupt after reaching the comparison value (when counting up) or on zero transition (when counting down)	Yes No	No
	If frequency counter selected, then select the gate time for the frequency counting	0.1 s 1 s 10 s	1 s
	No further parameters for period time counter	–	–
	No further parameters for external gate counter (24 bit)	–	–

Digital Inputs

If the universal inputs are deactivated in the parameter block (default setting), then the inputs react as digital inputs. However, no automatically updated process image will be made available to the user program for these inputs. The current state of the input can only be read by means of a direct I/O access. (See Table 8-2 or 8-3 for address).

8.2.3 Interrupt Inputs and Counter Interrupts

Introduction to Interrupt Inputs

If universal inputs are used as interrupt inputs, then a hardware interrupt will be generated every time there is a corresponding (assigned) edge at one of the inputs.

Introduction to Counter Interrupts

The universal input counters can be assigned parameters for hardware interrupts. In this case, a forward counter triggers a hardware interrupt when it reaches the comparison value, and a backward counter when it passes through zero.

Assignable Events

The parameter assignment can be performed with STEP 7 application *Configuring Hardware* or with one of the system functions SFC55 to SFC58.

Hardware Interrupt OB

If a hardware interrupt is sent from the I/O to the C7 CPU, then the hardware interrupt OB (OB40) will be called on the C7 CPU. The event that called the OB40 is stored in the start information (declaration section) of the OB40. You must evaluate the additional information Z1 to Z3 in the start information.

Declaration Section of OB40

The entries in the declaration section of OB40 can be found in Table 8-6. The bytes that are relevant to the user are hatched in the table.

Table 8-6 Declaration section of OB40

Byte	Meaning		Meaning	Byte
0	Class	Identifier	Event number	1
2	Priority class		Current OB number	3
4	Data identifier Z2/3		Data identifier Z1	5
6	Additional information Z1			7
8	Additional information Z2			9
10	Additional information Z3			11
12	Time stamp of event			13
14				15
16				17
18				19

Additional Information Z1

The start address of the C7 I/O module is contained in the additional information Z1 (byte 6/7).
Address: 272 or 0110_H

Additional Information Z2 for Interrupt Inputs

The consecutive number of the universal input that triggered the hardware interrupt can be found in byte 8 of the additional information Z2. Byte 9 is irrelevant.

You can find the additional information broken down into bits in Figure 8-2.

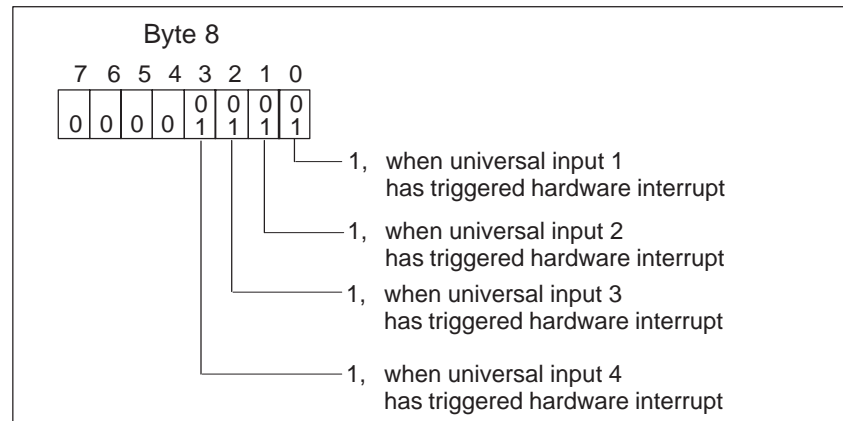


Figure 8-2 Additional Information Z2

Additional Information Z2 for Counter Interrupts

The consecutive number of the universal input that triggered the hardware interrupt can be found in byte 8 of the additional information Z2. Byte 9 is irrelevant.

You can find the additional information broken down into bits in Figure 8-3.

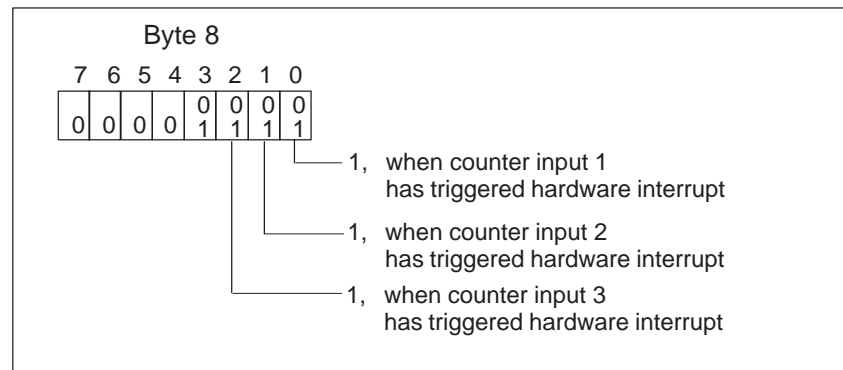


Figure 8-3 Structure of Additional Information Z3 in Declaration Section of OB40

Additional Information Z3

Additional information Z3 is not used and is set to 0000_H.

Evaluation in the User Program

The evaluation of hardware interrupts in the user program is described in the manual /280/.

8.2.4 Counters

Counter

The counter calculates the actual value of the count from the count pulses (up or down).

You can assign parameters with the STEP 7 application *Configuring Hardware* or with the system functions SFC55 to SFC58 to define whether:

- A count pulse is triggered by a rising or falling edge at the corresponding universal input
- Counting is up or down
- A hardware interrupt is to be triggered or not.

Actual Value of Counter

The counter calculates the actual value according to the following formula:

Actual value (counter up) = number of edges

or

Actual value (counter down) = start value minus number of edges

Counting Up

Counting up starts at zero or is continued from the last counter value until the selected comparison value is reached or to the end of the count range (default setting). The start value after resetting the counter is always zero. The comparison value is set by the user program.

Counting Down

Counting down starts counting backwards from the selected start value or is continued from the last counter value until the value zero is reached. The start value is set by the user program.

Exceeding the Threshold Frequency

The universal input counter counts count pulses up to a maximum frequency of 10 kHz.

A frequency filter is fitted to the inputs.



Warning

If the actual frequency exceeds the threshold frequency of 10 kHz, then the correct function of the universal inputs can no longer be guaranteed, since count pulses will be lost.

Before activating a counter in OB100, it is necessary to insert a delay time of at least 5 ms via SFC47.

Note

The counting process on the C7 I/O module is asynchronous to the C7 CPU user program. The user program is cyclically supplied with the current count value (update time 0.5 ms). This means that when reading in the current process value via the user program (for example, L PIW280), this value is up to 500 µs older. With high counting frequencies there can be an offset of several count pulses (for example, 10 kHz = 1 pulse every 100 µs; that is, the counter has already counted up to 4 more pulses).

Depending on the application, it is necessary to take this into account (for example, waiting time of > 0.5 ms after the counting encoder has stopped; or using a hardware interrupt until counter end value).

Starting and Stopping Counters

The universal counter inputs are controlled by the user program.

Table 8-7 lists the different ways of influencing the counter in the user program. For a detailed description of the individual bits in PQB287, please refer to Table 8-4.

Table 8-7 Controlling Counters with the User Program

Aim	Procedure
Start counter	<ul style="list-style-type: none"> Enter a valid start value (if counting down) or a valid comparison value (if counting up) (PQW280, PQW282, PQB284, PQB 285, PQB 286) Activate the new start/comparison value (PQB287 rising edge '0'→'1') Start the counter by selecting the start bit (PQB287 falling edge '1'→'0')
Stop counter	<ul style="list-style-type: none"> Reset the start bit (PQB287 falling edge '1'→'0')
Restart counter with counter initialization(reset)	<ul style="list-style-type: none"> If necessary, enter a new start value or retain old start value (for counting down) or comparison value (for counting up) (PQW280,PQW282, PQB284, PQB285, PQB286) Activate the new start/comparison value (PQB287 rising edge '0'→'1') Set the start bit (PQB287 rising edge '0'→'1')
Restart counter without counterinitialization (counter continues counting without a reset)	<ul style="list-style-type: none"> Do not set the new start/comparison value Start the counter by setting the start bit (PQB287 rising edge '0'→'1')

Table 8-7 Controlling Counters with the User Program

Aim	Procedure
Select new start/comparison value	<ul style="list-style-type: none"> • Enter new start/comparison value (PQW280, PQW282, PQB284, PQB285, PQB286) • Set value (PQB287 rising edge '0'→'1') <ul style="list-style-type: none"> – New start/comparison value will be activated with the next rising edge at the count input – If counting up is running: new comparison value will be accepted – If counting down is running: new start value will be accepted, current count value will be corrected by the difference
Initialize counter (start of a new counting process) always occurs:	<ul style="list-style-type: none"> • At zero transition (counting down) or comparison value reached/exceeded (counting up) • After setting the enable bit in the data area (PQB287 rising edge '0'→'1'), if the bit "set new start/comparison value" is set simultaneously (PQB287)
Generate hardware interrupt and reset counter	<ul style="list-style-type: none"> • Requirement is that the option "hardware interrupt = yes" has been assigned for the counter • When counting direction is forwards, if count value = comparison value • When counting direction is backwards, if count value = zero

8.2.5 Frequency Counters

Overview The universal input 3 (assigned as frequency counter) provides you with the option of continuously counting identical edges within an assigned time period for a frequency ≤ 10 kHz.

Application Calculation of high frequencies.

Frequency Calculation The frequency is calculated from the measured value and the assigned measurement period.

The signal to be measured is to be connected to the universal input 3 (see Sections 8.2.1 and 8.2.2) of the C7. The frequency counter counts the rising edges of the signal to be measured within the assigned time period.

From this, the user program can derive the actual frequency using the following formula:

$$\text{Frequency} = \frac{\text{Number of positive edges}}{\text{Measurement period}}$$

Measurement Period You can assign parameters for the measurement period using the STEP 7 application *Configuring Hardware*. You can choose between the measurement periods 0.1 s, 1 s, or 10 s. The measurement process is immediately restarted after the measurement period has elapsed, so that an updated frequency counter value is always available.

Example of Frequency Calculation The measurement period is 1 s. During a measurement period, 6500 rising edges of the signal to be measured are counted. The counter value 6500 is made available to the user program.

$$\text{Frequency} = \frac{6500}{1 \text{ s}} = 6500 \text{ Hz}$$

Frequency During First Measurement Period After starting up the C7, OB1 is processed and the universal input frequency counter is automatically started.

The first valid frequency is calculated after the first measurement period. Before the end of the first measurement period, the frequency counter value FFFFFFFH is available in the C7 CPU.

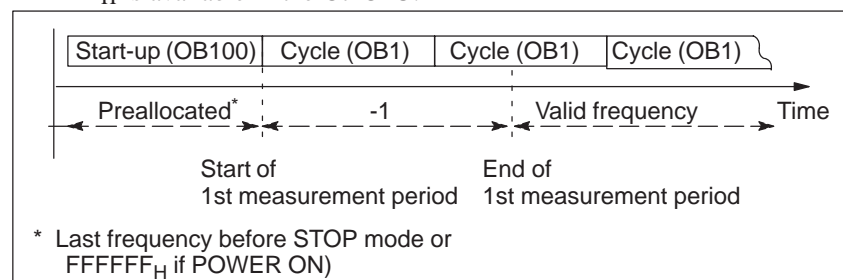


Figure 8-4 Frequency During First Measurement Period

Exceeding the Threshold Frequency



The universal input frequency meter is designed for a maximum frequency of 10 kHz.

A frequency filter is fitted to the input.

Warning

If the actual frequency exceeds the threshold frequency of 10 kHz, then the correct function of the universal inputs can no longer be guaranteed, since count pulses will be lost.

Resolution of Measurement

With relatively constant frequencies, the resolution of the measurement is higher if you set a longer measurement period. Table 8-8 displays the resolution of the measurement according to the configured measurement period.

Table 8-8 Resolution of the Measurement

Measurement Period	Resolution	Example of Count Value During First Measurement	Frequency (Calculated)
0.1 s	Frequency can be calculated in 10 Hz increments	900	9000 Hz
		901	9010 Hz
1 s	Frequency can be calculated in 1 Hz increments	900	900 Hz
		901	901 Hz
10 s	Frequency can be calculated in 0.1 Hz increments	900	90 Hz
		901	90.1 Hz

Disadvantage of Long Measurement Periods

The frequency meter calculates the frequency in longer intervals. This means that with long measurement periods, an updated frequency value is more seldom available. If the frequency continuously changes, then only average values are available.

Disadvantage of a Short Frequency

Due to the principle of measurement, the measurement error increases with a reduction in the measured frequency.

8.2.6 Period Time Measurement

Overview	The universal input 3 can be assigned as period time counter. This universal input reads pulses from a transducer. The transducer could, for example, be fitted to the barrel extruder of an injection moulding machine.
Application	Calculation of low frequencies and rotation speeds.
Principle	<p>The period time counter counts the number of increments (fixed time intervals) of $t_{zi} = 0.5 \mu s$ between two rising edges. The first period starts at the first transition from “0” to “1” (rising edge). It ends at the next rising edge. This is also the start of the next period.</p> <p>From this, a period time can be calculated:</p> <p>$t_p = \text{number of counted increments} * 0.5 \mu s$</p> <p>In addition, for every rising edge, a counter is started that increases its value by 1 every $0.5 \mu s$ until the next positive edge occurs.</p> <p>The period time counter can be defined with a resolution of $0.5 \mu s$.</p>

Explanation of Principle Based upon a Simple Transducer

Figure 8-5 illustrates a simple transducer. The transducer supplies a “1” when the light passes through one of the slots in the disc. If the disc rotates, then the transducer delivers the signal shown in the diagram.

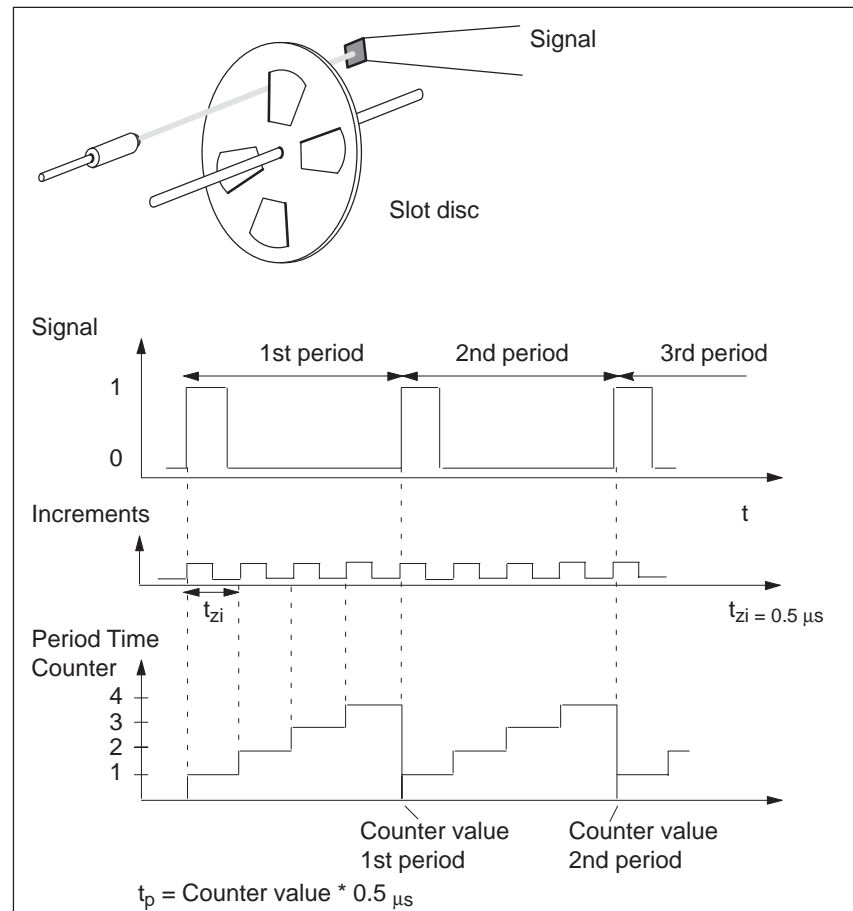


Figure 8-5 A Simple Transducer such as a Slot Disc on a Shaft

If you know the number of pulses that are supplied by the transducer for each revolution of the barrel extruder, then you can calculate the speed with which the barrel extruder is rotating. An example follows:

$N = 16$ pulses are generated per revolution of the barrel extruder (N is known as the slot number of the transducer). The interval between 2 pulses is 50000 increments (fixed time interval). The rotational speed of the barrel extruder is calculated as follows:

$$v = \frac{1}{N \times t_{i \text{ minimum}}} = \frac{1}{16 \times 50,000 \times 0.5 \mu s} = 2.5 \frac{1}{s} = 150 \frac{\text{rev}}{\text{min}}$$

Lower Threshold

The period time counter generates a 24-bit counter value. These 3 bytes can represent values up to FF FF FE_H (16777214 decimal). From this, the lower threshold frequency for N = 1 is (when taking into account the maximum period time stated below ($t_p = 8.39$ s)):

$$f_u = \frac{1}{t_p} ; \quad t_p = 16777214 * 0.5\mu s = 8.39s$$

$$f_u = 0.119 \text{ Hz}$$

And for N = 1, the lower threshold rotation speed

$$v = \frac{1}{N \times \text{minimum } t_i} = \frac{1}{1 \times 8.39s} = 0.119 \frac{1}{s} = 7.14 \frac{\text{rev}}{\text{min}}$$

Upper Threshold

The upper threshold frequency results from the condition that the universal inputs are designed for a maximum frequency of 10 kHz. The minimum period time of 0.1 ms follows. Therefore the upper threshold frequency is 10 kHz (corresponding to 600,000 rev/min).

If this frequency is exceeded, then the input values will be erroneous, since individual pulses will be suppressed by the input filter (of 10 kHz).

The relative measuring discrepancy gets smaller as the period time increases.

Thresholds

These thresholds are applicable for a transducer that generates one pulse per revolution. If you use transducers that generate several pulses per revolution, then you must reconsider the threshold frequencies.

Counter Overflow

The counter value FF FF FF_H indicates a shortfall of the lower threshold. Diagnostic messages will not be generated in this case.

Assigning Parameters

In order to use the universal input 3 as a period time counter, this must also be assigned as such (parameters). This is performed with the STEP 7 application *Configuring Hardware*.

8.2.7 External Gate Counter

Gate Time Measurement

You can count pulses within a gate time with an external gate counter. The counting direction is forwards. The counting process starts at zero with a rising edge on the external gate pin and ends with a falling edge.

After the falling edge, a hardware interrupt can be generated and the new count value is written to the output area.

Figure 8-6 illustrates gate time measurement with an external gate counter.

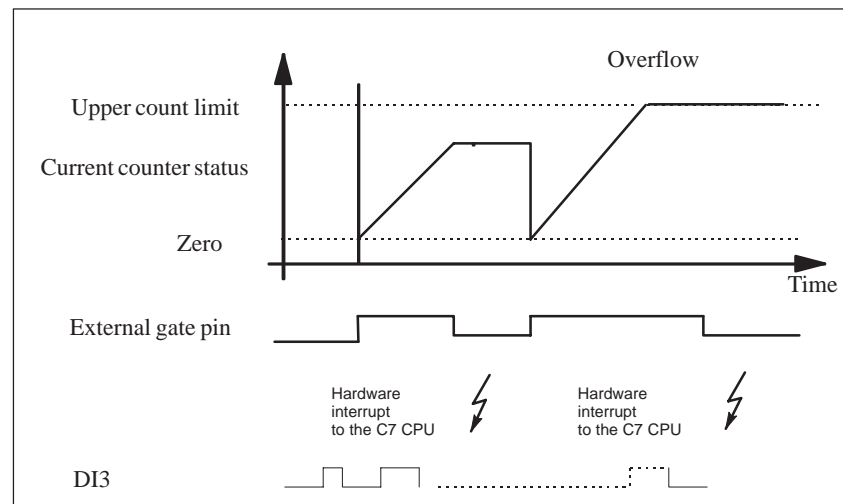


Figure 8-6 Gate Time Measurement with an External Gate Counter

Start Bit

The gate time measurement is only activated if the start bit is set in the input area at the same time as the external gate pin.

16-Bit and 24-Bit Counters

Counters 1 and 2 operate as 16-bit counters, while counter 3 is a 24-bit counter.

Default Value

The default value is 0xFFFF for counters 1 and 2 and 0xFFFFFFFF for counter 3. If no valid value is available, for example, during the first measuring cycle, this default value is output.

Counter Overflow

If the count value exceeds the upper count limit and an overflow occurs, the corresponding bit is set in byte 15.7 and value 0FFFF_H (for counters 1 and counter 2) or 0FFFFFFF_H (for counter 3) is output.

8.3 Example for Programming the Counters

Overview

The following programming example for the universal input counters is intended to familiarize you with programming the I/O.

Function of Block

The program is intended to implement a simple function which shows the principle of addressing the counter inputs by the STEP 7 program.

The counters are implemented to count up until the comparison value is reached. They are reset when the comparison value is reached and counting is restarted, beginning with zero. Due to the immediate reset, the specified comparison value never can be read out.

In the following program example, the universal inputs are assigned parameters as follows:

UI1	counter C1
UI2	counter C2
UI3	counter C3
UI4	standard digital input; not used in the example

The three counters are assigned parameters as follows:

Interrupt:	yes
Counting direction:	up
Edge:	rising

Execution of block:

OB100

1. First, all three counters are stopped on startup.

This is necessary so that the counter will start counting from zero after a complete restart. If this is not required, that is if the counter must continue after a restart with its "old" value, the counters must not be stopped.

2. After a waiting time of about 10 ms, a comparison value is written for each counter.

This waiting time is required so that the STOP command for the counters can become effective on the C7 module. In the complete restart OB (OB100), the times are not critical since the cycles are not monitored.

3. Immediately after the comparison value has been written, the comparison values are declared valid and the counters are started.

4. **OB1**

The counter values can be read cyclically in OB1. The counter status bits are evaluated to ensure that the counters are active. OB1 is ended if not all counters are activated.

If all counters are active, the read counter values are reassigned. This is an optional feature which can be useful for specific applications. If the same value must always be used within an OB1 cycle, re-assignment is recommended (for example in the case of high counting frequency and relatively long cycles > accessing OB1 more than once might supply different values).

5. OB40

This block is used for interrupt evaluation. A jump is executed by evaluating the information of the interrupt vector register from the start information of OB40 (LB 8). A memory byte is incremented as a function of the counter which has triggered the interrupt. OB40 is programmed to recognize even several interrupts occurring almost simultaneously.

6. OB35

OB35 is used to generate the count pulses. The following wiring is required to execute the example:

Connect	digital output 1.2	with	DI-X1
Connect	digital output 1.3	with	DI-X2
Connect	digital output 1.4	with	DI-X3

In OB35, the output bits of the C7 digital outputs are toggled (alternately enabled/disabled), and the effect is a period time of 200 ms at each output, corresponding to a frequency of 5 Hz. This value results from the 100 ms default cyclic interrupt time of OB35. This means that each output is set to a logical "1" for 100 ms and then, also for 100 ms, reset to a logical "0".

S7 Status

With the *Monitoring and Modifying Variables* application in STEP 7, the following can be monitored:

PIW280	current counter value C1
MW20	counter image C1
PIW282	current counter value C2
MW22	counter image C2
PIW285	current counter value C3
MW25	counter image C3
	(C3: direct monitoring only possible with a counter status between 0 and 65535, otherwise only indirect monitoring possible in <i>Monitoring and Modifying Variables</i>)
MB40	number of interrupts triggered by C1
MB41	number of interrupts triggered by C2
MB42	number of interrupts triggered by C3
PIB287	status of counters

OB100 Statement Sequence

The OB100 complete restart block contains the following statements:

```
ORGANIZATION_BLOCK OB100
var_temp
    start_info : array(0..19) of byte;
end_var
BEGIN

/**Resetting the counters***/
T PQB287;    // C1, C2, C3
```

```

CALL SFC 47 // wait so that STOP becomes effective
(WT:=10000) // 10000 s = 10 ms

****Setting comparison values****
L 10; // set comparison value C1
T PQW280;
L 20; // set comparison value C2
T PQW282;
L 40; // set comparison value C3
T PQW285;

****Declaring comparison values valid and starting counter****
L 3F; // declare comparison value valid and start
T PQB287; // C1, C2, C3

END_ORGANIZATION_BLOCK

```

OB1 Statement Sequence

OB1 contains the following statements:

```

ORGANIZATION_BLOCK OB1
var_temp
    start_info : array(0..19] of byte;
    status : BYTE;

end_var
BEGIN

****Check whether all counters are active****
L PIB287; // scanning status bits
T status;

A L20.4; // C1 signalled active
A L20.5; // C2 signalled active
A L20.6; // C3 signalled active
JC run;
BEU;

****Waiting time of 1 ms****
CALL SFC47 // "Wait function"
(WT:=1000); // 1000 s = 1 ms

****Determining counter image (optional)****
run: NOP 0;
L PIW280; // C1
T MW20;
L PIW282; // C2
T MW22;

either
**** Determining counter image for 16-bit counter ****
L PIW285; // C3
T MW25;

```

```
or
**** Determining counter image for 24-bit counter ****
L PIB284;      // read in C3 (PIB284-286) and status byte (PIB287)
S RD8;        // transfer PIB287 bits from ACCU
T MD24;        // transfer ACCU or C3 to memory double word
END_ORGANIZATION_BLOCK
```

OB35 Statement Sequence

OB35 contains the following statements:

```
ORGANIZATION_BLOCK OB35
var_temp
    start_info : array(0..19) of byte;
end_var
BEGIN
AN Q1.2;      // assigned to C1
=Q1.2;
AN Q1.3;      // assigned to C2
=Q1.3;
AN Q1.4;      // assigned to C3
=Q1.4;
L QW0;        // transfer QW0 immediately
T PQW0;
END_ORGANIZATION_BLOCK
```

OB40 Statement Sequence

OB40 contains the following statements:

```
ORGANIZATION_BLOCK OB40
var_temp
    start_info : array[0..19] of byte;
end_var
BEGIN
****Determining which input has triggered interrupt****
AN L8.0;      // interrupt from C1?
JC c2;
L MB40;       // counts number of interrupts from C1 (up to 255)
INC 1;
T MB40;
c2:NOP 0;
AN L8.1;      // interrupt from C2?
JC c3;
L MB41;       // counts number of interrupts from C2 (up to 255)
INC 1;
T MB41;
```

```
c3:NOP 0;  
AN L8.2;      // interrupt from C3?  
BEB;  
  
L MB42;      // counts number of interrupts from C3 (up to 255)  
INC 1;  
T MB42;  
  
END_ORGANIZATION_BLOCK
```



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Data Set Description, I/O Parameter Assignment

9

Chapter Overview

Section	Description	Page
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9.1 Data Set Description for Parameter Block of C7 Analog I/O and Universal Inputs

Overview

If a reassignment is to be performed during operation, then the validity and inter-relationships between the individual parameters must be checked by the user program.

Incorrect value ranges of the parameters can result in incorrect behavior of the I/O. Table 9-1 lists the layout of the parameter data sets.

Table 9-1 Table with Data Set Descriptions Parameter Block

DS	Byte	Bit	Default-Value	What Can Be Assigned	Meaning of the Respective Bits
0	00	7	0	Enable diagnostics AO4	0=No 1=Yes
		6	0	Enable diagnostics AO3	0=No 1=Yes
		5	0	Enable diagnostics AO2	0=No 1=Yes
		4	0	Enable diagnostics AO1	0=No 1=Yes
		3	0	Enable diagnostics AI4	0=No 1=Yes
		2	0	Enable diagnostics AI3	0=No 1=Yes
		2	0	Enable diagnostics AI2	0=No 1=Yes
		1	0	Enable diagnostics AI1	0=No 1=Yes
	01	7..5	000	–	
		4	0	Enable diagn. interrupt module	
		3	0	Enable diagn. wire break AI4	0=No, 1=Yes (only if measurement range 4 to 20mA)
		2	0	Enable diagn. wire break AI3	0=No, 1=Yes (only if measurement range 4 to 20mA)
		1	0	Enable diagn. wire break AI2	0=No, 1=Yes (only if measurement range 4 to 20mA)
		0	0	Enable diagn. wire break AI1	0=No, 1=Yes (only if measurement range 4 to 20mA)
	02	0..7	00000000	Reserved	Must always be zero, otherwise parameter assignment error
	03		00000000	Reserved	Must always be zero, otherwise parameter assignment error
1	04	7..6	00	AI2 –	
		5..4	01	Measurement range	00=Deactivated, 01=±10 V, 10=±20 mA, 11=4 to 20 mA
		3..2	00	AI1 –	
		1..0	01	Measurement range	00=Deactivated, 01=±10 V, 10=±20 mA, 11=4 to 20 mA

Table 9-1 Table with Data Set Descriptions Parameter Block

1	05	7..6	01	AI4	–	
		5..4	00		Measurement range	00=Deactivated, 01=±10 V, 10=±20 mA, 11=4 to 20 mA
	05	3..2	01	AI3	–	
		1..0	00		Measurement range	00=Deactivated, 01=±10 V, 10=±20 mA, 11=4 to 20 mA
	06	7..2	000000	–		
		1..0	00		Enable cyclic interrupt	00=No cyclic interrupt 01=Time cyclic interrupt (only if byte 7 > 1) 10=Cycle end interrupt (only if all AIx are not deactivated)
	07	7..4	0000	–		
		3..0	0001		Cycle time	0=16 ms, 1=Free-running, 6=3 ms, 7=3.5 ms, 8=4 ms etc. (increment 0.5 ms up to 15.5 ms)
	08	7..6	00	Univ. DI1	–	
		5	0		Direction	0=Up, 1=Down (only if mode=010)
		4	0		Edge	0=Rising edge, 1=Falling edge
		3	0		Hardware interrupt	0=No, 1=Yes
		2..0	000		Mode	000=General DI, 001=Interrupt DI, 010=Counter (CI), 101=External gate counter
	09	7..6	00	Univ. DI2	–	
		5	0		Direction	0=Up, 1=Down (only if mode=010)
		4	0		Edge	0=Rising edge, 1=Falling edge
		3	0		Hardware interrupt	0=No, 1=Yes
		2..0	000		Mode	000=General DI, 001=Interrupt DI, 010=Counter (CI), 101=External gate counter
	10	7..6	00	Univ. DI3	gate time	00=0.1 s, 01=1 s, 10=10 s (only if mode=010)
		5	0		Direction	0=Up, 1=Down (only if mode =010)
		4	0		Edge	0=Rising edge, 1=Falling edge
		3	0		Hardware interrupt	0=No, 1=Yes
		2..0	000		Mode	000=General DI, 001=Interrupt DI, 010=Counter (CI), 011=Frequency counter (FC) 100=Period duration counter (PC), 101=External gate counter
	11	7..5	00000	Univ. DI4	–	
		4	0		Edge	0=Rising edge, 1=Falling edge
		3	0		Hardware interrupt	0=No, 1=Yes
		2..0	0		Mode	000=General DI, 001=Interrupt DI
	12	7..6	00	AO2	Reaction to CPU STOP	00=Voltage/power idle (substitute value = 0) 01=Retain last value, 10=Global substitute value (byte 14 to 15)

Table 9-1 Table with Data Set Descriptions Parameter Block

		5..4	01	Output area	00=Deactivated, 01= ± 10 V, 10= ± 20 mA, 11=4 to 20 mA
1		3..2	00	AO1 Reaction to CPU STOP	00=Voltage/power idle (substitute value = 0) 01=Retain last value, 10=Global substitute value (byte 14 to 15)
		1..0	01	Output area	00=Deactivated, 01= ± 10 V, 10= ± 20 mA, 11=4 to 20 mA
	13	7..6	00	AO4 Reaction to CPU STOP	00=Voltage/power idle (substitute value = 0) 01=Retain last value, 10=Global substitute value (byte 14 to 15)
		5..4	01	Output area	00=Deactivated, 01= ± 10 V, 10= ± 20 mA, 11=4 to 20 mA
		3..2	00	AO3 Reaction to CPU STOP	00=Voltage/power idle (substitute value = 0) 01=Retain last value, 10=Global substitute value (byte 14 to 15)
		1..0	01	Output area	00=Deactivated, 01= ± 10 V, 10= ± 20 mA, 11=4 to 20 mA
	14		0000H	Global substitute value for AO1 to AO4	(only if “global substitute value” active on at least one of the AO)
	15				

I/O Diagnostics

10

In This Chapter

In this section, you will learn which diagnostic messages you can set and how the diagnostic buffer is structured.

The diagnostics of the C7 analog I/O are described.

This chapter also tells you how you can correct the reported errors for the most important diagnostic messages of the C7 analog I/O with universal inputs.

The term “module” refers here to a unit consisting of the analog I/O and the universal inputs.

Chapter Overview

Section	Description	Page
10.1	Diagnostic Messages	10-2
10.2	Diagnostic Data of the C7 Analog I/O and Universal Inputs	10-4
10.3	Dependencies and Reactions of the Diagnostic Evaluation	10-8

10.1 Diagnostic Messages

Overview

The C7 CPU possesses a diagnostic buffer in which detailed information is provided for all diagnostic events in the order of their occurrence. The contents of the diagnostic buffer is preserved even after a memory reset on the C7 CPU. The diagnostic entries in the diagnostic buffer can be read and interpreted by the user program.

Advantages

Errors in the system can be evaluated after a long time delay using the diagnostic buffer in order be able to identify the cause of a STOP, for example, or to trace and assign the occurrence of individual diagnostic events.

Diagnostic Events

Diagnostic events can be:

- Errors in an **I/O** (module)
- System errors in the C7 CPU
- Change in operating modes (for example, from RUN to STOP)
- Program errors in the CPU program

C7 CPU I/O Diagnostics

The I/O diagnostics are divided into two groups:

- Standard diagnostics (general malfunction of the C7 analog I/O module and universal inputs)
- Module-specific diagnostics

The standard diagnostics are always entered into the diagnostic buffers of the C7 CPU after the occurrence of a diagnostic interrupt. The requirement is that the module is able to diagnose.

The module-specific diagnostics provide detailed information regarding the type and possible cause of the error. This information can be called up by the user program by means of special system calls. The requirement is that diagnostics have been enabled (default setting is always “no” in this case).

Assigning I/O Diagnostic Parameters

You can set whether the analog I/O diagnostic messages should be generated using STEP 7.

Using the STEP 7 application *Configuring Hardware*, you can also assign parameters to the diagnostic behavior of the analog I/O, i.e. you set whether the analog I/O diagnostic messages should be sent to the C7 CPU on request. Furthermore, you can assign parameters to define whether the module should trigger a diagnostic interrupt in the C7 CPU after the occurrence of an error.

Diagnostic Information (I/O)

In the diagnostic information, we differentiate between permanent and temporary diagnostic errors.

- Permanent diagnostic errors cannot be influenced by the user program and can only be removed by resetting the C7 CPU (memory reset and complete restart) or equipment exchange (after a fault).
- Temporary diagnostic errors disappear automatically after a renewed measurement (ADC error, overrange or underrange error), can be removed by the user program (if necessary, by assigning parameters via SFC55 during operation) or by hand at the connections (correcting the wiring).

Read Diagnostic Messages

Diagnostic messages will be entered into the diagnostic buffer only if the diagnostic interrupt OB (OB82) occurs. The requirement is that the parameter “diagnostic interrupt enable = yes” was assigned. Then you can read out the detailed diagnostic messages in addition to the standard diagnostic information using the STEP 7 application *Module Information* (see *Manual I231*). No entry is made in the diagnostic buffer of the C7 CPU in all other cases. Therefore the diagnostic message cannot be read out.

10.2 Diagnostic Data of the C7 Analog I/O and Universal Inputs

Overview

This section describes the C7 analog I/O and universal inputs with regard to their module-specific diagnostic messages.

Analog Input Diagnostics

Table 10-1 provides an overview of the channel-specific diagnostic messages of the analog input.

The diagnostic information is allocated to the individual channels.

Table 10-1 Diagnostic Message of the Analog Input

Diagnostic message	Analog Input
Parameter assignment error	Yes
Common mode error	No
P short circuit	No
M short circuit	No
Wire break (only for 4 to 20mA by software)	Yes
Reference error	No
Underrange (underflow)	Yes
Overrange (overflow)	Yes

Analog Output Diagnostics

Only one group error exists for the analog output.
Possible causes of the group error could be:

- Parameter error
- Substitute value is connected

Layout of Diagnostic Area of the Module

The diagnostic area consists of:

- Data set 0: the standard diagnostic bytes (0 to 3)
- Data set 1: the channel-specific diagnostic bytes (for enabled diagnostics).
 - Bytes 4 to 7 and bytes 8 to 11 - channel and individual information analog input (AI) diagnostics
 - Bytes 12 to 15 - channel information- analog output (AO) diagnostics

Table 10-2 illustrates the structure of the diagnostic area and the meaning of the individual entries.

Table 10-2 Structure of the Diagnostic Area

Byte	Bit	Meaning	Explanation	Value Range
00	0	Module fault	1 = error occurred, 0 = everything OK	0 1
	1	Internal error	1 = watchdog, EPROM, ADC error	0 1
	2	External error	1 = error at AI or AO	0 1
	3	Channel error	1 = with byte 0/bit 2 and channel-specific diagnostic byte byte 4 ...	0 1
	4	External auxiliary voltage missing	(Cannot be checked)	0
	5	Front plug missing	(Cannot be checked)	0
	6	Module not assigned parameters	Normal state (standard parameters set) byte 0/bit 0=0 ****)	0 1
	7	Incorrect parameters	1 with bit 8,9,10,11.0 or 15.0 (Standard parameters set for channel	0 1
01	0	Module class	SM type class	5
	1	Module class	SM type class	
	2	Module class	SM type class	
	3	Module class	SM type class	
	4	System-oriented channel-specific diagnostic info.	Yes	1
	5	User-defined diagnostic info. (diag. info. not configured by system)	No	0
	6	—	—	0
02	0	Coding connector incorrect/missing	—	0
	1	Communications failure	Error during transfer of parameters/input data	0
	2	Operating mode RUN/STOP		0
	3	Watchdog activated	with bit 1 of byte 0 *) **)	0 1
	4	Internal voltage failed	—	0
	5	Battery 1 empty	—	0
	6	Entire backup battery failed	—	0
	7	—	—	0
03	0	Rack failure	—	0
	1	Processor failure	—	0
	2	EEPROM error	Serial calibration EEPROM for analog measured value calibration, set with bit 1 of byte 0 *) **)	0 1
	3	RAM error	—	0
	4	ADC error	with bit 1 of byte 0 *)	0

Table 10-2 Structure of the Diagnostic Area

Byte	Bit	Meaning	Explanation	Value Range
	5	Fuse failure	—	0
	6	Hardware interrupt lost	—	0
	7		—	0
Channel-Specific Diagnostic Entries				
04	0..7	Channel type AI of the following channel-specific diagnostic information		71 _H
05	0..7	Number of analog input channels		4
06	0..7	Number of diagnostic bits per channel		8
07		Channel Vector Channel Group AI		
	0	Error assigning parameters to DI1	0 = no, 1 = yes	0 1
	1	Error assigning parameters to DI2	0 = no, 1 = yes	0 1
	2	Error assigning parameters to DI3	0 = no, 1 = yes	0 1
	3	Error assigning parameters to DI4	0 = no, 1 = yes	0 1
	4	Error in channel AI1	0 = no, 1 = yes	0 1
	5	Error in channel AI2	0 = no, 1 = yes	0 1
	6	Error in channel AI3	0 = no, 1 = yes	0 1
	7	Error in channel AI4	0 = no, 1 = yes	0 1
08		Channel-Specific Diagnostic Byte AI1		
	0	Parameter error in parameters for channel	0 = no, 1 = yes *)	0 1
	1..3	—		000
	4	Wire break in software	0 = no, 1 = yes (only for 4 to 20mA)	0 1
	5	—		0
	6	Measurement underrange	0 = no, 1 = yes (underflow)	0 1
	7	Measurement overrange	0 = no, 1 = yes (overflow)	0 1
09		Channel-Specific Diagnostic Byte AI2		
	0	Parameter error in parameters for channel	0 = no, 1 = yes *)	0 1
	1..3	—		000
	4	Wire break in software	0 = no, 1 = yes (only for 4 to 20mA)	0 1
	5	—		0
	6	Measurement underrange	0 = no, 1 = yes (underflow)	0 1
	7	Measurement overrange	0 = no, 1 = yes (overflow)	0 1

Table 10-2 Structure of the Diagnostic Area

Byte	Bit	Meaning	Explanation	Value Range
10	Channel-Specific Diagnostic Byte AI3			
	0	Parameter error in parameters for channel	0 = no, 1 = yes *)	0 1
	1..3	—		000
	4	Wire break in software	0 = no, 1 = yes (only for 4 to 20mA)	0 1
	5	—		0
	6	Measurementunderrange	0 = no, 1 = yes (underflow)	0 1
	7	Measurementoverrange	0 = no, 1 = yes (overflow)	0 1
11	Channel-Specific Diagnostic Byte AI4			
	0	Parameter error in parameters for channel	0 = no, 1 = yes *)	0 1
	1..3	—		0
	4	Wire break in software	0 = no, 1 = yes (only for 4 to 20mA)	0 1
	5	—		0
	6	Measurementunderrange	0 = no, 1 = yes (underflow)	0 1
	7	Measurementoverrange	0 = no, 1 = yes (overflow)	0 1
12	0..7	Channel type AO of the following channel-specific diagnostic information		73 _H
13	0..7	Number of analog output channels on module		4
14	0..7	Number of diagnostic bits per channel		1
15	Channel Vector for Channel Group AO			
	0	Collective error in AO1	0 = no, 1 = yes	0 1
	1	Collective error in AO2	0 = no, 1 = yes	0 1
	2	Collective error in AO3	0 = no, 1 = yes	0 1
	3	Collective error in AO4	0 = no, 1 = yes	0 1
	4..7	—		0000

*) Analog inputs will be reset until the channel functions again.
(Exception: parameter assignment for wire-break check for setting <>4...20 mA) AI=7FFF_H

**) Analog output will be reset until channel functions again
AO=0V 0 mA

****) No hardware interrupt, no diagnostic interrupt, no disturbance on the bit 0 of byte 0 =0

10.3 Dependencies and Reactions of the Diagnostic Evaluation

Overview

The diagnostic entries are interdependent. For example, the message for the error “wire break” can only become effective if the diagnostic entries “external error” and “channel error” are set simultaneously.

Dependency of Error Entry

These dependencies are illustrated in Table 10-3.

Table 10-3 Dependencies and Reactions of the Error Entries

Byte 0 / Bit 0 = 1 Module error	
Byte 0 / Bit 1 = 1 Internal error	
Byte 2 / Bit 3 = 1 Watchdog	(R)
Byte 3 / Bit 2 = 1 EEPROM error	(R)
Byte 3 / Bit 4 = 1 ADC error (M/R)	(R)
Byte 0 / Bit 2 = 1 External error	
Byte 0 / Bit 3 = 1 Channel error	
Byte 7 Evaluate channel vector if req.	
Wire break Byte 8, 9, 10, 11: Bit 4 = 1 channel-specific diagnostic byte AI (E/P)	
Underrange Byte 8, 9, 10, 11: Bit 6 = 1 channel-specific diagnostic byte AI (E/P/M)	
Overrange Byte 8, 9, 10, 11: Bit 7 = 1 channel-specific diagnostic byte AI (E/P/M)	
Byte 0 / Bit 7 = 1 Incorrect parameters	
Byte 8,9,10,11 / Bit 0 = 1 channel-specific diagnostic byte AI (P)	
Byte 15 / Bit 0 = 1 Collective error AO (only parameter error possible) (P)	
Byte 0 / Bit 6 = 1 Module not assigned parameters	

Legend:

E = temporary, can be removed by hand at connection
P = permanent, can be reset by assigning correct parameters
R = permanent, can be removed by RESET (memory reset and complete restart of C7 CPU) or by exchanging equipment
M = temporary, disappears after new measurement

Reaction to Diagnostic Messages

The diagnostic messages listed in Table 10-4 refer to Table 10-3.

Table 10-4 lists the diagnostic messages and also possible reactions of the user.

Table 10-4 Diagnostic Messages and Reaction Possibilities

Reason for the Diagnostic Message	Source of Error	Reaction of the Module	Possible Elimination
Module not assigned parameters	During the startup of the module, if no parameters were assigned by the C7 CPU. The “module fault” bit is not set if no further error exists.	Report to C7 CPU that the module is working with default parameters (no channel-specific module diagnostics, no hardware and diagnostic interrupts).	Assign parameters to module
Module fault	Group error of all set diagnostic bits (except if the message “module not assigned parameters” is set)	The error is set/reset with the subordinate diagnostic bits. If the diagnostic interrupt has been assigned, one will be generated.	See error under the grouping “module fault” (Table 10-3)
Internal error	The error bit is set simultaneously with the error bits “Watchdog”, “EEPROM error”, or “ADC error”. In addition, the watchdog is activated with “EEPROM error”.		See error under the grouping “Internal error” (Table 10-3)
Watchdog	The watchdog error is identified after an internal reset of the module. The watchdog error can arise as the result of an EPROM or general module error.	With watchdog, the module adopts a safe state. 0 V is output, the measured values become 7FFF _h and the counter values become FFFF _h /FFFFFF _h .	The error cannot be corrected by the user. The module can only be restarted after a reset on the bus (restart C7 CPU).
EEPROM error	The error is identified after resetting the module during the reading of the calibration values for the compensation of the offset error of the analog I/O from the serial EEPROM.	The module adopts a safe state. 0 V is output, the measured values become 7FFF _H and the counter values become FFFF _H /FFFFFF _H .	The error cannot be corrected by the user. The module can only be restarted after a reset on the bus (restart C7 CPU) or the analog I/O must be recalibrated at the manufacturer’s factory (equipment exchange).
External error	The error bit is set when channel-specific errors of the analog inputs or outputs occur.	Refer to the grouping “External error” in Table 10-3.	See error under the grouping “External error” in Table 10-3.
Channel error	A channel caused an error. Diagnosis of the channel causing the error has been enabled	Refer to the grouping “External error” in Table 10-3.	See error under the grouping “Channel error” in Table 10-3.

Table 10-4 Diagnostic Messages and Reaction Possibilities

Reason for the Diagnostic Message	Source of Error	Reaction of the Module	Possible Elimination
Wire break	Requirement: The measurement range 0 to 20 mA has been set for the channel. If a wire-break check has been assigned, then the error is identified by evaluation of the input current of the analog input channel (<1.6 mA).	An error counter will be incremented. If the error counter reaches a fixed value of 3, then the error "wire break" is reported.	Check the connection of the appropriate measurement channel.
Overflow	The error is identified after the comparison of the measured value (incl. correction calculation). Measurement \geq positive overflow range.	The bit is set and reset again when the measurement decreases.	Check the connection of the appropriate input channel or transducer.
Underflow	The error is identified after the comparison of the measured value (incl. correction calculation). Measurement \geq negative overflow range. That is <0 mA for 4 to 20 mA.	The bit is set and reset again when the measurement becomes valid.	Check the connection of the appropriate input channel or transducer.
Incorrect Parameters	The error is identified when checking the parameter after reading and processing the parameter area.	The measurement 7FFF _H is set in the incorrectly configured measurement channel and the corresponding diagnostic bit set or, for an output channel, 0 V / 0 mA is output and the corresponding bit set. If the module had not been assigned parameters and the assignment is correct, then the bit "incorrect parameter" is reset and (if diagnostic interrupt = yes) a diagnostic interrupt reported to the C7 CPU.	Assign correct parameters.
Hardware Interrupt Lost	The module is sending more interrupts than can be processed by the CPU.	Bit 6 in byte 3 "hardware interrupt lost" is set for at least 500 ms, if no further hardware interrupt is lost during this time period.	Change parameter settings for counter values

Maintenance

11

Chapter Overview

Section	Description	Page
11.1	Changing the Backup Battery	11-2
11.2	Replacing the C7	11-4

11.1 Changing the Backup Battery

Change During Power On Only

You must always change the backup battery during power on. This prevents any data loss in the internal user memory while changing the battery.

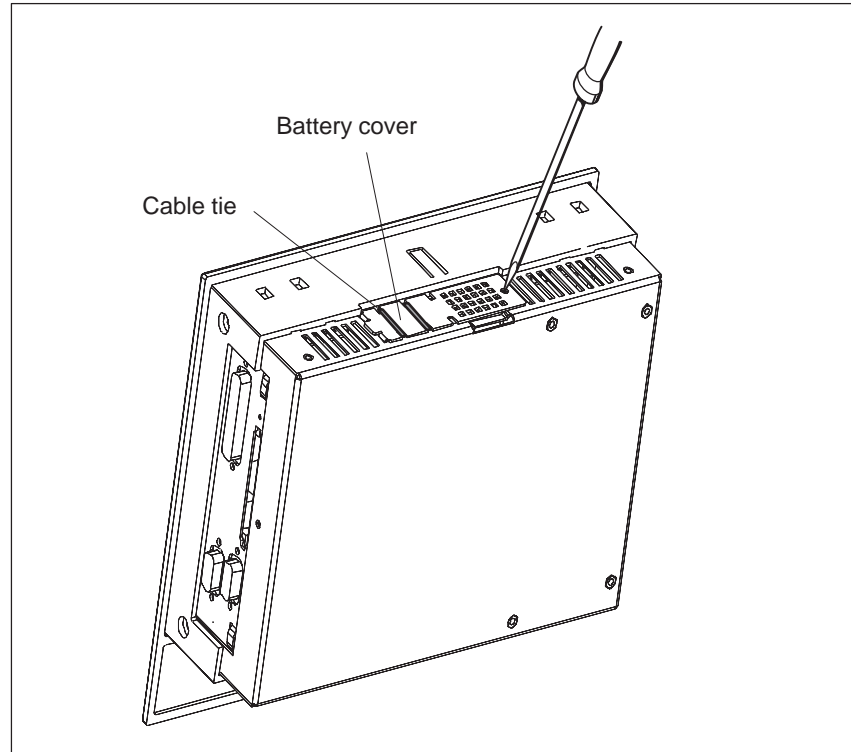


Figure 11-1 Removing the Cover of the C7-633 DP

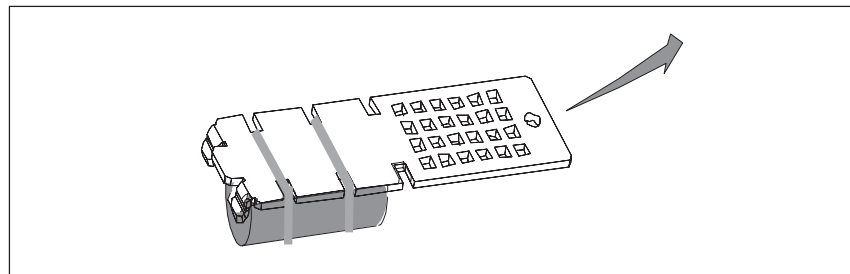


Figure 11-2 Battery Cover

Note

Observe the ESD guidelines. Do not use any metal objects (screwdriver) inside the C7. Electrical components and printed circuit boards are not sufficiently protected.

Proceed as follows to change the backup battery:

1. Unscrew the cover of the C7 battery compartment (see Figure 11-1).
2. Lift the cover up and to the right (see Figure 11-2). Make sure you raise the cover only as far as the battery connections allow.
3. Unplug the battery connector from the old backup battery (see Figure 11-3).
4. Loosen the cable ties with which the battery is attached to the cover (see Figure 11-3).
5. Attach the new backup battery to the cover using the cable ties.
6. Plug the battery connector of the new battery into the two-pin plug connector. The battery connector is coded to prevent it being plugged incorrectly (see Figure 11-3).
7. Replace the battery cover on the C7 with the clips to the left and screw the cover tight again.

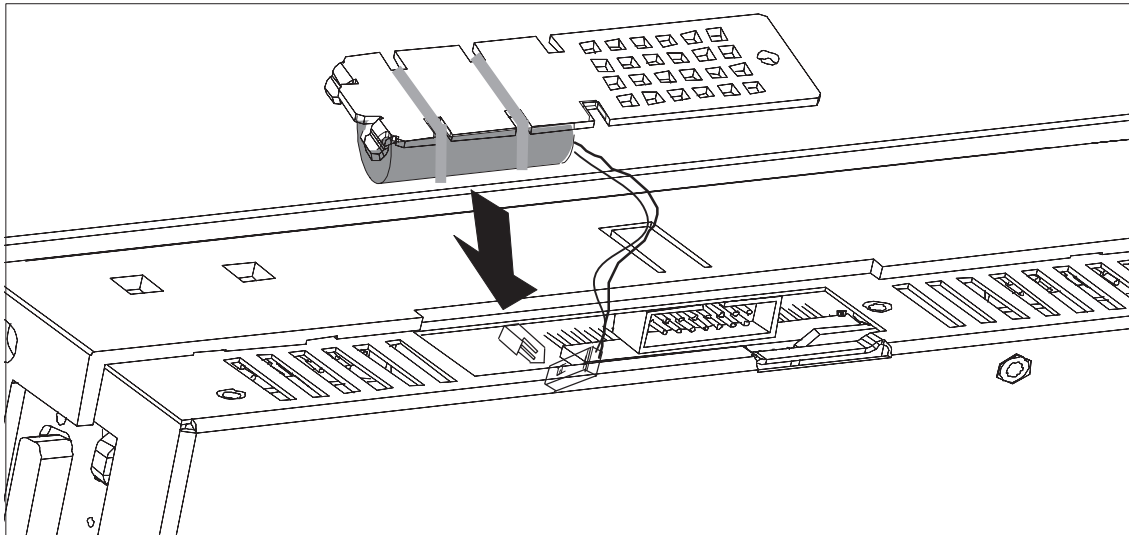


Figure 11-3 Inserting the Backup Battery

Service Life of the Backup Battery

We recommend that you change the battery every year.

Note

Observe the regulations or guidelines concerning the handling and disposal of lithium batteries enclosed with the battery.

Storage of Backup Batteries

Store your backup batteries in a cool, dry place. Backup batteries can be stored for up to five years.

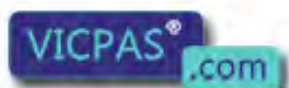
11.2 Replacing the C7

Introduction	On-site repair of the C7 has not been provided for. For this reason, a defective C7 must be replaced.
Requirement	<p>The following components must be available in order to replace a C7:</p> <p>Hardware</p> <ul style="list-style-type: none">• Programming device/PC with MPI interface module• Connection cable (MPI and RS 232/TTY) <p>Development tools</p> <ul style="list-style-type: none">• STEP 7• ProTool or ProTool/Lite <p>User software (stored outside the C7)</p> <ul style="list-style-type: none">• OP configuration• CPU user program (if data from the C7 CPU can no longer be read and no memory card is inserted)
Removal	<p>Dismantle the device in the opposite order to the installation. Proceed as follows to remove the C7:</p> <ol style="list-style-type: none">1. Connect a programming device/PC to the multipoint interface.2. Use STEP 7 to save the user program on the C7 CPU to a programming device/PC or remove the memory card on which the CPU user program is stored. <p>If the C7 CPU is defective and the user program can no longer be read out, remove the C7 without any further safety measures.</p> <p>The configuration loaded on the C7 cannot be displayed. It must be available on a programming device/PC.</p>

Installation

The mechanical and electrical installation is as described in Sections 2.2 and 2.3. Once you have obtained a new C7, install it as follows:

1. Connect a programming device/PC to the multipoint interface.
2. Perform a memory reset on the C7 CPU.
3. **Without a memory card:**
Transfer the previously saved CPU user program from the programming device/PC with the relevant data to the C7 CPU (with STEP 7).
With a memory card:
Insert the memory card and perform another memory reset (MRES) on the C7 CPU.
4. Connect the C7 operator panel to the serial interface of the programming device/PC.
5. Load your configuration onto the C7 operator panel using ProTool or ProTool/Lite.
6. Start the CPU user program (by selecting a CPU mode).



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C7-633/C7-634 Control Systems
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System Messages

A

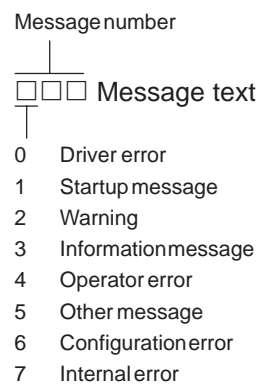
In This Chapter

This chapter lists the most important system messages, when they occur and, where applicable, how you can eliminate the error.

Message number

C7 system messages can be subdivided into various categories.

The information as to which category a system message belongs to is contained in the message number as indicated below.



The message category enables you to identify the general area in which the cause of the fault is to be found.

Below you will find a selection of system messages listed together with details of under what circumstances they occur and, where applicable, how the cause of the fault can be eliminated.

Self-explanatory system messages are not included.

Note

System messages are displayed in the language selected in the configuration. If the C7 does not have access to any configuration data, the messages are displayed in English.

**Procedure for
“Internal Errors”**

In the case of all system messages that relate to “internal errors”, please follow the procedure outlined below.

- a) Switch off the C7 and then restart it again.
- b) During startup, set the C7 to download mode, retransfer the configuration and then restart the C7 again.
- c) If the fault occurs again, please contact your nearest Siemens representative. When doing so, please quote the number of the error that has occurred and any variables referred to in the message.

Message	Cause	Remedy
Please wait	Mode change in progress or recipe function started	
Ready for transfer	Waiting for data from programming device/PC	
Data transfer	Data transfer between programming device/PC and C7 in progress	
Firmware not compatible	The firmware can not be used for the current configuration	
EPROM memory failure	Memory module defective or internal hardware fault	Send unit for repair quoting details of error message
RAM memory failure		
Flash memory failure	Memory module defective or transmission error	Retransfer configuration or send C7 for repair

Message	Cause	Remedy:
005	<i>Internal error:</i> Error message returned if nothing configured for a system message	
006	<p>Error during data transfer in download mode. Two variables are transferred with this message which contain information about the function in which the error has occurred (variable 1) and the cause of the error (variable 2).</p> <p>Variable 1:</p> <ul style="list-style-type: none"> 0 Initialize function 1 Receive data 2 Send data 3 Send message block 4 Terminate function <p>Variable 2:</p> <ul style="list-style-type: none"> 1 Internal error 3 Timeout error 5 Parity error 6 Framing error 7 Overrun error 8 Break in line 9 Receive buffer overflow 10 Control character error when receiving 11 Logging error 	Repeat data transfer after first checking the physical connection if necessary.
026...029	Storage medium not ready, contains errors or status undefinable.	Reset hardware, remove then refit Flash memory module or carry out hardware test.
030	Storage medium not initialized.	Switch to download mode.
032	Error accessing module, Flash may not be supported or initialized by incorrect C7.	<p>Check whether module is properly inserted and compatible.</p> <p>If restoring: repeat backup with correct C7.</p>
033	Internal Flash memory initialized; configuration data deleted, some recipe data preserved.	Retransfer configuration.
034	Inserted submodule initialized, all stored data deleted.	Retransfer configuration.
035	Size of selected recipe memory has been reduced.	<p>The reduced-size recipe memory can not be used and all data records must be deleted.</p> <p>The recipe memory is only initialized when requested.</p>
040	<p>Driver error</p> <p>If FAP is set, the character delay time setting may be too short.</p>	<p>Check physical connection to PLC.</p> <p>Alter character delay time.</p>
041	<p>Fault in connection to PLC.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> – Fault on the transmission link, e.g. connecting cable defective – Incorrect interface parameters set on C7 or on communication partner. 	

Message	Cause	Remedy:
043	<p>Data transfer error. A variable indicating the cause of the fault is transferred with this message.</p> <p>Variable:</p> <ul style="list-style-type: none"> 0 Timeout error 1 Framing error (receiving) 2 Overrun error 3 Parity error 4 No connection established 5 Checksum error (receiving) 6 Unexpected characters received 7...11 Internal errors 12 Receive data block too large 13 Memory area not available on PLC 	Repeat the data transfer. Before doing so, check the physical connection/configured interface parameters if necessary.
044	<p>Fault in connection to PLC.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> – Fault on the transmission link, e.g. connecting cable defective – Incorrect interface parameters set on C7 or on communication partner. 	
045	No connection to PLC established.	Set different CPU using the menu command “System” and the “Parameters” button in the dialog box which appears.
100	Restart due to RAM failure.	
101	Restart following termination of COM-UNI mode.	
103	Startup following cancellation of COM-UNI mode.	
104	Transfer cancelled by operator. Connection with C7 is still open, the C7 is waiting.	
105	Fault resulting in wait message has been eliminated.	
107	Restart following activation of COM-UNI mode.	
108	C7 is in download mode.	
109	Restart after change of operating mode from offline to online.	
110	C7 is in “normal” mode.	
113, 114	PLC has been restarted.	
115	Establishing logical link to PLC.	
117	Connection to PLC is OK again following a fault.	
119	Automatic restart.	
120	Restart after change of S5/S7 protocol.	
124	Restart following selection of different language.	
130	Startup due to loop-through operation when online.	
132	Startup due to loop-through operation when offline.	
129	SINEC L1 or SINEC L2 parameter has been changed.	
134	Restart due to offline operation.	
136	PLC not responding.	<p>Check program sequence on PLC.</p> <p>Check physical connection.</p>

Message	Cause	Remedy:
138	Data block not available on PLC	Set up relevant memory area.
200	Battery power no longer sufficient for internal data buffer on C7. Battery on memory card is discharged, data may no longer be readable.	Replace battery. Note: Replace the battery while the unit is switched on in order to prevent loss of data.
201	Hardware fault in timer.	Send unit for repair.
202	Error reading date.	Send unit for repair.
203	Error reading time.	Send unit for repair.
204	Error reading day.	Send unit for repair.
205	Printer not ready and internal storage of print jobs is no longer possible.	Make sure printer is ready or disable message logging.
206	Printer not ready. Print job placed in temporary storage.	Make sure printer is ready.
207	Buffer printout or print screen function cancelled.	Check printer, cable, and connectors.
210	<i>Internal error</i> C7 co-ordination area not receivable during startup.	Press restart button.
212	<i>Internal error</i> Bit for changing operating mode has been inverted erroneously.	Restart C7.
213	Offline mode not possible at present.	Try changing of operating mode again later.
214	The job number sent by the PLC or configured in a function field is too large.	Check PLC program and configured screen.
217, 218	Overlapping specified/actual values.	Check configuration of actual/specified values in the process link.
219	Hardware fault: relay or port could not be set.	Send unit for repair.
220	Print buffer overflow due to overload. Logging not possible.	Messages have been lost.
221	Print buffer overflow due to overload. Printout of overflow messages not possible.	Messages have been lost.
222	Warning: the event message buffer is full apart from the specified remaining buffer space.	Clear the buffer or configure a smaller size for the remaining buffer space.
224	The event message buffer has overflowed.	If a printer is connected and buffer overflow has been configured, the overflow messages will automatically be printed out.
225	Warning: the interrupt message buffer is full apart from the specified remaining buffer space.	Clear the buffer or configure a smaller size for the remaining buffer space.
227	The interrupt message buffer has overflowed.	If a printer is connected and buffer overflow has been configured, the overflow messages will automatically be printed out.
229	No keyboard connected (internal keyboard with ribbon cable).	
230	The minimum value is greater than the maximum value for variable limits.	Correct the limit settings.
231	The minimum value is equal to the maximum value for variable scales.	Correct the scale on the C7.

Message	Cause	Remedy:
250	You can not switch to the desired operating mode.	Check parameters of PLC job.
251	Error transferring data record to PLC.	Check recipe configuration.
252	Function can not be executed as a function of the same group has not yet been completed (e.g.: setpoint entry is active, password list can not be opened).	Wait until preceding function has been completed (or terminate function) and then call desired function again.
253	Access to data medium is not possible.	<ol style="list-style-type: none"> 1. Floppy drive not present, 2. Floppy is read only, 3. Disk is not formatted.
254	The disk must be formatted before a data record can be saved for the first time.	First format the disk.
255	Not enough space on disk for this data record.	Delete data records that are no longer required.
256	Not enough system memory available to execute the desired function.	<p>Try activating function again. Check configuration.</p> <ol style="list-style-type: none"> 1. Move function to a different screen. 2. Simplify screen structure. 3. Do not use any trends on the screen together with this function.
257	Data record has been stored with a different version stamp than defined in the current configuration.	<p>If you are continuing to use the data records, the old version number must be entered in the recipe configuration.</p> <p>Caution:</p> <p>The structure of the recipe determines the assignment of data to a data record.</p>
258	A parameter record has been selected as a recipe. Parameter records can not be edited directly.	Only individual data records of a parameter record can be edited.
259	<p>Transfer of a data record to the PLC is taking too long.</p> <p>Example:</p> <p>PLC is not acknowledging data record or very large data records are being transferred.</p>	Check PLC program. In the case of large data records no modifications are necessary as the function is being processed correctly.
260	Operating mode of PLC does not match the configuration.	Change operating mode of PLC.
261	The data in this data record are no longer consistent and it can therefore no longer be used.	Edit data record and check that all entries are correct.
262	Password or query window already in use by another function.	Complete first function then execute desired function again.
263	Specified remaining buffer space for messages has been reached.	Configure smaller remaining buffer space, clear event/interrupt message buffer.
264	Message buffer overflow.	The overflow messages are printed out if so specified in the configuration.
265	The number of passwords issued has already reached 50. You can not enter any more passwords.	If you wish to issue additional passwords, you must first delete some of the existing ones.
266	The field configured in the PLC job does not exist.	Change the parameters of the PLC job and retransfer the configuration.

Message	Cause	Remedy:
303	Fault in connection with PLC. S5 : this error may occur when transferring large data records. In such cases the watchdog is activated.	Check PLC status. S5 : set value in data word 98 to at least 2000.
304	Illegal S5 job number or job parameters in a function field.	
305	Data block number missing.	Set up data block or change configuration.
306	Incorrect CPU specified under the menu command "System," "Parameters" button in the dialog box which appears.	Change configuration and retransfer.
307 ... 311	Variable not present on PLC	Check configuration of process link.
312	The printer is already processing a print job and cannot accept this next job at present.	Wait until the printer is free again and repeat the print job.
313	Information message: print job completed.	
314	S7 diagnostic buffer not present.	The CPU has no diagnostic buffer (hardware problem).
315	No information text available.	
316	Active password level insufficient for menu item	Enter password with higher password level.
317	Input is password-protected.	Enter password.
318	Incorrect password entered when attempting to log in.	
319	An existing password was entered when editing the password.	Enter a different password.
320	You have attempted to alter the level of the supervisor password or to delete it.	
321	You have attempted to alter the level of an invalid password.	First enter the password then specify the level.
322	The password entered is too short.	Password must be at least three characters long.
323	You have pressed <- Statistics or Message Text -> on a buffer screen but there is no entry for the current message.	—
324	The entry number specified does not exist on the selected screen.	—
325	The FM/NC (= MPI partner) has no alarm message buffer.	A node does not have the required functional capability.
326	You have attempted to collect a recipe number other than the active recipe number from the PLC.	Select the appropriate recipe number.
327	Recipe number not present when selecting a recipe.	Configure missing recipe or select a different one.
328	Recipe number >99 when selecting a recipe.	
329	The same number has been entered for source and destination on the "Data Record Transfer" screen.	Enter different numbers.
330	Full details of source and destination not entered when initiating data record transfer function.	
331	The data record specified as the source does not exist.	
332	Data record number >99 when selecting a recipe screen.	

Message	Cause	Remedy:
333	Data record number not present when selecting a recipe screen.	
335	Information message: alarm message will be suppressed.	
336	No process screens have been configured.	
337	No recipes have been configured.	
338	C7 can not establish a connection to the printer.	<ol style="list-style-type: none"> 1. Printer is not switched on. 2. Printer is not ready. 3. Connecting lead between printer <—> C7 is not connected or defective. 4. No interface submodule inserted.
339	Startup completed.	Communication with PLC has been resumed.
340	Status processing in progress on programming device/PC. The C7 cannot be used during this time.	
341	<i>Internal error</i> In the case of external connections: data block error	
342	Network node has illegal address.	Max. addresses: S7 MPI: 32 PROFIBUS DP: 128
343	You are attempting to edit a variable of a type that cannot be edited in a recipe: currently applies to ARRAY variables only.	
350	PLC is performing initialization. You cannot enter any setpoints during initialization. Scrolling of screens is possible.	This operating mode may be set by the PLC programmer.
351	PLC has completed initialization. You can resume entering setpoints once this message has appeared.	
352	You are attempting to select a screen that does not exist or has been disabled by the function Hide.	
353	The minimum value is greater than the maximum value for variablescales.	Minimum and maximum values are being confused by C7. To prevent this, enter correct minimum and maximum values.
354	You are attempting to enter a value in an input field when the current password level is insufficient for input.	Log on with a higher password level.
355	Entry of this variable has not been configured for the current PLC mode.	
356	A print function has been initiated on the C7. When attempting to print it has been ascertained that the printer is offline.	Switch the printer online. Check the connection between the C7 and the printer. Has the printer been connected to the correct interface?
357	You are attempting to enter a setpoint that contains an illegal character.	Enter a correct value.

Message	Cause	Remedy:
358	The C7 is currently executing a function which does not permit use of the C7 while it is in progress.	Wait until the function has been completed. This message may appear in the case of recipe functions, for example.
359	The CPU is in STOP mode.	System error message issued if S7 messages are not available.
365	Incorrect index.	A multiplex index is outside the defined range.
370	Hard copy printout has been cancelled manually.	
371	Print function disabled at present.	
372	The function started has been cancelled.	
383	Information message: transfer of data records completed.	
384	Data record required is not on data medium.	Check the data record selection parameters (recipe, data record name, data medium) or use the Select function to select the data record.
385	Information message: transfer of data records from C7 to data medium or vice versa has been initiated.	Possible reason why operation is not possible: the PLC has not reset the relevant control/checkback bit in the interface area that unlocks the recipe mailbox.
386	Information message: transfer of data records from C7 to PLC or vice versa has been initiated.	
387	Data record not found.	There is no data record relating to the selected recipe on the data medium.
388	Activating selected function.	
389	De-activating selected function.	
391	No Help text configured.	Check configuration.
400	Illegal key pressed.	
401	Value entered could not be converted.	
402	Operator error on STATUS VAR or FORCE VAR screen.	Only 10 entries are permitted (after pressing INS if 10th line already used).
403	Incorrect time entered.	
404	Incorrect date entered.	
406	Operator error on STATUS VAR or FORCE VAR screen.	Values can only be changed after update operation has been cancelled (BREAK key).
407	You have attempted to delete the only data record for a recipe.	
409	Lower limit violated: you have attempted to enter a setpoint that is below the configured lower limit.	Enter a value that is greater than or equal to the specified value. No limit is indicated for data of the type DOUBLE.
410	Upper limit violated: you have attempted to enter a setpoint that is above the configured upper limit.	Enter a value that is less than or equal to the specified value. No limit is indicated for data of the type DOUBLE.
411	Illegal screen selection because incorrect PLC type specified (external driver)	Change configured interface parameter.

Message	Cause	Remedy:
442	Data block error x DB no. y This message indicates a data block error. The variables x and y identify the cause of the fault (x) and the number of the receive block concerned (y). Variable x: 0 Incorrect block length entered in receive block no. y 1 Incorrect block number entered in receive block no. y	Correct the block length/block number as necessary or send the correct data block.
450	When entering a value, you have attempted to press a key that is not compatible with the defined input field.	
451	You have entered a setpoint that is below the configured lower limit.	Enter a value that is greater than or equal to the limit.
452	You have entered a setpoint that is above the configured upper limit.	Enter a value that is less than or equal to the limit.
453	Time not entered correctly.	Enter time correctly.
454	Interface parameters incorrectly set, e.g. when specifying parameters for printer interface	Enter valid value for interface parameters. The following values are valid: – Transmission rate: 300, 600, 1200, 2400, 4800, 9600, 19200 bps – Data bits: 5,6,7,8 – Stop bits: 1,2 – Timeout: 1...600
455	You have set graphics printing on the C7 but the corresponding ESC sequence has not been configured.	Select a different printer or check printer configuration in ProTool.
456	You have entered an incorrect value, e.g. a variable with a user function that blocks certain input values.	Enter permissible value.
458	You have entered a value that is too great or too small for the variable type concerned, e.g. a value greater than 32767 for a variable of the type Integer.	Enter a value that is within the permissible range.
459	You are attempting to enter an illegal character (e.g. letter in a numerical value) The input is rejected and the existing entry retained.	Enter permissible value.
500...503	Cyclic interrupt, counter, date or time data can not be sent.	This error can occur if the PLC is temporarily overloaded or if the function block is not called for more than 1.5 s.
504	Free ASCII protocol: operator input value could not be sent.	
505	The data record can not be sent as the recipe disable bit on the PLC is set or because transfer of a recipe is still in progress.	Try sending again later when the PLC has released the recipe mailbox.
506	Overload: too many message blocks with the same block number in transit.	This error occurs if the PLC sends too many jobs using 'collect message area' within a certain period of time.
507	Transfer of the data record was not acknowledged by the PLC within a certain period.	Checking of data records by the user at the PLC end must be carried out more quickly (< 10 s).
509	Firmware version is different from standard FB version.	Please contact the SIMATIC Hotline.
510	Data record not present.	A process link with a non-existent data block has been configured in a recipe or the recipe data contain errors.

Message	Cause	Remedy:
511	You have used a PLC job to select a recipe or a request data record that does not exist.	
512	Configured data block length is too short. The variable transferred with the message identifies the number of the data block.	Change configuration and retransfer.
516	SINEC L2 protocol configured but no interface submodule inserted.	Change configuration and retransfer.
518	Interface submodule inserted and protocol configured do not match.	Change configuration and retransfer.
520	Excessive number of saved returns has meant that maximum nesting level has been exceeded.	Go to Message Level (by pressing ESC key if necessary).
521, 522	Screen can not be constructed or selected because there is not enough memory available. Message 522 triggers a restart with memory optimization.	You can optimize memory availability by 1. Removing unused fields from the configuration. 2. Configuring the screen with fewer fields, or splitting it into more than one screen. 3. Creating fewer recipe data records.
523	No text found.	
524	Object class does not exist.	
525	Illegal address.	
526	Loop-through operation is set on the C7.	Change mode from "Loop-through operation" to "Normal operation".
527	Access to recipe data is not possible at present.	
528	Recipe does not exist.	
529	File does not exist.	
530	Data record not present.	
531	Data record can not be loaded.	
532	Information message: data record memory is full.	
533	Floppy connection unclear.	
534	Information message: disk is full.	
535	Disk access error.	
536	Disk transfer error.	Check the physical connection.
537	Information message: disk is blank.	
538	Simultaneous accessing of data record by job and operator.	Repeat uncompleted accessing operation.
539	The data records in the RAM for recipe no. x contained errors and have been deleted.	If data records are stored in the Flash memory they will remain valid.
540	The maximum number of data records has already been created.	
541 ... 550	Specified variable not available on PLC.	Change configuration and retransfer.
551	An MPI/PPI connection to the PLC cannot be established using the specified station address.	Check MPI station addresses and wiring.

Message	Cause	Remedy:
552	Query: safety check as to whether the selected data record is to be deleted. The data record is only deleted if 0 is entered. If not the function is cancelled.	This query is also used when backing up or restoring configurations. In that case, it relates to deletion of all data records in the system memory.
553	Information message: selected data record has been deleted.	
554	Query: 1st safety check as to whether the data medium for storing data records is to be formatted. Any data records already on the disk will be deleted when the function is executed! The function is only executed if 0 is entered.	
555	Query: 2nd safety check as to whether the data medium for storing data records is to be formatted. Any data records already on the disk will be deleted when the function is executed! The function is only executed if 0 is entered.	
556	Information message: disk has been formatted.	
557	Query: if 0 is entered the data record will be adopted with the new values. If anything else is entered, you may continue editing.	
558	Query: if 0 is entered the edited data record is rejected. The data remain as they were before editing. If anything else is entered, you may continue editing.	
559	Query as to whether the event message buffer should be cleared.	
560	Query as to whether the alarm message buffer should be cleared.	
561	Information message: appears if a global data record (V3.0 or later) is edited and not all entries that are defined in the current recipe are completed. The data record can only be saved if the marked entries are edited. If no entries are marked, only the version number has changed.	Only returned in the case of data records that are transferable from one recipe to another. Missing entries are marked and must be edited. Editing can, however, be cancelled at any time.
562	Information as to which mode was set using the function "First/LastMessage".	
563	Information as to which mode was set using the function "First/LastMessage".	
564	Query: if 0 is entered the data record is created. If anything else is entered, the function is cancelled.	
565	Query: if during transfer of a global data record it is found that not all entries are present, the missing entries can be <ul style="list-style-type: none"> – read by the PLC if 1 is entered, or – edited if 2 is entered If 3 is entered, transfer is cancelled.	Only returned in the case of data records that are transferable from one recipe to another. (V3.0 or later, plastic functions.)
566	Data record contains array that does not fit the current recipe structure.	The following question appears: Save yes/no?. If you elect to save, the array data are set to 0.

Message	Cause	Remedy:
567, 568	If the message buffer has to be cleared, pending event/alarm messages also have to be deleted in order to make space for new message events.	Check configuration. Too many messages are pending.
569	Fault on CPI submodule.	<ul style="list-style-type: none"> – CPI no.: defective CPI submodule – Error: <ul style="list-style-type: none"> 1 = Voltage too low 2 = Current too high 3 = Temperature too high 4 = Module not present (failed during operation)
570	Variable contains errors: variable name from ProTool is used as parameter.	Check configuration. Frequently occurs with NC variables and when multiplexing.
571	S7 system diagnosis/INTERRUPT_S returns error if C7 logs on/off.	CPU operating system out of date.
572	Query: data record already exists on data medium.	If 0 is entered the data record will be overwritten with the new values.
600	Configuration error: overflow warning at basic setting 1	
601	Configuration error: message logging at basic setting 1	
602	Configuration of remaining buffer space incorrect.	Correct the remaining buffer space and retransfer configuration.
604	Message does not exist.	Configure message.
605	Process link is only configured symbolically.	Change configuration and retransfer.
606	Too many message variables configured.	
607	Data type configured does not exist.	
608	The process screen number does not exist.	
609	Special object or operator object for message text does not exist or is not permissible.	
610	Operator object for header or footer does not exist or is not permissible.	If the fault is not corrected by performing a restart, please contact the SIMATIC Hotline.
611	Special operator object for buffer printout does not exist or is not permissible.	
613	Data block not available or too short.	Create data block of required length on the PLC.
614	No entry present for log (header and footer not present).	Configure log fully.
615	The line to be output is larger than the amount of print memory reserved for it or the number of control sequences is too great.	Check configuration as regards logging.
616	<i>Internal error</i> Incorrect data format in process link.	Correct the data format.
617	<i>Internal error</i> Incorrect word length in process link.	Correct the word length.
618	Configuration error in actual control value (bit number > 15).	Bit number for actual control variable must be < 15.
619	Error presetting setpoint (error in data structures).	Change configuration and retransfer.

Message	Cause	Remedy:
620	Illegal keyboard ID: submodule number too high or number of keys does not match keyboard ID.	Enter configuration to match hardware.
621	Incorrect parameter transferred: message type	Set required value by way of standard screen or PLC.
622	Configured recipe does not fit in recipe mailbox on PLC (> 512 data words).	Reduce configured size of recipe and retransfer configuration.
623	<i>Internal error</i> Screen object for "Send Recipe" is not a recipe type (fixed by COM TEXT).	If the fault is not corrected by performing a restart, please contact the SIMATIC Hotline.
624	No recipe entries found.	Set up area pointers and retransfer configuration.
625	Recipe number does not exist.	Reconfigure recipe.
626	No setpoints have been configured.	
627	<i>Internal error</i> Configured keyboard block number too high.	Correct the block number.
628	Recipe does not fit in mailboxes.	Increase configured size of recipe mailbox or succeeding recipe mailbox.
629	LED image area too small.	Increase size of LED image area according to bit numbers used.
630	Keyboard image area too small.	Increase size of keyboard image area according to bit numbers used.
631	Message configuration incomplete or incorrect. Variable x: 1, 2 Alarm message triggered not configured. 3 Process link only created symbolically. 4 Actual value field only created symbolically. 5, 6 Event message triggered not configured. 7 Symbolic actual value field only created symbolically. 21..24 Field texts for symbolic actual value do not exist. 25 Illegal field type. 8..20 Internal error.	Complete configuration. If the fault is not corrected by performing a restart, please contact the SIMATIC Hotline.
632	Configuration error: Variable x: 1, 4 Information text does not exist 2 Information text ID for messages does not exist 3, 6..8, Internal error 11, 13 5 Field only created symbolically 9 Screen or recipe entry only created symbolically 12 Process screen or recipe contains no entries	Check the configuration. If the fault is not corrected by performing a restart, please contact the SIMATIC Hotline.
634	Configuration error: Variable x: 0..8, 34 Internal error 18 Screen or recipe title not configured	Screen or recipe title not configured. If the fault is not corrected by performing a restart, please contact the SIMATIC Hotline.

Message	Cause	Remedy:
635	Configuration error: Variable x: 1 Screen or recipe entry only created symbolically. 3 Field only created symbolically. 6 Message, entry or information text not configured for current language. 7...9, Internal error. 19, 28, 41...43 18 Screen or recipe title not configured. 20 Process link only created symbolically. 21 Information text only created symbolically. 22 Symbolic field only created symbolically. 23 Fewer than 2 field texts configured for symbolic field. 24 Current field type for symbolic field not configured. 25 Illegal data format for symbolic field (only KF and KY permissible). 26 Recipe setpoint configured with data format KC. 33 Illegal data format for setpoint field. 35 Data format for cyclic interrupt too short. 36 Illegal data format for actual control value. 44 If specific reference to menu: menu item not present. 45 If specific reference to screen: Entry or field number does not exist. 46 Too many actual control values on screen (max. 200 permitted). 48 Too many fields on process screen. 50 Process link for soft keys does not exist. 51 Soft key number too high. 53 Information text for soft key not configured or not configured in all languages. 55 Soft key specified in entry does not exist.	Check the configuration. If the fault is not corrected by performing a restart, please contact the SIMATIC Hotline.
636	Event message is not configured	Configure event message (→ message number) fully.
637	Missing configuration for an event message	
638, 639	Actual value field for event message has only been created symbolically.	
640	Alarm message is not configured	Configure alarm message (→ message number) concerned.
641	Alarm message triggered is not configured	
642, 643	The actual value field for alarm message has only been created symbolically.	Reconfigure interrupt message (→ message number).
645	<i>Internal error</i> PLC co-ordination area is not receivable during startup.	Press key to restart. If the fault is not corrected by performing a restart, please contact the SIMATIC Hotline.
648	The driver number configured cannot be interpreted.	
649	<i>Internal error</i> Driver number configured cannot be interpreted.	If the fault is not corrected by performing a restart, please contact the SIMATIC Hotline.
650	Missing area pointer.	Configure an area pointer.

Message	Cause	Remedy:
651	<i>Internal error</i> There is not at least one data record for every recipe.	If the fault is not corrected by performing a restart, please contact the SIMATIC Hotline.
652	Configuration is not compatible with S5.	Change configuration and retransfer. If the fault is not corrected by performing a restart, please contact the SIMATIC Hotline.
653	The configured user version number does not match the version number stored on the PLC.	Change configuration and retransfer.
654	The PLC acknowledgement area has not been configured to follow on physically from the message area.	
655	PLC acknowledgement area does not physically follow on from the alarm message area (→ no startup).	
656	Configured protocol is not possible.	Check protocol in configuration.
657	Configured PLC protocol is not possible.	Use current firmware version or configure different protocol.
658	Configured PLC protocol is not possible.	
659	Illegal process link in recipe, destination does not exist.	Change configuration and retransfer.
660	Invalid destination configured for return reference in menu.	Break key on C7; complete configuration and retransfer
661	On process screen: recipe setpoint or previous value configured in recipe: field is neither recipe setpoint or previous value.	Change field type or remove field and retransfer configuration
662	Invalid destination configured for return reference in screen.	Change configuration and retransfer.
663	Data record memory full (during startup)	
664	Standard data records for the configured recipes require more than 20 Kbytes. Unit switches to COM TEXT mode.	Configure fewer or smaller recipes.
665	Configuration of interfaces incorrect, printer/PLC interfaces have same physical characteristics.	Check interface parameters.
667	Configuration error: Variable x: 1 Data type is not DB 2 DB number is greater than 15 3 DB length is greater than 1024 4 DW is in data block header 5 Actual value not in send block 6 Setpoint not in receive block 7 Setpoint/actual value not in receive block 8 Initial value not in send block 9 Data type is not DB 10 DB number is greater than 15 11 DB length is greater than 1024 12 DW is in data block header 13 Area is in wrong DB 14 Sum of data blocks too great	x = 1..8: Change the configuration of the process link and retransfer. x = 9..13: Change configuration of area pointer and retransfer. x = 14: Restrict configuration and retransfer.

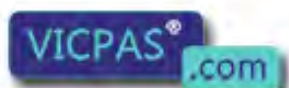
Message	Cause	Remedy:
668	Incorrect configuration. Meaning of variables: 1: Incompatible PLC types configured. 2: No PLC configured. 3: Incorrect transmission rate configured.	Change configuration and retransfer.
669	Too many actual values (> 512) have been configured for cyclic reading in a screen/variable.	
670	Too many variables requested simultaneously.	
671	Configuration of message variables incompatible. Differences between configuration and PLC.	Lengthen standard clock pulse or configure fewer variables on screen.
672	Message not configured.	Check S7 programs. Check message server configuration.
681	Overload caused by too many variables (setpoints/actual values). Fault in connection between the C7 and PLC.	Change configuration and retransfer.
682	Incorrect interface parameters configured.	Check the interface parameters.
683	Configuration error: upper limit = lower limit	Configure fewer process links for the screen displayed.
684	Non-existent trend switch buffer requested.	Correct the limits and retransfer configuration.
685	Illegal job issued to send task for parallel interface.	Check PLC program/C7 configuration. Only use trend request area 2 for trends with switch buffer.
701	<i>Internal error</i> Incorrect assignment of "head -> res" when receiving variable.	
702	Job can not be executed.	Change interface or configure area pointer.
703	Flash memory full.	Restrict the configuration.
704	Incorrect CPU specified under the menu command "System," "Parameters" button in the dialog box which appears.	Change configuration and retransfer.
705	An acknowledged message cannot be entered in the buffer because the corresponding message or a message in the same acknowledgement group is missing.	
706	Recipe request will not be processed as another request is already active.	
707	<i>Internal error</i> S7 message task error.	
708	<i>Internal error</i> Incorrect mailbox type.	

Message	Cause	Remedy:
709	<i>Internal error</i> Invalid mailbox type.	
710	<i>Internal error</i> Incorrect operating mode.	
711	<i>Internal error</i> Display status invalid.	
712	No submenu configured.	
713	<i>Internal error</i> No special operator object configured.	
714	<i>Internal error</i> Menu number invalid.	
715	<i>Internal error</i> Mailbox type of received message is incorrect.	
716	<i>Internal error</i> The setting for the maximum number of messages is too high (variable overflow).	
717	<i>Internal error</i> Incorrect message status when entering in statistics.	
718	<i>Internal error</i> Incorrect message status when entering in event message buffer.	
719	<i>Internal error</i> Incorrect message status when entering in alarm message buffer.	
720	<i>Internal error</i> Error reading messages from message buffer.	
721	<i>Internal error</i> Configuration message error.	
722	<i>Internal error</i> Incorrect mailbox type received (OP15 -> OP5)	
723	<i>Internal error</i> OP5: more than 500 messages are specified in the area pointer lists.	Change area pointer list.
724	<i>Internal error</i> Mailbox type not implemented.	
725	<i>Internal error</i> Block number does not exist.	
726	<i>Internal error</i> Incorrect mailbox type.	

Message	Cause	Remedy:
727	<i>Internal error</i> Illegal screen type.	
728	<i>Internal error</i> Return reference number incorrect.	
729	<i>Internal error</i> Error in internal mailbox buffer management for direct message logging.	
731	<i>Internal error</i> Transfer parameter LEDSTATUS is incorrect in RIO function "Change LED Status".	
732	<i>Internal error</i> Key number can not be higher than 7/15/23 (8-key/16-key/24-key keyboard).	
733	<i>Internal error</i> Key number must be less than 4 as a maximum of 4 keys is possible.	
734	<i>Internal error</i> The submodule number must be 0.	
735	<i>Internal error</i> Illegal RIO function.	The following are permissible: Read, Write (LEDs, outputs) and Initialize.
736	<i>Internal error</i> Keyboard driver error.	
737	<i>Internal error</i> Too many keyboard image areas (mailboxes) being transferred to PLC.	
738	<i>Internal error</i> Mailbox type of received message is incorrect.	
739	<i>Internal error</i> Key acknowledgement received when message already acknowledged.	
740	<i>Internal error</i> Message status not permitted for first alarm/event message.	
741	<i>Internal error</i> Buffer type different from event or alarm message buffer.	
742	<i>Internal error</i> Message type different from event or alarm message buffer.	
743	<i>Internal error</i> Configuration message error.	

Message	Cause	Remedy:
744	<i>Internal error</i> Incorrect mailbox type received.	
746	<i>Internal error</i> Actual control value and process link are identical on a screen.	In COM TEXT: change address.
747	<i>Internal error</i> Buffer type different from event or alarm message buffer.	
748	<i>Internal error</i> Message type different from event or alarm message buffer.	
749	<i>Internal error</i> Error in data structure of a buffer function screen.	
750	<i>Internal error</i> Error in data structure of the password function screen.	
751	<i>Internal error</i> Error in data structure of screen for setting time.	
752	<i>Internal error</i> Error in data structure of the Login screen.	
753	<i>Internal error</i> Error in data structure of other type of function screen.	In COM TEXT: IHV recipes affected.
754	<i>Internal error</i> Error in data structure of "Average Statistics" screen.	
759	<i>Internal error</i> Error group (task ID) does not exist.	
760	<i>Internal error</i> The message number for this error group does not exist.	
761	<i>Internal error</i> Communication: mailbox type of received message is incorrect.	
762	<i>Internal error</i> Configuration error: message for which there is no text expected. 761 received instead.	Occurs if, for example, new firmware is being used with old COM TEXT version.
763	<i>Internal error</i> Configuration error.	
764, 765	<i>Internal error</i> There are two variables: Var.1: for the message number, Var.2: a number for the error location	

Message	Cause	Remedy:
767, 769, 771	<i>Internal error</i> With stop, TD10 - TD/OP20 different.	
772	<i>Internal error</i> Communication error (→ Message frames).	
774	<i>Internal error</i> Error reading area pointer.	
776	<i>Internal error</i> Data record memory full.	
777	<i>Internal error</i> Too many cyclic interrupts in transit.	
780	<i>Internal error</i> Internal error during MPI download; possibly due to buffer problems.	Reset and repeat MPI download.
781	<i>Internal error</i> Undefined error from communication with PLC.	
782	An "Online Setter" function has been incorrectly defined in ProTool.	



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C7-633/C7-634 Control Systems
C79000-G7076-C634-01

Technical Specifications for the C7

B

What are the Technical Specifications?

This chapter lists the technical specifications of the C7.

These technical specifications include the standards and test values that the C7 conforms to or the criteria against which the C7 has been tested.

Chapter Overview

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B.1 Technical Specifications

General Technical Specifications	C7-633 DP	C7-634 DP	C7-633 P	C7-634 P
Order number	6ES7633-2BF00-0AE3	6ES7634-2BF00-0AE3	6ES7633-1DF00-0AE3	6ES7634-1DF00-0AE3
Dimensions <ul style="list-style-type: none">Device (B x H x D)Cutout (B x H)	240 x 203.5 x 74.4 mm 231 x 159 mm		240 x 203.5 x 89.4 mm 231 x 159 mm	
Weight	1600 g	1700 g	1800 g	1900 g
Safety of electrical equipment <ul style="list-style-type: none">StandardsProtection against foreign particles and waterFire safety<ul style="list-style-type: none">Plug connectorsBasic connectors in housingHousing/front	EN 61131-2 according to IEC 1131-2 Front: IP 65 according to IEC 529 Housing: IP 20 according to IEC 529 According to UL 94 V2 V0 V0			
Acceptance tests, certification	EN 61131-2 (IEC 1131-2) UL Listing UL 508 Canadian Standard Association (CSA) acc. to Standard C22.2 Number 142 FM approval, FM standards No. 3611, 3600, 3810 Class I, Div. 2 Group A, B, C, D ISO 9001 certification of manufacture and development			
Operational ambient temperature <ul style="list-style-type: none">when mounted vertically through 455when mounted horizontally through 455storage/transport	tested to IEC 68-2-1, IEC 68-2-2 ±0 to +50°C ±0 to +45°C -20°C to +70°C			
Relative humidity <ul style="list-style-type: none">operationstorage/transport	tested to IEC 68-2-3 5 to 95 % at 25°C (no moisture condensation) 5 to 95 % at 25°C (no moisture condensation)			
Air pressure <ul style="list-style-type: none">operationstorage/transport	795-1080 hPa (corresponds to -1000 m to +2000 m) 660-1080 hPa (corresponds to -1000 m to +3500 m)			
Isolation	---		yes, digital inputs/outputs, analog inputs/ outputs (not for universal inputs) 500 V DC	
Supply voltage <ul style="list-style-type: none">rated voltage (V_N)permissible rangepolarized input voltageopen circuit (can be jumpered)current consumption (I_N) typ. / max.power loss	Safety extra-low voltage, SELV 24 VDC 20.4 VDC to 30.2 VDC Note: The C7 has no integrated protection against high-energy glitches in ms range (surges). yes ≥ 20 ms 550 mA / 1 A 12 W			
Electromagnetic compatibility (EMC) <ul style="list-style-type: none">Limit class for emitted interference	Class B to EN55022 (corresponds to CISPR 22)			

General Technical Specifications	C7-633 DP	C7-634 DP	C7-633 P	C7-634 P
<ul style="list-style-type: none"> Conducted interference on voltage supply lines 	$\pm 2\text{kV}$ to IEC 1000-4-4; burst $\pm 1\text{kV}$ to IEC 1000-4-5; μs -pulse / line to line *) $\pm 2\text{kV}$ to IEC 1000-4-5; μs -pulse / line to ground *) *) with protection element lightning conductor KT Type 24 VAD from "Dehn" firm			
<ul style="list-style-type: none"> Immunity to interference on signal lines 	$\pm 2\text{kV}$ at IEC 1000-4-4; burst			
<ul style="list-style-type: none"> Immunity to discharge 	$+6\text{kV}$, contact discharge, to IEC 1000-4-2; ESD $+8\text{ kV}$, air discharge, to IEC 1000-4-2; ESD			
<ul style="list-style-type: none"> Immunity to high-frequency radiation 	10V with 80% amplitude modulation with 1KHz 10KHz to 80MHz , to IEC 1000-4-6 10V/m with 80% amplitude modulation with 1KHz 80KHz to 80MHz , to IEC 1000-4-3 10V/m pulse-modulated 50% ED with 900MHz , to EN 50140			
Mechanical loading <ul style="list-style-type: none"> Vibration 	tested to IEC 68-2-6			
Tested with	10 to 58 Hz ; amplitude 0.075 mm 58 to 500 Hz ; acceleration 9.8 m/s^2			
Storage/transport	5 to 9 Hz ; amplitude 3.5 mm 9 to 500 Hz ; acceleration 9.8 m/s^2			
<ul style="list-style-type: none"> Shock 	tested to IEC 68-2-29			
Tested with	semi-sinusoidal: 100 m/s^2 (10 g), 16 ms ; 100 shocks			
Storage/transport	semi-sinusoidal: 250 m/s^2 (25 g), 6 ms ; 1000 shocks			
Backup battery	Backup time approx. 1 year			

Communication	C7-633 DP	C7-634 DP	C7-633 P	C7-634 P
Communication functions <ul style="list-style-type: none"> PG/OP communication Global data communication Basic communication Expanded communication S5-compatible communication Standard communication 	yes	yes	yes	yes
Number of connections static/dynamic	4/8			
Multipoint interface MPI	yes, 2 nodes occupied per device (1x CPU, 1x OP)			
<ul style="list-style-type: none"> No. of nodes max. 	32 nodes; programming device/PC, OP, S7-300; per node max. 4 active connections to programming device/PC or OP			
<ul style="list-style-type: none"> Transfer rate max. Distance between 2 neighboring nodes 	187.5 Kbps without repeaters: 50 m with 2 repeaters: 1100 m with 10 repeaters in series: 9100 m via fiber-optic cables: 23.8 km (with star coupler or OLM)			
<ul style="list-style-type: none"> Connectable programming devices 	PG 720/720C, PG 740, PG 760, PC (AT) with MPI connection			
<ul style="list-style-type: none"> Guaranteed connections 	1 for connection of programming device 1 for connection of operator panel 8 for program-controlled communication			
<ul style="list-style-type: none"> Free connections 	2 for free programming device/OP program-controlled communication			

Communication	C7-633 DP	C7-634 DP	C7-633 P	C7-634 P
PROFIBUS DP interface				
Integrated / external	1 / CP342-5 (via IM expansion)		--- / CP342-5 (via IM expansion)	
<ul style="list-style-type: none"> Transfer procedure Transmission rate Number of DP stations per master (integrated or external interface) Address area per DP station 	PROFIBUS DP to DIN 19245 Part 3 DP master / slave 12 Mbps 64 122 bytes inputs and 122 bytes outputs, configurable in up to 32 address areas, max. 32 bytes per address area			
<ul style="list-style-type: none"> Modules per ET200M Master or slave 	8 yes			

Programming, Planning, Configuration	C7-633 DP	C7-634 DP	C7-633 P	C7-634 P
Programming, Configuration (PLC) <ul style="list-style-type: none"> Programming software Programming languages 	STEP 7, STEP 7 Mini STL, LAD, other languages optional			
HMI configuration	ProTool, ProTool/Lite			

Programmable Controller	C7-633 DP	C7-634 DP	C7-633 P	C7-634 P
Main memory (1 instruction corresponds to approx. 3 bytes)	64 Kbytes / 20 K instruction RAM		48 Kbytes / 16 K instruction RAM	
Load memory <ul style="list-style-type: none">IntegratedExternal max.	96 Kbytes RAM 512 Kbytes FEPROM (memory card)			
Data backup <ul style="list-style-type: none">with batterywithout battery	all data max. 4736 bytes, can be configured for bit memory, timers, counters, data (max. 8 DBs, max. 4096 data bytes retentive in total)			
Programming organization	linear, structured			
User program protection	<ul style="list-style-type: none">Knowhow-protectPassword protection			
Instruction set	Binary logic, bracketed commands, result assignment, save, count, load, transfer, compare, shift, rotate, generate complement, call blocks, integer math instructions, floating-point math instructions, jump functions			
Types of blocks	<ul style="list-style-type: none">Organization blocks (OB)Function blocks (FB)Functions (FC)Data blocks (DB)System functions (SFC)System function blocks (SFB)			
No. of blocksmax.	128 FCs, 128 FBs, or 127 DBs			
Program processing	<ul style="list-style-type: none">Startup (OB100)Free cycle (OB1)Real-time controlled (OB10)Time-driven (OB35)Interrupt-driven (OB40)Error handling (OB80, 81, 82, 85, 86, 87, 121, 122)		<ul style="list-style-type: none">As C7-633/634 DP, but without error handling OB86	

Programmable Controller	C7-633 DP	C7-634 DP	C7-633 P	C7-634 P
System functions (SFC)	Masking of interrupts, copying of data, real-time clock functions, diagnostic functions, error handling, module parameter assignment			
Block nesting depth	8 for each program execution level			
Bracket levels	8			
Execution times for <ul style="list-style-type: none"> • Bit operations • Word operations • Time/counter operations • Fixed-point addition • Floating-point addition 	0.3 μ s (0.3 ms per 1000 binary instructions) 1 μ s 12 μ s 2 μ s 50 μ s			
Cycle-time monitoring	150 ms (preset), selectable 1 to 6000 ms			
Bit memories <ul style="list-style-type: none"> • Retentive with battery • Retentive without battery • Clock memory 	2048 0 to 2047 0 to 2047, selectable 8 (1 memory byte), freely selectable address of a memory byte (clock memory that can be used in the user program)			
Counters <ul style="list-style-type: none"> • Retentive with battery • Retentive without battery • Counting range 	64 0 to 63 0 to 63, selectable 1 to 999			
Timers (are only updated in OB1) <ul style="list-style-type: none"> • Retentive with battery • Retentive without battery • Counting range 	128 0 to 127 0 to 127, selectable 10 ms to 9990 s			
Process image <ul style="list-style-type: none"> • Digital inputs • Digital outputs 	0 to 127 I0.0 to Q127.7 Q0.0 to Q127.7			
On-board interface module	IM 360			
Expansion with S7-300 modules	max. 3-tier			
S7-300 expansion modules	max. 24			
I/O expansions <ul style="list-style-type: none"> • Digital inputs/outputs • Analog inputs/outputs 	max. 768 max. 192			
Operable modules FM CP, point-to-point CP, LAN	8 4 2			
Clock	Real-time clock (hardware clock)			
Run-time meter <ul style="list-style-type: none"> • Value range • Granularity • Retentive 	0 to 32767 hours 1 hour yes			

Human-machine interface (HMI)	C7-633 DP	C7-634 DP	C7-633 P	C7-634 P
Built-in configuration memory	128 Kbyte Flash	256 Kbyte Flash	128 Kbyte Flash	256 Kbyte Flash
Display	STN LC display, LED backlighting approx. 100,000 h (approx. 11 years)			
<ul style="list-style-type: none"> Operating life of backlighting Number of lines x characters per line Line height 	4 x 20 8 mm	4 x 20 / 8 x 40 selectable 11 mm / 6 mm	4 x 20 8 mm	4 x 20 / 8 x 40 selectable 11 mm / 6 mm
Keyboard	Membrane keyboard	Membrane keyboard	Membrane keyboard	Membrane keyboard
<ul style="list-style-type: none"> Softkeys Function keys Function keys that can be configured as softkeys System keys Number of LEDs / of which two-color LEDs 	4 16 6 24 32 / 16	8 16 8 24 32 / 16	4 16 6 24 32 / 16	8 16 8 24 32 / 16
Event messages max.	499	999	499	999
<ul style="list-style-type: none"> Event message buffer Page event messages 	max. 256 entries max. 256			
Alarm messages	499	999	499	999
<ul style="list-style-type: none"> Alarm message buffer 	max. 256 entries			
No. of variables in message text	max. 8			
No. of displays	99			
Entries per display	99			
Recipes	max. 99			
<ul style="list-style-type: none"> Recipe data memory Data records per recipe Entries per data record 	4 Kbytes	20 Kbytes	4 Kbytes	20 Kbytes
	max. 99			
	max. 99			
Semi-graphics	According to character set			
Symbols/character sets	1			
Dynamic objects	Input, output, I/O fields, date/time fields, symbolic I/O fields			
Online languages	3			
Password levels	9			
Clock	Software clock	Hardware clock	Software clock	Hardware clock
Load/printer interface	RS 232 / TTY			

Built-in inputs/outputs	C7-633 DP	C7-634 DP	C7-633 P	C7-634 P
Built-in digital inputs	-		16	
Input voltage			24 V DC 11 to 30 V -3 to 5 V	
<ul style="list-style-type: none"> Rated value With signal "1" With signal "0" 				
Isolation			Yes, via optocouplers in groups of 16	
Input delay			3/4.8 ms	
typ./max.				
Input current with signal "1"			11.5 mA	
max.				

Built-in inputs/outputs	C7-633 DP	C7-634 DP	C7-633 P	C7-634 P
Connecting 2-wire Beros <ul style="list-style-type: none"> Permissible closed-circuit current max. 			2 mA	
Cable lengths <ul style="list-style-type: none"> Unshielded Shielded 			600 m 1000 m	
Built-in digital outputs	-		16	
Load rated voltage <ul style="list-style-type: none"> permissible range 			24 V DC 20.4 to 28.8 V	
Output voltage <ul style="list-style-type: none"> with signal "1" max. 			L + (-0.8 V)	
Isolation			Yes, via optocouplers, two groups of 8	
Output current <ul style="list-style-type: none"> with signal "1" rated value minimum current with signal "0" max. 			0.5 A 5 mA 0.5 mA	
Cumulative current per group of 8 <ul style="list-style-type: none"> at 20 °C at 50 °C 			4 A 2 A	
Lamp load max.			5 W	
Switching frequency <ul style="list-style-type: none"> under impedance load under inductive load 			100 Hz 0.5 Hz	
Limiting of voltage induced on circuit interruption to			L + (-48 V)	
Short-circuit protection			Yes, electronically clocked	
Cable lengths <ul style="list-style-type: none"> Unshielded Shielded 			600 m 1000 m	
Built-in universal inputs	-		4	
			Can be used as UI1 Digital/interrupt input 24 V DC or up/down counter or external gate counter UI2 Digital/interrupt input 24 V DC or up/down counter or external gate counter UI3 Digital/interrupt input 24 V DC or up/down counter or frequency/period duration counter or external gate counter UI4 Digital/interrupt input 24 V DC	
Isolation			No	
Input voltage <ul style="list-style-type: none"> Rated value With signal "1" With signal "0" 			24 V DC 11 to 30 V -3 to 5 V	
Input current with signal "1" typ.			2 to 8 mA	
Cable lengths <ul style="list-style-type: none"> Unshielded Shielded 			600 m 1000 m	

Built-in inputs/outputs	C7-633 DP	C7-634 DP	C7-633 P	C7-634 P
Counter frequency max.			10 kHz	
Counters max. <ul style="list-style-type: none"> • Principle • Count range C1/C2 • Count range C3 • Limit value (nominal) default • Count interrupt up counter • Count interrupt down counter • Enable 			3 Edge counting up: 0 to 65535 down: 65535 to 0 up: 0 to 16777215 down: 16777215 bis 0 1 value per counter On reaching the limit value On reaching "0" Within the program	
Period duration counter max. <ul style="list-style-type: none"> • Principle • Count range • Period duration max. 			1 Counting fixed time units between two positive edges 0 to 16777215 8.388 s or 0.119 Hz	
Frequency counter max. <ul style="list-style-type: none"> • Principle • Count range • Gate width 			1 Counting pulses within a timer period 0 to 16777215 0.1 s; 1 s; 10 s (selectable)	
External gate counter max. <ul style="list-style-type: none"> • Principle • Count range C1/C2 • Count range C3 			3 Counting edges within a gate time via external pin 0 to $2^{16}-1$ 0 to $2^{24}-1$	
Built-in analog inputs	-		4	
Input range (selectable) / input resistance			$\pm 10\text{V}/50\text{ k}\Omega$ $\pm 20\text{ mA}/105.5\text{ }\Omega$ 4 to 20 mA/105.5 Ω	
Permissible input voltage for voltage input max.			30 V	
Permissible input current for current input max.			30 mA	
Isolation			Yes, shared with A0	
Cycle time (all channels)			2 ms	
Conversion time per channel			0.5 ms	
Resolution			12 bits incl. sign	
Operational limit (over entire temperature range, with reference to input range) <ul style="list-style-type: none"> • Voltage • Current 			$\pm 0.8\%$ $\pm 0.8\%$	
Basic error limit (operational limit at 25 °C, with reference to input range) <ul style="list-style-type: none"> • Voltage • Current 			$\pm 0.6\%$ $\pm 0.6\%$	

Built-in inputs/outputs	C7-633 DP	C7-634 DP	C7-633 P	C7-634 P
Interrupts <ul style="list-style-type: none"> Hardware interrupts <ul style="list-style-type: none"> As cyclic interrupt As end-of-cycle interrupt Diagnostic interrupt <ul style="list-style-type: none"> Interrupt cycle 			Yes, configurable Yes, configurable Overranging, open-circuit detection at 4 to 20 mA with software Yes, configurable	
Cable length, shielded max.			200 m	
Built-in analog outputs	-		4	
Output range <ul style="list-style-type: none"> Voltage output Current output 			$\pm 10 \text{ V}$ $\pm 20 \text{ mA}$	
Load impedance <ul style="list-style-type: none"> For voltage outputs min. For current outputs max. For capacitive load max. For inductive load max. 			2 k Ω 0.5 k Ω 1 μF 1 mH	
Voltage output <ul style="list-style-type: none"> Short-circuit protection Short-circuit current 			Yes 25 mA	
Current output <ul style="list-style-type: none"> No-load voltage max. 			$\pm \times 15 \text{ V}$	
Isolation			Yes, shared with AI	
Resolution			12 bits incl. sign	
Cycle time (all channels)			Type 2 ms max. 4 ms	
Transient recovery time <ul style="list-style-type: none"> For resistive load max. For capacitive load max. For inductive load max. 			0.1 ms 3.3 ms 0.5 ms	
Applicable substitute values			Yes, configurable	
Operational limit (0 to 60 °C, with reference to output range) <ul style="list-style-type: none"> Voltage Current 			$\pm 0.8 \%$ $\pm 1 \%$	
Basic error limit (operational limit at 25 °C, with reference to output range) <ul style="list-style-type: none"> Voltage Current 			$\pm 0.5 \%$ $\pm 0.6 \%$	
Interrupts <ul style="list-style-type: none"> Diagnostic interrupt 			Yes, configurable for parameter error	
Cable length, shielded max.			200 m	

24-VDC Power Supply

The whole 24-VDC power supply for the C7 (operating voltage, load voltage, relay power supply etc.) must be provided in the form of safety extra-low voltage (SELV).



Warning

Personal injury and property damage can occur.

If you do not provide the correct 24-VDC power supply for your C7, this may result in damage to components of your programmable controller or injury to personnel.

Use only safety extra-low voltage (SELV) for the 24-VDC power supply to your C7.

Important for the USA and Canada

If the device carries any of the following markings, the respective approval has been obtained:



Underwriters Laboratories (UL) to UL 508 standard



UL Recognition Mark



Canadian Standard Association (CSA) to standard C 22.2. No 142

FM Approval



APPROVED

FM Standards No. 3611, 3600, 3810 APPROVED for use in Class I, Division 2, Group A, B, C, D indoor hazardous locations.

B.2 Notes on the CE Marking

EU EMC Directive 89/336/EEC



The product meets the requirements of EU Directive 89/336/EEC
“Electromagnetic Compatibility.”

In accordance with the above-mentioned EU Directive, Article 10 (1), the EU declarations of conformity and the relevant documentation are held at the disposal of the competent authorities at the address below:

Siemens Aktiengesellschaft
Bereich Automatisierungs- und Antriebstechnik
A&D AS E4
Postfach 1963
D-92209 Amberg
Federal Republic of Germany

Areas of Use

The C7-633 and C7-634 control systems have been designed for use in the following areas in accordance with their CE marking:

Area of Use	Requirements	
	Emitted interference	Immunity
Industrial environment	EN 50081-2: 1993	EN 50082-2: 1995
Residential, commercial, light industry	EN 50081-1: 1992	EN 50082-1: 1992

Observing the Installation Guidelines

SIMATIC products meet the requirements if you observe the installation guidelines described in the manual when installing and operating the equipment.

B.3 Notes for Machine Manufacturers

Introduction

The SIMATIC programmable controller is not a machine as defined in the EU Machinery Directive. There is therefore no declaration of conformity for SIMATIC with regard to the EU Machinery Directive 89/392/EEC.

EU Machinery Directive 89/392/EEC

The EU Machinery Directive 89/392/EEC regulates requirements relating to machinery. A machine is defined here as an assembly of linked parts or components (see also EN 292-1, paragraph 3.1).

SIMATIC is part of the electrical equipment of a machine and must therefore be included by the machine manufacturer in the declaration of conformity procedure.

Electrical Equipment of Machinery in Accordance with EN 60204

The EN 60204-1 standard (Safety of Machinery, Electrical Equipment of Machines, Part 1, Specification for General Requirements) applies for electrical equipment of machinery.

The table below is designed to help you with the declaration of conformity and to show which criteria apply to SIMATIC according to EN 60204-1 (as of June 1993).

EN 60204-1	Subject/Criterion	Remarks
Paragraph 4	General requirements	Requirements are met if the devices are mounted/installed in accordance with the installation guidelines. Observe the explanations on the previous pages.
Paragraph 11.2	Digital I/O interfaces	Requirements are met.
Paragraph 12.3	Programmable equipment	Requirements are met if the devices are installed in locked cabinets for protection of memory contents against change by unauthorized persons.
Paragraph 20.4	Voltage tests	Requirements are met.

B.4 Transport and Storage Conditions for Backup Batteries

Transport of Backup Batteries

Transport backup batteries where possible in their original packaging. Observe the regulations for the transport of dangerous goods and substances. The backup battery contains approximately 0.25 g of lithium.

Note: According to air freight transport regulations, the backup battery is in Hazardous Goods Class 9.

Storage of Backup Batteries

Store backup batteries in a cool, dry place.
Backup batteries can be stored for up to five years.



Warning

Backup batteries can ignite or explode and constitute a serious fire hazard if they are heated or damaged.

Store batteries in a cool, dry place.

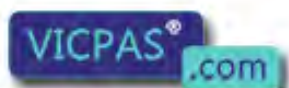
Rules for Handling and Using Backup Batteries

To prevent hazards when using backup batteries, you must observe the following rules:

Do not

- Recharge
- Heat
- Burn
- Drill
- Crush
- Short-circuit

backup batteries.



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C7-633/C7-634 Control Systems
C79000-G7076-C634-01

Guidelines for Handling Electrostatically-Sensitive Devices (ESD)

C

Chapter Overview

Section	Description	Page
C.1	What is ESD?	C-2
C.2	Electrostatic Charging of Objects and Persons	C-3
C.3	General Protective Measures against Electrostatic Discharge Damage	C-4
C.4	Taking Measurements and Working on ESD Modules	C-6
C.5	Packing Electrostatically-Sensitive Devices	C-6

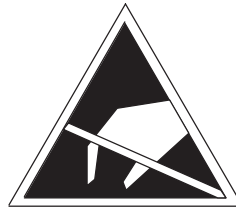
C.1 What is ESD?

Definition

All electronic modules are equipped with large-scale integrated ICs or components. Due to their design, these electronic components are very sensitive to overvoltages and thus to any electrostatic discharge.

These **E**lectrostatically-**S**ensitive **D**evices are commonly referred to by the abbreviation **ESD**.

Electrostatically-sensitive devices are labeled with the following symbol:



Caution

Electrostatically-sensitive devices can be damaged by 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 module without previously being electrostatically discharged. In most cases, 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 Objects and Persons

Electrostatic Charging

Any object with no conductive connection to the electrical potential of its surroundings can be charged electrostatically. Small charges up to 100 V are very common; these can, however, very quickly rise up to 15,000 V.

Examples:

- | | |
|---|----------------|
| • Plastic covers | up to 5 000 V |
| • Plastic cups | up to 5 000 V |
| • Plastic-bound books and notebooks | up to 8 000 V |
| • Desoldering device with plastic parts | up to 8 000 V |
| • Walking on plastic flooring | up to 12 000 V |
| • Sitting on a padded chair | up to 15 000 V |
| • Walking on a carpet (synthetic) | up to 15 000 V |

Limits for Perceiving Electrostatic Discharges

An electrostatic discharge

- of 3500 V and upwards can be felt
- of 4500 V and upwards can be heard
- of 5000 V and upwards can be seen.

Just a fraction of these voltages is capable of destroying or damaging your electronic devices/components.

Carefully note and apply the protective measures described below to protect and prolong the life of your modules and components.

C.3 General Protective Measures against Electrostatic Discharge Damage

Keep Plastics Away

Keep plastics away from sensitive devices. Most plastic materials have a tendency to build up electrostatic charges easily.

Provide Sufficient Grounding

Make sure that the personnel, working surfaces, and packaging are sufficiently grounded when handling electrostatically-sensitive devices. This helps to avoid static charges.

Avoid Direct Contact

If possible, avoid any contact with electrostatically-sensitive devices unless absolutely necessary (for example, to work on them). Hold modules without touching the pins of components or printed conductors. In this way, the discharged energy cannot affect the sensitive components.

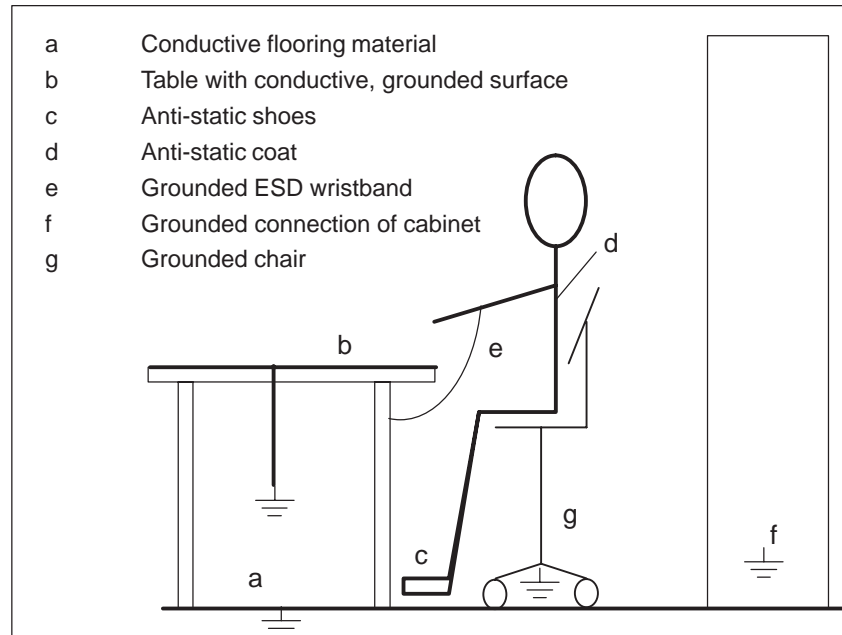
Special Precautions for Modules without a Casing

Note the following measures that have to be taken for modules that are not protected against accidental contact:

- Touch electrostatically-sensitive devices only
 - if you wear a wristband complying with ESD specifications or
 - if you wear special anti-static footwear or ground straps when walking on an ESD floor.
- Before working on electronic devices, discharge your body by touching grounded metallic objects (for example, bare metal parts of cabinets, water pipes etc.).
- Protect modules against contact with chargeable and highly insulating materials such as plastic foils, insulating table tops, or synthetic clothing.
- Place electrostatically-sensitive devices only on conductive surfaces:
 - Tables with anti-static table top,
 - Conductive ESD foam plastic (ESD plastic foam is mostly colored black),
 - ESD bags.
- Avoid placing electrostatically-sensitive devices in the immediate vicinity of visual display units, monitors, or TV sets (minimum distance to screen > 10 cm).

ESD Precautions

The following figure again illustrates the precautions for handling electrostatically-sensitive devices.



C.4 Taking Measurements and Working on ESD Modules

Use Grounded Measuring Devices Only

Measurements may be taken on electrostatically-sensitive devices only if:

- The measuring device is grounded (for example, via protective conductor) or
- The tip of the isolated measuring device has previously been discharged before use (for example, by briefly touching grounded metal parts).

C.5 Packing Electrostatically-Sensitive Devices

Using Conductive Material for Packing Modules without a Casing

Always use conductive materials for packing modules without a casing and components. You may also use metal-clad plastic boxes or metal containers. Always store ESD modules in conductive packing material.

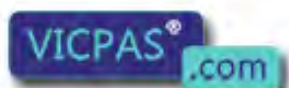
Cover Batteries

When packing modules incorporating batteries, cover the battery connections with insulating tape or insulating material to avoid short-circuiting the battery. Remove the battery if possible.

Literature on SIMATIC C7 and S7

D

- /30/** Primer: *S7-300 Programmable Controller, Quick Start*
- /70/** Manual: *S7-300 Programmable Controller, Hardware and Installation*
- /71/** Reference Manual: *S7-300 and M7-300 Programmable Controllers, Module Specifications*
- /72/** Instruction List: *S7-300 Programmable Controller*
- /230/** User Manual: *Standard Software for S7, Converting S5 Programs*
- /232/** Manual: *Statement List (STL) for S7-300 and S7-400, Programming*
- /233/** Manual: *Ladder Logic (LAD) for S7-300 and S7-400, Programming*
- /235/** Reference Manual: *System Software for S7-300 and S7-400, System and Standard Functions*
- /236/** Manual: *Function Block Diagram (FBD) for S7-300 and S7-400, Programming*
- /280/** Programming Manual: *System Software for M7-300 and M7-400, Program Design*



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Glossary

A

Analog I/O

The analog I/O converts analog process values (for example, temperature) into digital values that can be processed by the C7 CPU or converts digital values into analog manipulated variables.

Assigning Parameters

Assigning parameters means setting the behavior of a module.

B

Backup Battery

The backup battery guarantees that the user program in the C7 CPU is stored safe from power failures and that data areas, bit memory, timers, and counters remain retentive.

Backup Memory

The backup memory backs up memory areas of the CPU without the need for a backup battery. The memory backs up a programmable number of timers, counters, bit memory, and data block bytes.

Bus

A bus is a transfer medium that connects two or more nodes together. Data transfer can be serial or parallel, via electrical conductors or fiber-optic cables.

C

C7

The C7 control system integrates a SIMATIC S7-300 CPU, a SIMATIC OP, the possibility of connecting to the S7-300 I/O (for example, via an integrated IM 360), and a communication connection (for example, ASi master, PROFIBUS DP master/slave).

C7 CPU

The C7 CPU is the central processing unit for the C7, complete with processor, arithmetic unit, memory, operating system, and interfaces for programming devices. The C7 CPU is independent of the → C7 OP. The C7 CPU has its own MPI address and is connected to the C7 OP via the MPI (multipoint interface).

C7 OP

The C7 OP handles the OP functions. It is independent of the → C7 CPU and continues to operate, for example, if the C7 CPU goes into STOP mode. The C7 OP has its own MPI address and is connected to the C7 CPU via the MPI (multipoint interface). It is via the MPI that the C7 OP is connected to a configuring computer (programming device/PC).

Communications Processor	Communications processors are intelligent programmable modules with their own processor. They form an important group within the components of a programmable controller. A distinction can be made between various types of communications processors according to their tasks. For example, CPs for messages and logging, for point-to-point connection, for operator interfacing (COROS), for bus connections (SINEC), for diagnostics, and mass storage applications.
Complete Restart	When a CPU starts up (for example, when the mode selector is moved from STOP to RUN or when power is turned on), before cyclic program processing starts (OB1), either the organization block OB101 (restart; only in the S7-400) or OB100 (complete restart) is processed first. In a complete restart the process-image input table is read in and the STEP 7 user program processed starting with the first statement in OB1.
Configuration Memory	The configuration memory is a flash memory integrated in the C7 OP. It is used for storing the configuration data.
Configuring	Configuring is the selection and putting together of the individual components of a programmable logic controller (PLC), and the installation of the required software (for example, the operating system on an M7 automation computer) and adapting it to the specific task (such as assigning parameters to the modules).
CP	→ Communications processor
Cyclic Interrupt	A cyclic interrupt is generated periodically by the CPU according to a time interval which can be assigned parameters. It triggers execution of the relevant organization block.
D	
Diagnostics	A collective term for system diagnostics, process error diagnostics, and user-defined diagnostics.
Diagnostic Buffer	The diagnostic buffer is a retentive area of memory within the CPU which stores the diagnostic events in the order they occurred.
Diagnostic Event	Diagnostic events include errors in a digital function in the C7, system faults in the C7 caused, for example, by programming errors or operating mode transitions.

Diagnostic Functions The diagnostic functions comprise the complete scope of system diagnostics, process error diagnostics, and user-defined diagnostics, and the detection, evaluation, and signaling of faults within the C7.

Diagnostic Interrupt Modules with diagnostics capability signal system errors to the CPU by means of diagnostic interrupts.

E

Equipotential Bonding Electrical connection (equipotential bonding conductor) that brings the bodies of electrical resources to the same or approximately the same potential as foreign bodies in order to prevent interference or hazardous voltages arising between the bodies.

Error Display The error display is one of the possible responses of the operating system to a run-time error. The other possible responses are: error response in the user program, CPU STOP mode.

F

Flash EPROM FEPROMs correspond to the electrically erasable EEPROMs, but can be erased much faster (Flash EPROM = Flash Erasable Programmable Read-Only Memory). They are used on the memory cards.

Flash Memory → Flash EPROM

Functional Ground Grounding with the sole purpose of ensuring the intended purpose of the electrical resources. Function grounding has the effect of short-circuiting interference voltages that would otherwise have an impermissible influence on the resources.

Function Module (FM) A function module (FM) is a module which relieves the CPU in the S7-300 and S7-400 programmable logic controllers of time-critical and memory-intensive process signal processing tasks. Function modules generally use the internal communication bus for high-speed data exchange with the CPU. Examples for function module applications are: counting, positioning, closed-loop control.

G**Ground**

Conductive ground whose electrical potential at any point can be taken as zero. In the area of grounding electrodes, the ground can have a potential other than zero. This is frequently referred to as the “reference ground.”

Ground (Verb)

To connect an electrically conductive part with the grounding electrode (one or more conductive parts that have very good contact to ground) by means of a grounding point.

H**Hardware Interrupt**

A hardware interrupt is triggered by interrupt-triggering modules as the result of certain events in the process. The hardware interrupt is signaled to the C7 CPU. Depending on the priority of the interrupt, the corresponding organization block is then executed.

I**Information Function**

The information functions of the STEP 7 programming software permit the display of status information from the CPU (for example, information about memory space or cycle time statistics).

Interrupt

SIMATIC S7 recognizes 28 different priority classes which control the processing of the user program. These priority classes include interrupts, such as hardware interrupts. When an interrupt occurs, the relevant organization block is called automatically by the operating system in which the user can program the required reaction to the interrupt (for example, in a function block (FB)).

Isolated

In isolated I/O modules, the reference potentials of the control circuit and the load circuit are electrically isolated by, for example, optocouplers, relay contactors, or transformers. Input/output circuits can be connected to common potential.

L

Load Memory

The load memory is part of a programmable module. It contains objects created by the programming device (load objects). It can be either a plug-in memory card or an integrated memory. In SIMATIC M7 the load memory can be defined as a directory on the hard disk.

M

Memory Card

A memory card is a memory submodule in credit-card format and in the form of RAM or EPROM for programmable modules and CPUs which can store the user program and parameters.

Memory Reset (MRES)

The memory reset function deletes the following memories in the CPU:

- Work memory
- Read/write area of the load memory
- System memory

In S7/M7/C7 the MPI parameters and the diagnostic buffer are retained. In M7 the operating system is also rebooted if the M7 was reset via the mode selector. In SIMATIC HMI devices, all buffers are cleared. The MPI address is reset to the default value.

Memory Submodule

→ × Memory card

MPI

→ Multipoint interface

MPI Network

A network is the connection of a number of C7 and/or S7-300 and other devices, such as a programming device, via a connecting cable. Data are exchanged between the connected devices over the network.

Multipoint Interface

The multipoint interface (MPI) is the programming device interface in SIMATIC S7. It allows a number of programmable modules, text display operator panels, and operator panels (OPs) to be accessed from a CPU. The nodes on the MPI can communicate with each other.

N

Node Number The node number represents the “access address” of a CPU or a programming device or other intelligent I/O module when it communicates with other nodes via a network. The node number is assigned to the CPU or the programming device using the “S7 Configuration” application.

Non-Isolated In non-isolated I/O modules, the reference potentials of the control circuit and the load circuit are electrically connected.

O

Operating System A collective term for all functions which, in conjunction with the hardware, control and monitor the execution of the user programs, the distribution of the operational equipment among the individual user programs, and the maintenance of the operating mode (for example, MS-DOS).

P

Parameter

1. A parameter is a variable in a STEP 7 logic block (see block parameter, actual parameter, formal parameter).
2. A parameter is also a variable for setting the behavior of a module (one or more per module).

Every programmable module has a basic parameter setting when it is shipped from the factory, but this can be changed by configuring the hardware. There are two types of parameters: static and dynamic parameters.

Parameter, Dynamic Dynamic parameters of modules, in contrast to static parameters, can be changed by the user program during operation by calling an SFC in S7 and by calling a function in M7, for example, limit values of an analog input module.

Parameter, Static Static parameters of modules, in contrast to dynamic parameters, cannot be changed by the user program, but only by configuring the hardware, for example, the input delay of a digital input module.

PG → Programming device

PLC → Programmable logic controller

Process Image

The signal states of the digital input and output modules are stored in the CPU in a process image. There is a process-image input table (PII) and a process-image output table (PIQ).

The process-image output table is transferred to the output modules by the operating system at the end of the user program.

The process-image input table is read by the input modules before execution of the user program by the operating system.

Programmable Logic Control

Programmable logic control is the automation technique using electronic controllers whose function is stored in the control device as a program. The structure and the wiring of the device are not therefore dependent on the function of the controller. A programmable logic controller has the structure of a computer; it consists of a CPU with memory, I/O modules, and internal bus system. The I/O and the programming language are set up according to the requirements of control engineering.

Programmable Logic Controller

A programmable logic controller (PLC) comprises a central processor, a CPU, and a number of I/O modules.

Programming Device

Programming devices are essentially personal computers that are compact and portable and suitable for industrial use. They are characterized by being equipped with special hardware and software for programming SIMATIC programmable controllers.

R

RAM

The Random Access Memory or RAM is a read/write memory in which each memory location can be addressed individually and have its contents changed. RAM is used as a memory for data and programs.

Reference Ground

The reference ground is the total of all connected conductive inactive parts of an operating resource that cannot carry a hazardous touch voltage even in the event of a fault.

Reference Potential

Potential from which the voltages of the connected circuits are considered and/or measured.

S

Scan Cycle Time	The scan cycle time is the time the CPU takes to run the user program once through. The scan cycle time for analog modules is the time in which all the channels (input and output channels) are converted and the next conversion can start.
Signal Module	Signal modules (SM) form the interface between the process and the programmable controller. There are digital input modules, output modules, and in/out modules and analog input modules, output modules, and in/out modules.
STEP 7	Programming software for creating user programs for SIMATIC S7 programmable controllers.
STEP 7 Application	A STEP 7 application is a tool of STEP 7 which is tailored to a specific task.
Substitute Value	Substitute values are values which are output to the process in the case of faulty signal output modules or which are used in the user program instead of a process variable in the case of faulty signal input modules. The substitute values can be specified in advance by the user (for example, retain last value). They are values which the outputs are to output when the CPU goes into STOP.
System Diagnostics	System diagnostics comprises the detection, evaluation, and signaling of errors which occur within the programmable controller. Examples of such errors include: program errors or module faults.
System Memory	The system memory is integrated in the S7 CPU in the form of RAM. The address areas (for example, timers, counters, bit memory) and data areas required internally by the operating system (for example, backup for communication) are stored in the system memory. In M7, the system memory is not a separate area but is integrated in the work memory.

T

Time-Delay Interrupt	The time-delay interrupt belongs to one of the priority classes in SIMATIC S7 program processing. It is generated when a timer has expired in the user program. It triggers execution of the relevant organization block.
-----------------------------	---

Time-of-Day Interrupt The time-of-day interrupt belongs to one of the priority classes in the program processing of the C7 CPU. It is generated at a specific date (or daily) and time (for example, at 9:50 or every hour or every minute). It triggers execution of the relevant organization block.

Total Current Sum of the currents of all output channels of a digital output module.

Transmission Rate Data transmission rate in bits per second (bps).

U

Ungrounded Without electrical connection to ground.

User-Defined Diagnostic Event A diagnostic event recognized by the user which can be entered in the diagnostic buffer (via SFC52).
Note: If the entry is prepared in the diagnostic buffer in clear text and sent, a message appears.

User Memory The user memory contains the logic blocks and data blocks of the user program. The user memory is either integrated in the CPU or in the form of insertable memory cards or memory submodules. The user program is, however, always executed from the internal RAM memory of the CPU.

User Program The user program contains all the statements and declarations and the data required for signal processing to control a plant or a process. The program is linked to a programmable module (for example CPU or function module) and can be structured in the form of smaller units (blocks).

V

Varistor Voltage-dependent resistor

W

Work Memory The work memory is a random-access memory (RAM) in the CPU which the processor accesses while executing the user program.

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