

SIMATIC S5

**S5-115F
Programmable Controller**

Manual

Volume 1/2

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Abbreviations

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Preface

The S5-115F is a failsafe programmable controller for the mid performance range. It is for use wherever safety is the first priority and where potential dangers must be avoided.

Hardwired solutions have dominated failsafe technology until now. With the S5-115F, you can now apply all the advantages of our programmable controllers (PLCs) to your safety-related controls. You write your process-oriented program as before and then enter all safety-related data with the COM 115F programming software.

You require detailed information in order to use the controller to its best advantage.

This manual aims to provide the necessary information in condensed form without overloading the user with superfluous knowledge, which means:

- Standardization of terminology
- More detailed breakdown of subjects
- Illustration of individual problems
- User-friendly arrangement of the contents
- Particular observance of the rules of safety technology

In this way, you will gain all the information required to operate your S5-115F. This manual is aimed at:

- Users with little previous experience
- SIMATIC S5 experts
- Officials conducting Licensing Authority acceptance tests.

However, the applications are so numerous that not all the problems that might occur can be dealt with in one manual. You will find a list of Siemens representatives in the Appendix who will help you in those cases where the manual cannot answer your questions.

Introduction

Please read the introduction carefully. You will then find it easier to use the manual and this will save time.

This manual contains a detailed description of the S5-115F PLC with the CPU 942-7UF15. For the description of the S5-115F PLC with the CPU 942-7UF11 or CPU 942-7UF12, see the manual with the order no. 6ES5 998-1UF21. For the description of the CPU 942-7UF13 or CPU 942-7UF14 (incl. product information), see the manual with the order no. 6ES5 998-1UF23.

Description of Contents

This manual consists of two volumes and contains a detailed description of our SIMATIC S5-115F failsafe programmable controller.

Volume 1 contains the description of the hardware components. The contents of this volume can be divided into blocks according to topic:

- Reference manual
(System Overview, Technical Description)
- Installation and operation
(Installation Guidelines, Startup, Addressing)
- Special capabilities
(Analog Value Processing, Communications Capabilities)
- Overview of technical specifications
- Safety-related rules and regulations

Volume 2 contains the description of the software components. The contents of this volume can be divided into blocks according to the following topics:

- Working with COM 115F programming software
In the chapter "Configuring with COM 115F" you will find all the steps you require for configuring your S5-115F with the CPU 942-7UF15. Of course, you can also configure programmable controllers with the CPU 942-7UF11 to CPU 942-7UF14 using COM 115F system software, Version 3.2.
- Programming Guide
(Introduction to STEP 5, STEP 5 Operations)
- Testing
(Program Test, Error Diagnostics)
- Blocks
(Description of integral blocks and the use of loadable function blocks)
- Simple installation example with configuration of an S5-115F

You will find additional information in tabular form in the Appendices.

At the end of the book you will find correction forms. Please enter in these forms any suggestions you may have for improvements and corrections and send them to us. Your comments will help us to improve the next edition.

Conventions

In order to improve the readability of the manual, a menu-style breakdown was used, i.e.:

- The individual chapters can be quickly located by means of a thumb register.
- At the front of the manual is an overview containing the headings of the individual chapters.
- Each chapter has its own detailed table of contents.
The individual chapters are subdivided into sections and subsections. **Bold-face** type is used for further subdivisions.
- Figures and tables are numbered separately in each chapter. The page following the chapter table of contents contains a list of the figures and tables appearing in that chapter.

Certain conventions were observed when writing the manual. These are explained below.

- A number of abbreviations have been used.
Example: CPU (central processing unit)
- Footnotes are identified by superscripts consisting of a small digit (e.g. "1") or "*". The actual footnote is generally at the bottom left of the page.
- Cross-references are shown as follows:
"(7.3.2)" refers to subsection 7.3.2.
No references are made to individual pages.
- Dimensions in drawings are given in "mm" with the value in inches given in brackets.
Example: 187 (7.29).
- Values may be given in binary, decimal or hexadecimal numbers. The number system used is indicated in each case with a subscript, e.g. F000_H.
- Information of special importance is printed black-framed "windows".



Warning

See the Safety-Related Guidelines for the user for definitions of the terms "Note", "Caution", "Important", "Warning" and "Danger".

Manuals can only describe the current version of the programmable controller. Should modifications or supplements become necessary in the course of time, a supplement will be prepared and included in the manual the next time it is revised. The relevant version or edition of the manual appears on the cover. The present manual is edition "1". In the event of a revision, the edition number will be incremented by "1".

Courses

Siemens provides SIMATIC S5 users with extensive opportunities for training.

For more information, please contact your Siemens representatives.

Reference Literature

This manual is a comprehensive description of the S5-115F programmable controller. Topics not specific to the S5-115F, however, are only briefly dealt with. You will find more detailed information in the following literature:

- **Automating with the S5-115U**
SIMATIC S5 Programmable Controllers

Hans Berger
Siemens AG, Berlin and Munich 1987

Contents:

- STEP 5 programming language
- Program scanning
- Integral program blocks
- Interfaces to the I/Os

Order No.: ISBN 3-8009-1484-0

You will find information on the range of controllers and programmers in the following catalogs:

- ST 52.3 "S5-115U, S5115H and S5115F Programmable Controller"
- ST 57 "Standard Functions Blocks and Driver Software for Programmable Controllers of the U Range"
- ST 59 "Programmers"
- ET 1.1 "ES 902 C 19 in. Packaging System"
- MP 11 Thermocouples, Compensation Boxes

Further components and modules (e.g. CPs and SINEC L1) have their own manuals. We will refer you to these sources at the appropriate points in the text.

1 System Overview

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1 System Overview

1.1 Areas of Application

The S5-115F programmable controller is used in the most varied industrial fields. The following are the main areas of application:

- Safety-oriented applications requiring official authorization (e.g. burner controls, cable-car controls, fairground carousels)
- Applications not requiring official approval but constituting a high degree of danger for personnel and environment (e.g. controls for chemical processes)
- Applications with high capital risk (e.g. controls for processing expensive materials).

1.2 Regulations for Applications Requiring Official Approval

The failsafe S5-115F has been prototype-tested by the Bavarian Technical Inspectorate (TÜV). The prototype test covers a range of different regulations laid down by the various supervisory bodies and professional associations.

The S5-115F meets the requirements for safety-related applications

- with TÜV safety class 2
- with quality level 6 to DIN V 19250

TÜV safety classes

The Technical Inspectorate (TÜV) has arranged the requirements laid down in the regulations into five safety classes with the strictest requirements in safety class 1. It should be noted that the safety class is not necessarily an indication of the risk involved in the areas of application in question.

The S5-115F PLC meets the requirements of all regulations belonging to safety class 2 of the Technical Inspectorate. This means that the regulations of safety classes 3 to 5 are also met:

- Class 2:
 - Elevator controls to TRA 200/101
 - Escalator controls (not to EN 115)
- Class 3:
 - Road traffic signal systems to DIN 57832/VDE 0832
 - Electrical equipment of furnaces to DIN 57116/VDE 0116
 - Telecontrol installations for gas and oil pipelines to TRGL 181
 - Fairground carousels (present plants)
 - Cable-car controls
- Class 4:
 - Electromedical equipment to DIN IEC 601/VDE 0750
 - Remote radio control for cranes to ZH1/547
 - Manufacturing and processing machines to DIN 57113/VDE 0113
 - Flame monitoring equipment
 - Lifting platforms to VBG 14
- Class 5:
 - Powered gates (controls)

Quality levels to DIN V 19250

The classification to DIN 19250 is not based on existing regulations but rather uses risk parameters to define the risk inherent in a process. Risk parameters are the degree of damage, duration of stay in danger areas, the possibility of avoiding danger and the probability of undesired states arising. The risk graph gives information on the quality level in the case of protection facilities for measurement, open-loop control and closed-loop control.

1.3 System Components

The S5-115F system is made up of various modular components, as pictured in Figure 1-1. These components include the following:

- Power supply modules (PS)
- Central processing units (CPU)
- Input and output modules (I/O)
- Interface modules
- CP 523 communications processor

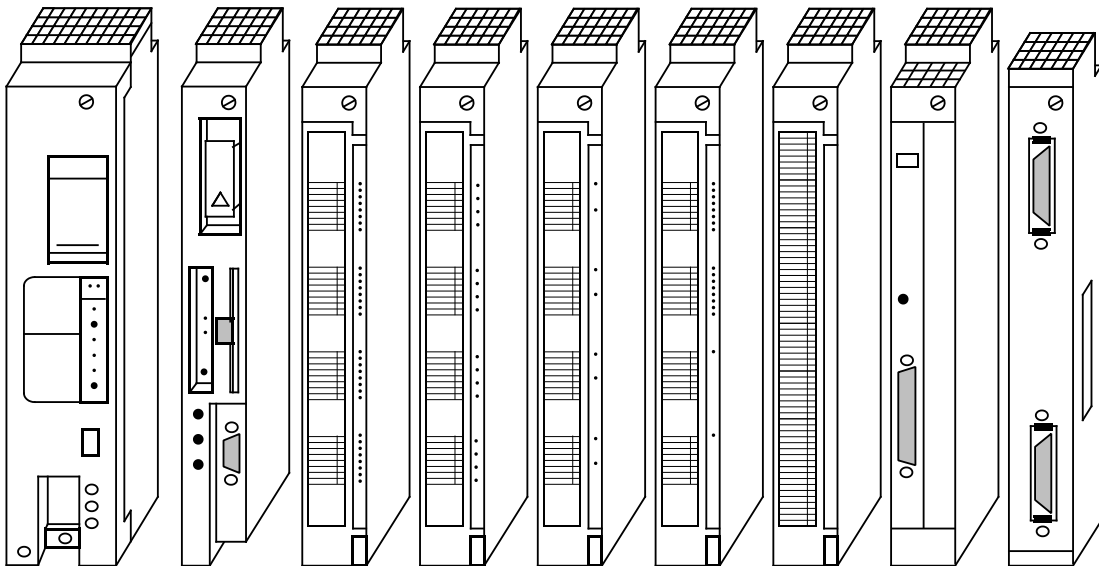


Figure 1-1. S5-115F Components

1.3.1 Power Supply

The power supply module (PS) converts the external power supply to the internal operating voltage. Supply voltage for the S5-115F is 24 V DC. The 24 V DC system voltage must be reliably isolated from the line voltage (e.g. 220 V).

Screw-type terminals connect the power supply lines to the bottom of the PS.

Lithium batteries ensure that the CPU RAM is backed up in the event of a power failure. Battery failure is indicated by an LED. Backup voltage can be supplied externally via sockets so that the batteries can be changed also when the PLC is in RUN.

1.3.2 Central Processing Unit

The central processing unit (CPU) is the "brain" of the programmable controller. It executes the control program.

The CPU 942F is used in the S5-115F. This is a slightly modified version of the CPU 942 in the S5-115U.

- PG/SINEC L1 interface optocoupler, for reliable electrical isolation
- No 5.2 V supply for the SINEC L1 terminal on the interface connector (so that the SINEC L1 LAN does not bypass the reliable isolation, even in the event of a fault)
- Operating system with all the safety functions of the S5-115F

You can use the CPU 942F in combination with analog modules and closed-loop control software to control nonsafety-related processes. A PID algorithm is integrated in the operating system of this CPU. Time constants starting at approximately one second are possible. You can implement a maximum of eight control loops.

1.3.3 Input and Output Modules

Input and output modules are the interfaces to the sensors and actuators of a machine or controlled system.

The following features make S5-115F modules easy to handle:

- Fast installation
- Mechanical coding
- Large labeling areas

Digital Modules

Digital modules conform to the voltage and current levels of your machine.

Digital modules have the following convenient features:

- Connection of signal lines via front connectors
- A choice of screw-type or crimp snap-in connections

Analog Modules

As a programmable controller's degree of performance increases, so does the significance of its analog value processing. The significance of the analog input and output modules increases accordingly.

The S5-115F offers the AE 460 and 463 nonfloating analog input modules. The desired level for the AE 460 is set via range cards and for the AE 463 via jumpers in the front connector. A range card is required for each of the four channels on the AE 460. This feature allows you to do the following:

- Have up to two different measuring ranges on one module.
- Change the measuring ranges simply by exchanging range cards.

In the case of the AE 463, the measuring range is jumpered separately for each of the four channels.

One analog output module covers the various voltage or current ranges of analog actuators.

1.3.4 Intelligent Input/Output Modules and Communications Processors

You can connect the CP 523 to the S5-115F direct in the central controller or in expansion units of one of the subunits. All further CPs and IPs of the SIMATIC family are used via an S5 controller of the U range (S5-115U, -135U, -150U, -155U) connected via a SINEC L1 LAN.

Intelligent input/output modules (IPs) preprocess input signals and data.

Communications modules (CPs) control communications using:

- Operator panels
- Process visualization panels
- Other programmable controllers

Intelligent I/Os and communications processors offload the CPU considerably.

1.4 Expansion Capability

If the connection capability of one central controller (CC) is no longer sufficient for your machine or system, increase the capacity with expansion units (EUs).

Interface modules connect a CC to EUs and connect EUs to each other. Choose an interface module to suit the controller configuration you need.

1.4.1 Centralized Configuration

The interface modules for centralized configurations connect bus lines and supply voltage to the EUs. The expansion units in such configurations therefore need no power supplies of their own.

A centralized configuration allows you to connect up to three EUs to one CC. The cables between the individual controllers or expansion units have a total maximum length of 2.5 m (8.2 ft.).

1.4.2 Distributed Configuration

A distributed configuration allows you to relocate expansion units nearer to the sensors and actuators of your machine.

Distributed configurations reduce cabling costs for these devices.

The flexibility of a controller is of decisive importance for the productivity of a manufacturing plant. Complex control tasks can be shared out among distributed controllers in order to achieve the highest possible flexibility.

This means you have:

- Smaller, more manageable units. This makes configuring, startup, diagnostics, modification and operation easier, and facilitates monitoring of the overall process.
- More availability in the system since the remaining system can continue to operate despite the failure of one unit.

Information flow between the individual controllers must be guaranteed in the case of distributed systems so that

- Data can be exchanged between the individual programmable controllers
- Manufacturing plants can be monitored, operated and controlled centrally
- Management information can be gathered (e.g. production data and stock levels).

1.5 Communications Systems

We offer the following communications facilities for the S5-115F programmable controller via the SINEC L1 LAN:

- Reliable communications among several S5-115F controllers (max. 30) (single-channel SINEC L1 LAN)
- Reliable and fault-tolerant communications among several S5-115F controllers (max. 15) (double-channel SINEC L1 LAN)
- Communications with an S5 controller of the U range for operator-process communication and visualization (single-channel SINEC L1 LAN) (Reaction-free, i.e. no adverse effects possible on the safety-oriented parts of the system.)
- Communications with two S5 controllers of the U range for operator-process communication and visualization (double-channel SINEC L1 LAN) (Reaction-free, i.e. no adverse effects possible on the safety-oriented parts of the system.)

A failsafe point-to-point connection between two S5-115F PLCs can also be established using the CP 523 (Catalog ST57).

Note

Since the SINEC L1 link has been proven to be reaction-free, the area in which acceptance tests are required ends at the CPU 942F.

The user program must constitute a safety filter for incoming data. Higher-level systems then have no influence on the reliable functioning of the S5-115F. This considerably simplifies individual system acceptance tests.

1.6 Operator-Process Communication, Process Visualization, and Programming

Today, users expect good process visualization with the capability to intervene where necessary. Previously, they had to hard-wire indicating lights, switches, potentiometers, and pushbuttons, even for simple requirements. For more complex processes, they had to use expensive video display terminals.

The S5-115F enables you to react optimally to the most varied automation requirements, even where programming is concerned.

To help you with this, the following performance-graded and compatible spectrum of programmers is available:

- The PG 635 in briefcase design with swing-up liquid crystal display,
- The PG 685 CRT-based programmers,
- The PG 695 with Siemens PC 16-11/PC 16-20 hardware as programming and documentation workstation,
- PG 710, PG 720, PG 730 and PG 740 as portable programming unit
- PG 750 and PG 770 with colour monitor.

All the programmers feature high performance, simple handling, user-friendly operator prompting, and the standard, easily learned STEP 5 programming language.

1.7 Software

Until now, prices for hardware components tended to drop constantly and prices for software tended to increase. The reasons were as follows:

- The processes to be automated became more and more complex
- Safety requirements increased
- Personnel costs increased
- Ergonomic demands increased

Siemens has put an end to this trend. SIMATIC provides the following four solutions to keep software costs down:

- The user-friendly STEP 5 programming language with its four methods of representation and convenient structuring capabilities
- An extensive software catalog
- User-friendly programmers
- Menu-driven configuration of safety and system features

1.8 Redundancy Structure

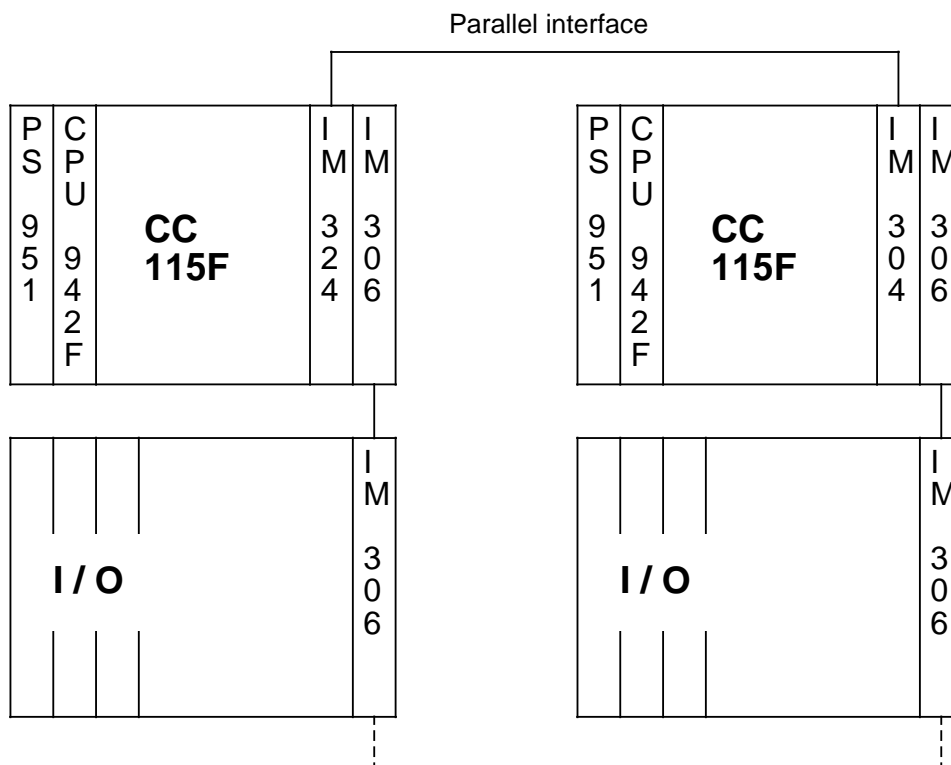
1.8.1 Hardware

The CPU 942F and the input/output modules are designed with two-channel redundancy. Both channels, referred to below as subunits, are connected via the parallel interface. The operating system and the user program are identical in both subunits.

The parallel interface has the task of implementing event-driven synchronization of both subunits and also data exchange. Synchronization is triggered by external interrupts (process interrupts) or internal interrupts (time interrupts, time updates, input module accesses).

Both subunits work with the same programs in such a way that user programs are run on the same program paths. In contrast, the operating system in both subunits does not run path-identically. This allows an asymmetrical hardware structure of the subunits, such as:

- A programmer to a subunit
- A SINEC L1 LAN to a subunit
- Single-channel, nonsafety-related input/output modules
- Single-channel test outputs for safety inputs.



Features:

- Two-channel redundancy structure (2-out-of-2 system)
- Event-driven synchronous processing of the user program
- Data exchange via high-speed parallel interface
- Expanded operating system: self-test, time-driven synchronization, image comparison

Figure 1-2. Hardware Structure Overview

1.8.2 Operating System - Additional Tasks

The operating system of the S5-115F has the following additional tasks compared to those of the S5-115U:

- Subunit synchronization
 - Program synchronization
 - Standardization of input data (necessary for path-identical processing of control programs)
 - Standardization of user times (necessary for path-identical processing of control programs)
 - Transfer of data from components connected at one end (e.g. PG 685, single-channel SINEC L1 LAN, single-channel I/O modules) to the other subunit
- Component test
 - Cyclical I/O module test with input signal discrepancy analysis
 - SINEC L1 LAN test for every message
 - Supplementary test of all function units such as processors, memory, parallel interface and I/O modules
- Error analysis and error response for
 - Subunit synchronization
 - Component test
 - CPU defects
 - Erroneous programming, configuration and handling by the user
 - System interrupts

1.8.3 Control Programs

The control program is fundamentally the same as a single-channel S5-115U program. A single logic operation (e.g. AND input) referenced to an I/O address is all that is required to scan a double-channel input. Similarly, an output operation referenced to an I/O address is used to output a control command via a double-channel output. This is the basic facility. Beyond this, the user must program the following:

- Standard synchronization function block FB 254 SYNC calls at intervals freely selectable by the user, in order to enable
 - Synchronous updating of user data
 - Synchronization of time calls, process interrupts and SINEC L1 LAN traffic;
- Command sequence to increment the logical program counter after every 127 words (maximum) of program code.

1.8.4 Programmer Functions

In addition to the programming functions of STEP 5 and startup support (e.g. with "Status display") familiar from the S5-115U, the programmer can also be used for the following in the case of the S5-115F:

- Safety parameter configuration for the operating system (monitoring times, structure of the feedback module required for the I/O) including check display of the configuration data
- Error display in plaintext.

These additional functions are implemented using the COM 115F programming package, which offers a modern forms-oriented operator interface.

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2 Technical Description

This chapter describes the design and principle of operation of an S5-115F with accessories.

2.1 Modular Design

The S5-115F consists of various functional units that can be combined to suit the particular problem. Figure 2-1 shows an S5-115F system.

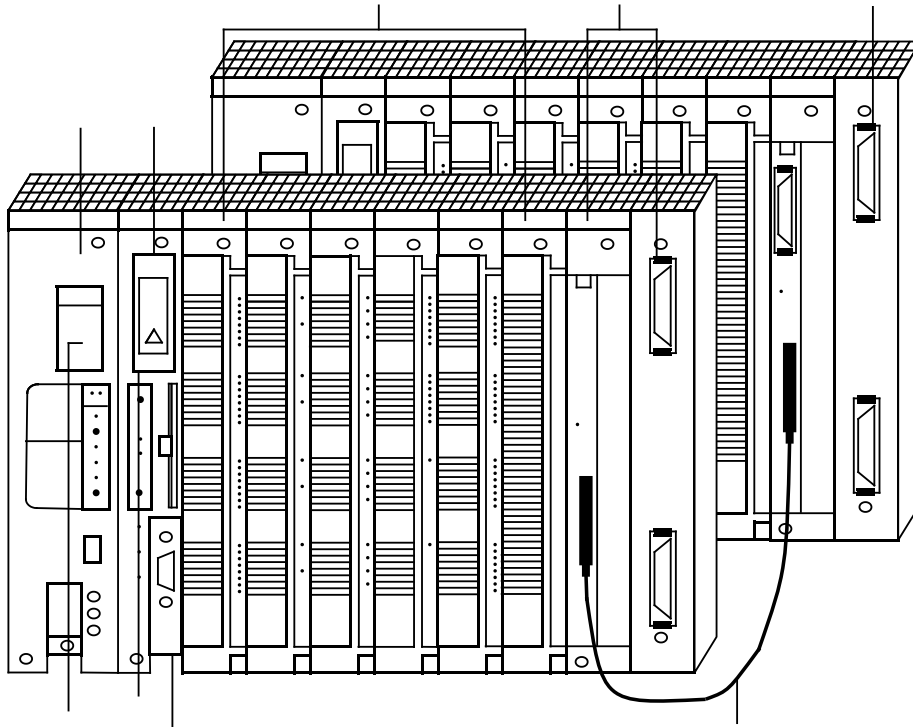


Figure 2-1. The S5-115F (Central Controller)

The numbered information below briefly describes the most important components of the S5-115F. The circled numbers refer to Figure 2-1:

Power Supply Module (PS 951)

The PS 951 power supply module generates the operating voltage for the programmable controller from the 24 V DC power system voltage. This module use batteries or an external power supply to back up the RAM.

The PS 951 power supply module also performs monitoring and signalling functions.

Central Processing Unit (CPU)

The central processing unit reads in input signal states, processes the control program, and controls outputs. In addition to program scanning functions, the CPU provides internal flags, timers, and counters.

You can diagnose errors using the LEDs of the CPU. Use the Overall Reset switch on the CPU to delete the RAM contents.

The control program can be transferred to the CPU using a programmer or a memory submodule.

Input and Output Modules (I/Os)

- Digital input modules adapt digital signals, e.g. from pressure switches or BERO® proximity switches, to the internal signal level of the S5-115F.
- Digital output modules convert the internal signal level of the S5-115F into digital process signals, e.g. for relays or solenoid valves.
- Analog input modules convert analog process signals, e.g. from transducers or resistance thermometers, to the S5-115F, which functions digitally.
- Analog output modules convert internal digital values of the S5-115F to analog process signals, e.g. for speed controllers.

Interface Module (IM)

The S5-115F is installed on one or more mounting racks with a specific number of mounting locations (slots). An installation with power supply, CPU, and input/output modules is called a central controller. If the slots on the central controller's mounting rack are insufficient, you can install expansion units (systems without CPUs) on additional mounting racks. Interface modules connect an expansion unit to a central controller.

Mounting Rack (CR, ER)

A mounting rack consists of an aluminum mounting rail to which all the modules are fastened mechanically. It has one or two backplanes that connect the modules to each other electrically.

TTY Interface

Connect a programmer or an operator panel at the TTY interface. You can also set up a SINEC L1 interface here.

Memory Submodule

Battery Compartment

Parallel link

The parallel interface is used to synchronize data exchange between the two subunits.

2.2 Principle of Operation of the Programmable Controller

This section describes how the PC processes your program.

2.2.1 Functional Units

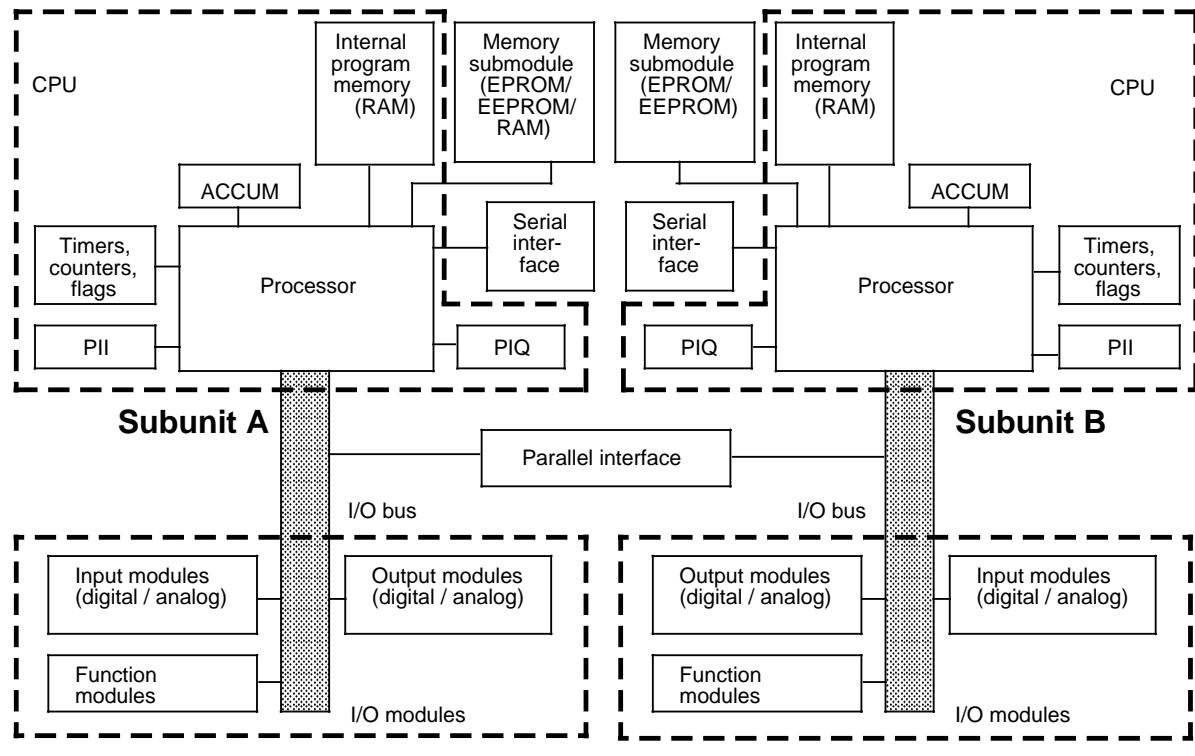


Figure 2-2. Schematic Representation of the S5-115F

Program Memory

The control program is stored in the memory submodule (2.3.2) or in the internal RAM.

To safeguard against losing the program, dump it in an external EEPROM/EPROM memory submodule. In contrast to these memory submodules, the internal RAM or a RAM memory submodule has the following characteristics:

- The memory contents can be changed quickly.
- User data can be stored and changed.
- When the power fails and there is no battery, the memory contents are lost.

In safety mode, the control program must be stored in the EEPROM/EPROM submodule. If no memory submodule or another memory submodule is connected, the S5-115F switches automatically into test mode.

Process images (PII, PIQ)

The signal states of input and output modules are stored in the CPU in "process images". Process images are reserved areas in the RAM of the CPU. Input and output modules have separate images as follows:

- Process image of the inputs (PII)
- Process image of the outputs (PIQ)

Serial interface

You can connect programmers and also the SINEC L1 local area network.

Flags, timers, and counters

The CPU provides internal flags (memory locations for storing signal states), timers, and counters that the control program can call.

The following are available

- 2048 flags*
- 128 timers
- 128 counters

Accumulator (ACCUM)

The accumulator is an arithmetic register for loading internal timer and counter values. Comparison, arithmetic, and conversion operations are also executed in the accumulator.

Processor

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

Input/output bus

The input/output bus establishes the electrical connection for all signals that are exchanged between the CPU and the other modules in a central controller or an expansion unit.

Parallel interface

The parallel interface is the electrical connection between both subunits for synchronization and data exchange.

* FW 0 is reserved for the logical program counter.
FW 2 to FWS 198 (F 2.0 to F 199.7) are permitted for the control program.
FW 200 to FW 254 (F 200.0 to F 255.7) can only be used if you are not using standard FBs.

2.2.2 Program Scanning

The input signals to the input modules are scanned cyclically before program scanning and mapped in the PII. The control program processes this information along with the current flag, timer, and counter data. The control program consists of a sequence of individual statements. The processor fetches the control program from the program memory and processes it statement by statement.

The results are written to the PIQ. After the processor scans the program, it transfers the PIQ data to the output modules.

The operating system of the S5-115F executes the following additional functions when addressing double-channel I/O modules:

- Digital inputs
 - Read in
 - Exchange and comparison
 - Discrepancy analysis (differentiation between long-term and short-term signal discrepancies with uniform input signal generation)
- Digital outputs
 - Exchange and comparison of I/O images
 - Output
- Analog inputs
 - Read in
 - Exchange and comparison
 - Discrepancy analysis (differentiation between permissible and impermissible discrepancies between both analog values and between short-term and long-term impermissible discrepancies)

Even during cyclic program scanning, quick response to signal changes is possible using the following methods:

- Using operations with direct I/O access (e.g. L PB, T PB).
- Programming multiple direct I/O scans in the control program.
- Programming organization blocks to handle interrupts.

The processor starts a monitoring time every time program scanning starts (scan trigger). If the scan trigger is not restarted within the configured scan time, e.g. because the control program contains an infinite loop or there is a malfunction in the CPU, the PC goes into the "STOP" mode and disables all output modules. Figure 2-3 shows a schematic representation of cyclic program scanning.

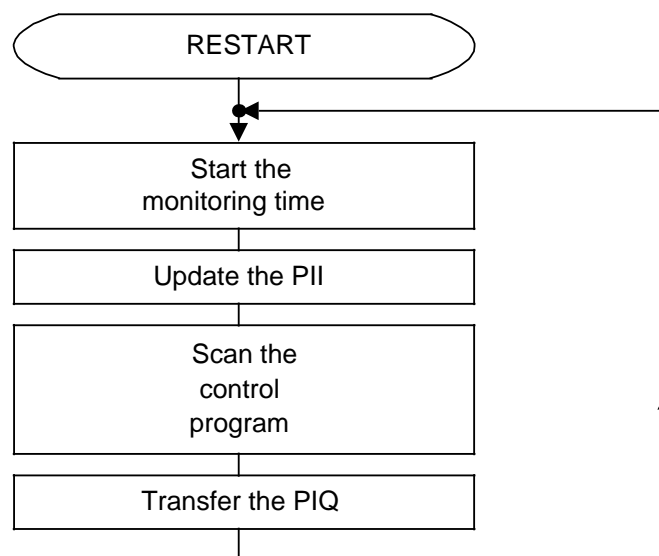


Figure 2-3. Schematic Representation of Cyclic Program Scanning

System response time:

Response time is the period between the input signal change on the process side and the output signal change on the process side.

This time is typically the sum of the following elements (Figure 2-4):

- The inherent delay of the input module
- The program scan time
- The inherent delay of the output modules

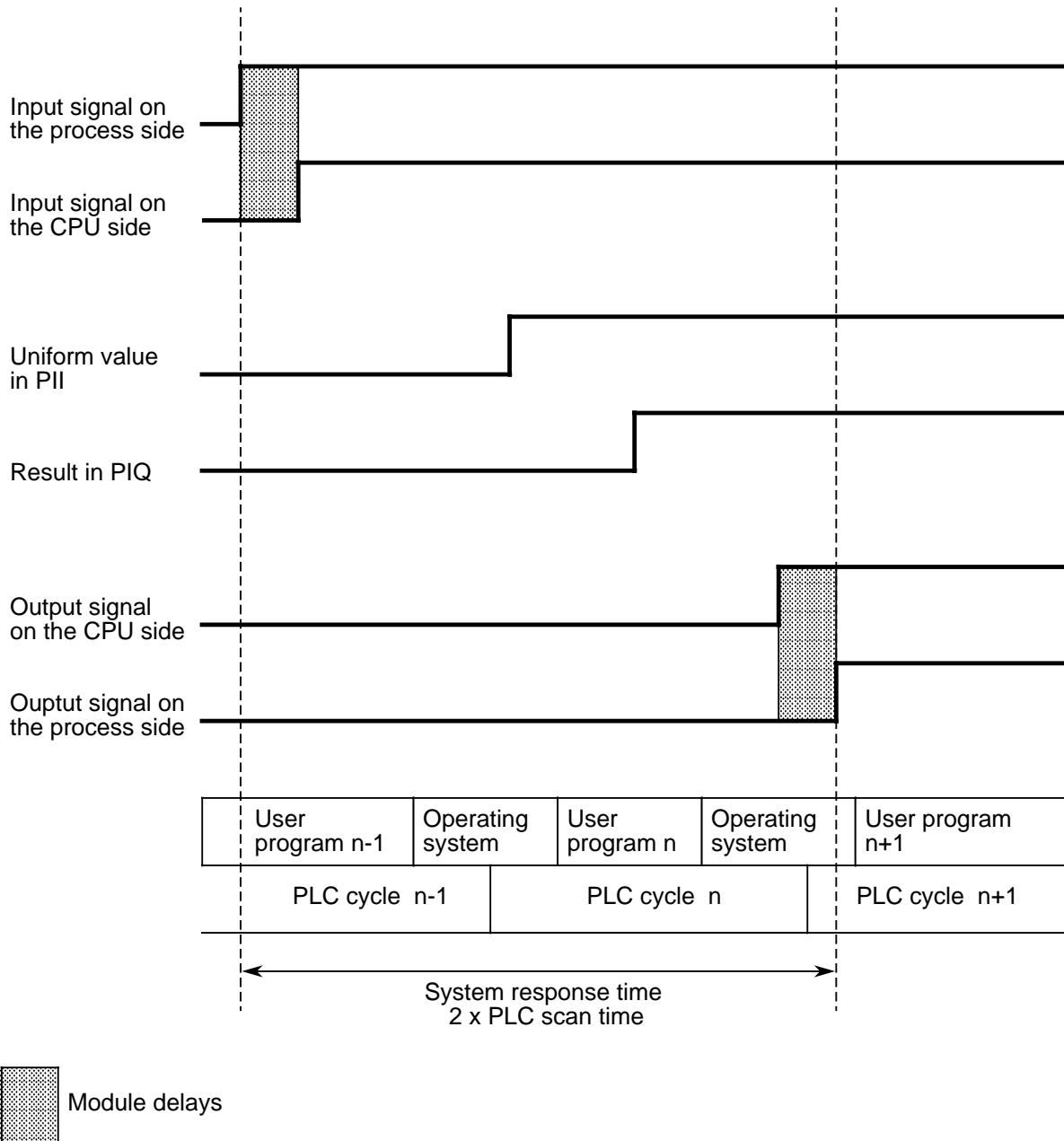


Figure 2-4. Definition of the System Response Time

Under worst case conditions, the system response time is double the PLC scan time.

Discrepancy times

The operating system tests the logical signal levels of the digital inputs in both subunits. If the level of a DI bit differs between the two subunits, this is referred to as a discrepancy.

Discrepancy can be caused by

- Fleeting errors (e.g. edge change)
- Permanent errors (e.g. hardware errors)

The duration of the discrepancy is monitored by the 115F operating system. The discrepancy time begins when the discrepancy is first detected, and ends only when the operating system detects that both DI bits match or when the discrepancy time has elapsed.

You can choose between two different discrepancy times when configuring the I/Os with the COM 115F programming software:

- Short discrepancy time

This is configured for inputs with a typical discrepancy time of less than 50 ms. When a discrepancy occurs, the 115F operating system scans the relevant input continuously until the discrepancy has disappeared or until the discrepancy time has elapsed. After the maximum discrepancy time has run, the 115F operating system initiates an error response.

You configure the short discrepancy time

- Uniformly between 10 and 2550 msec. for all noninterrupt DIs.
- Uniformly between 1 and 255 msec. for all interrupt DIs.

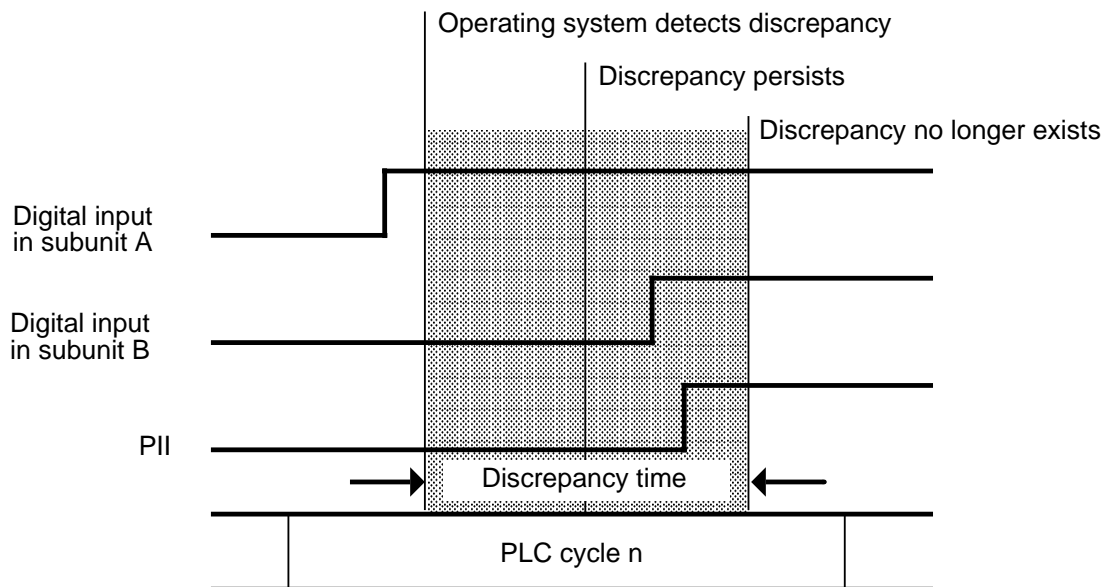


Figure 2-5. Definition of the Short Discrepancy Time

- Long discrepancy time

Long discrepancy times are defined if discrepancies at the inputs

- last longer than 2550 msec. in error-free operation as a result of the particular process
- are greater than the defined short discrepancy time
- are to be differently defined bitwise.

Configure the long discrepancy time individually for each digital input. The 115F operating system checks the DI bits for discrepancy only once per PLC cycle.

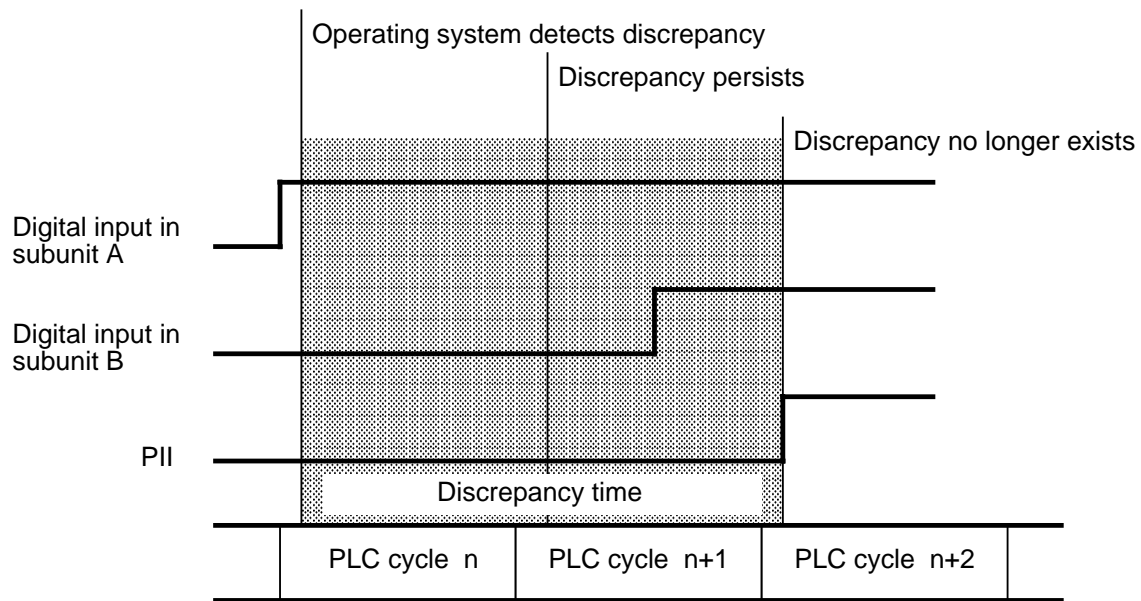


Figure 2-6. Definition of the Long Discrepancy Time

2.2.3 Central Processing Unit Description

The following table shows the most important features of the CPU 942F.

Table 2-1. Execution Times of the CPU 942F in μ s (rounded off)

Operation	Execution Time in μ s
Boolean logic operations	1.6
Load/Transfer operations (I, Q, F, T, C)	1.6
Comparison/ Arithmetic operations	1.6
Jump/Conversion operations	1.6
Timer/Counter operations	81 to 124
Block call operations	66 to 161
Load/Transfer operations (DW)	64 to 72
Substitution operations (formal operands)*	129
Load/Transfer operations (LIR, TIR, TNB)**	92 to 155
Bit test operations	152 to 154
Load/Transfer operations I/O modules	1330

* Plus execution time of the substituted operation!

** Plus transmission time!

Table 2-2. CPU Description

Features of the CPU 942F	
Typical run time of operating system (dependent on configuration programming)	60 ms
Execution time per - 1000 statements	approx. 15 ms
Internal program memory (RAM)	5 Kbytes
Total program memory (max.)	32 Kbytes
Scan monitoring time	configurable
Program scanning	cyclical, time-driven, interrupt-driven
Address range max. (Digital inputs)	1024 I 0.0 to I 127.7
Address range max. (Digital outputs)	1008 Q 0.0 to Q 125.7
Address range max. (Analog inputs)	64 PW 128 to PW 254
Address range max. (Analog outputs)	64 PW 128 to PW 254
Flags (nonretentive)	2048 FW 0 to 254*
Timers (nonretentive)	T0 to T127
Counters (nonretentive)	C0 to C127
Time range	0.01 to 9990 s
Counting range	0 to 999
Operation set	approx. 170 operations
Integral PID control FB	yes

* FW 0 is reserved for the logical program counter.
 FW 2 to FW 198 (F 2.0 to F 199.7) are permitted for the control program.
 FW 200 to FW 254 (F 200.0 to F 255.7) can only be used if you are not using standard FBs.

CPU 942F

The CPU 942F has a microprocessor and an application-specific integrated circuit (ASIC¹). The microprocessor handles all programmer interface module functions, processes integral timers, processes word operations, and controls the S5 bus. The microprocessor also controls the ASIC that monitors scan time, processes bit operations quickly, and processes some word operations. Besides the operating system memory, the CPU 942F contains an internal RAM that can be used to store up to 5 Kbytes of user data. External memory submodules with a capacity of 8 to 32 Kbytes can also be plugged into the CPU.

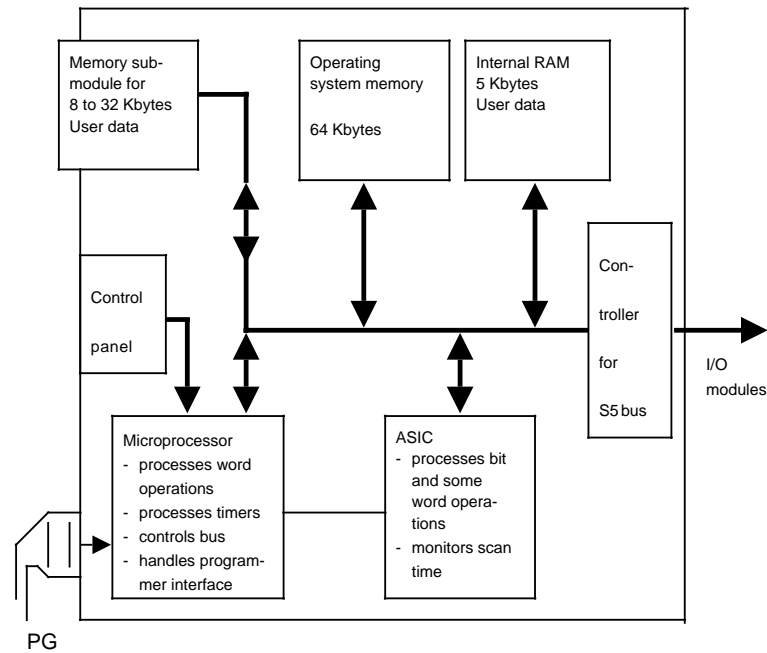


Figure 2-7. Schematic Representation of CPU 942F

Note

Two CPU 942Fs of the same version are always required to construct an S5-115F. You can read and check the system software version using the "SYSPAR" (system parameter) programmer function.

1 application specific intergrated circuit

2.3 Accessories

You can optimize the degree of expansion of your programmable controllers with the accessories listed in 2.3.1 through 2.3.4.

2.3.1 Backup Battery

For each S5-115F submodule there is minimum one backup battery indispensable. They maintain the program and data when the S5-115U is switched off. The backup battery has a service life of approximately two years but, for safety reasons, it must be replaced every year.

Note

The existing regulations on dangerous materials must be observed when transporting lithium batteries!

2.3.2 Memory Submodules

The following three memory submodule types are available for the S5-115F to store the control program or to transfer the program to the PLC:

- The EPROM submodule is a read-only memory. Program an EPROM module on a PG 635, PG 675, PG 685, PG 695 or PG 750 programmer. Use an ultraviolet erasing device to erase the submodule's contents (2.1.1).
- The EEPROM submodule is a read-only memory. Program and erase an EEPROM submodule on a PG 635, PG 675, PG 685, PG 695 or PG 750 programmer.
- The RAM submodule is used, in addition to program storage, to test a control program during system startup. It should be used as a program memory only when backup is guaranteed.

Safety mode in the S5-115F requires EEPROM/EPROM submodules as code memories for the control program. The system automatically switches to Test mode in the case of other submodules (RAM).

The individual memory submodules are available with different memory capacities as shown in Table 2-3 and 2-4.

Table 2-3. Memory Submodules for Safety Mode

Order Number	Type	Capacity *	Programming Number
6ES5 375-0LA15 /	EPROM	8x2 ¹⁰ Byte	11
6ES5 375 -0LA21 /	EPROM	16x2 ¹⁰ Byte	12
6ES5 375 -0LA41 /	EPROM	32x2 ¹⁰ Byte	17
6ES5 375-1LA15 /	EPROM	8x2 ¹⁰ Byte	411
6ES5 375-1LA21 /	EPROM	16x2 ¹⁰ Byte	412
6ES5 375-1LA41 /	EPROM	32x2 ¹⁰ Byte	417
6ES5 375-0LC31 /	EEPROM	8x2 ¹⁰ Byte	211
6ES5 375-0LC41 /	EEPROM	16x2 ¹⁰ Byte	212

* 2 Kbytes (=2 x 2¹⁰ Byte) correspond approximately to 1000 STEP 5 statements.

Table 2-4. Memory Submodules for Test Mode

Order Number	/	Type	Capacity	Programming Number
6ES5 375-0LD11	/	RAM	8x2 ¹⁰ Byte	-
6ES5 375 -0LD21	/	RAM	16x2 ¹⁰ Byte	-
6ES5 375 -0LD31	/	RAM	32x2 ¹⁰ Byte	-

2.3.3 Programmers (PG)

The programmer has the following applications:

- Entering programs
- Testing programs
- Monitoring programs

and with the COM 115F programming package:

- Configuring of safety-related systems
- Error messages in plaintext
- Extension of signature and subunit identifier

You can use the following programmers:

- With COM 115F: PG 635, PG 685, PG 695, PG 710, PG 720, PG 730, PG 740, PG 750, PG 770
- Without COM 115F: PG 605, PG 615, both with adapter for separate power supply.

You can work in on-line or off-line mode with the programmers.

2.3.4 Printers (PT)

Use a printer to output the following items:

- Inputs
- Outputs
- Programs
- Configuration data

The following printers can be used: confer Catalog ST59

The printers can be connected to programmers from PG 615 upwards.

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3 Installation Guidelines

Programmable controllers of the S5-115F system consist of two central controllers to which one or more expansion units can be connected if necessary. The modules that make up the S5-115F are mounted on racks which are located in cabinets to reduce the effects of interference.

3.1 Mounting Rack

Various mounting racks are available to suit the performance or the degree of expansion the control system is to have.

Each mounting rack consists of an aluminum mounting rail for fastening all modules mechanically and one or two backplanes for connecting the modules to each other electrically. The module locations (slots) are numbered in ascending order from left to right.

3.1.1 Central Controller (CC)

A central controller has a power supply module (PS), a central processing unit (CPU), and various input/output modules (I/Os). Depending on requirements, digital or analog modules can be used. Interface modules (IMs) are required when expansion units are used.

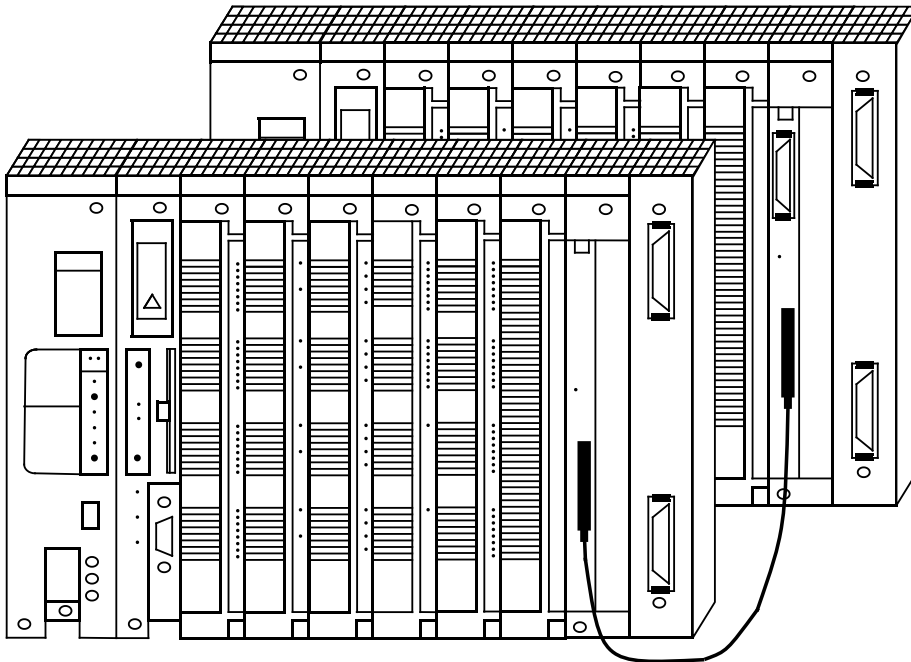


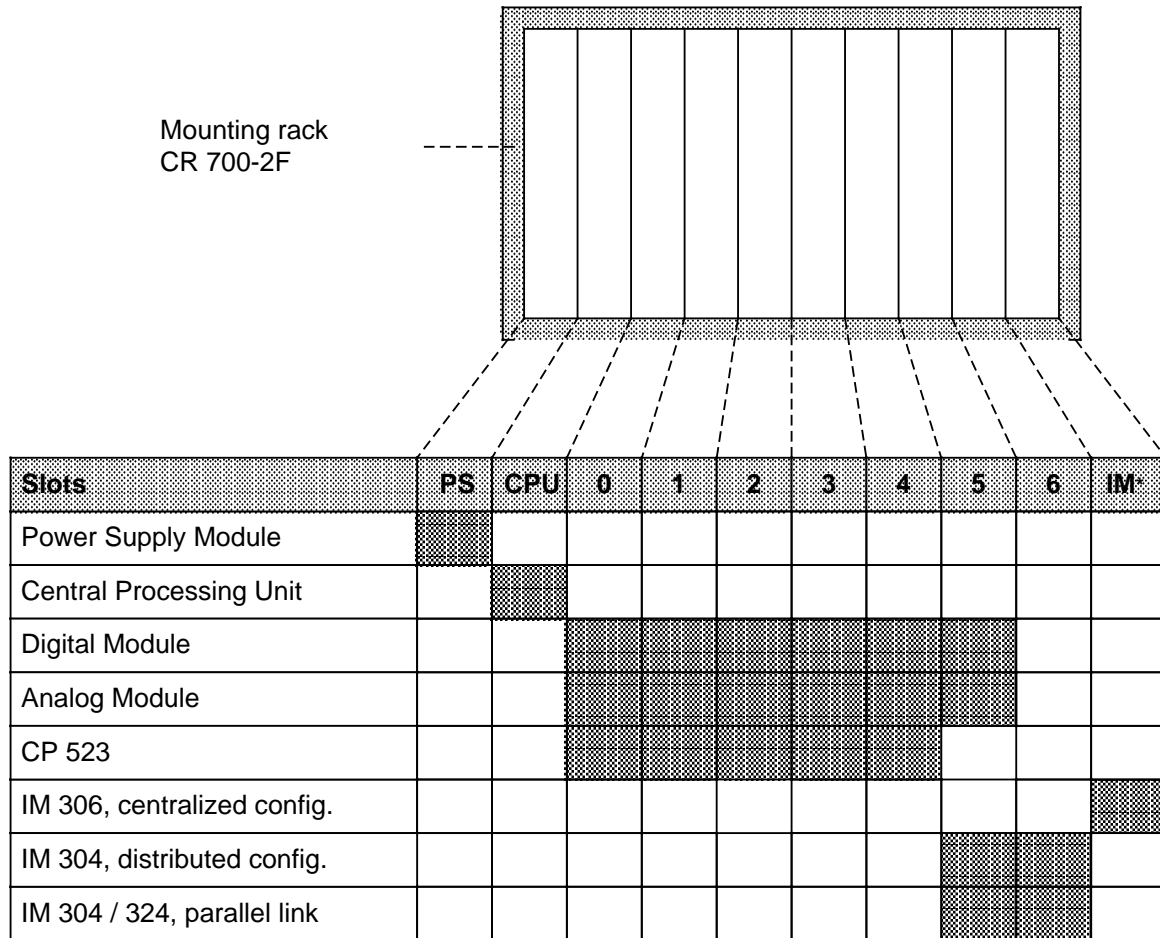
Figure 3-1. Programmable Controller without Expansion Units

A CR 700-2F or a CR 700-0 mounting rack is required for installing a central controller.

Possible configurations on mounting rack CR 700-2F (6ES5 700-2LA22)

The CR 700-2F mounting rack allows you to install safety-related controls in 19 in. cabinets. It has slots for a power supply module, a central processing unit and up to six input/output modules. An interface module can be used to:

- Link both subunits (IM 304 to subunit A, IM 324 to subunit B or vice versa)
- Connect expansion units in distributed configurations (IM 304 and IM 314).

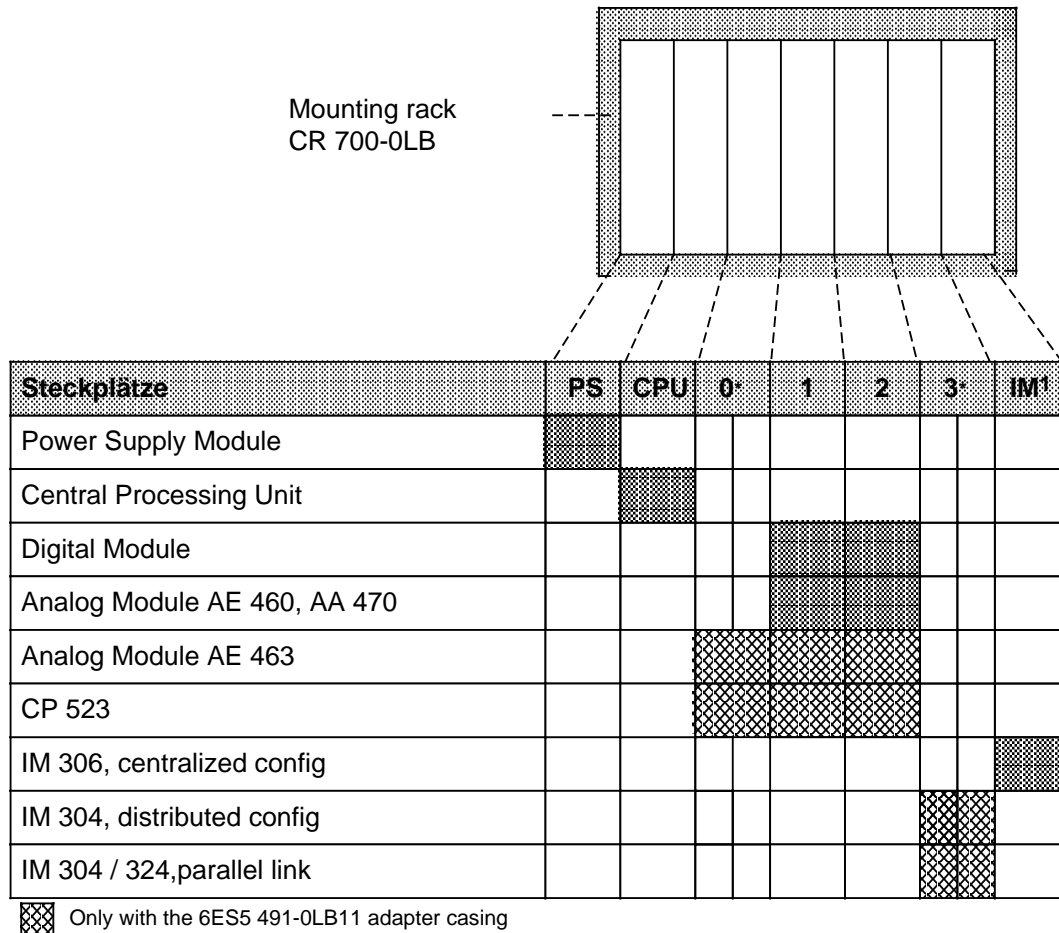


* The central rack is supplied with a termination connector in this slot. It can stay in this slot if you use the central rack without expansion racks. This assigns fixed initial module addresses to the slots in the central rack (5.2).

Figure 3-2. Possible Configurations on Mounting Rack CR 700-2F

Possible configurations on mounting rack CR 700-0 (6ES5 700-0LB11)

The CR 700-0 mounting rack is suitable for installing smaller controls. You can also use adapter casings with two printed circuit boards in the case of the CR 700-0 (6ES5 700-0LB11) mounting rack. There are also slots available for a power supply module (PS), a central processing unit (CPU), digital and analog block-type modules, the CP 523 communications processor and interface modules for expansion units.



* Only the 6ES5 491-0LB11 adapter casing can be used in these slots.

1 The central rack is supplied with a termination connector in this slot. It can stay in this slot if you use the central rack without expansion racks. This assigns fixed initial module addresses to the slots in the central rack (5.2).

Figure 3-3. Possible Configurations on Mounting Rack CR 700-0

3.1.2 Expansion Units (EU)

If the slots of a central controller are not sufficient for the installation of a control system, one or more expansion units can be connected to the central controller.

A distinction is made between centralized and distributed configurations:

- Centralized configuration
Up to three expansion units can be connected to one central controller (CC) or to one special expansion unit (EU). These are without power supply. The cable must not exceed 2.5 m (8.2 ft.).
- Distributed configuration
Up to eight EUs can be connected to one CC. Each of the EUs has a power supply module. The cable must not exceed 600 m/2000 ft.

This allows a maximum configuration of five groups of four racks each, one rack being the central controller rack.

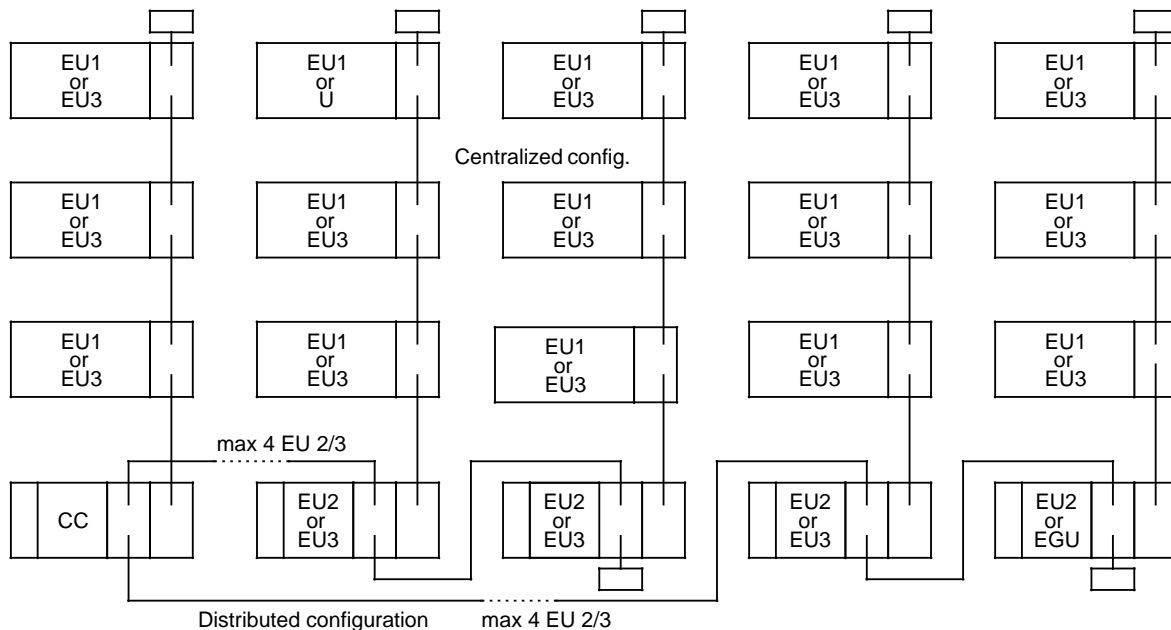


Figure 3-4. Maximum Configuration of an S5-115F Subunit

Three mounting racks are available for expansion units. The type used depends on the configuration. The three types of expansion racks are as follows:

- ER 701-1 for expansion unit "1" (EU1)
- ER 701-2 for expansion unit "2" (EU2)
- ER 701-3 for expansion unit "3" (EU3)

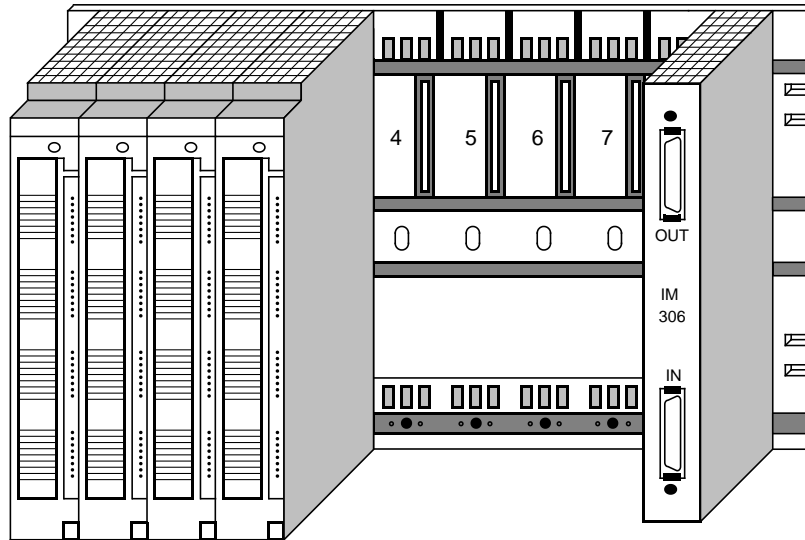


Figure 3-5. Possible Configurations on Expansion Unit 1

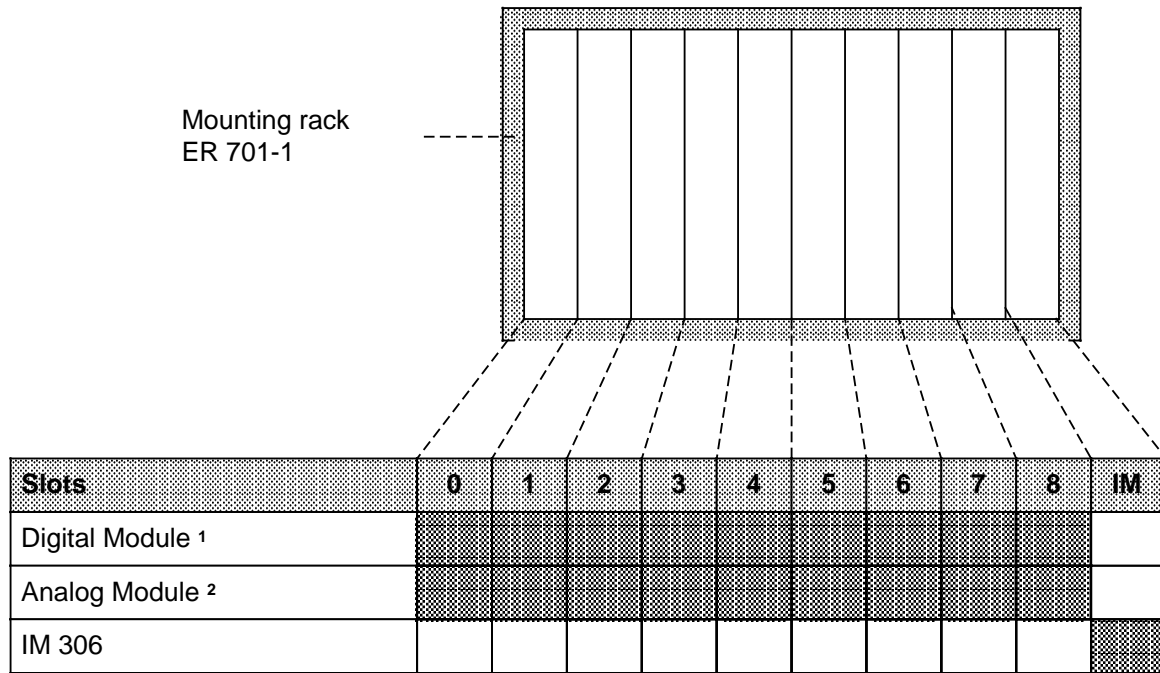
The IM 306 expansion unit interface module connects expansion units to a central controller in centralized configurations (3.2.5).

A combination of the IM 304 and IM 314 interface modules connects expansion units to a central controller in distributed configurations (3.2.6).

Possible configurations on mounting rack ER 701-1

Use expansion mounting rack ER 701-1 to install expansion unit EU 1. EU 1 is suitable for centralized connection to a CC or distributed EUs.

The ER 701-1 has nine slots for digital and analog input or output modules and one slot for an IM 306 expansion unit interface module. The expansion unit is powered via the EU interface module.



- 1 Interrupt input module 6ES5 434-7LA12 cannot be plugged into these slots.
- 2 Safety-related analog input module 6ES5 463-4UA11 cannot be plugged into these slots.

Figure 3-6. Possible Configurations on Mounting Rack ER 701-1

Figure 3-7 shows the possible location of an EU 1 in the maximum configuration of a subunit:

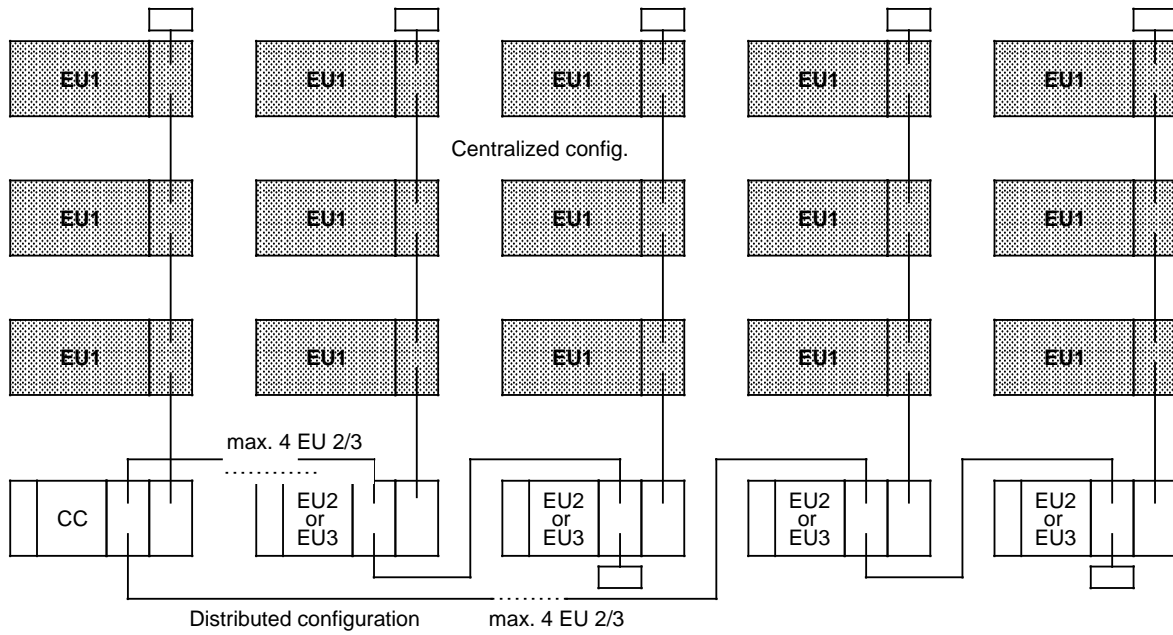
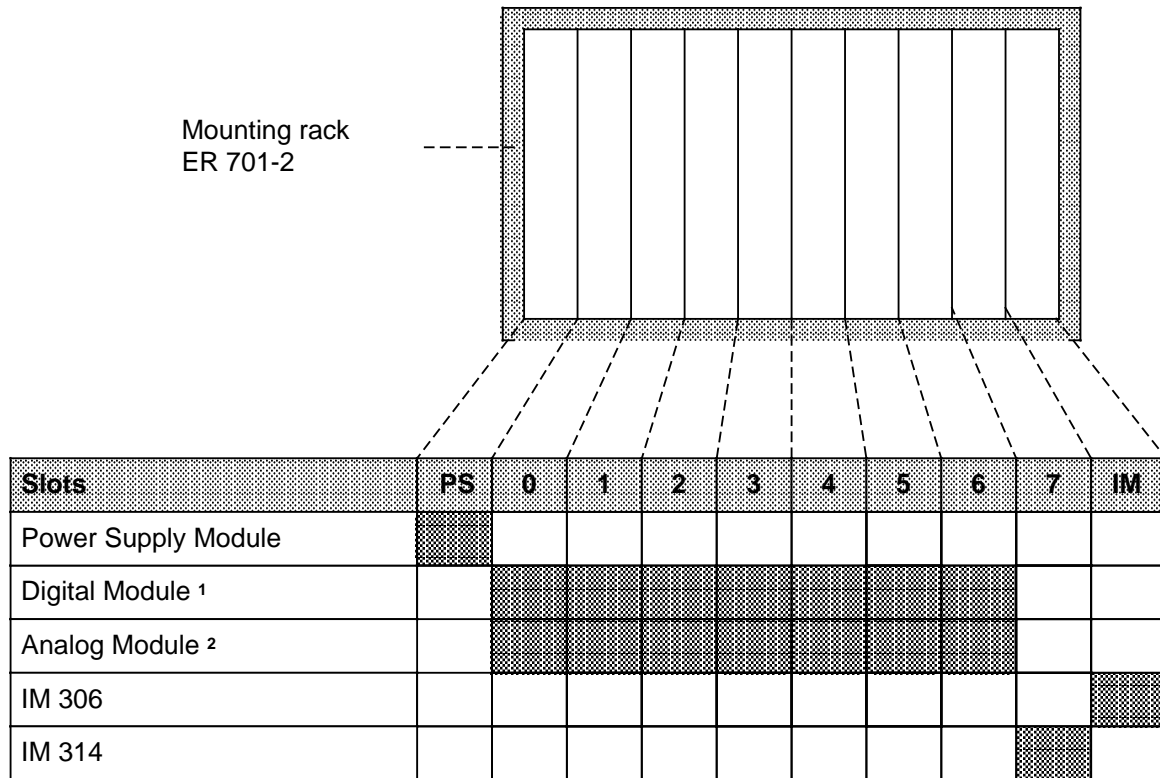


Figure 3-7. EU 1 in Maximum Configuration of an S5-115F Subunit

Possible configurations on mounting rack ER 701-2

Use expansion mounting rack ER 701-2 for expansion unit EU 2. EU 2 is suitable for distributed connection to a central controller or to an EU 2 expansion unit.

The ER 701-2 has slots for a power supply module, digital and analog input or output modules and the IM 306 and IM 314 central controller interface modules.



- 1 Interrupt input module 6ES5 434-7LA12 cannot be plugged into these slots.
- 2 Safety-related input module 6ES5 463-4UA11 cannot be plugged into these slots.

Figure 3-8. Possible Configurations on Mounting Rack ER 701-2

Figure 3-9 shows the possible location of an EU 2 in the maximum configuration of a subunit:

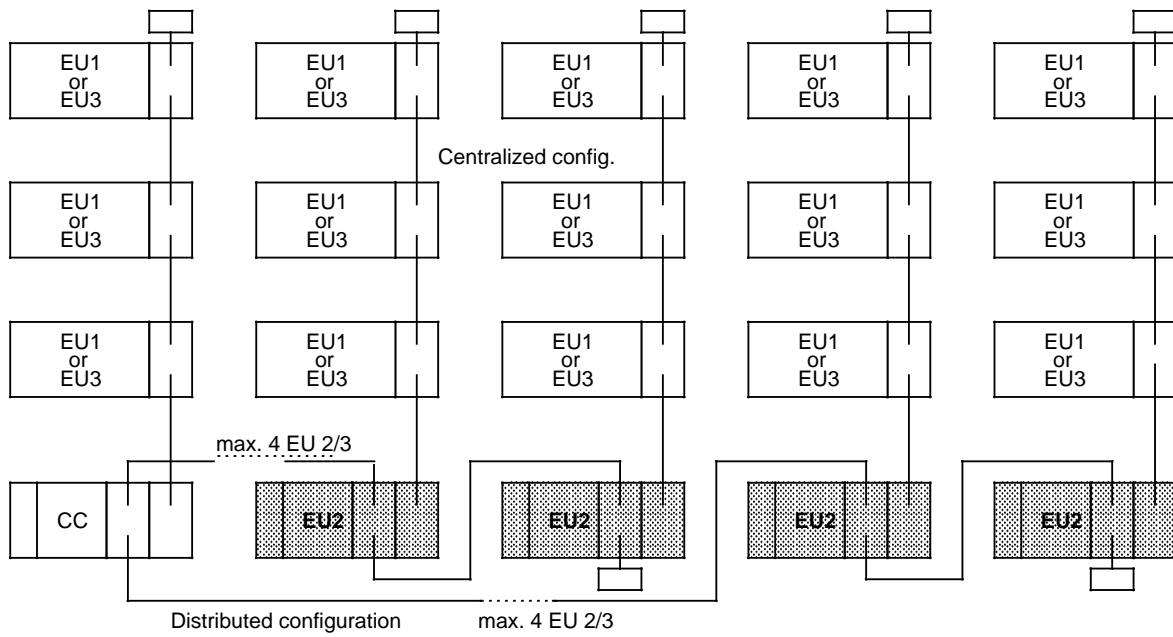


Figure 3-9. EU 2 in Maximum Configuration of an S5-115F Subunit

Possible configurations on mounting rack ER 701-3

The modules on an ER 701-3 mounting rack form an EU 3. The EU 3 is suitable for

- Connection to a central controller (CC) in centralized configurations
- or
- Connection to a distributed EU 2 or EU 3 in centralized configurations
- or
- Connection to a CC, EU 1 or EU 2 in distributed configurations.

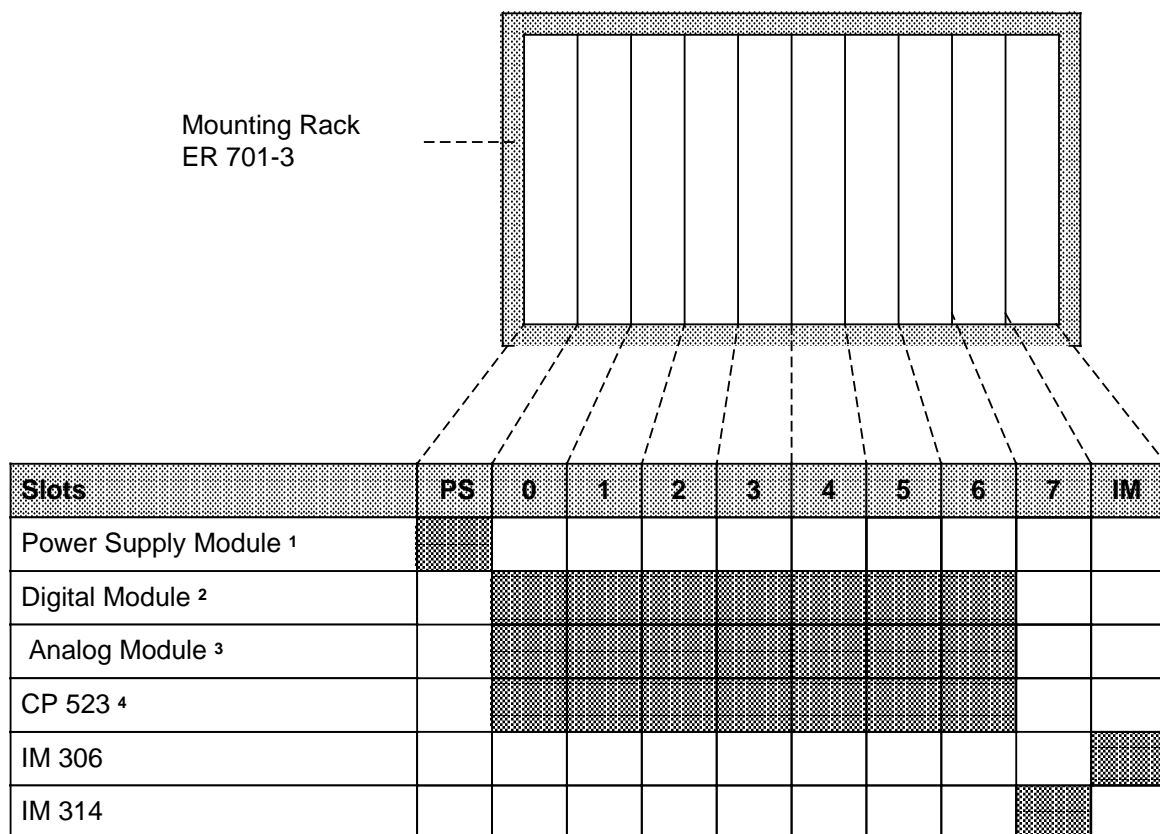
Note

You must always use an EU 3 if you want to operate several safety-related 463 AI modules or CP 523 communications processors in one expansion unit.

When the AE 463 is used in a central configured ER 701-3 with IM 306 please notice:

- the 705 connecting cable must not longer than 0.5 m
- it is not allowed to use the AE 463 in the third expansion unit (EU)

The ER 701-3 has slots for a power supply module, digital and analog input or output modules, the CP 523 as well as the IM 306 and IM 314 EU interface modules.



- 1 Only required in the case of distributed configurations
- 2 Except the 6ES5 434-7LA12 interrupt input module
- 3 Also for the 6ES5 463-4UA11 safety-related AI module
- 4 Only in the case of distributed configurations

Figure 3-10. Possible Configurations on Mounting Rack ER 701-3

Figure 3-11 shows the possible location of an EU 3 in the maximum configuration of a subunit:

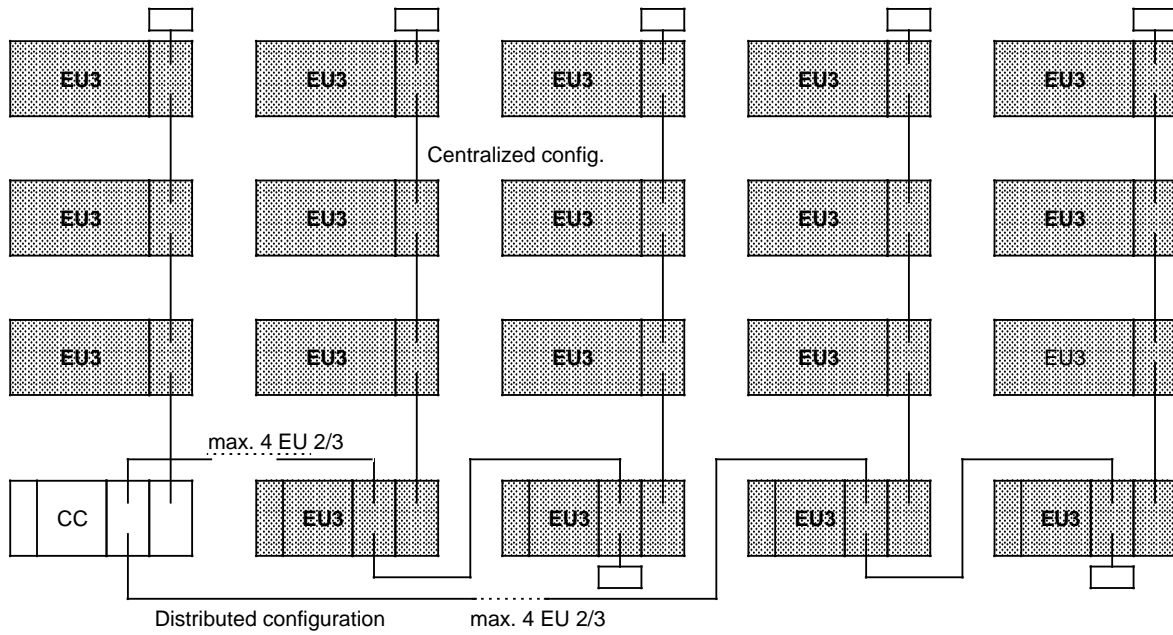


Figure 3-11. EU 3 in Maximum Configuration of an S5-115F Subunit

3.2 Mechanical Installation

Fasten all modules on the appropriate mounting racks. You can install the mounting racks in cabinets with dimensions in inches or millimeters. You can also fasten the racks to surfaces that are at an angle of up to 15° to the vertical. Block-type modules are mounted directly on the rack. Place printed circuit boards in double-height Eurocard format in adapter casings.

3.2.1 Installing the Modules

Install block-type modules according to the following procedure:

- Remove the protective caps from the socket connectors on the backplane
- Hook the top of the module into place between the two guides on the top of the mounting rack
- Swing the module down until it engages with the socket connectors on the backplane
- Fasten the screws at the top and bottom of the module.

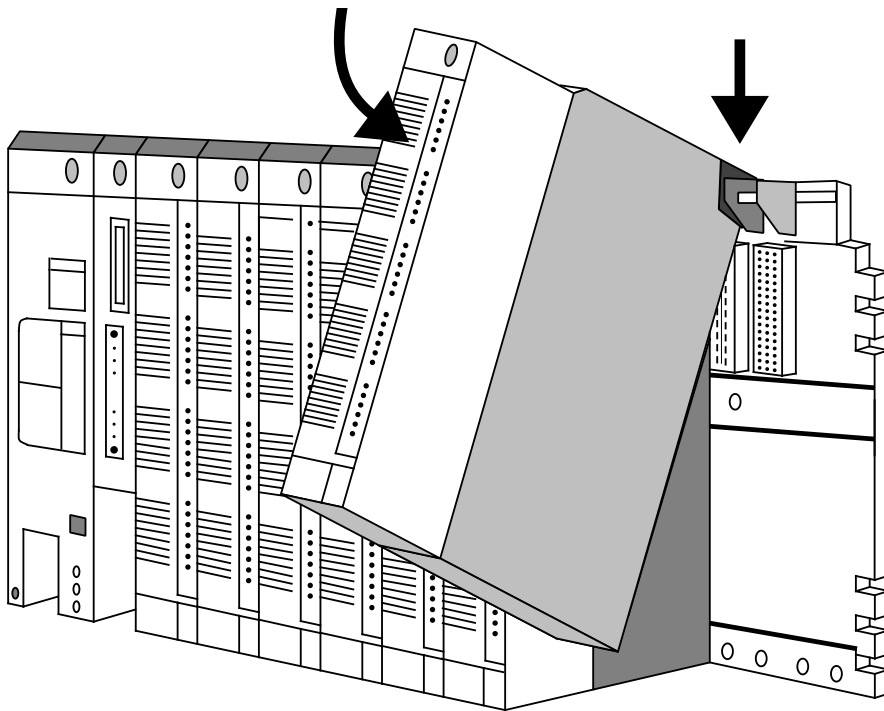


Figure 3-12. Installing the Modules

If the modules are subjected to mechanical vibration, they should be installed as close together as possible, i.e. do not leave slot empty between the modules.



Important

Turn off the power supply for the central controller and the sensors before plugging in or removing input/output modules.

Mechanical slot coding

On the back of each module, with the exception of the power supply and central processing unit, is a slot coding element in the form of a two-part plastic cube. This coding element ensures that, when a module is replaced, only another module of the same type will be plugged in in its place.

The coding element consists of two parts, one like a lock and one like a key. The two parts fit together in a defined position. This position is specific to each type of module. When you install the module, the coding element is inserted into the mounting rack. When you swing the module out, the key-shaped part of the element stays in the mounting rack and the lock-shaped part stays on the module.

Now you can install only this particular module or an identical one in this slot.

If you want to install a different module, you have to remove the coding element from the mounting rack.

You can also work without slot coding. To do this, you must pull the coding element off the module before you swing the module into place for the first time.

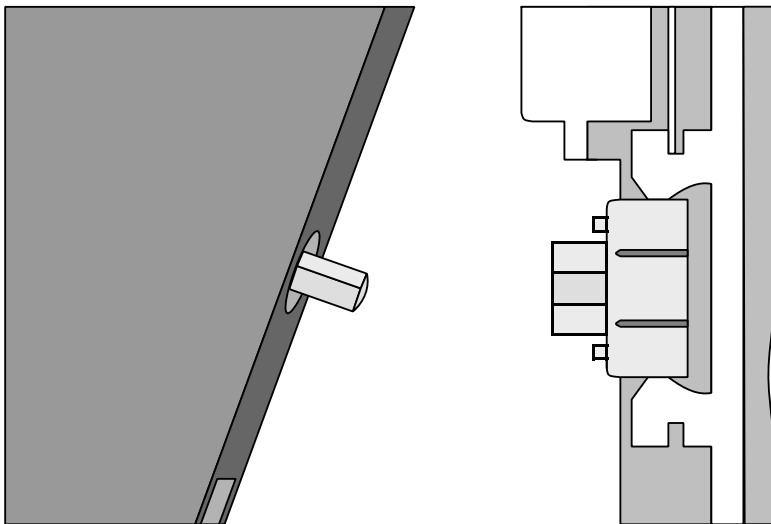


Figure 3-13. Slot Coding Element

Adapter casing

Use an adapter casing to fasten printed circuit boards in double-height Eurocard format to a mounting rack as you would fasten block-type modules. The adapter casing is required for the following modules in the S5-115F:

- IM 304
- IM 314
- IM 324
- AE 463
- CP 523

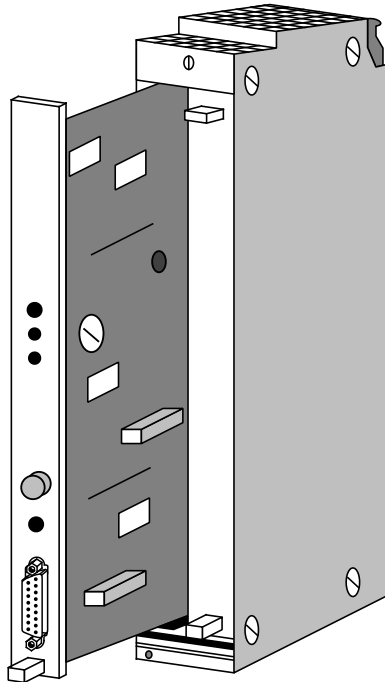


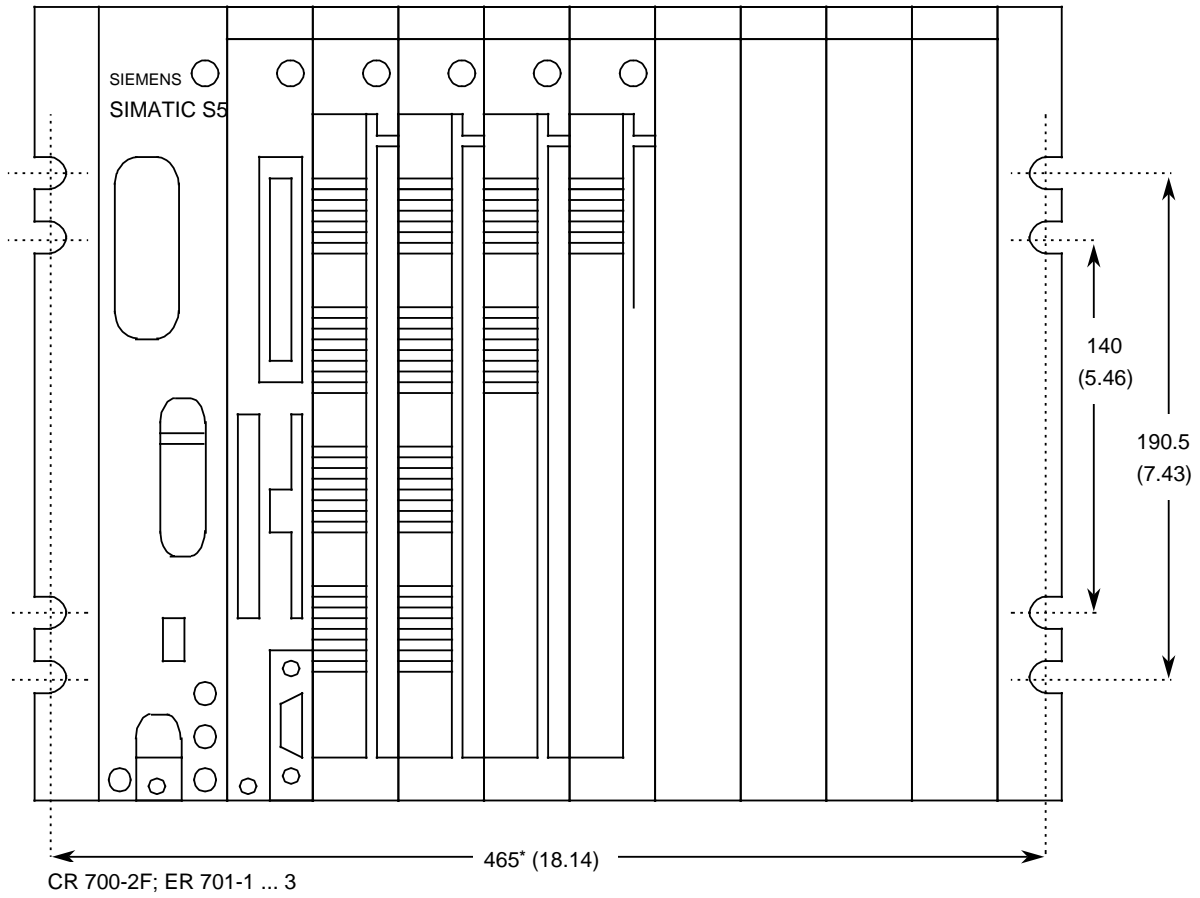
Figure 3-14. Installing a Printed Circuit Board in an Adapter Casing (6ES5 491-0LB11)

Push the printed circuit board into the casing along the guide tracks. Lock the module into place with the eccentric locking collars at the top and bottom of the casing.

If an opening remains on the front after the module has been inserted, cover it with a blanking plate.

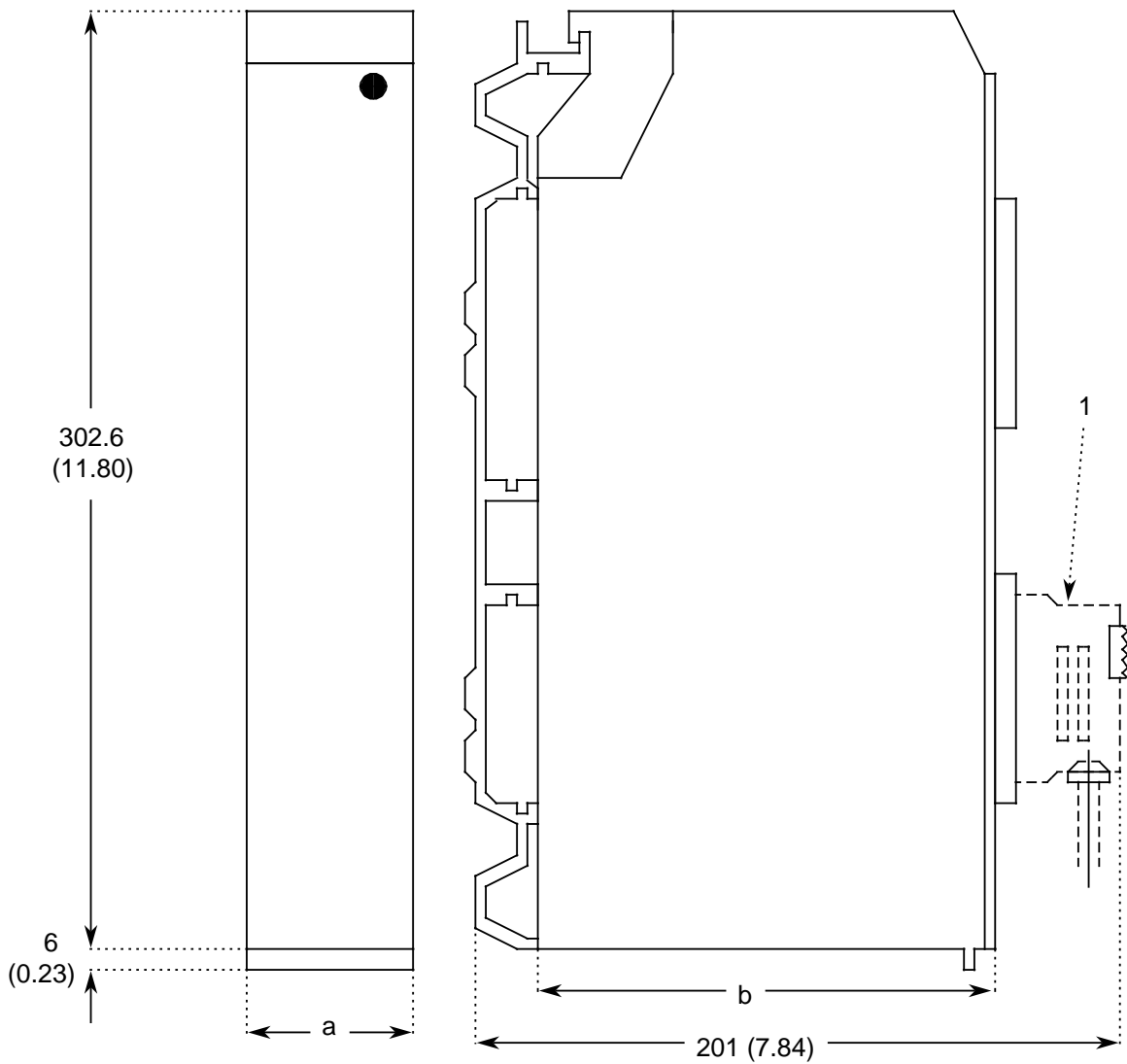
Hang the completed unit on the mounting rack and fasten the screws at the top and bottom of the adapter casing.

3.2.2 Dimension Drawings



* The width of the CR 700-0 (6ES5 700-0LB11) is 353 mm (13.9 in.)

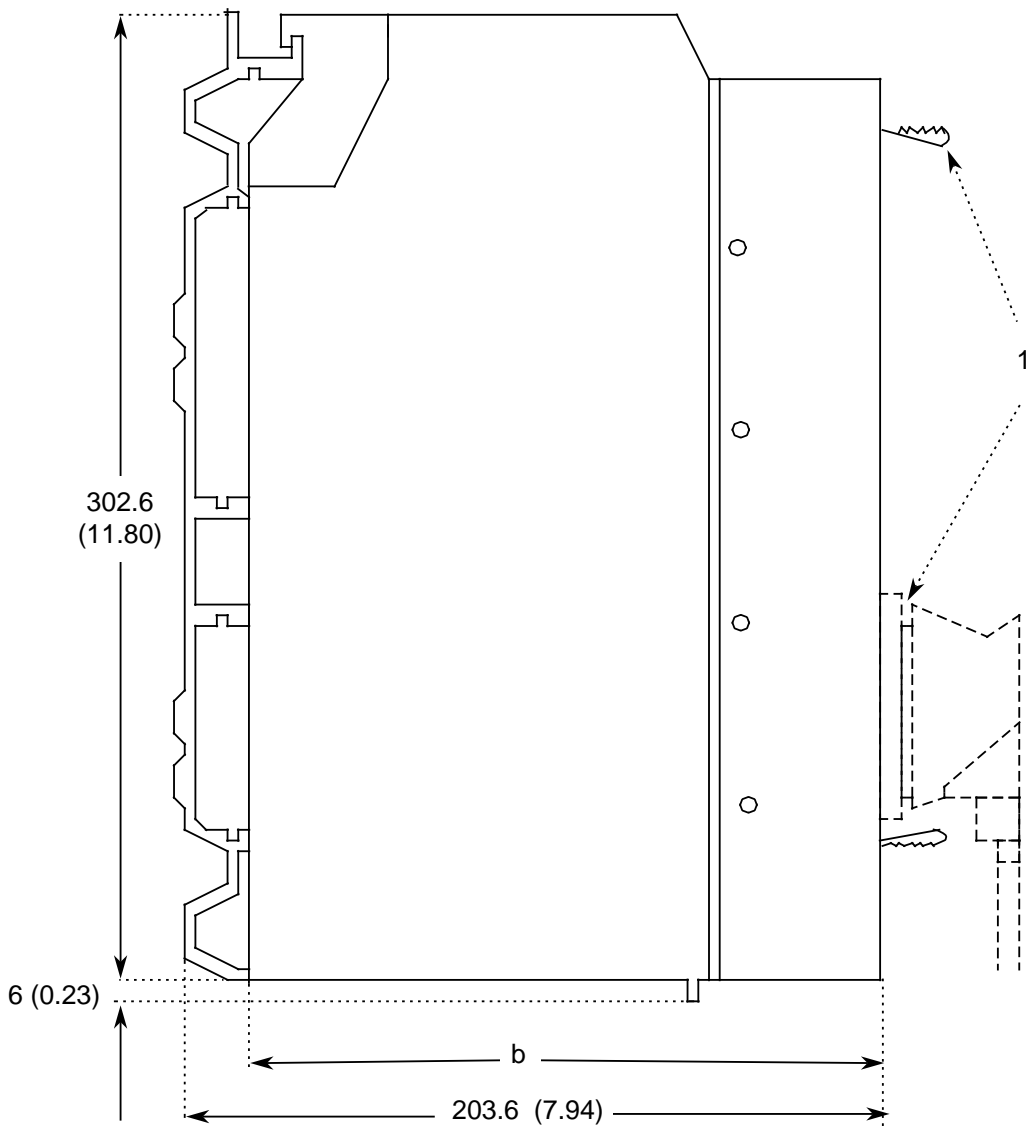
Figure 3-15. Dimension Drawing of Mounting Racks



1 Controls and front connectors extend beyond the front

Figure 3-16. Dimension Drawing of Module without Adapter Casing

	^a mm (in.)	^b mm (in.)	Mechanical Slot Coding
Power Supply Module	65 (2.54)	187 (7.29)	---
Central Processing Unit	43 (1.68)	187 (7.29)	---
Digital and Analog Modules			built in
Interface Module	25 (0.98)	133 (5.19)	---



1 Controls and front connectors extend beyond the front

Figure 3-17. Dimension Drawing of Module with Adapter Casing

	Width mm (in.)	b mm (in.)	Mechanical Coding
Adapter Casing	43 (1.68)	187 (7.29)	built in
Analog Input Module			
Interface Module	25 (0.98)	133 (5.19)	---

3.2.3 Cabinet Installation

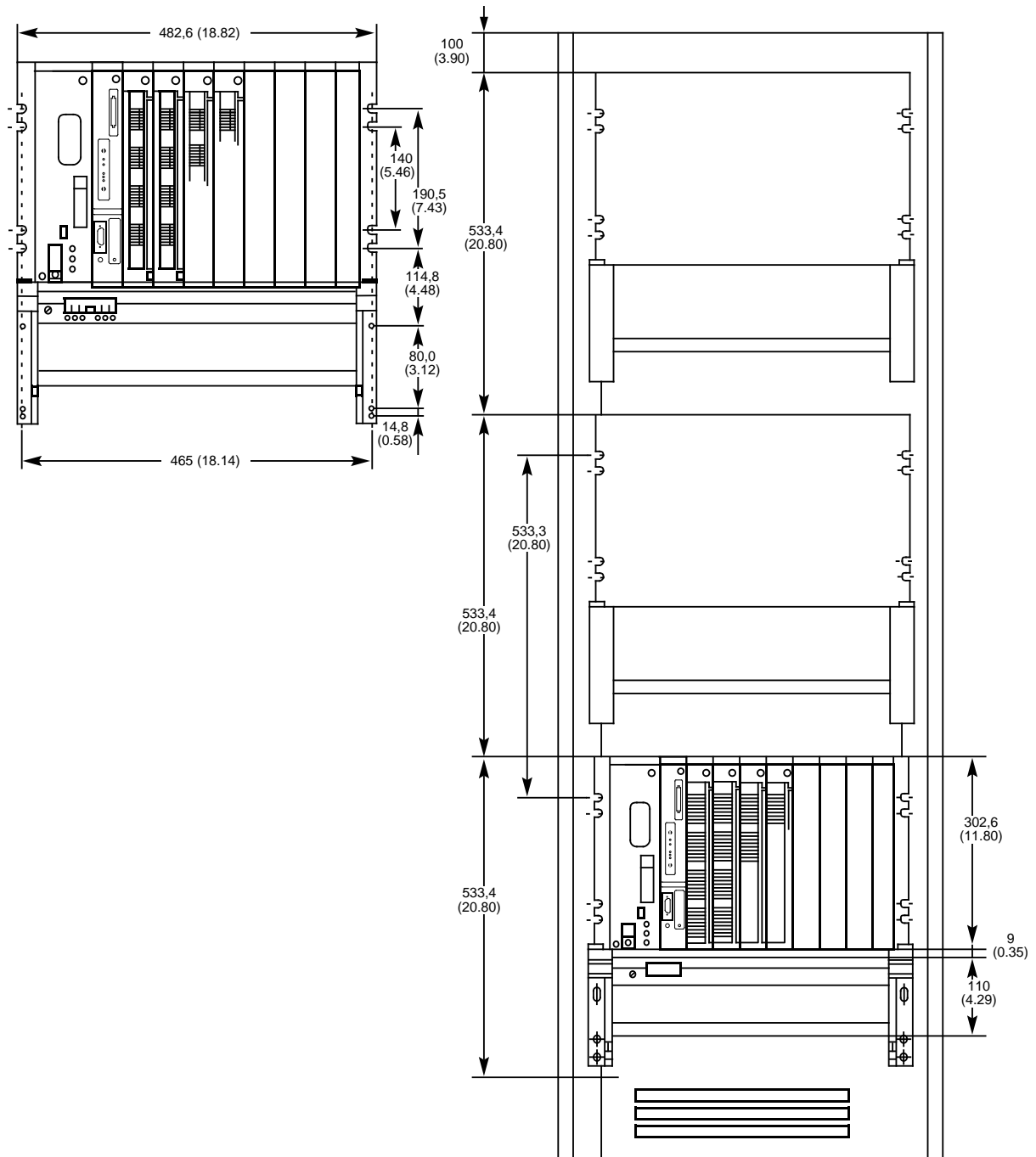


Figure 3-18. Dimensions for Installation in a 19-in. Cabinet

3.2.4 Interconnecting the Two Subunits

The two subunits are interconnected via an IM 304 / IM 324 parallel link. The IM 304 interface module can be plugged into either subunit A or subunit B. The IM 304 and IM 324 modules are connected to each other with the 721 connecting cable over a maximum distance of 10 m (33 ft.). The cable is connected to the lower of the two interface ports. Please use the switch and jumper settings shown in Figures 3-19 and 3-20 for establishing the parallel link between the two subunits.

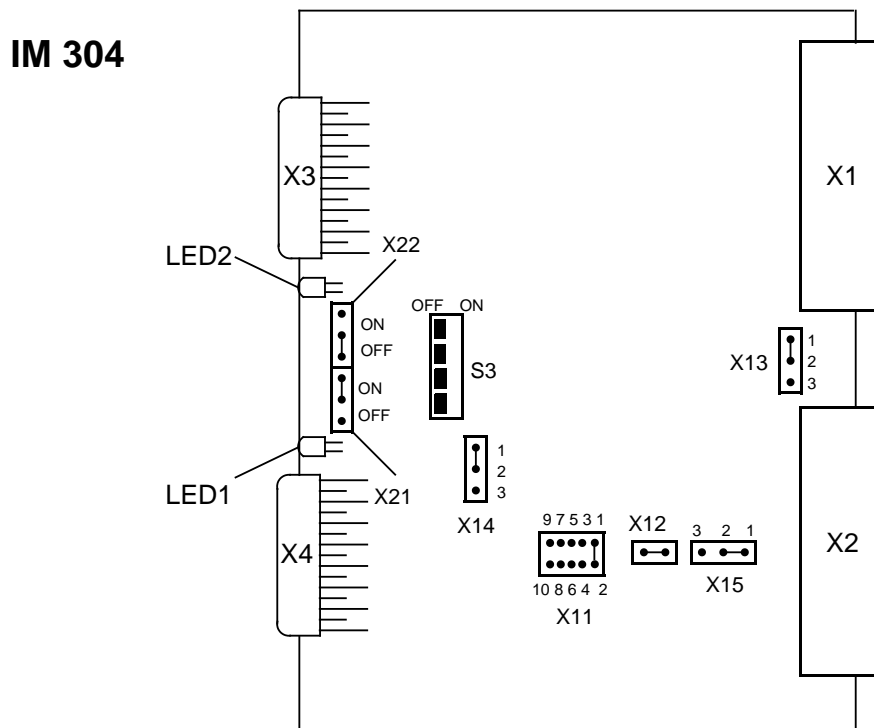


Figure 3-19. Switch and Jumper Settings on the IM 304-3UB11 for the Parallel Link

IM 324

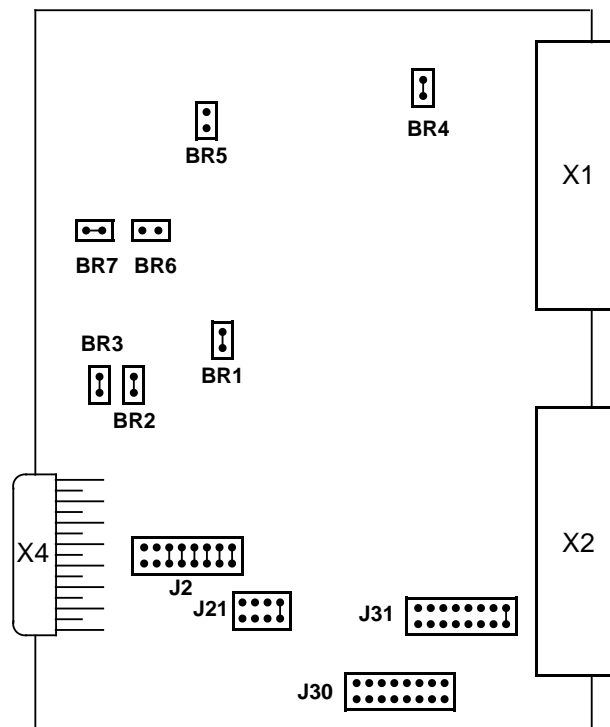
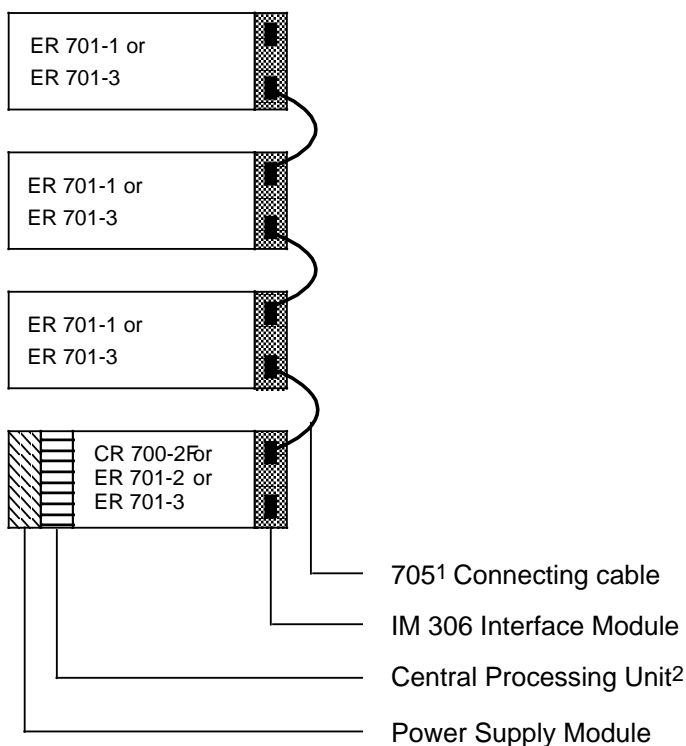


Figure 3-20. Switch and Jumper Settings on the IM 324-3UA12 for the Parallel Link

3.2.5 Centralized Configurations

A central controller connected to as many as three expansion units makes up a centralized configuration. Use only the IM 306 interface module to connect an ER 701-1 mounting rack. If a 463 analog input module is to be plugged into the expansion unit, an ER 701-3 without power supply module must be used. Please note the following when installing the IM 306:

- Number of EUs: max. 3
- Total cable length: max. 2.5 m (8.2 ft.)
- Slot addressing: variable (in the case of the CC and the EU)
- Power supply to the EUs: max. 2 A*



- 1 You can also order a 1.25m (4.1 ft.) 705 connecting cable (Order No.: 6ES5 705-0BB20), and use it to mount two EUs next to each other.
- 2 Only in the CR 700-2F central controller rack

Figure 3-21. Centralized Configuration with the IM 306 Interface Module

* The EU with the highest current should be located as closely as possible to the CC.

3.2.6 Distributed Configurations

A central controller connected to expansion units installed over a maximum distance of 600 m (approx. 2000 ft.) makes up a distributed configuration. A distributed configuration is described on the pages that follow.

Please note the following:

- Each ER 701-2 expansion rack, or ER 701-3 in a distributed configuration, requires a PS 951 power supply module and an IM 306 interface module for addressing input/output modules.
- Please note Section 3.4.4!
- If you use digital input modules on the ER 701-2 or ER 701-3, it is recommended that these be modules with revision level "2" (or higher).

Table 3-1. Technical Specifications for Distributed Configuration Interface Modules

	IM 304	IM 314
Maximum number of EUs that can be connected	8	
Max. total cable length	600 m	
Current consumption at 5 V	1.2 A	0.85 A

Connection with IM 304/IM 314 interface modules

Plug the IM 304 interface module into a CR 700-2F central rack to connect as many as four EUs per interface to the CC. In this way, you can connect up to eight distributed EUs to the CC via the IM 304. Plug an IM 314 into each ER 701-2 or ER 701-3 expansion rack. Connect the interface modules with the 6ES5 721-.... connecting cable as shown in Figure 3-22.

Please note the following special features:

- Switches S1 and S2 on the frontplate can be set to determine whether only one interface (X3 or X4) or both interfaces (X3 and X4) should be in operation.
Switch in RUN position: relevant interface in operation
Switch in OFF position: relevant interface not in operation; LED off.
- The lower front socket (X4) on the last IM 314 must always have a termination connector plugged into it.

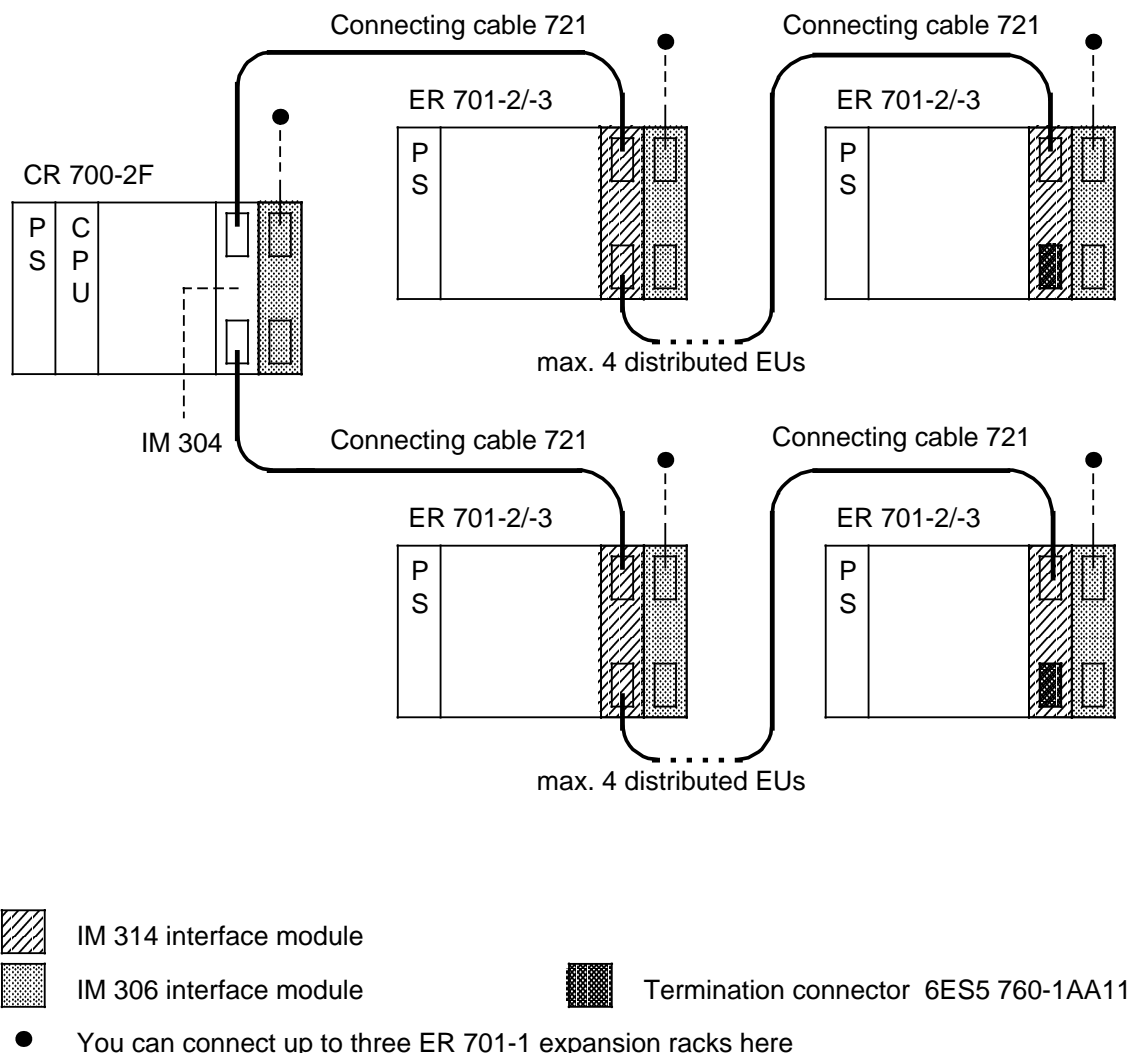


Figure 3-22. Distributed Configuration with IM 304/314

Switch and jumper settings on the IM 304 interface module in the case of distributed configurations

Figure 3-23 shows switch and jumper positions on the IM 304 module. If you use the IM 304 interface module for distributed configurations, please adopt the jumper settings shown on jumper block X11.

All toggles must be in the ON position on the S3 switch.

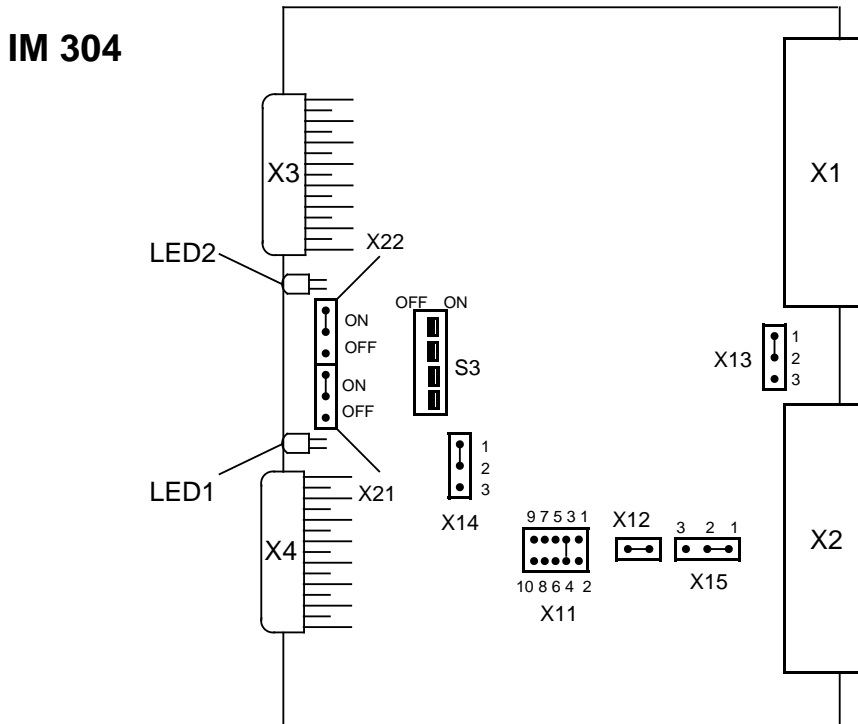


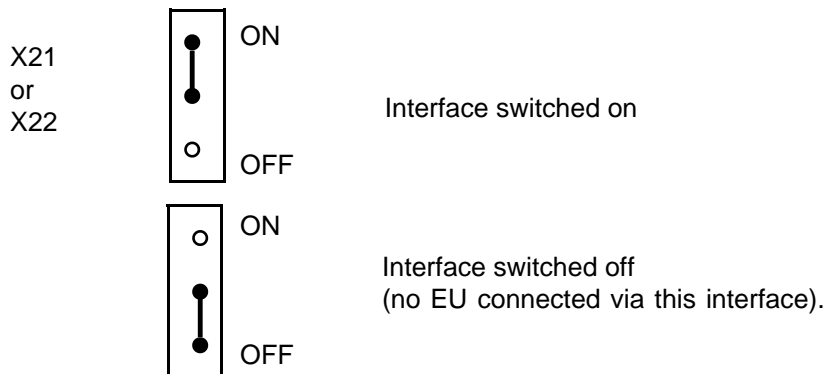
Figure 3-23. Switch and Jumper Settings on the IM 304-3UB11 for Distributed Configurations

In Figure 3-23, the IM 304 has been set for distributed configuration.

- Permissible cable length up to 100 m (328 ft.) (X11)
- The PLC evaluates the PEU CPU signal if **one** interface signals "not ready" (X14)
- The PLC evaluates the PEU (I/O module not ready) CPU signal (X15)
- Both interfaces are switched on (X21 and X22)

You can change the settings of jumpers X21, X22 and X11, X14 and X15.

- You can switch the interfaces on or off with jumpers X21 and X22.

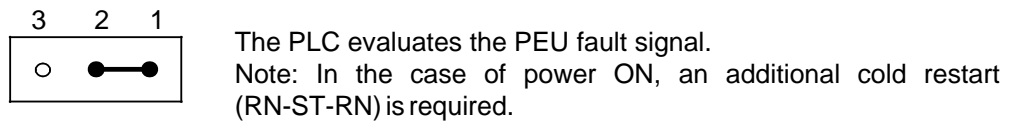
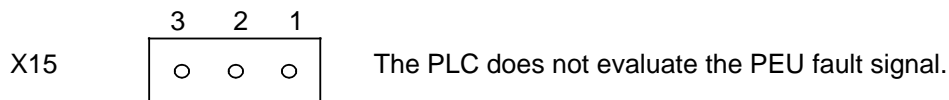
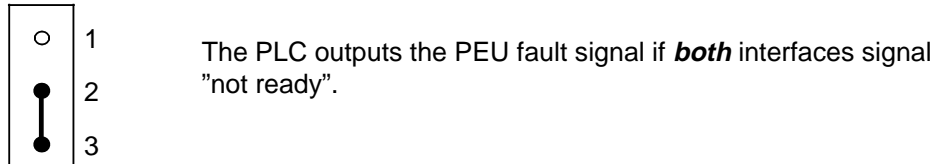
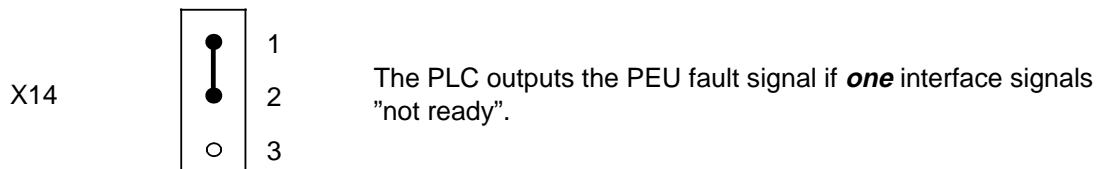


- Use jumper X11 to set the total cable length to the last EU of the 721 connecting cables of one interface. The interface with the longest connection is decisive for the setting of jumper X11.

Jumper plug X11						
Position of the jumper						
Cable length	<table border="1" style="width: 100%; text-align: center;"> <tr> <td style="width: 20%;">up to 10 m (32 ft)*</td> <td style="width: 20%;">10 to 100 m (32 to 328 ft.)</td> <td style="width: 20%;">100 to 250 m (328 to 820 ft.)</td> <td style="width: 20%;">250 to 450 m (820 to 1476 ft.)</td> <td style="width: 20%;">450 to 600 m (1476 to 1968 ft.)</td> </tr> </table>	up to 10 m (32 ft)*	10 to 100 m (32 to 328 ft.)	100 to 250 m (328 to 820 ft.)	250 to 450 m (820 to 1476 ft.)	450 to 600 m (1476 to 1968 ft.)
up to 10 m (32 ft)*	10 to 100 m (32 to 328 ft.)	100 to 250 m (328 to 820 ft.)	250 to 450 m (820 to 1476 ft.)	450 to 600 m (1476 to 1968 ft.)		

* Setting only permissible for parallel configuration of central controllers.

- The X14 and X15 jumpers can be set as follows in the case of IM 304 / 314 distributed configuration:



Note

If the PEU signal is not evaluated, you must make sure at restart that the EU is ready for operation before the CC or that the necessary adjustments to the process I/O images will be made in OB1.

Switch and jumper settings on the IM 314 interface module in the case of distributed configurations

Figure 3-24 shows the switch and jumper positions on the IM 304 module. If you use the IM 314 interface module for distributed configurations, please adopt the settings shown in the figure. All toggles must be in the OFF position on the S1 switch.

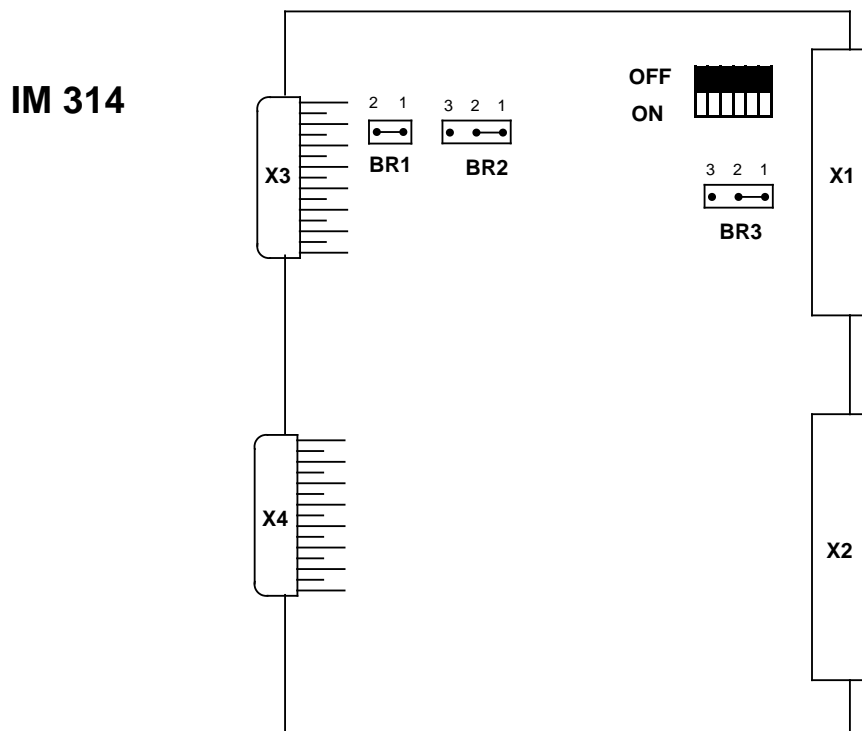


Figure 3-24. Switch and Jumper Settings on the IM 314 for Distributed Configurations

Note

For distributed configurations, you must not change the IM 314 setting shown above.

3.3 Wiring

The backplane on the mounting rack establishes the electrical connection between all modules.

Make the following additional wiring connections:

- The PS 951 power supply module to the power line
- The sensors and actuators to the digital or analog modules.

Connect the sensors and actuators to a front connector that plugs into the contact pins on the front of each module. You can connect the signal lines to the front connector before or after you plug it into the module. The connection diagram of each module is on the inside of the front door.

Perforated label strips are included with each input and output module. Use these strips to note the addresses of the individual channels on the module.

Slip the strips along with their protective transparent covers into the guides on the front door.

- A number of check modules are required to ensure the safety of the I/O modules:
 - Check digital output modules for digital input modules
 - Readback digital input modules for digital output modules
 - Check relay output modules and check analog output modules for analog input modules.

Subsections 3.3.1 through 3.3.6 explain how to connect individual modules.

3.3.1 Connecting the PS 951 Power Supply Module

Connect the power cable of the 24 DC supply to terminals L+, M and \oplus in order to connect the PS951.

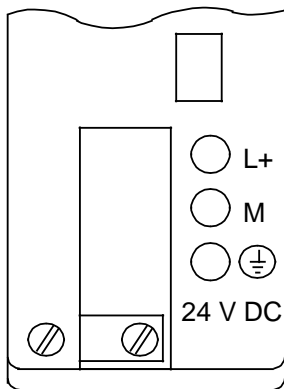


Figure 3-25. PS 951 Power Supply Module

3.3.2 Connecting Digital Modules

Floating digital modules are available for the S5-115F. An optocoupler isolates the external voltages from the internal voltages.

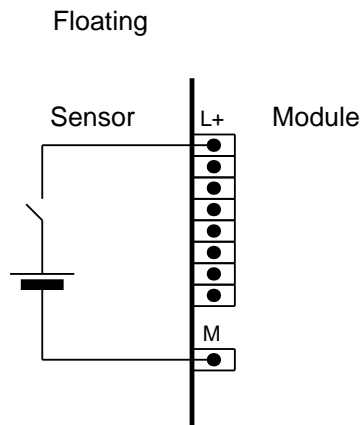


Figure 3-26. Connection to Floating Modules

Feedback modules are required for digital modules used in safety-related systems (10.9).

3.3.3 Connecting Analog Modules

See Section 6 and 10.11 to 10.14 for a description of connecting and starting up analog modules.

3.3.4 Front Connectors

Various front connectors are available for wiring:

Table 3-2. Front Connector Overview

Order No.	Terminals per Front Connector	Connection Method	Wire Cross Section per Terminal ¹
6ES5 490-7LB11	24	Screw connection (SIGUT)	1 x (1.0 ... 2.5) mm ² or 2 x (0.5 ... 1.5) mm ² *
6ES5 490-7LC11	46	Spring-loaded connection	1 x (0.25 ... 1.5) mm ² ** or max. 1.5 mm ² in the case of combinations of conductors in one end sleeve
6ES5 490-7LB21	46	Screw connection*** (box terminal)	max. 1.5 mm ² in the case of combinations of conductors in one end sleeve
6ES5 497-4UB11	42		
6ES5 490-7LA11 (with crimp snap-in contacts)	46	Crimp snap-in (mini-spring contact)	1 x (0.5 ... 2.5) mm ² or 2 x (0.5 ... 0.75) mm ²
6ES5 490-7LA12 (without crimp snap-in contacts) ²			

- 1 When plug-in jumpers are used, the conductor cross sections are reduced.
- 2 Use crimp snap-in contacts with the order no. 6XX5 070 (Qty: 250)
- * Flexible cable with end sleeves: 0.75 to 1.5 mm²
- ** With end sleeves: 0.5 to 1.5 mm²
- *** 1.5 mm² with jumer comb

In general, we recommend use of end sleeves, especially where corrosion is to be expected.

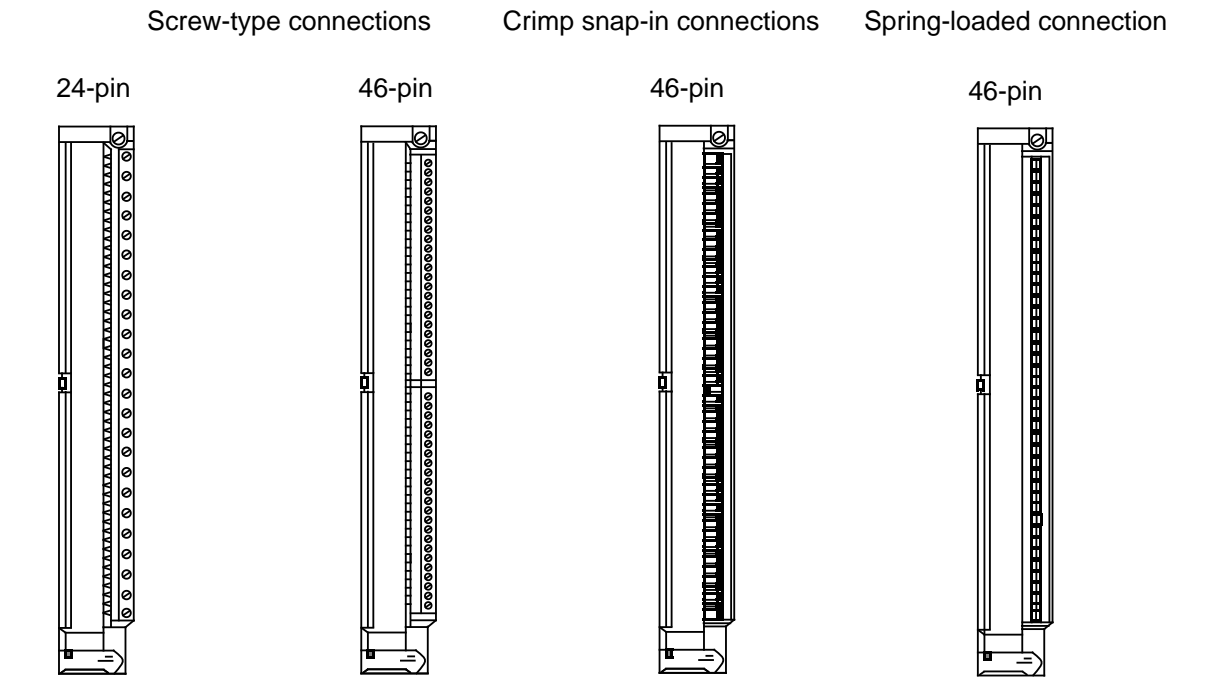


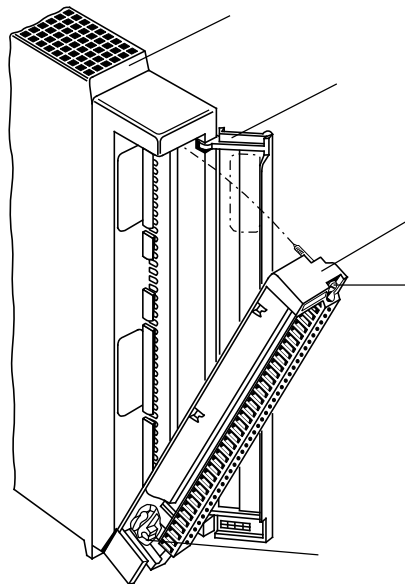
Figure 3-27. Front Connector - Front View

The connectors have openings at the bottom for standard strain-relief clamps.

Installing the front connector (on all I/Os except the 463 analog input module)

Install the front connector as follows :

1. Open the front door of the module.
2. Hook the front connector into the pivot at the bottom of the module.
3. Swing the front connector up and in until it engages with the module.
4. Tighten the screw at the top of the front connector to secure it.
5. Close the front door of the module



Module

Front door is open

Front connector is swung
up and in

Screw

Pivot

Figure 3-28. Installing Front Connector

Installing the front connector of the 463 analog input module

Proceed as follows:

1. Unscrew the connector cover.
2. Hook the front connector into the pivot at the bottom of the module.
3. Swing the front connector up and in until it engages with the module.
4. Tighten the screw at the top of the front connector to secure it.
5. Screw on the connector cover.

3.3.5 Simulator

You can use an appropriate simulator instead of a front connector. Use the toggle switches on the front of this device to simulate input signals (Figure 3-29). A simulator needs an external power supply.

Simulators can not be used for mixed digital input/output modules or for output modules.

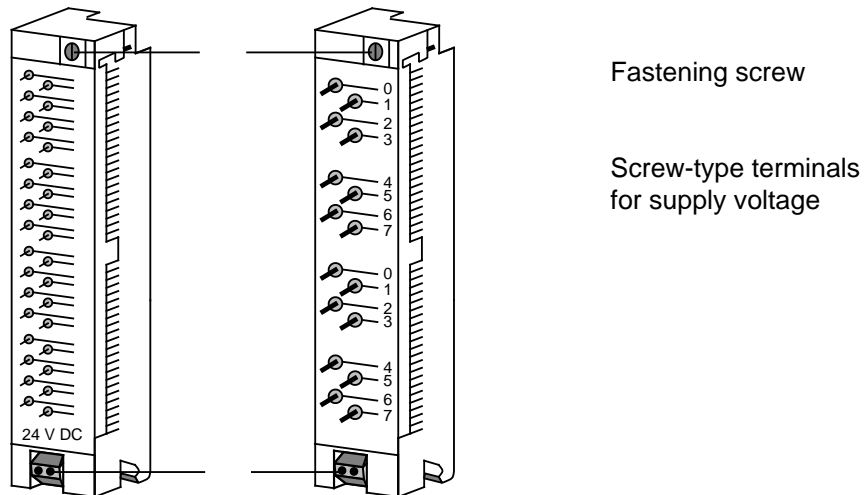


Figure 3-29. Simulators

3.4 General Configuration

The following sections explain the electrical installation of the S5-115F.

3.4.1 Power Supply

A completely assembled controller consists of the following separate electrical circuits:

- The control circuit for the central controllers and expansion units
- The load circuit for the sensors and actuator.

PS 951 power supply module

The PS 951 power supply module supplies the following:

- CPU
- I/O bus
- Control circuits of the input/output modules.

The following table gives you an overview of the power supply modules which can be used in the S5-115F.

Table 3-3. Overview of Power Supply Modules for S5-115F

Power Supply Module	Input Voltage	Output Current	Galvanic Isolation	Remarks
6ES5 951-7ND21	24 V DC	Max. 7 A	No	High-level external voltage monitor required
6ES5 951-7ND31	24 V DC	Max. 7 A	Yes	To be replaced by 6ES5 951-7ND41
6ES5 951-7ND41	24 V DC	Max. 7 A	Yes	-----

Please note the following points when using the PS 951 power supply module:

- S5-115F central controllers and expansion units may only be operated with the power supply modules listed in Table 3-3.
These power supply modules have been prototype-tested and approved for use in safety-related systems.
- The PS 951-7ND31 and PS 951-7ND41 power supply modules have safe electrical isolation to DIN VDE 0160. The 24 V DC input voltage must be a functional extra-low voltage in accordance with DIN VDE 0100 or a comparable standard. If not, the PE terminal must be connected to the protective ground wire.
- The PS 951-7ND21 power supply module has **no galvanic isolation** between the primary and secondary sides. If you want to use this module, you will require high-level monitoring facilities for the 5 V DC operating voltage on the secondary side. The 24 V DC input voltage must be switched off automatically in the event of overvoltage.

Note

Since the S5-115F is operated without fans for safety reasons, the power supply module must not be loaded with more than the rated value of 7 A/5 V. This means that the current consumption of all the modules used must not exceed 7 A.

- Magnetic voltage stabilizers must not be connected direct on the input side of the power supply module!
If you use magnetic voltage stabilizers in parallel circuit branches, there is a likelihood of overvoltages, which could destroy the power supply module! Please consult your local SIEMENS regional office in such cases.

Load power supply

The load power supply supplies the following:

- Input and output circuits (load circuits)
- Sensors and actuators.

For monitoring reasons, both control and load circuits should be connected to the same power supply.

We recommend that you use our load power supply units from the 6EV1 series. If you decide to use load power supply units of a different type, please note that you must monitor the output voltage. The output voltage of a 24 V DC load voltage supply unit must not exceed 30 V DC. Modules may be destroyed at higher voltages.



Warning

For SIMATIC modules supplied with functional extra-low voltages (V 60 V DC, V 25 V AC), you require load power supply units with safe (electrical) isolation to DIN VDE 0160.

Load power supply for non-floating modules

If you use non-floating modules, you must create a common reference potential for the internal control circuits of the PLC and for the load circuits. For this reason, connect the reference potential of the load power supply unit with the ground connection of the PLC (PE terminal or \oplus). The ground connection is permanently connected to the internal reference potential of the controller.

Load power supply for floating modules

Note

If you use switched-mode power supply units to supply floating analog modules and BEROs, you must first run this supply over a mains filter.

Dimensioning the load power supplies

The electronic short-circuit protection of DO modules activates only when triple the rated current is exceeded. For this reason, dimension the load power supply units in such a way that the power supply can deliver the current required for switching off in the case of a short-circuit at an output.

If the load power supply unit has not been sufficiently dimensioned, this can result in a current higher than the rated current flowing for an extended period in the case of a short-circuit at digital outputs, without the short-circuit protection of the DO module activating. Overrange operation can destroy the module.

3.4.2 Electrical Installation with Field Devices

The following figures each show an example circuit for connecting control power supply and load power supply. They also show the grounding concept for operation from the following:

- Grounded supplies
- Centrally grounded supplies
- Nongrounded supplies.

Please note the following when installing your controller. The text contains reference numbers which you can find in Figures 3-30 to 3-32.

Master switch and short-circuit protection

- You must provide a master switch to DIN VDE 0113, Part 1, or a disconnecting device to DIN VDE 0100, Part 460, for the programmable controller, sensors and actuators. These devices are not required in the case of subsystems where the relevant device has been provided at a higher level.
- You can provide the circuits for sensors and actuators with short-circuit protection and/or overload protection in groups. According to DIN VDE 0100, Part 725, single-pole short-circuit protection is required in the case of grounded secondary side and all-pole protection is required in all other cases.
- For nonfloating input and output modules, connect terminal M of the load power supply unit with the PE ground conductor of the control circuit's PS 951 power supply module.

Load power supply

- For 24 V DC load circuits, you require a load power supply unit with safe electrical isolation.
- You require a back-up capacitor (rating: 200 μ F per 1 A load current) for nonstabilized load power supply units.
- For controllers with more than five electromagnetic operating coils, galvanic isolation by a transformer is required by DIN VDE 0113, Part 1; it is recommended by DIN VDE 0100, Part 725.
- For nonfloating input and output modules, connect terminal M of the load power supply unit with the PE ground conductor of the control circuit's PS 951 power supply module.

Grounding

- You should ground load circuits where possible . Provide a removable connection to the protective conductor on the load power supply unit (terminal L- or M) or at the isolating transformer in secondary circuit.
- To protect against stray noise, use copper conductors of at least 10 mm² cross section to ground the mounting racks by the shortest possible route.



Warning

You must provide insulation monitoring devices for nongrounded power supply modules

- If hazardous plant conditions could arise from double-line-to-ground faults or double fault to frame faults
- If no safe (electrical) isolation is provided
- If circuits are operated with voltages > 60 V DC
- If circuits are operated with voltages > 25 V AC.

- The mounting racks of the S5-115F must be connected to the protective conductor. This grounds the reference potential of the controller. Nongrounded operation of S5-115F controllers is only permissible if all the circuits are operated with functional extra-low voltage. In this case, connect the mounting rack or DIN rail over an RC network with the protective conductor.
(rating: C = 1µF, R = 100 k).

Operating a programmable controller with field devices on grounded supply

Operation from grounded power supplies offers the best protection against interference.

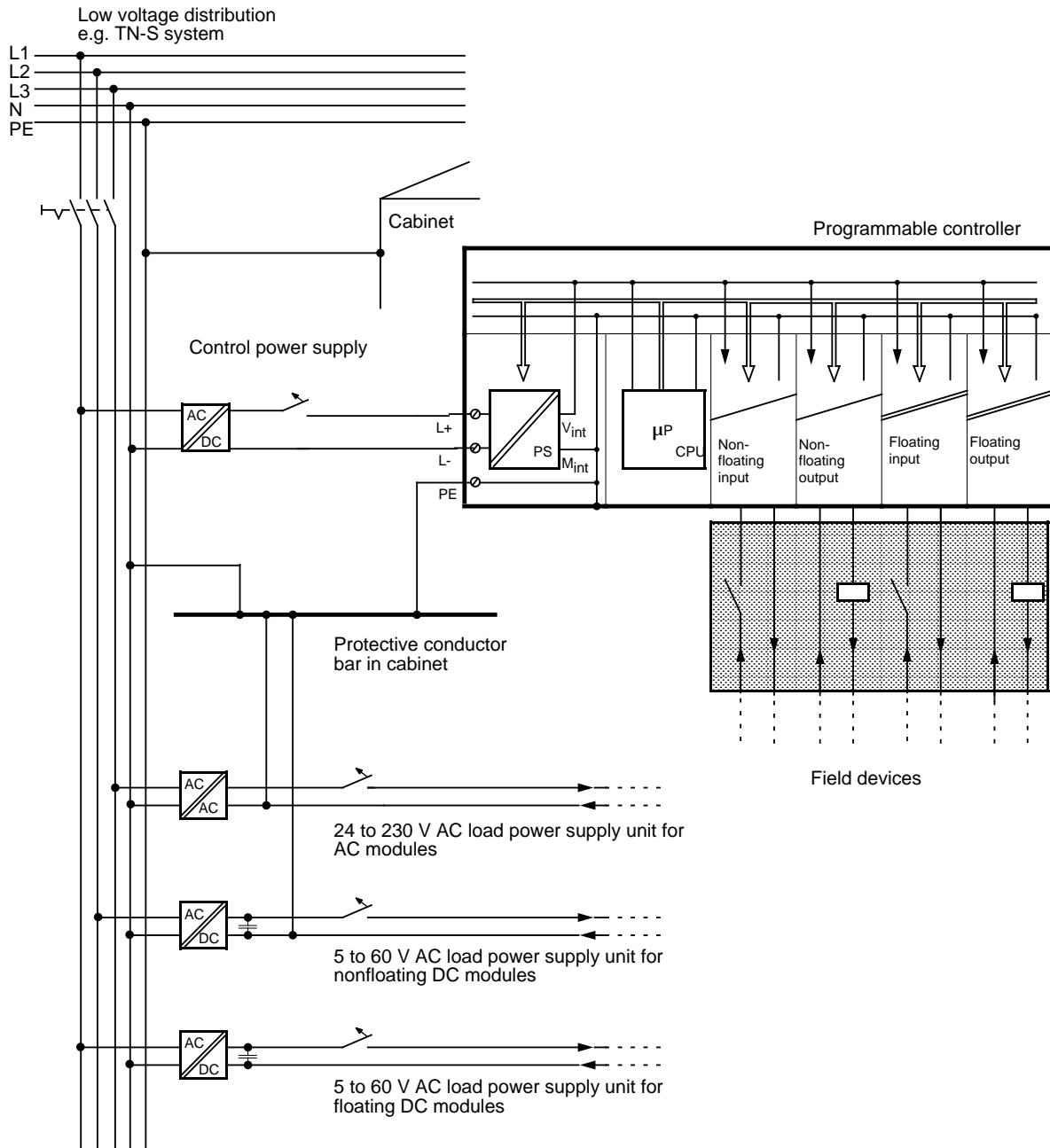


Figure 3-30. Operating a Programmable Controller with Field Devices on Grounded Supply

Operating a programmable controller with field devices on a centrally grounded supply

In plants with their own transformers or generators, the PLC is connected to the central grounding point. A removable connection must be provided for measuring ground faults.

Installation of the PLC must be such that there is insulation between the cabinet potential and the protective conductor potential. In order to maintain the insulation, all connected devices must be **grounded capacitively or they must be nongrounded**. For this reason, programmers must be supplied only over an isolating transformer.

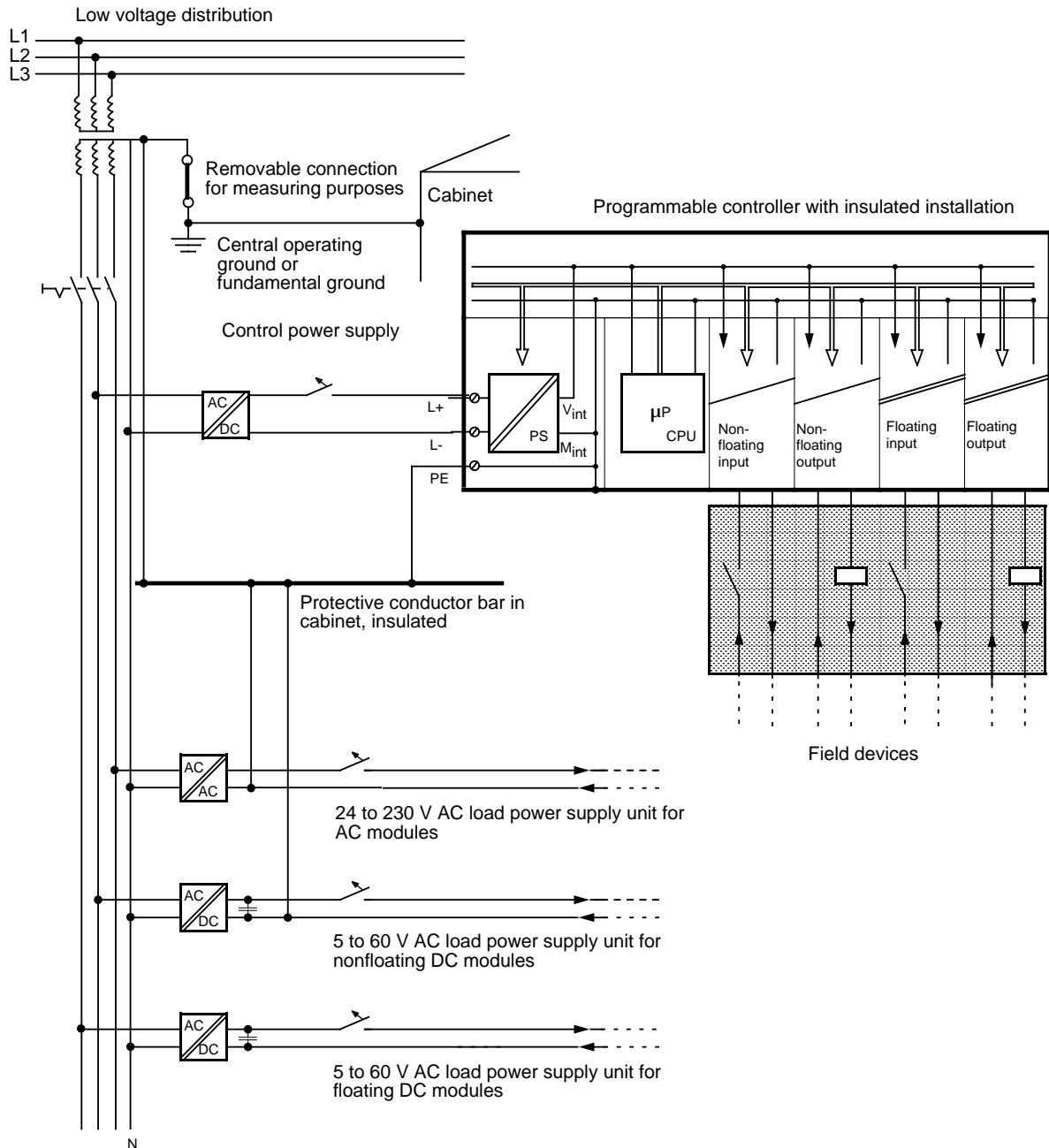


Figure 3-31. Operating a Programmable Controller with Field Devices on Centrally Grounded Supply

Operating a Programmable Controller with Field Devices on Ungrounded Supply

Neither the outer conductor nor the neutral are connected to the protective conductor in the case of nongrounded supplies. Operation of the PLC with nonfloating power supply modules is **not** permissible.

Please note the following when connecting power supply modules:

In networks with 3 x 230 V, you can connect the power supply module direct to two outer conductors (see Figure 3-32).

In networks with 3 x 400 V, connection between the outer conductor and the neutral conductor is not permissible (unacceptably high voltage in the case of ground fault). Use intermediate transformers in these networks.

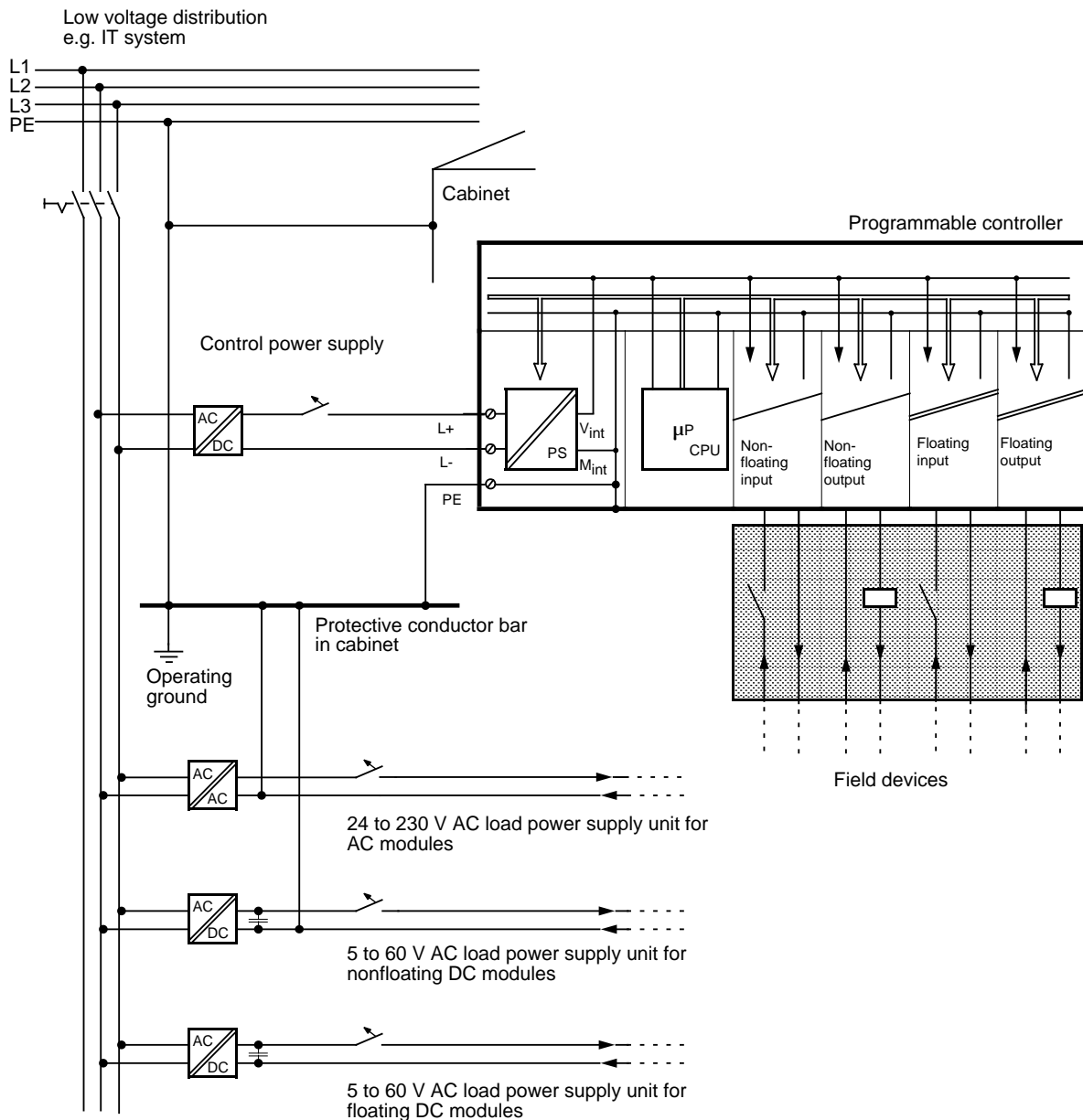


Figure 3-32. Operating a Programmable Controller with Field Devices on Nongrounded Supply

3.4.3 Connecting Nonfloating and Floating Modules

The following sections show the special features involved in installations with nonfloating and floating modules.

Installation with nonfloating modules

In installations with nonfloating modules, the reference potential of the control circuit (M_{internal}) and the load circuits (M_{external}) are not galvanically isolated.

The reference potential of the control circuit (M_{internal}) is at the PE terminal or \oplus and must be connected to the reference potential of the load circuit via a line to be run externally.

Figure 3-33 shows a simplified representation of an installation with nonfloating modules. The installation is independent of the grounding concept. The connections for the grounding measures are therefore **not** shown:

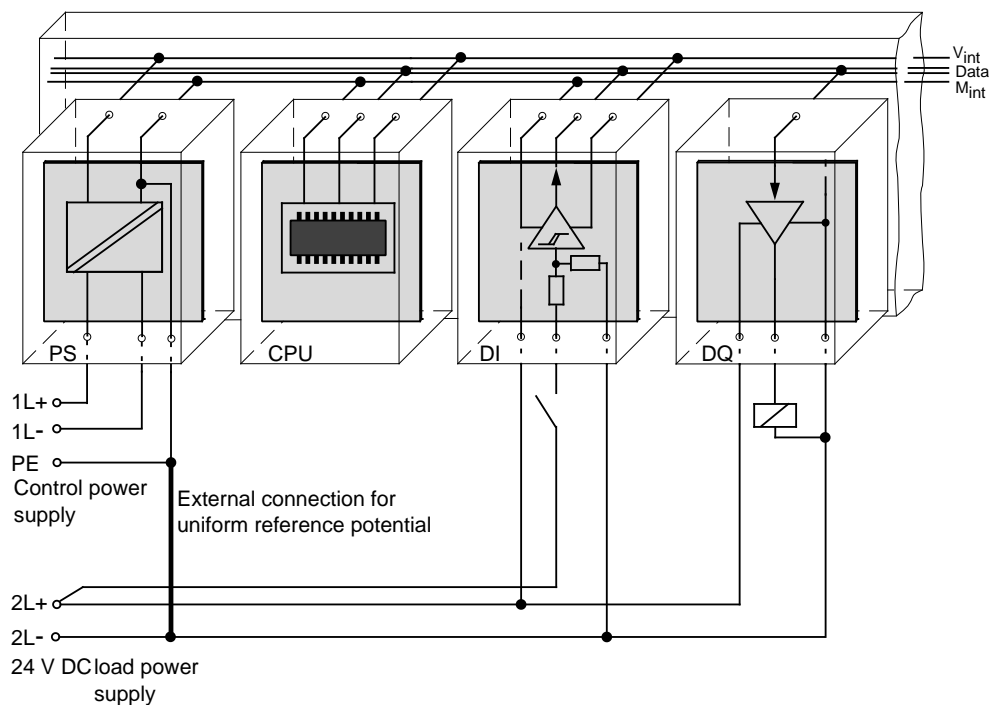


Figure 3-33. Simplified Representation of an Installation with Nonfloating Modules

Voltage drop on line must not exceed 1 V, otherwise the reference potentials will shift and result in failures of the module.

Note

It is imperative that you connect the reference potential of the load power supply unit with the L- terminal of the module in the case of 24 V DC DQ modules. If this connection is missing (e.g. wirebreak), a current of typically 15 mA can flow at the outputs. This output current can be sufficient to ensure that

- Energized contactors do not drop out and
- High-resistance loads (e.g. miniature relays) can be driven.

Installation with floating modules

Control circuit and load circuit are galvanically isolated in the case of floating modules.

Installation with floating modules is necessary in the following cases:

- All AC load circuits and
- Non-connectable DC load circuits.
The reasons for this are, e.g. different reference potentials of the sensors or the grounding of the plus poles of a battery, ...

Figure 3-34 shows the simplified representation of an installation with floating modules. The installation is independent of the grounding concept. The connections for grounding measures are therefore **not** shown.

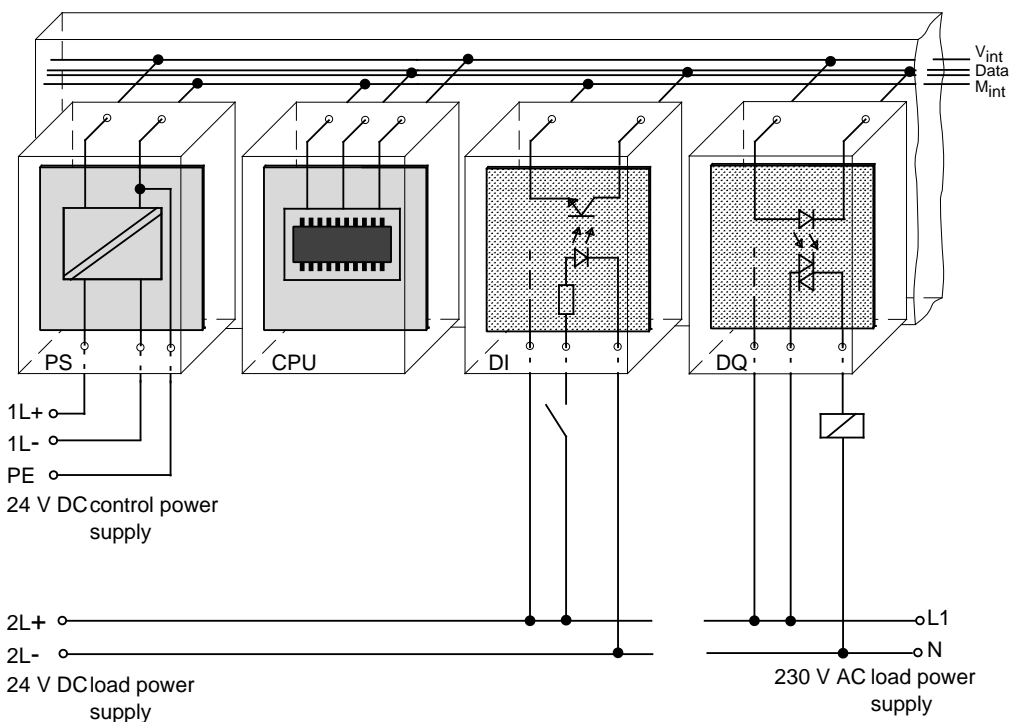


Figure 3-34. Simplified Representation for Installation with Floating Modules

3.5 Installing Programmable Controllers in Conformity with EMC Guidelines

Measures to suppress interference are frequently only taken when the controller is already in operation and reception of a signal has already been affected. In most cases, such interference is attributable to inadequate reference potentials caused by faulty installation of the programmable controller.

When installing the programmable controller, you must ensure that all inactive metal parts have surface contact grounding. Correct grounding creates a uniform reference potential for the controller and reduces the effects of strays.

Grounding means the conductive connection of all inactive metal parts. The total of all interconnected inactive parts is called the ground.

Inactive metal parts are all conductive parts that have at least basic electrical isolation from active parts and that are energized only in case of a fault.

Even in case of a fault, the ground must **not carry a dangerous touch voltage**. The ground must therefore be connected with the protective conductor. To avoid ground loops, you must always connect locally separated ground configurations (cubicles, structural parts and machine parts) to the protective conductor system in a star configuration.

Note the following when grounding:

- Connect the inactive metal parts as carefully as the active parts.
- Make sure that the metal-to-metal connections are of low impedance, e.g. through large-surface contacting with good conductivity.
- If you include enamelled or anodized metal parts in the grounding, these insulating protective layers must be penetrated. For this purpose, use special contact washers or remove the insulation layers.
- Protect joints against corrosion, for example, by means of grease.
- Movable ground parts (e.g. cubicle doors) must be connected via flexible grounding strips. The grounding strips should be short and have a large surface, since the surface is decisive for the discharge of high-frequency interference.

3.6 Wiring Arrangement

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

3.6.1 Running Cables Inside and Outside a Cabinet

Dividing the lines into the following groups and running the groups separately will help you to achieve electromagnetic compatibility (EMC).

- Group A: Shielded bus and data lines (for programmer, OP, SINEC L1, SINEC L2, printer, etc.)
 Shielded analog lines
 Unshielded lines for DC voltage 60 V
 Unshielded lines for AC voltage 25 V
 Coaxial lines for monitors
- Group B: Unshielded lines for DC voltage > 60 V and 400 V
 Unshielded lines for AC voltage > 25 V and 400 V
- Group C: Unshielded lines for AC voltage > 400 V
- Group D: Lines for SINEC H1

You can use the following table to see the conditions which apply to the running of the various combinations of line groups.

Table 3-4. Rules for Common Running of Lines

	Group A	Group B	Group C	Group D
Group A				
Group B				
Group C				
Group D				

Legend for table:

- Lines can be run in common bundles or cable ducts
- Lines must be run in separate bundles or cable ducts (without minimum distance)
- Inside cabinets, lines must be run in separate bundles or cable ducts and outside cabinets but inside buildings, lines must be run on separate cable trays with a gap of a least of 10 cm between lines.
- Lines must be run in separate bundles or cable ducts with at least 50 cm between lines.

3.6.2 Running Cables Outside Buildings

Run lines outside buildings where possible in metal cable supports. Connect the abutting surfaces of the cable supports galvanically with each other and ground the cable supports.

When you run cables outdoors, you must observe the regulations governing lightning protection and grounding. Note the general guidelines:

Lightning Protection

If cables and lines for SIMATIC S5 devices are to be run outside buildings, you must take measures to ensure internal and external lightning protection.

Outside buildings run your cables either

- In metal conduits grounded at both ends
or
- In steel-reinforced concrete cable channels

Protect signal lines from overvoltage by using:

- Varistors
or
- Lightning arresters filled with inert gas

Install these protective elements at the point where the cable enters the building.

Note

Lightning protection measures always require an individual assessment of the entire system. If you have any questions, please consult your local Siemens office or any company specializing in lightning protection.

Grounding

Make certain that you have sufficient equipotential bonding between the devices (3.7).

3.7 Equipotential Bonding

Potential differences may occur between separate sections of the system if

- Programmable controllers and I/Os are connected via non-floating interface modules or
- Cables are shielded at both ends but grounded via different sections of the system.

Potential differences may be caused, for instance, by differences in the system input voltage. These differences must be reduced by means of equipotential bonding conductors to ensure proper functioning of the electronic components installed.

Note the following for equipotential bonding:

- A low impedance of the equipotential bonding conductor makes equipotential bonding more efficient.
- If any shielded signal cables connected to earth/protective earth at both ends are laid between the system sections concerned, the impedance of the additional equipotential bonding conductor must not exceed 10 % of the shield impedance.
- The cross-section of the equipotential bonding conductor must be matched to the maximum compensating currents. The following cross-sections are recommendable:
 - 16 mm² copper wire for equipotential bonding line up to 200 m (656.2 ft).
 - 25 mm² copper wire for equipotential bonding line over 200 m (656.2 ft).
- Use equipotential bonding conductors made of copper or zinc-plated steel. Equipotential bonding conductors are to be connected to earth/protective earth via a large contact area and to be protected against corrosion.
- The equipotential bonding conductor should be laid in such a way as to achieve a relatively small contact area between equipotential bonding conductor and signal cables (see Figure 3-35).

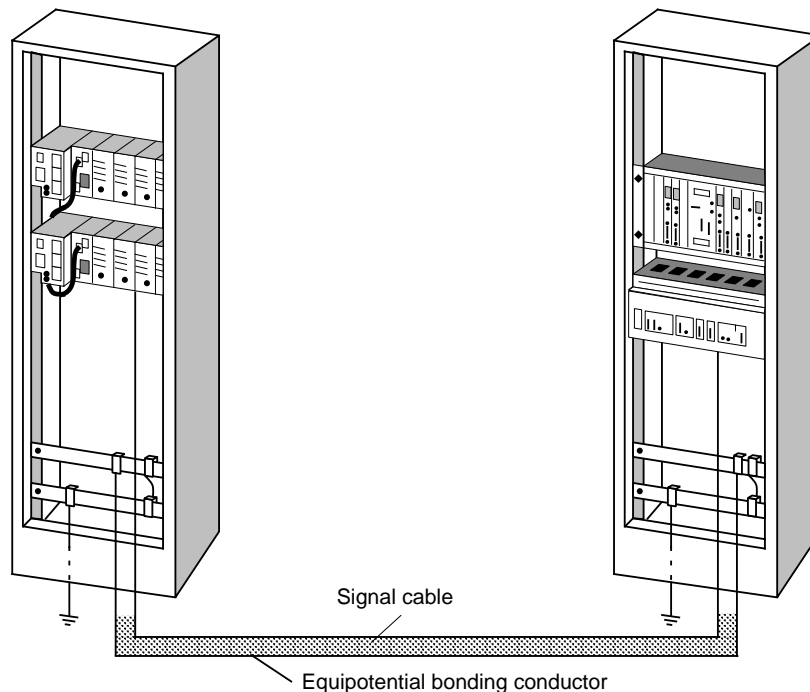


Figure 3-35. Laying Equipotential Bonding Conductor and Signal Cable

Protection in the case of Indirect Contact

For distributed configurations, differentiate between the following cases:

- Separate arrangement (up to 200 m/656.2 ft.) of central controllers and expansion units when connected by the IM 304/314 interface modules.
The IM 304/314 interface modules are nonfloating. In this case, provide a potential equalization line (see VDE 0100, Section 547).
- Signal transfer between separate systems via input and output modules.
Use floating input and output modules for signal transfer.

3.8 Shielding Cables

Shielding is a measure to weaken (attenuate) magnetic, electric or electromagnetic interference fields.

Interference currents on cable shields are discharged to ground over the shield bar which has a conductive connection to the housing. So that these interference currents do not become a source of noise in themselves, a low-resistance connection to the protective conductor is of special importance.

Use only cables with shield braiding if possible. The effectiveness of the shield should be more than 80%. Avoid cables with foil shielding since the foil can easily be damaged by tension and pressure; this leads to a reduction in the shielding effect.

As a rule, you should always shield cables at both ends. Only shielding at both ends provides good suppression in the high frequency range.

As an exception only, you can connect the shielding at one end. However, this attenuates only the lower frequencies. Shielding at one end can be of advantage in the following cases:

- If you cannot run an equipotential bonding conductor
- If you are transmitting analog signals (e.g. a few microvolts or microamps)
- If you are using foil shields (static shields).

Always use metallic or metalized connectors for data lines for serial connections. Secure the shield of the data line at the connector housing. Do **not** connect the shield to the PIN1 of the connector strip!

In the case of stationary operation, you are recommended to insulate the shielded cable without interrupt and to connect it to the shield/protective ground bar.

Note

If there are potential differences between the earthing points, a compensating current can flow over the shielding that is connected at both ends. For this reason, connect an additional equipotential bonding conductor (3.7).

Note the following when connecting the cable shield:

- Use metal cable clamps for fixing the braided shield. The clamps have to enclose the shield over a large area and make good contact (see Figure 3-36).
- Connect the shield to a shield bar immediately at the point where the cable enters the cabinet. Route the shield to the module; do **not** connect it to the module.

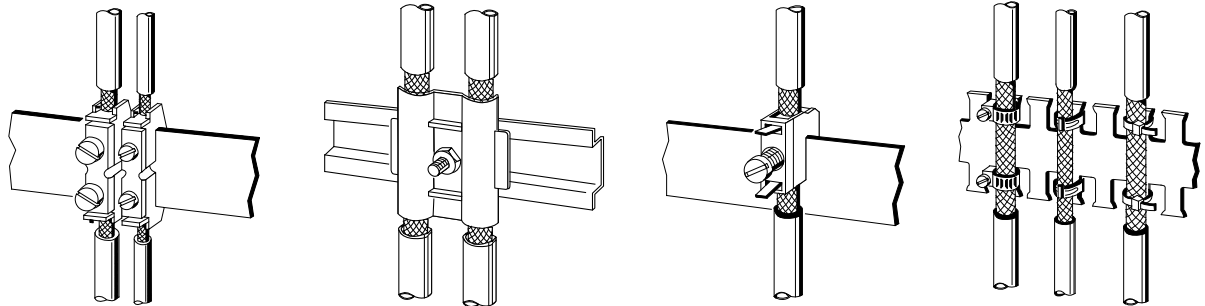


Figure 3-36. Fixing Shielded Cables with Various Types of Cable Clamps

3.9 Special Measures for Interference-Free Operation

Arc Suppression Elements For Inductive Circuits

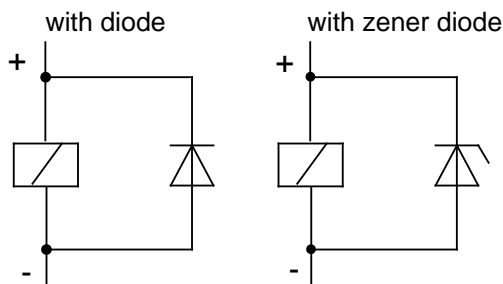
Normally, inductive circuits (e.g. contactor or relay coils) energized by SIMATIC S5 do not require to be provided with external arc suppressing elements since the necessary suppressing elements are already integrated on the modules.

It only becomes necessary to provide arc suppressing elements for inductive circuits in the following cases:

- If SIMATIC S5 output circuits can be switched off by additionally inserted contactors (e.g. relay contactors for EMERGENCY OFF). In such a case, the integral suppressing elements on the modules become ineffective.
- If the inductive circuits are **not** energized by SIMATIC S5.

You can use free-wheeling diodes, varistors or RC elements for wiring inductive circuits.

Connecting DC-controlled coils



Connecting AC-controlled coils

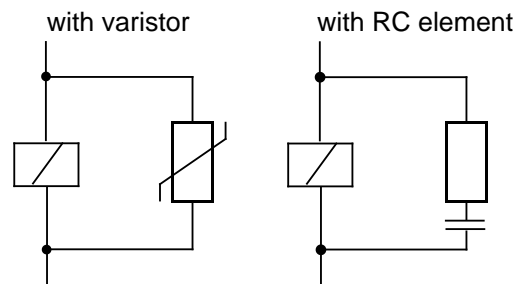


Figure 3-37. Connecting Coils

Mains connection for programmers

In each cabinet group, provide a grounding-type receptacle to supply power for a programmer. The receptacle should be supplied from the distribution board to which the protective ground for the cabinet is connected.

Cabinet lighting

Take normal lamps for cabinet lighting, e. g. LINESTRA® lamps are more suitable. For reasons of noise immunity, do not use fluorescent lamps inside the cabinet. If you must use fluorescent lamps, take the measures shown in Figure 3-34.

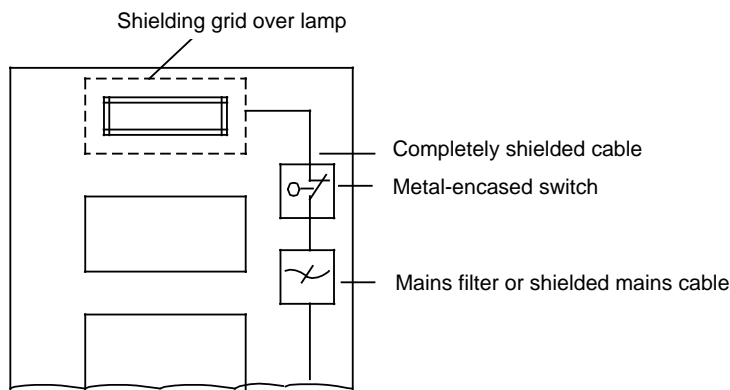


Figure 3-38. Measures for Suppressing Noise from Fluorescent Lamps in the Cabinet

Separating inductors

Sheet-metal barriers are recommended for the part of the cabinet containing strong inductances such as transformers or contactors.

Protection against electrostatic discharge

Metal housings or cabinets closed on all sides and with good metallic contact to the grounding point at the installation location should be used to protect decivers and modules from electrostatic discharge.

If you install your controller in a terminal box, use cast or sheet-metal where possible. Plastic housings should always have a metallic surface.

Housing doors and covers must be connected to the housing ground with grounding strips or contact springs.

If you are working on the controller with the cabinet open, please observe the guidelines on protective measures for ESD-(electrostatic discharge) endangered components and modules.

Filters for power cables and signal cables

Filtering of power and signal cables is a measure for suppressing conducted interference. Over-voltages must not occur on power cables within the cabinet.

Suppress overvoltages with the following measures:

- Suppressing interference in power cables
 A mains filter (e.g. B84299-K64, 250 V AC/10 A) should be installed in the supply cable in the case of a mains supply of 230 V. The mains filter must be located at the entrance to the cabinet. Please note that the filter must have a large surface contact and low-impedance connection with the cabinet ground (contact surfaces must be uninsulated).
- Noise suppression capacitors for DC supply voltage
 If a cabinet is connected to a central 24 V supply, noise can reach the controller via this supply cable.
 You are therefore recommended to install 24 V noise suppression capacitors. These should be installed at the cabinet ground or on the shielding bar.

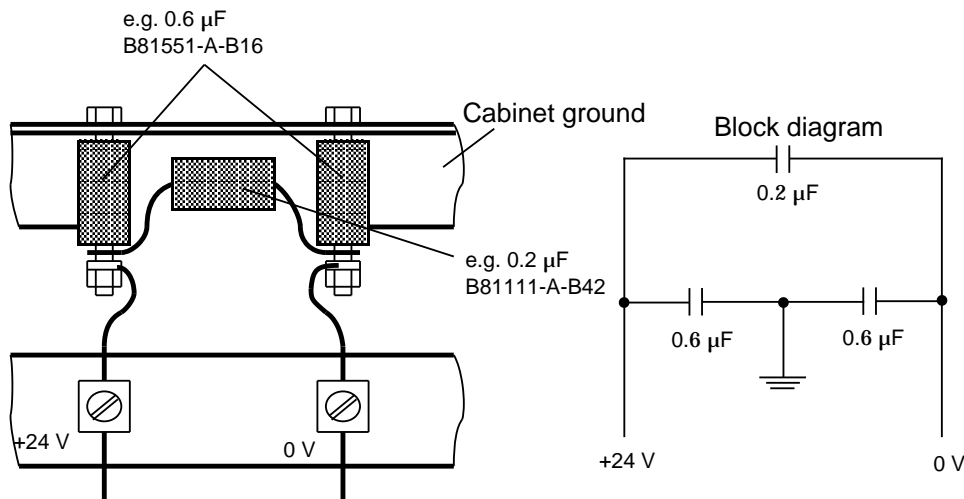


Figure 3-39. Arrangement of Suppression Capacitors

3.10 Checklist for the Installation of Programmable Controllers in Conformity with EMC Guidelines

Table 3-5. Checklist for the Installation of Programmable Controllers in Conformity with EMC Guidelines

EMC Measures	Notes
Connection of inactive metal parts (Section 3.5) Specially check the connections on: <ul style="list-style-type: none"> • Racks • Supporting bars • Shielding buses and protective conductor bars 	
Have all inactive metal parts been connected and grounded with large surface contact and a low impedance?	
Is there a sufficient connection to the ground electrode/protective conductor system?	
Have insulating layers on enamelled and anodized surfaces been removed or have the connections been implemented with special contact washers?	
Have the joints been protected against corrosion, e.g. by means of grease?	
Have the cubicle doors been connected to the cubicle body via grounding strips?	
Wiring arrangement (Section 3.6)	
Cabling divided into cable groups?	
Supply lines (230 to 400 V) and signal cables run in separate ducts or bundles?	
Equipotential bonding (Section 3.7)	
In the case of a distributed configuration, check the installation of the equipotential bonding conductor	
Cable shielding (Section 3.8)	
Have metal connector sockets been used everywhere?	
Have all analog and data lines been shielded?	
Have cable shields been applied to the shield bus or protective conductor bar?	
Have cable shields been fixed with a large surface contact and a low impedance by means of cable clamps?	
Have cable shields been connected at both ends where this is possible?	
Inductive circuits (Section 3.9)	
Have contactor coils that are not energized via SIMATIC contacts been provided with arc suppression elements?	

4 System Startup

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4 System Startup

This chapter tells how to operate the S5-115F programmable controller, including its input and output modules.

4.1 Operating Instructions

Subsections 4.1.1 through 4.1.6 provide important information on operating an S5-115F.

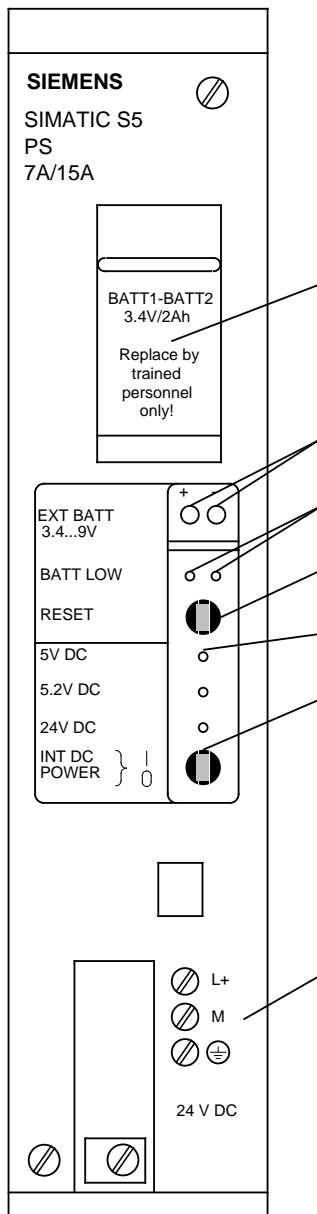
4.1.1 Controls on the Power Supply Module and Central Processing Unit

Use the switches on the power supply module and CPU to control PC operation. LEDs indicate current statuses.

Power supply module

You can set the following switches on the PS 951 power supply module (Figure 4-1):

- The ON/OFF switch turns the 5V power on or off.
- The RESET switch acknowledges a battery failure indication.



Battery compartment

Sockets for external DC voltages 3.4 to 9 V for memory backup during battery change. The battery can be changed in PLC RUN.

Battery failure indicator

The LED lights up under the following conditions:

- there is no battery
- the battery has been installed incorrectly
- the battery voltage has gone below 2.8 V

If the LED lights up, the "BAU" signal is sent to the CPU and the PLC goes to STOP.

RESET switch

Use this switch to acknowledge a battery failure signal after you have installed a new battery. If you are operating the PS 951 power supply module without a battery, activate this switch to suppress the "BAU" signal.

Operating voltage display of 5 V for the central controller and expansion units in centralized configurations.

ON/OFF switch (I=ON, O= OFF)

When the switch is in the "OFF" position, the operating voltage is disabled without interrupting the connected line voltage.

Screw-type terminals for connecting the line voltage

Figure 4-1. Front View of the Power Supply Module

Central Processing Unit

The following operator functions are possible on the front panel of the CPU:

- Plug in a memory submodule
- Connect a programmer (PG)
- Connect SINEC L1
- Select the operating mode
- Perform an Overall Reset

LEDs indicate the current CPU operating mode. A slot in the CPU front panel contains a plastic card with the most important operating instructions for the PS and CPU. Figure 4-2 shows the front of the CPU.

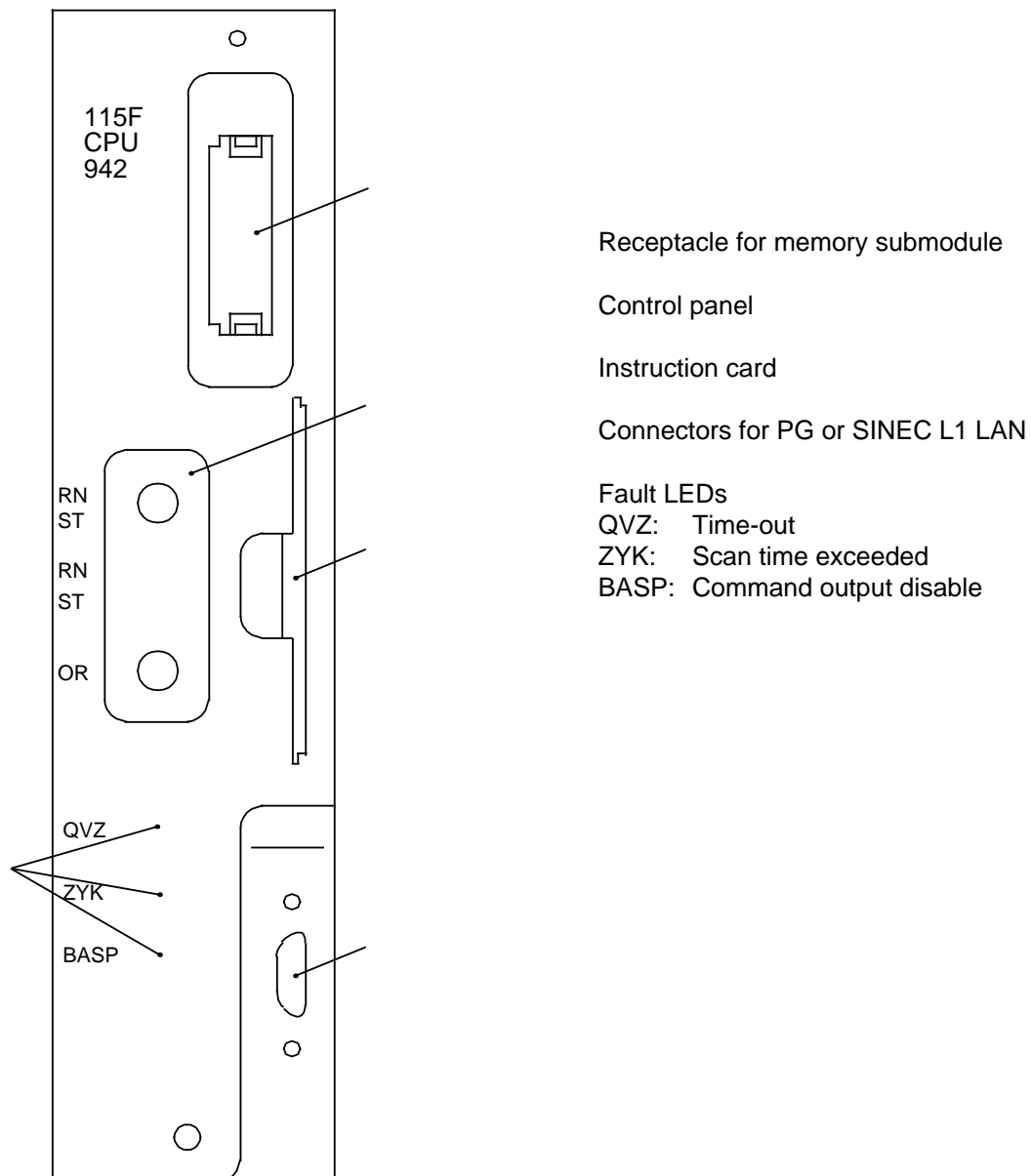


Figure 4-2. Front View of the CPU

The CPU controls are arranged in a panel on the front of the CPU and are shown in Figure 4-3 below.

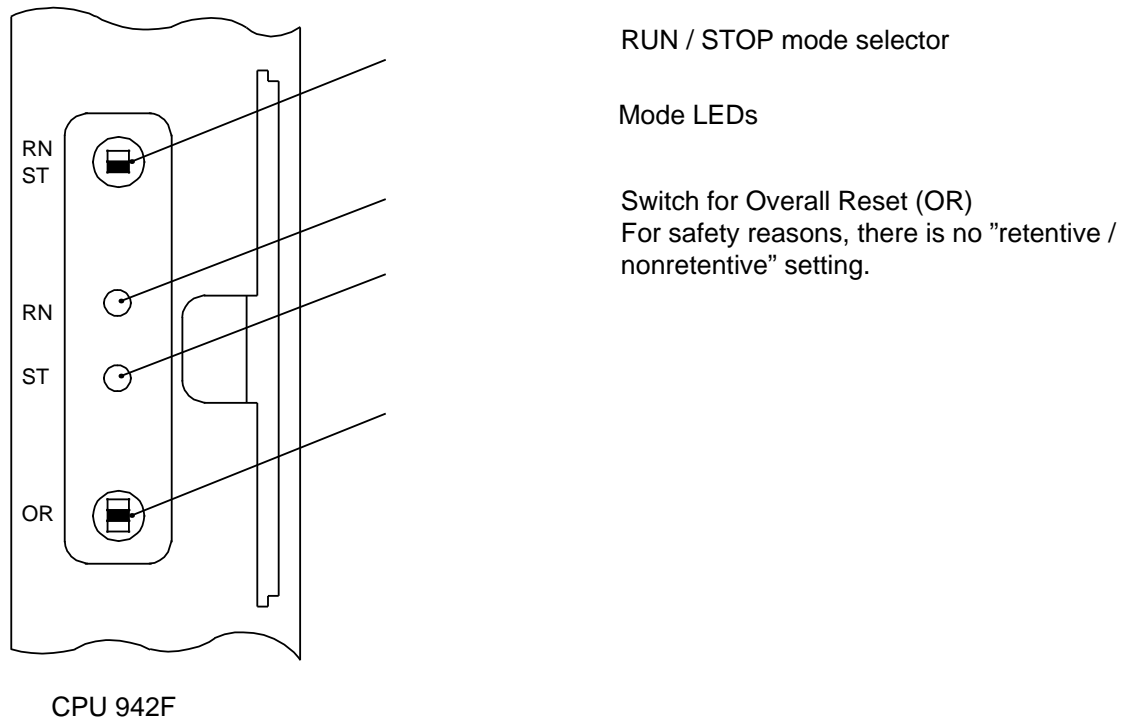


Figure 4-3. CPU Control Panel

4.1.2 Operating Modes

Use the mode selector to set the "STOP" (ST) or "RUN" (RN) mode. The CPU executes the initialization program automatically on power up and the "RESTART from STOP" program when the RUN mode is selected.

"RESTART from POWER ON" program and "RESTART from STOP" program

- Restart block OB 22 (RESTART from POWER ON) or OB 21 (RESTART from STOP) is processed.
- All input and output modules are disabled. Outputs have signal state "0".
- All inputs and outputs in the process image have signal state "0".
- Scan time monitoring is inactive.
- No restart test is run in test mode (4.1.3).
- The restart test (approx. 2 min.) is run in safety mode (4.1.3) .



Important

When the CPU goes from "STOP" to "RUN", the process images and the nonretentive flags, timers and counters are set to zero.

"RUN" Mode

- All input and output modules are enabled before the start of cyclical program scanning.
- The program is scanned cyclically.
- The two subunits are synchronized.
- Timers that were started in the program run down.
- Input module signal states are read in, exchanged and compared.
- Output modules are addressed.
- S5-115F self-test runs (organized in time slices).

"STOP" mode, large Stop loop

- The program is not scanned.
- The two subunits are synchronized.
- The values of the timers, counters, flags, and process images that were current when the CPU went into the "STOP" state are maintained.
- Digital output modules are disabled (signal state "0"). The "BASP" LED lights up.
- An S5-115F self-test runs (organized in time slices).
- Use of the programmer and SINEC L1 transfers are possible.
- Mode change possible.

STOP mode, lesser Stop loop

(activated if serious errors are detected)

- The program is not scanned.
- The subunits are not synchronized.
- The values of timers, counters, flags and process images are maintained.
- Digital output modules are disabled. The "BASP" LED lights up.
- The self-test no longer runs.
- SINEC L1 transfers are no longer processed. Programmer operation is restricted to reading out error DBs.
- Mode changes are no longer possible.

4.1.3 CPU Operation in "RUN" and "STOP" Modes

In these modes the CPU can operate in two ways:

- Safety mode
The CPU is automatically in safety mode as soon as an EPROM submodule is plugged in.
- Test mode
In all other cases, the CPU is automatically in test mode.





















Safety mode and test mode differ from each other in the following points:

- Programmer operation (Volume 2, Chapter 4 of the manual):
In safety mode and in "RUN" mode at present, the operator cannot use the programmer input functions; in "STOP" mode, he is restricted mainly to enquiry functions only, but cannot make entries that will change the contents of the RAM (exception: inputs using the parameter entry DB). In test mode and in "RUN" mode, the programmer can be used for enquiry and test functions and, in "STOP" mode, the whole range of programmer functions is available.
- Supplementary self-test with test slice organization (Volume 2, Section 5.4.1 of the manual)
In test mode, the RAMs of the two subunits are not compared and no restart test takes place.
- Transmission of the RAM contents of subunit A to subunit B (on restart, to transfer any program changes to subunit B):
In safety mode, the parameter entry DB can only be changed when the PC is in "STOP" mode; for this reason, it is transferred to subunit B on restart. In test mode, the entire user RAM (5 Kbytes of internal RAM plus the contents of any RAM submodules) is transferred to subunit B to cope with any blocks loaded later.
- Error response:
In safety mode, there are the following error responses:
 - "Passivate" (deactivation of I/O modules)
 - "Large STOP loop" and
 - "Lesser STOP loop".
- Passivation entries
Passivated I/O modules can be re-activated during operation using the FB 255.
The passivation entries in the error DB are deleted.
Passivation is also revoked in the following cases:
 - In safety mode with Overall Reset
 - In test mode by performing the following: Power OFF, Power ON, RUN.
- Deleting entries for RAM comparison errors
In safety mode, entries for RAM comparison errors can only be removed with an Overall Reset.
Other error entries are deleted on restart.


Meaning of the LEDs


Two LEDs on the control panel of the CPU indicate the status of the CPU (and in Figure 4-3). Table 4-1 lists the possible displays.

Table 4-1. Coordination of Operating Mode Settings and LEDs

Status of the LEDs on the CPU				Note
First Subunit		Second Subunit		
Red LED	Green LED	Red LED	Green LED	
				System is in large STOP loop Section 4.1.2
				System is in lesser STOP loop Section 4.1.2
				First subunit is switched to RUN and is waiting for the second subunit to be switched to RUN also
				System is processing the restart selftest or the restart OBs. The test lasts between 30 to 120 secs approximately, depending on number of I/O modules.
				System is in PLC RUN

 LED off

 LED on

 LED flashes

Changing the operating mode

Figure 4-4 shows the conditions for changing the operating mode.

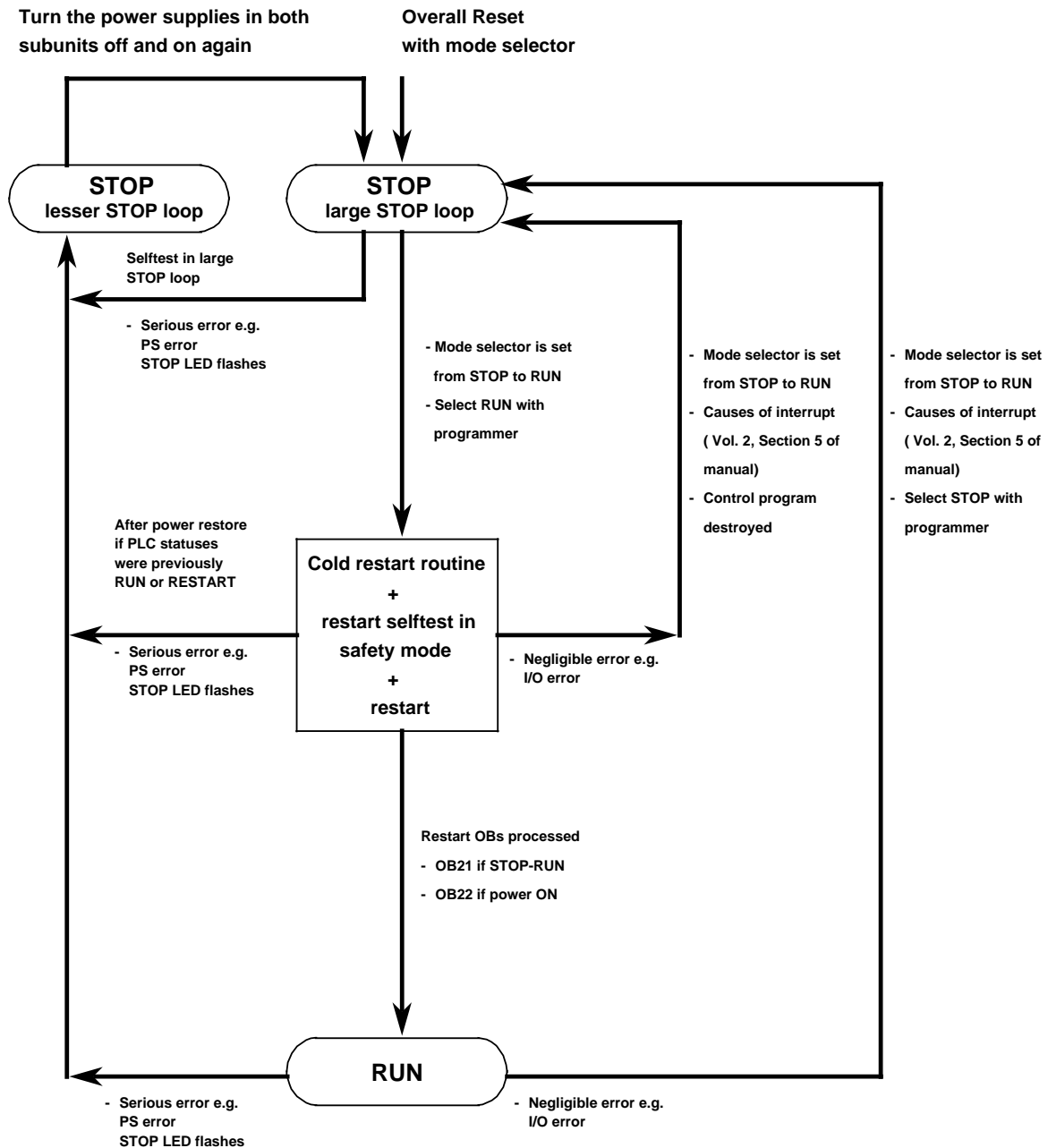


Figure 4-4. Conditions for Changing the Operating Mode

4.1.4 Cold Restart and Warm Restart

The S5-115F undergoes a cold restart after POWER ON which takes it into RUN mode via the STOP program, provided all RUN conditions are met. It can also be restarted from the STOP mode (loop in the STOP program).

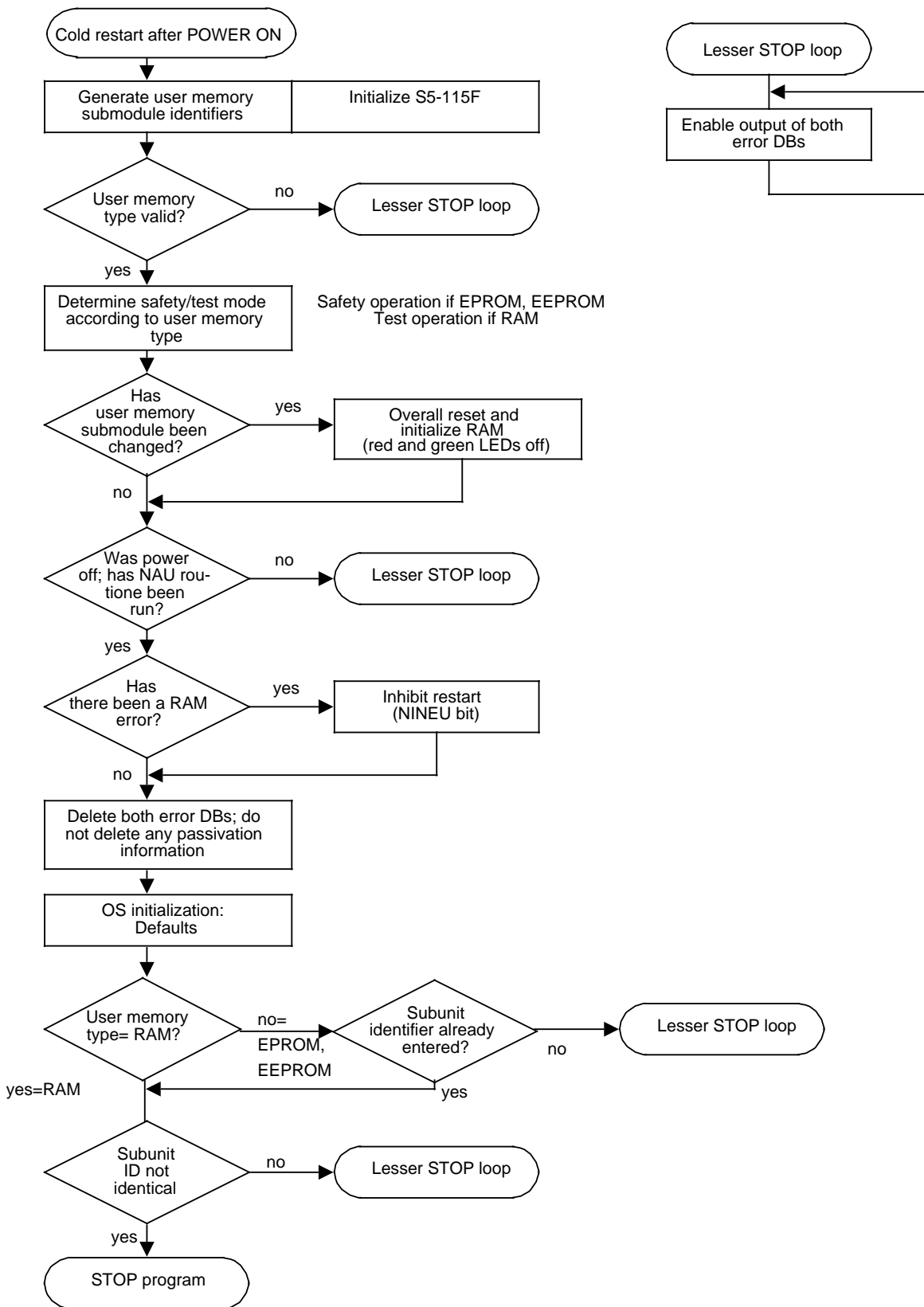


Figure 4-5. Restart after POWER ON

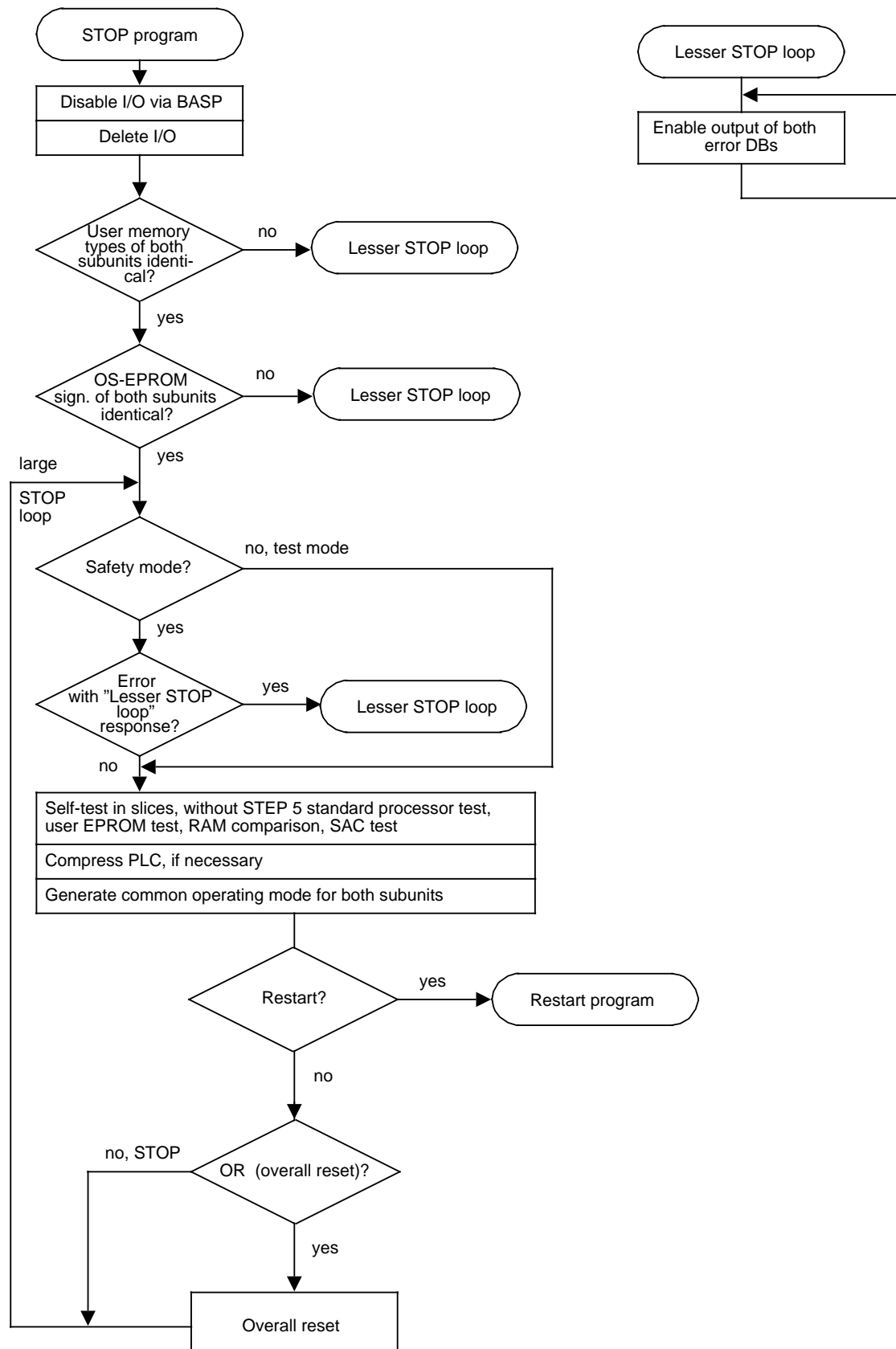


Figure 4-6. STOP Program

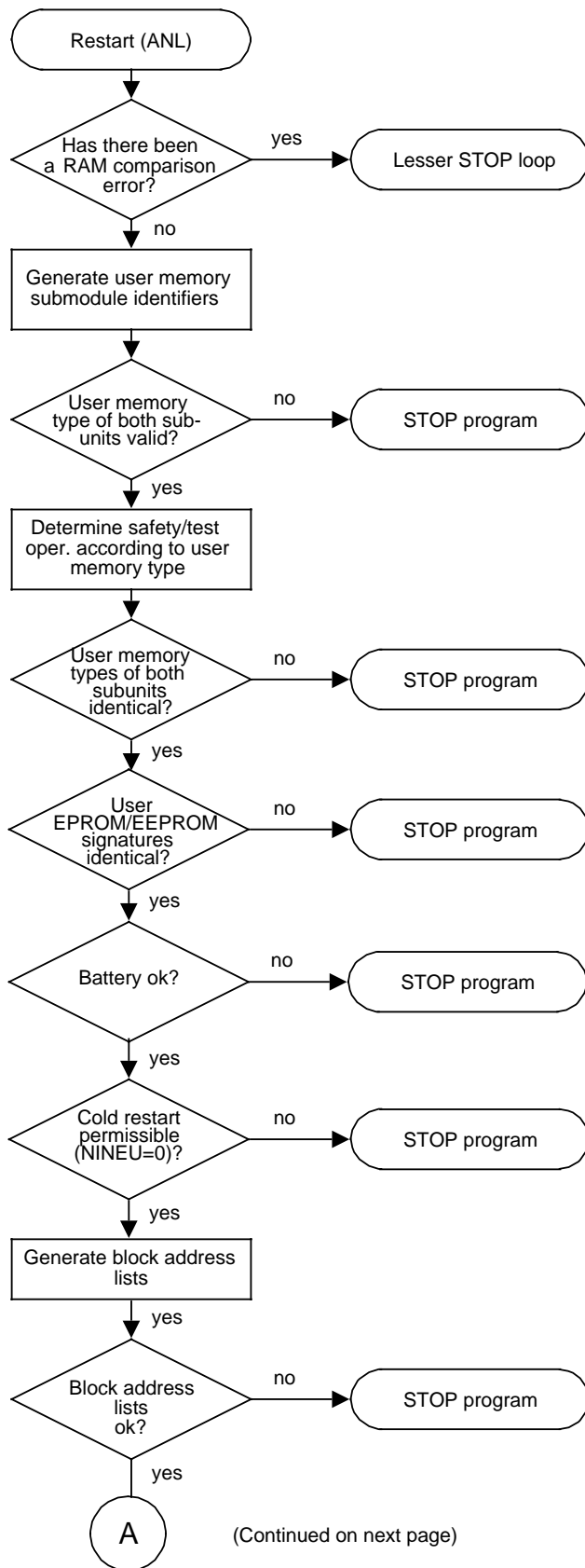


Figure 4-7. Restart from PLC STOP Program

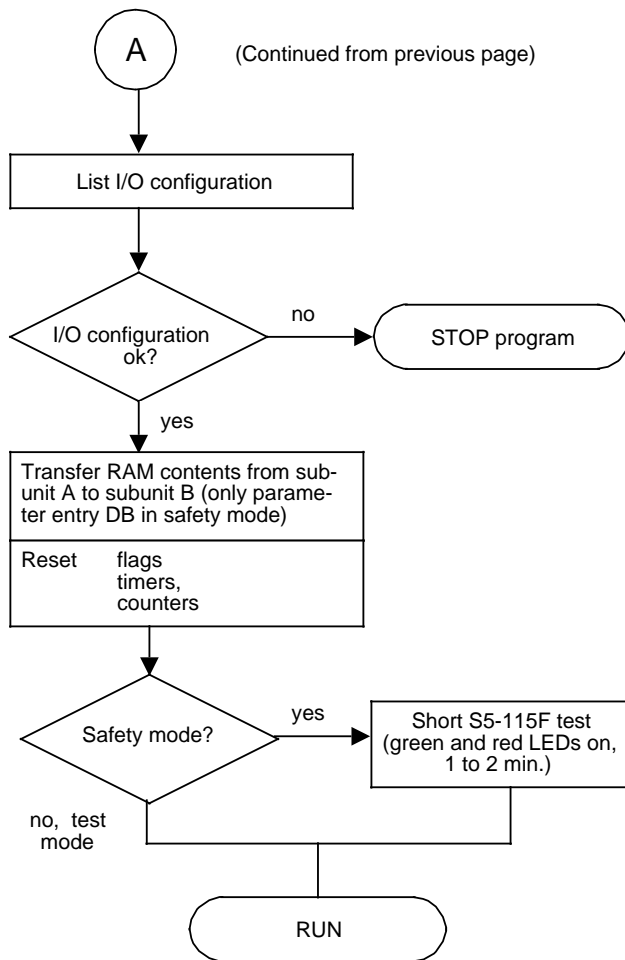


Figure 4-7. Restart from PLC STOP Program (continued)

4.1.5 Battery Backup

A battery is absolutely necessary for program and data backup on RESTART after POWER OFF. Flags, timers, and counters are always set to zero in the "RESTART" mode.

Note

If a battery failure is detected in the "RESTART" mode after POWER ON, the PLC goes into the "STOP" mode.

4.1.6 Overall Reset

It is recommended that you perform the "Overall Reset" function before entering a new program. Overall Reset clears the following items:

- The PLC program memory,
- All data (flags, timers, and counters),
- All error DBs.

Note

Without Overall Reset, information is maintained even if the program is overwritten.

You can perform Overall Reset on the CPU in the following ways:

- in online mode via the "Overall Reset" programmer function
- by replacing the memory submodules
- via the switches on the CPU.

Overall Reset via the switches on the CPU:

1. Hold the switch in the OR position
2. Switch the mode selector twice from RUN to STOP.

The red and green LEDs go out briefly during Overall Reset.



Important

Overall Reset is of great significance in safety mode because it leads to the loss of error information.

An Overall Reset should only be carried out after repair of all defective components and is done at the user's own risk!

4.1.7 Steps for System Startup

The following pages contain flowcharts, which will help you in starting up your S5-115F.

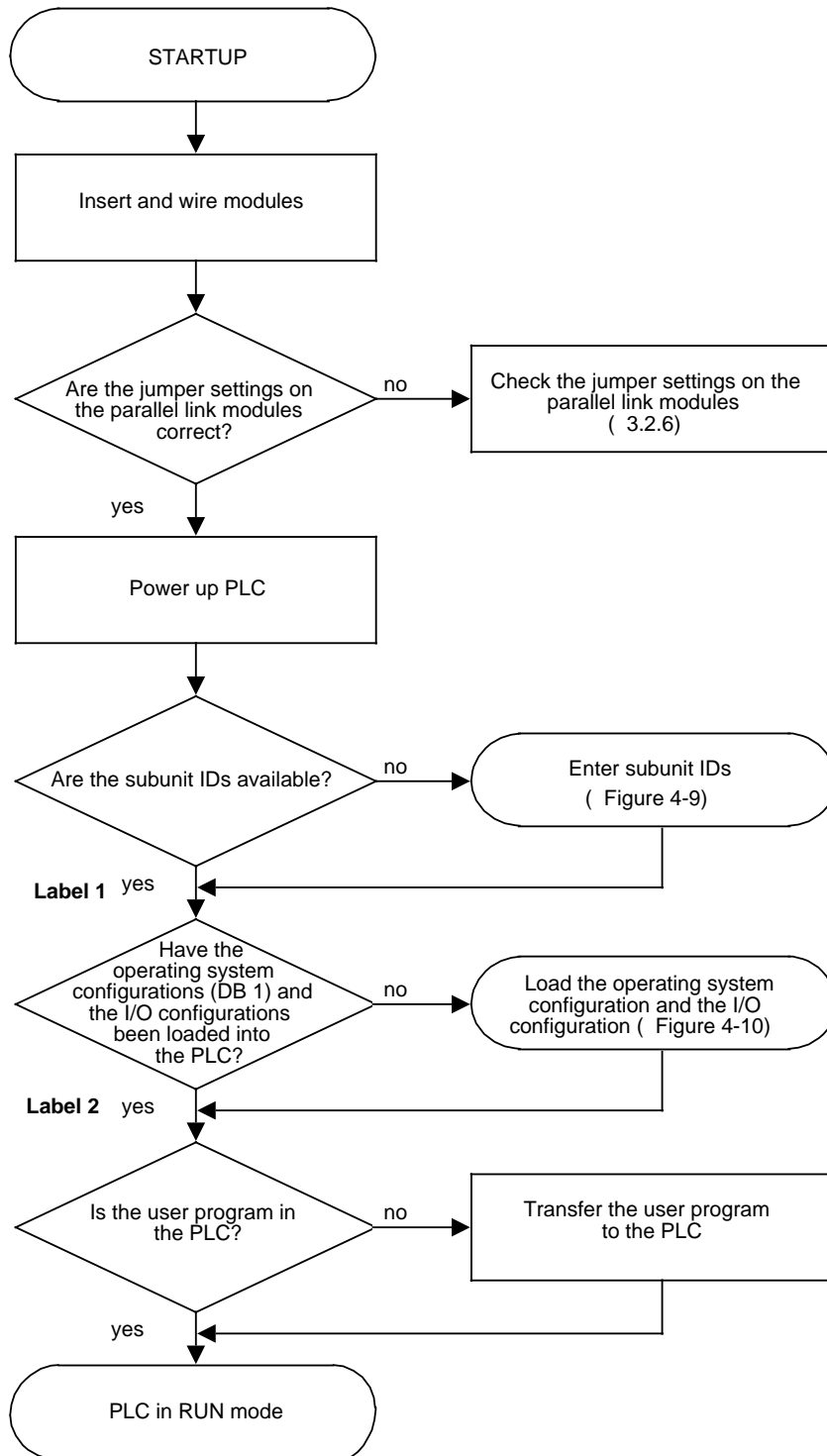


Figure 4-8. Flowchart for Startup: Overview (Main Tree)

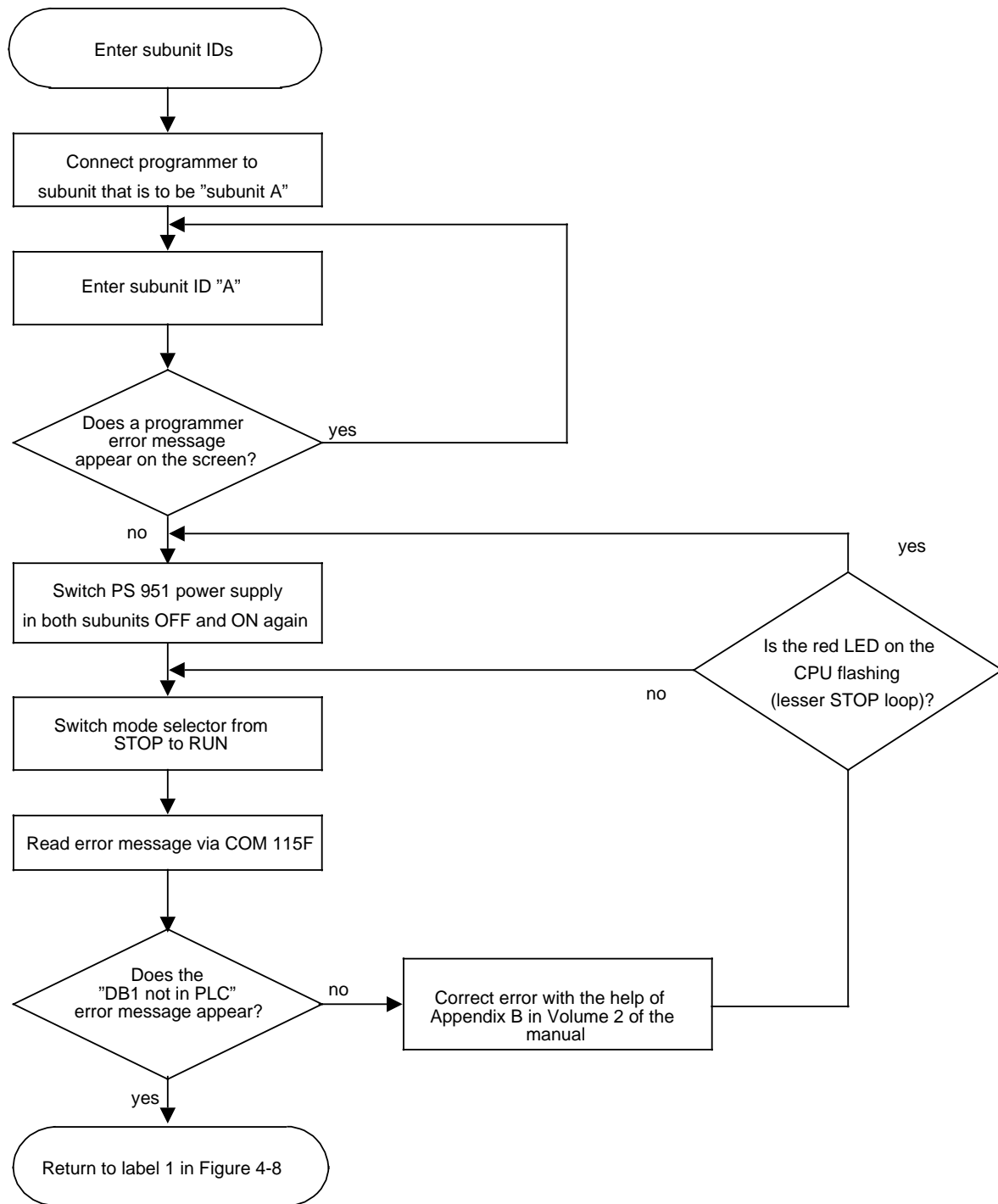


Figure 4-9. Flowchart for Startup: Entering the Subunit IDs

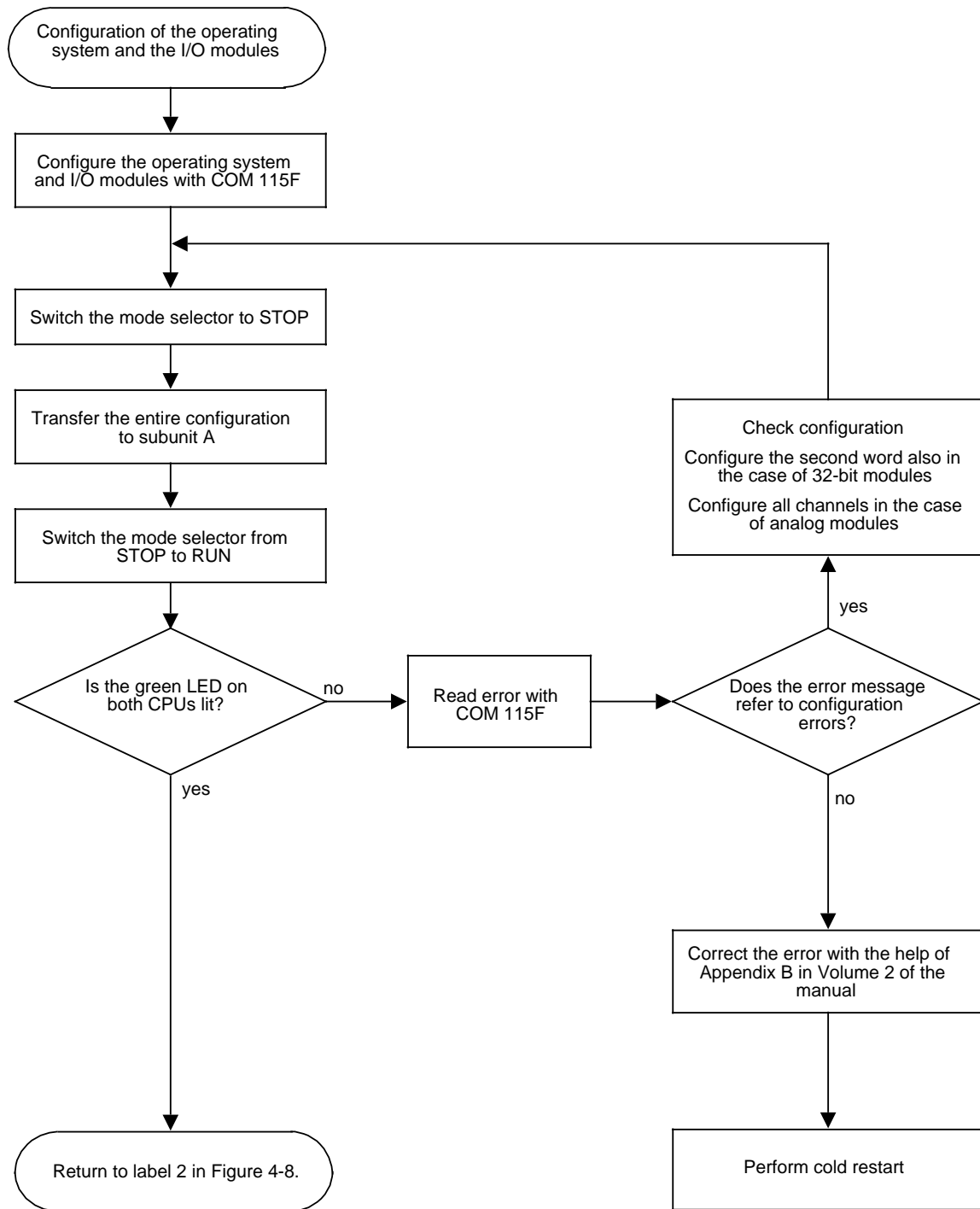


Figure 4-10. Flowchart for Startup: Configuring the Operating System and the I/O Modules

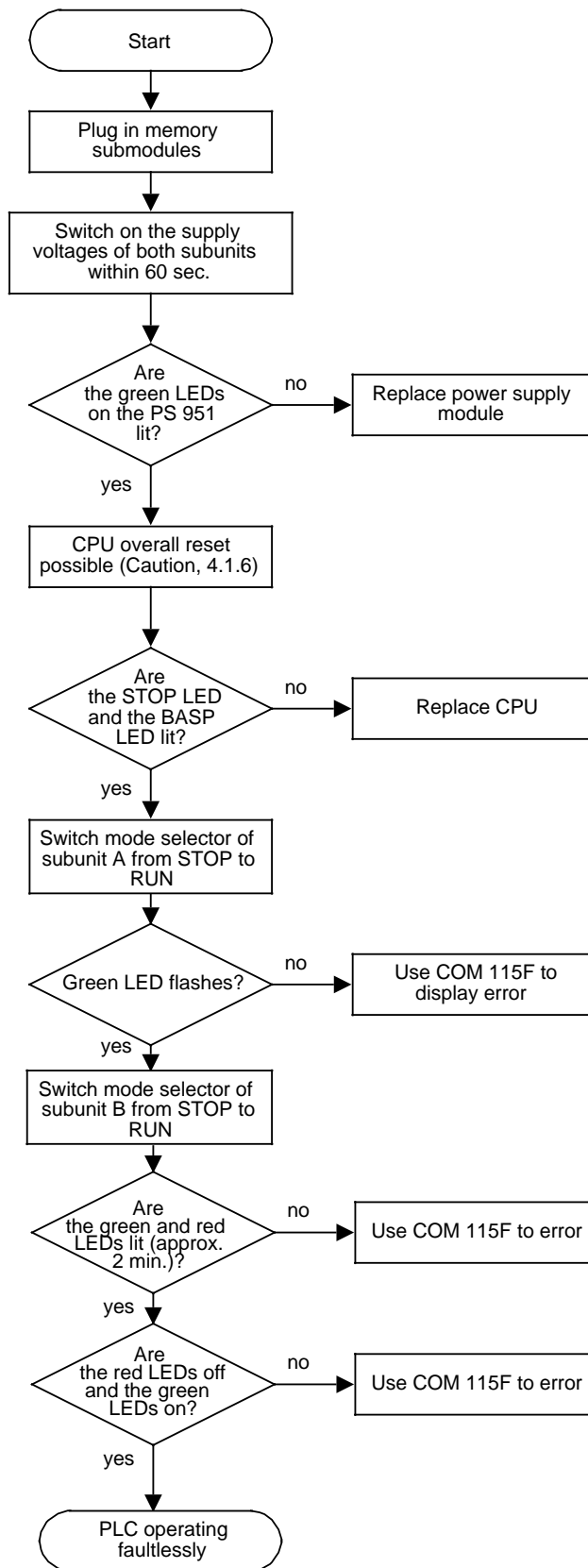


Figure 4-11. Startup of an S5-115F in Safety Mode

4.2 Working with Input/Output Modules

A distinction is made between the following two module types according to the type of process signals they handle:

- Digital modules
- Analog modules.

Please observe the rules laid down in Chapter 10 for feedback modules and their configuration.



Important

Turn off the power supply for the central controller and the sensors before plugging in or removing input/output modules.

Suitable digital modules are available for various signal levels. The wiring of the power supply, sensors, and actuators is printed on the front doors of the modules.

LEDs on the frontplate indicate the signal states of inputs and outputs. The LEDs are assigned to the front connector terminals.

4.3 System Startup Procedure

This section contains information on how to configure a system incorporating programmable controllers and how to put such a system into operation.

4.3.1 Safety Measures

When configuring systems incorporating programmable controllers, follow the relevant VDE regulations (e.g. VDE 0100 or VDE 0160). Pay special attention to the following points:

- The 24 V DC supply must be safely isolated from the power system voltage (e.g. 220 V AC).
- Prevent conditions that might endanger persons or property.
- When switching the S5-115F on for the first time, the user must make sure that the disconnection facilities are in order.
- When power is restored after a power failure or after EMERGENCY OFF devices have been tripped, machines must not be able to restart automatically.
- When EMERGENCY OFF devices are activated, safety must be guaranteed for persons and equipment as follows:
 - Actuators and drives that could cause dangerous situations (e.g. main spindle drives for machine tools) must be shut off.
 - On the other hand, actuators and drives that could endanger persons by being shut off (e.g. clamping devices), must not be shut off by EMERGENCY OFF devices.
- The programmable controller must be able to record the activation of EMERGENCY OFF equipment and the control program must be able to evaluate this information.

4.3.2 Checking a Plant or Controlled System before Startup

Perform each step in the operator procedure shown in Table 4-2 before switching on the power supply.

Table 4-2. Operator Procedure Prior to Switching On the Power Supply

Prerequisite	Check List	Remarks
The plant and S5-115F are not live, i.e. the main switch is turned off.	<ul style="list-style-type: none"> - Check the line voltage connections. Protective ground conductors must be connected. - Make sure that all modules plugged in are screwed tightly to the mounting rack. - Compare the configuration of the I/O modules to the location diagram. (Pay particular attention to fixed and variable addressing). - For I/O modules, make sure that no high-voltage lines (e.g. 220 V AC) terminate at low-voltage connectors (e.g. 24 V DC). 	Visual check of the installation, observing VDE 0100 and VDE 0113.
Disconnect fuses for sensors and actuators. Switch off the power circuits of the actuators. Turn on the main switch.	<ul style="list-style-type: none"> - Plug RAM user submodules required into subunit A and B - Enter subunit identifier in subunit A using the programmer (Vol. 2, chap. 1) - Perform Overall Reset on S5-115 	After the power switch is turned on, the green LEDs light up on the power supply and the red "ST" LED lights up on the CPU.
Test mode* / Stop Insert the fuses for the sensors. Leave the fuses for the actuators and power circuits disconnected.	<ul style="list-style-type: none"> - Activate all sensors in sequence. - You can interrogate each input using the "STATUS VAR" programmer function. 	If the sensors function properly and their signals are received, the appropriate input LEDs must light up on the I/O module.
Test mode* / Stop Insert the fuses for the actuators. Leave the power circuits of the actuators disconnected.	<ul style="list-style-type: none"> - You can force each output using the "FORCE VAR" programmer function. 	The LEDs of the forced outputs must light up and the circuit states of the corresponding actuators must change.
Test mode* Leave the power circuits for the actuators disconnected.	<ul style="list-style-type: none"> - Switch PC to Stop. Transfer all configuration DBs to subunit A using COM 115F - Switch both subunits to RUN thus triggering comparison of configured I/Os with actual I/Os <p>Remarks: The green LED will light up if there is no discrepancy</p>	Block input via subunit A only possible in PLC Stop mode
Test mode* / STOP	<ul style="list-style-type: none"> - Test the program, block by block 	
Test mode* Switch on power circuits of the actuators	<ul style="list-style-type: none"> - Switch the PLC to "RUN" mode. 	The PLC scans the program.
Safety mode**; Individual system acceptance test required	<ul style="list-style-type: none"> - Switch the PLC to "RUN" mode. 	The PLC scans the program.
Individual system acceptance test by relevant authority, where applicable		

* Control program and configuration data in RAM

** Control program and configuration data in EPROM/EEPROM

5 Addressing

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5 Addressing

Assign specific addresses to input and output modules so that you can reference them.

Please note the following when assigning addresses:

- In the case of two-channel I/Os, the modules in both subunits must be assigned the **same addresses**.
- In the case of single-channel I/Os, an assigned address must **not** be used in the other subunit.

5.1 Address Structure

Digital modules generally have bit addresses. Analog modules generally have byte or word addresses. Consequently, their addresses have different structures.

5.1.1 Digital Module Addresses

One bit represents a channel of a digital module. You must therefore assign a separate number to each bit. When numbering, note the following:

- The CPU program memory is divided into different address areas (5.4).
- Number individual bytes consecutively in relation to the starting address of each address area.
- Number the eight bits of each byte consecutively (0 to 7).

Figure 5-1 shows the format of a digital address:

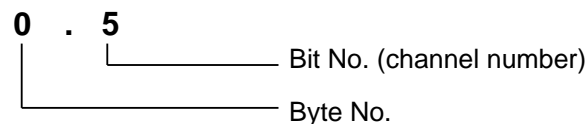


Figure 5-1. Digital Address Structure

5.1.2 Analog Module Addresses

Each channel of an analog module is represented by two bytes (two bytes are equal to one word). An analog channel address is represented by the high-byte number.

5.2 Slot Addressing

Variable addressing is possible since an IM 306 interface module is plugged into each central controller and each expansion unit. For addressing purposes, it does not matter whether the module in question is plugged into a central controller or an expansion unit. Under a hinged cover on the right side of the interface module is an addressing panel. It has a DIP switch for each slot. Use the DIP switch to set the least significant byte number for a particular slot (Figure 5-2).

Note

Input and output modules in different slots can have the same address.

Note

In the case of the 463 analog input module and the CP 523, the initial address is set on the module and not on the IM 306 interface module. The address set for this slot on the IM 306 is not significant.

We recommend that the address set on the module be repeated on the IM 306 for reasons of clarity.

I/O modules that are not safety-related are not duplicated. Each module is assigned to one of the subunits. The address in question may not then be set in the other subunit.

The control program is identical in both subunits. The operating system assigns the "correct" subunit.

If you are operating the central controller without expansion units, you can do without the IM 306 for variable slot addressing. You must then use the terminating connector supplied instead of the IM 306 interface module. This assigns fixed addresses to slots 0 to 5.

Fixed slot addressing

Slot	Initial module address	
	Digital module	Analog module
0	0	128
1	4	160
2	8	192
3	12	224
4	16	-
5	20	-

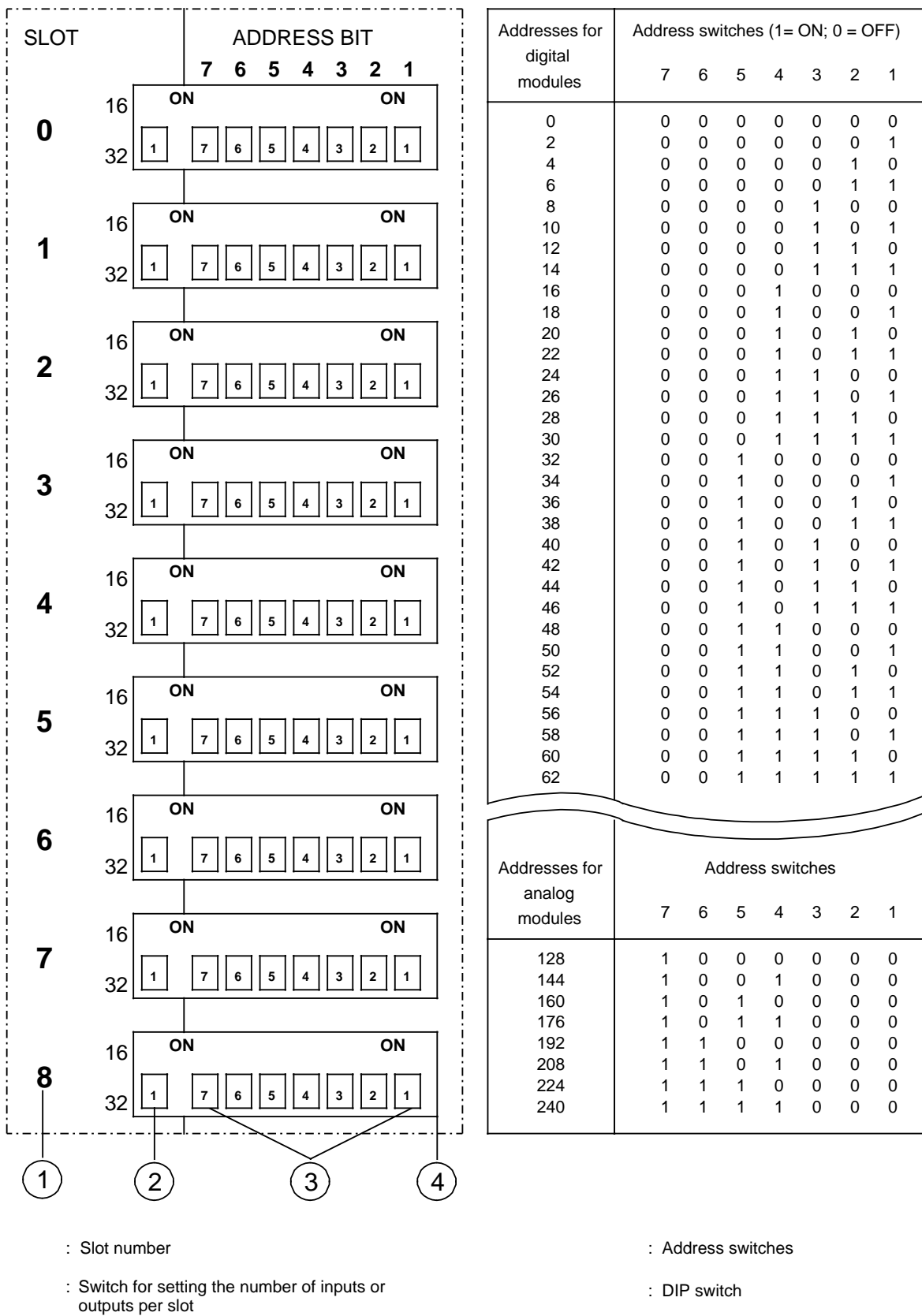


Figure 5-2. Setting Addresses on the Addressing Panel of the IM 306 Interface Module

Setting addresses

Use the left-hand switch (in Figure 5-3) on the addressing panel of the IM 306 to indicate what type of module* you have plugged into the slot. Proceed as follows:

Set the switch to OFF for a 32-bit digital module.

Set the switch to ON for a 16-bit digital module or an 8-channel analog module (16 bytes).

Use the seven address switches (in Figure 5-3) on the addressing panel of the IM 306 to indicate the least significant address (the address for channel "0") for the module in question. This setting establishes the addresses of the other channels in ascending order.

When setting starting addresses, note the following:

- 32-bit digital modules can only have starting addresses whose byte number is divisible by 4 (e.g. 0, 4, 8 etc.).
- 16-bit digital modules can only have starting addresses whose byte number is divisible by 2 (e.g. 0, 2, 4 etc.).
- 16-bit addressing is used for 8-bit digital modules. The even-numbered byte is used and the remaining eight bits are unused.
- The interrupt input module also has eight bits. The following assignment applies:
 - Read even byte (e.g. byte 0): Status byte
 - Read odd byte (e.g. byte 1): Interrupt register byte
 - Write even byte (e.g. byte 0): Interrupt enable byte ("1" =enable)
 - Write odd byte (e.g. byte 1): Interrupt edge byte ("1" = falling)
- 16-channel analog modules can only have the starting addresses 128, 144, 160 to 240.
- The four-channel 463 analog module is addressed without gaps using a switch on the front cover of the module.

Example

Plug a 16-bit digital input module into slot 2.

Assign it starting address 46.0 by performing the following steps:

- Check to see if the byte number of the starting address can be divided by 2 since you are dealing with a 16-bit digital module.
 $46 : 2 = 23$ Remainder 0
- Set the number of input bits (switch in ON position).
- Set the address switches on the DIP switch for slot number 2 as shown in Figure 5-2.

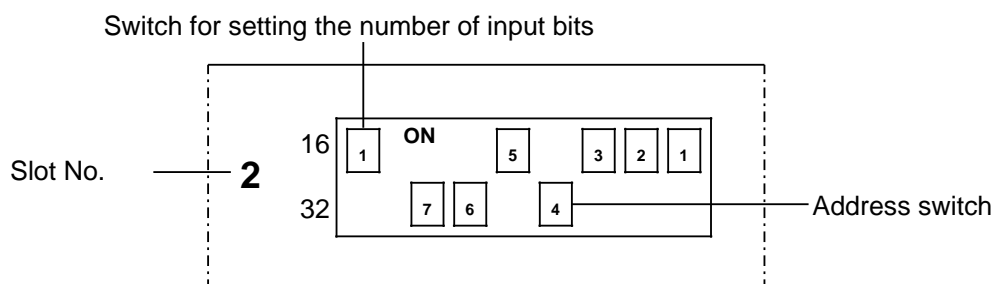


Figure 5-3. Setting a DIP Switch

* The digital input/output modules 482-7LA 11, 482-7LF11, 482-7LF21 and 482-7LF31 are handled like 16-channel modules.

The module is then addressed as follows:

Bit No.	0	1	2 . . .	7	8	9	10 . . .	15
Address	46.0	46.1		46.7	47.0	47.1		47.7

5.3 Handling Process Signals

Input/output module signal states can be read from, or written to, the addresses shown in Figure 5-4.

F000 _H	Digital modules	0
F07F _H		127
F080 _H	Analog modules	128
F0FF _H		255

Absolute addresses

Relative byte addresses

Figure 5-4. Addressing Input and Output Modules

Digital module signal states are also stored in a special memory area called the process image. The process image has two sections, namely the process image of the inputs (PII) and the process image of the outputs (PIQ). Figure 5-5 shows where the process images are in the program memory:

EF00 _H	PII	0
EF7F _H		127
EF80 _H	PIQ	0
EFFF _H		127

Absolute addresses

Relative byte addresses

Figure 5-5. Location of the Process Images

Process signals can be read or output either via the process image or directly.

5.3.1 Accessing the PII

In the "RESTART" mode and at the beginning of program scanning, the digital and analog input module signal states are written into the PII. The input images of subunit A and subunit B are then exchanged and compared. Any differences in input information are subjected to discrepancy analysis to establish whether there is a hardware error in the relevant input module or whether the deviation is tolerable. A standard value is generated from tolerable input value differences. This uniform value allows both subunits to execute identically.

The statements in the control program use a particular address to indicate what information is currently needed. The processor then reads the data that was current at the beginning of program scanning and works with it.

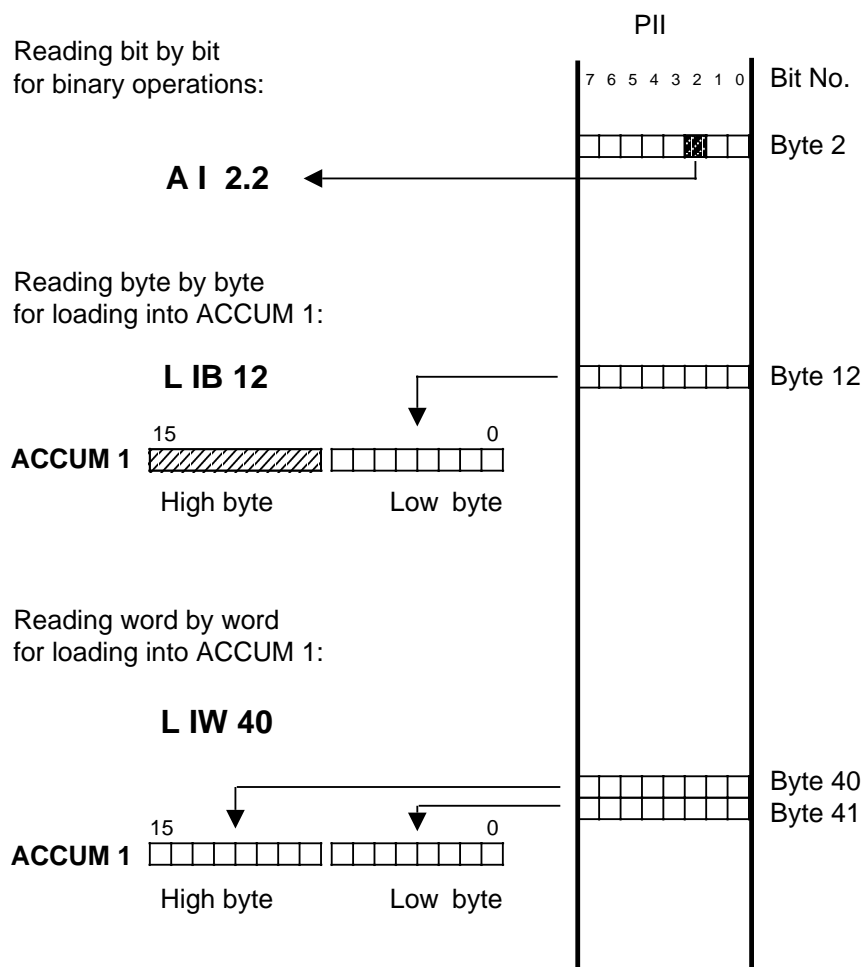


Figure 5-6. Accessing the PII in the Case of Digital Input Modules

5.3.2 Accessing the PIQ

New signal states are entered in the PIQ during program scanning. At the end of each program scan, the PIQs are exchanged between the two subunits, compared, and transferred to the output modules only if they are identical.

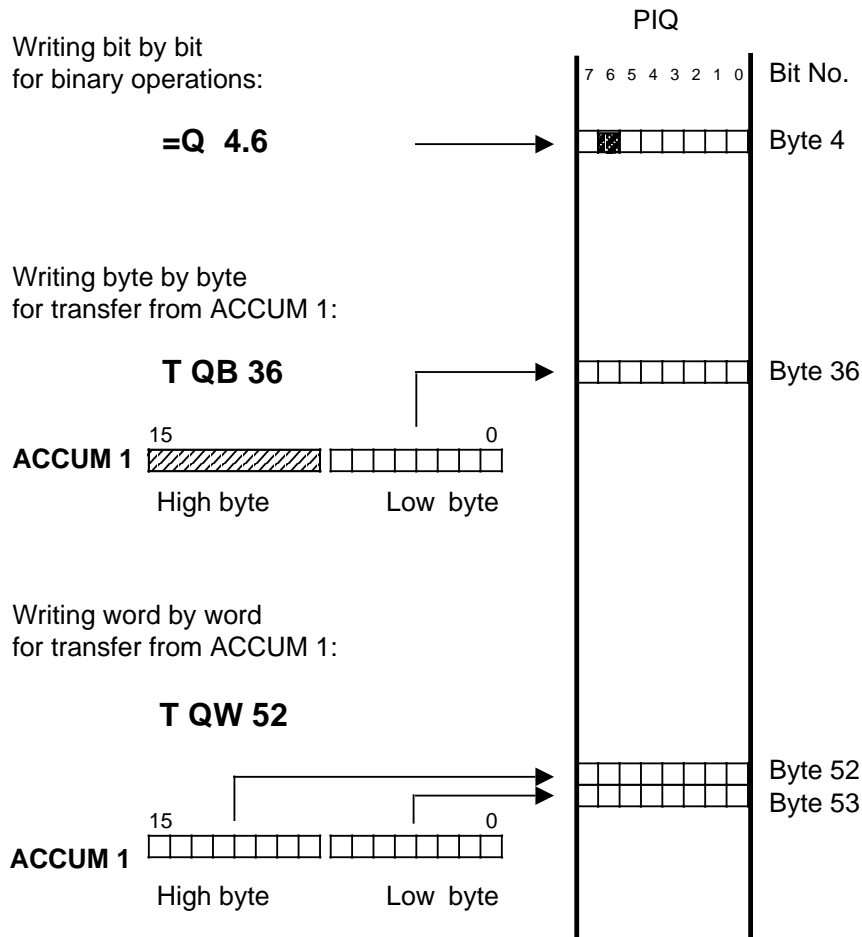


Figure 5-7. Accessing the PIQ

5.3.3 Direct Access

Analog values are read in direct or transferred to the output module by calling the ANEI or ANAU function blocks. All safety functions are performed in these FBs.

You can also exchange information with digital modules direct. This is necessary when signal states have to be processed in the control program immediately. Figure 5-8 shows the differences when loading signal states.

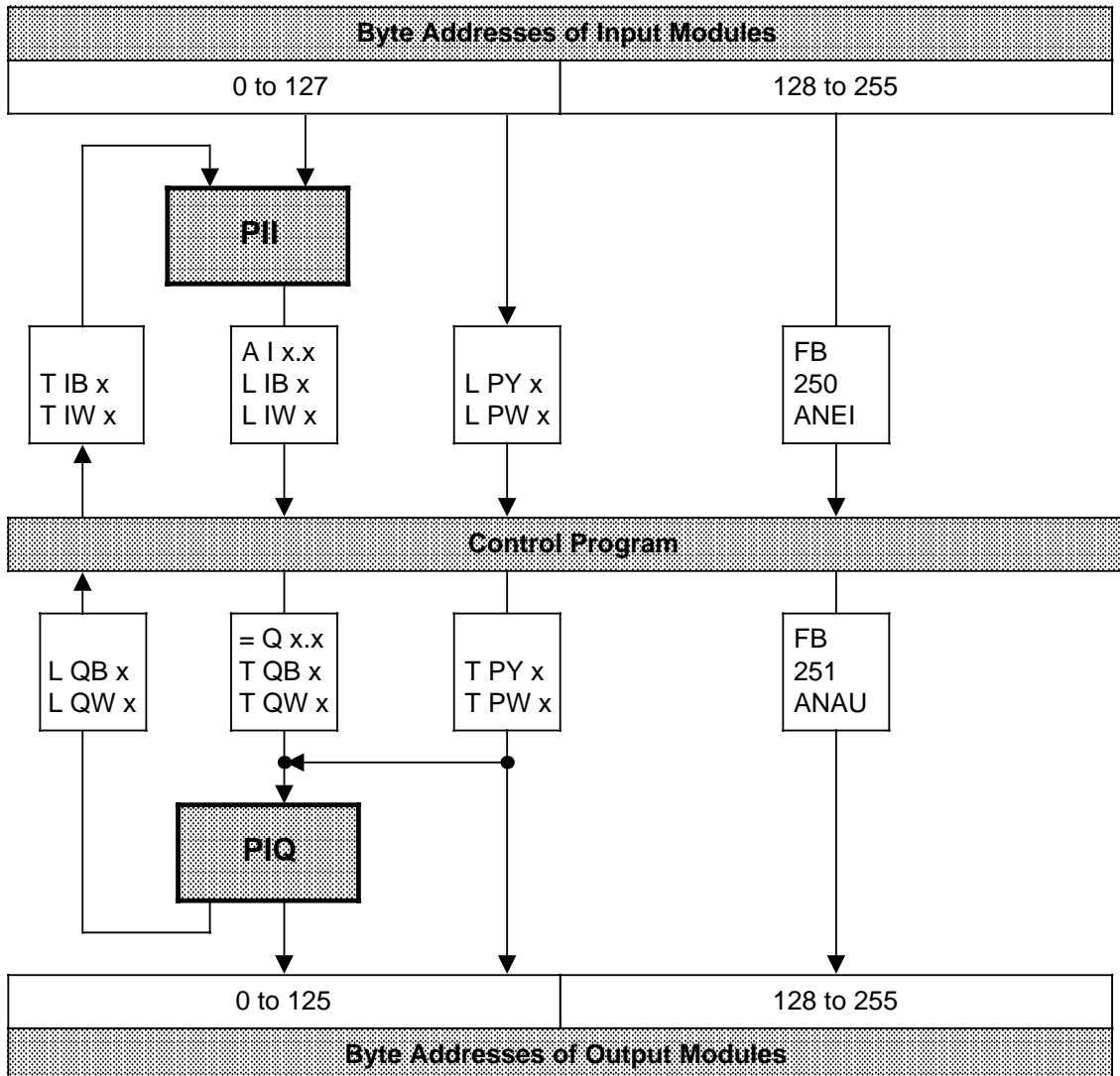


Figure 5-8. Loading Input and Output Values

Note

The PII is not updated in the case of direct read access with the "L PY x", "L PW x" statements.

Table 5-1. Order of Suboperations for Direct Access to Digital Modules

	Read	Write
First	The accumulator is loaded	The I/O byte/word is output
Then		The PIQ byte/word is overwritten with the new I/O byte/word.

Note

If you use direct access to call an address whose slot is unoccupied, the CPU goes into the "STOP" mode with the "QVZ" (time-out) error message.

5.4 CPU Address Assignment

Figure 5-9 shows the CPU RAM map.

Address		Kbytes
0000 _H		0
1000 _H		4
.		.
3000 _H		12
.		.
7000 _H	Memory submodule	28
9000 _H		36
.		.
B000 _H	Internal user memory (5 Kbytes)	44
.		.
.		.
C400 _H	(Internal data)	49
.		.
.		.
DC00 _H	Block address list	55
.		.
.		.
E600 _H	(Internal data)	57.50
.		.
.		.
EA00 _H	System data RS	58.50
.		.
.		.
EC00 _H	Timers T	59
.		.
.		.
ED00 _H	Counters C	59.25
.		.
.		.
EE00 _H	Flags F	59.50
.		.
.		.
EF00 _H	Process I/O image	59.75
.		.
.		.
F000 _H	I/O area and internal registers	60
.		.
.		.
FFFF _H		64

CPU 942 F

* ST = Statements = Code words (2 bytes each)

Figure 5-9. CPU Memory Map

The input/output area is divided as shown in Figure 5-10:

Address		Kbytes
F00 _H	I/O modules P	60
F100 _H		60.25
F200 _H		60.50
F300 _H		60.75
F400 _H	Page frames (parallel interface)	61
F800 _H		62
FF00 _H	(Internal registers)	63.75
FFFF _H		64

Figure 5-10. Address Assignment in the I/O Area

5.5 Process Interrupt Generation with the 6ES5 434-7LA12 Digital Input Module

Interrupt generation can be programmed on the 6ES5 434-7LA12 input module. In the S5-115F there are only two-channel, i.e. safety-related, interrupt inputs. There is a limit of one module per subunit. This module must be plugged into the central controller.

5.5.1 Functional Description

Process interrupts trigger two different responses in the interrupt module:

- They change register contents
 - The interrupt register stores configured edge changes with a "1" (LPY with module address + 1)
 - The status register flags the current signal status (LPB with module address). Register contents are not transferred cyclically to the PII. They can only be read in by direct access. The interrupt register is automatically deleted when read.
- An LED lights up on the module and a relay picks up. This indication is also retained even after power failure, and can only be reset by pressing the 24 V Reset input.

5.5.2 Initialization

The CPU 942-7UF12 operating system automatically programs the interrupt DI bits used in the screen form for negative-going edge.

However, the user can change the parameters in the restart OBs (OB 21, OB 22). The operating system monitors that none of the enabled interrupt DI bits is assigned a positive-going edge during edge initialization. This ensures that a sensor in the process of losing voltage can initiate the safety function.

The following must be programmed in the OB 21 and OB 22 restart blocks

- Those inputs which are to trigger an interrupt
- Whether the interrupt is to be triggered by a rising or falling edge (in the case of the safety-related S5-115F, interrupts can only be triggered by a falling edge).

This information is defined in two bytes, which are transferred to the module by the program in OB 21 or OB 22.

Programming the restart blocks

STL			Meaning
L	KM	a b	Load a two-byte bit pattern into ACCUM 1.
T	PW	x	Transfer the information from ACCUM 1 to the module (x=initial module address)

The bits in the high-order byte¹ (byte a in this example), which have been loaded into ACCUM 1 with the "L KM a b" statement, correspond to the bit addresses of the eight input channels. If a bit is set to "1", the interrupt is enabled for this channel.

The bits in the low-order byte¹ indicate whether the interrupt on this channel is triggered by a rising edge ("0") or by a falling edge ("1").

Note

- In the case of the S5-115F, interrupts may only be configured with falling edge. All interrupts used must be enabled.
- Initialization may only be implemented in OBs 21 and 22.
- The interrupt register must be scanned in OB 2.

5.5.3 Access**Status processing**

Unlike the interrupt register, a status scan may also be programmed in OB 1.

The signal states should be loaded into the PII before further processing as the status byte is not written cyclically to the PII.

OB 1:

STL			Meaning
L	PY	x	Load I/O byte "x".
T	IB	x	Transfer loaded I/O byte to the PII (x=Initial module address)
A	I	x.y	Evaluate inputs (y=Bit address).

¹ The high-order byte is the even byte (e.g. 2) and the low-order byte the odd byte (e.g. 3)

Interrupt processing

There must be a precise response to an interrupt in OB 2 once the interrupt has been enabled. This block is called by the module with the PRAL-N¹ signal (process interrupt). This signal is produced as follows:

The interrupt flag is "1" if an interrupt is present, irrespective of the type of pulse edge generating the interrupt.

Every interrupt request is stored until the interrupt is serviced. The module reports the request via the internal bus system of the CPU (PRAL-N signal).

This produces the following chronological sequence:

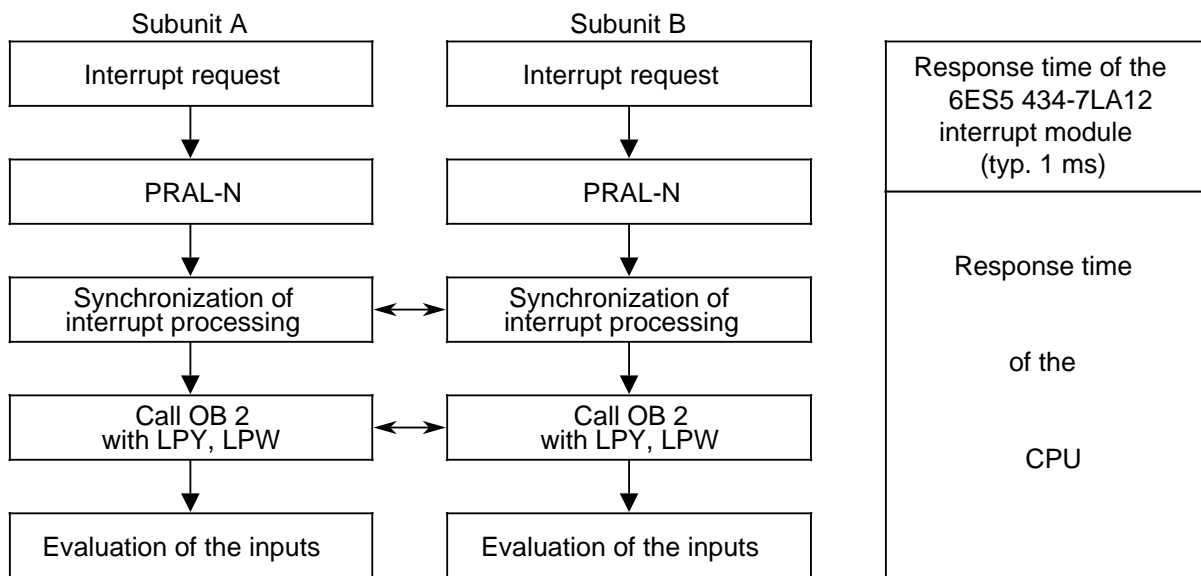


Figure 5-11. Chronological Sequence of Interrupt Processing

Every input enabled for the interrupt must be scanned in OB 2. The address of the inputs is obtained by incrementing the initial module address by one.

Example: Scanning inputs 0 and 1 of the module with the initial address 8 for an interrupt.

STL			Meaning
L	PY	9	Interrupt register is read.
T	IB	9	The information is transferred to the PII.
A	I	9.0	Scan input 0.
JC	PY	1	Process interrupt 0 in PB 1.
A	I	9.1	Scan input 1.
JC	PY	2	Process interrupt 1 in PB 2.
BE			

¹ Negation of the PRAL signal

5.5.4 Programming Example

The digital module with process interrupt generation has the initial module address "8".

Input 0 is an interrupt input that responds to a falling* pulse edge. FB 12, in which output byte 13 is overwritten with FF_H, is called by an interrupt request at this input.

Input 1 is an interrupt input that responds to a falling* pulse edge. FB 13, in which output byte 13 is overwritten with FF_H, is called by an interrupt request.

OB 21 and 22:

STL			Meaning
L	KH**	0303	Initializing interrupt input enable and edge generation
T	PW	8	
BE			

OB 2:

STL			Meaning
L	PY	9	Evaluating the interrupt request Reading the interrupt byte Updating the PII
T	IB	9	
A	I	9.0	
JC	FB	12	
A	I	9.1	
JC	FB	13	
BE			

FB 12:

STL			Meaning
Name:	Case A		Loading QB 13
L	KH	00FF	
T	QB	13	
BE			

FB 13:

STL			Meaning
Name:	Case B		Loading QB 14
L	KH	00FF	
T	QB	14	
BE			

* In safety-related programs, interrupt inputs must be initialized with a falling edge only.

** This value can be entered as bit pattern KM 00000011 00000010 in the case of larger programmers.

6 Analog Value Processing

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6 Analog Value Processing

Analog input modules convert analog process signals to digital values that the CPU can process. Analog output modules perform the opposite function. This chapter explains the relationship between the two conversion types.

6.1 Analog Input Modules

The analog measured value is digitized and stored in a data memory in the module. You can transfer it to the CPU where it can be processed further.

Signal exchange between module and CPU

The CPU reads the digitized value from the module memory with the FB 250 ANEI. The total measured value (2 bytes) is stored in the CPU. The measured value contains additional condition code bits as well as the coded analog value.

460 and 463 analog input modules

There are two analog input modules available with the following characteristics:

6ES5 460-7LA12

- Floating
- Eight channels
- 2 range cards
- 60 V AC / 75 V DC maximum permissible isolation voltage between each channel and M as well as between the channels
- Not permissible for safety-related use

6ES5 463-4U...

- Floating
- Four channels
- Measuring range set via plug-in jumpers
- 30 V AC / 75 V DC maximum permissible isolation voltage between each channel and M as well as between the channels
- Permissible for safety-related use.

6.2 460-7LA12 Analog Input Module

6.2.1 Connecting Sensors to the 460 Analog Input Module

Pin assignment on the front connector

a	b
1	L+=24V
2	
3	M0+
4	
5	M0 -
6	
7	M1+
8	
9	M1 -
10	
11	S+
12	
13	
14	
15	M2+
16	
17	M2 -
18	
19	M3+
20	
21	M3 -
22	
23	KOMP+
24	
25	KOMP -
26	△
27	M4+
28	
29	M4 -
30	
31	M5+
32	
33	M5 -
34	
35	S -
36	
37	
38	
39	M6+
40	
41	M6 -
42	
43	M7+
44	
45	M7 -
46	
47	L -

460-7LA12

a = Pin No.
b = Assignment

Figure 6-1. Pin Assignments of the 460 Analog Input Module

Depending on the design of the current or voltage sensor, you must observe different conditions when connecting analog input modules.



Important

Unused inputs must be terminated with a voltage divider or shunt (Table 6-1).

In the case of the 498-1AA11 module, the unused inputs must be short-circuited (M+ and M- in each case).

Other modules require no additional circuits.

The galvanic isolation between analog inputs and L+ or L- is revoked when using the 498-7LA51 module for a 2-wire transducer!

Connecting sensors

Certain precautions must be taken so that the permissible potential difference V_{CM} is not exceeded. These precautions differ for floating and nonfloating sensors.

For floating sensors, the measuring circuit can accept a potential to ground that exceeds the permissible potential difference V_{CM} (see maximum values of the individual modules).

Prevent this by connecting the negative potential of the sensor to the reference voltage of the module (reference bus).

Example: Temperature is measured on a busbar with an isolated thermocouple.

Under worst case conditions, the measuring circuit can accept a potential that would destroy the module. Prevent this with an equipotential bonding conductor (Figure 6-2).

Possible causes:

- Static charge
- Transfer resistances through which the measuring circuit assumes the potential of the busbar (e.g. 230 V AC)

For nonfloating sensors, the permissible potential difference V_{CM} between the inputs and the reference bus must not be exceeded.

Example: Measuring the temperature of the busbar of a galvanic bath with a nonisolated thermocouple. The potential of the busbar compared with the reference potential of the module is 24 V DC (max.). A 460 analog module with floating input is used (permissible V_{CM} 60 V AC / 75 V DC).

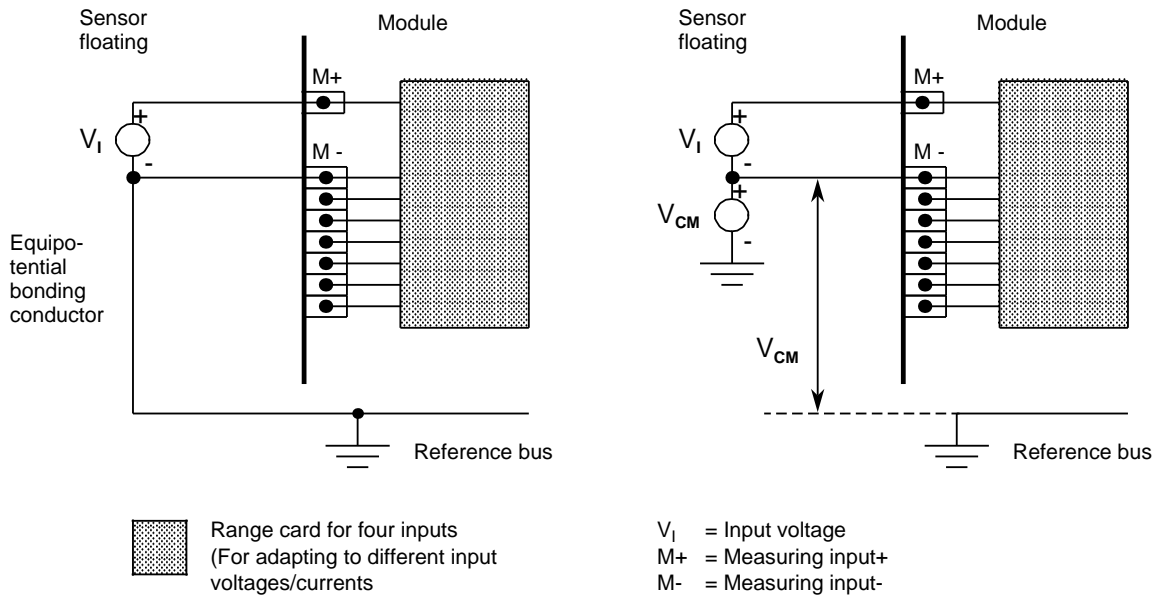


Figure 6-2. Connecting Sensors to the 460 Analog Input Module

Connecting thermocouples with compensating box

The influence of temperature on a reference junction (e.g. in a terminal box) can be offset with a compensating box. To do this, bring the compensating box into thermal contact with the terminals. For the analog input modules, a group signal line is brought out to pins 23 and 25 as input for the compensation voltage. Use the function selection switch to set the module for compensating box operation. When connecting the compensating box, please note the following:

- The box must have a floating supply.
- The power supply for the compensating box must have a grounded shielding winding.

Each module must have its own compensating box with its own power supply unit.

Note

If you connect a measuring point with compensating box to a reference junction, you can use the measured input voltage to correct other measuring points through software.

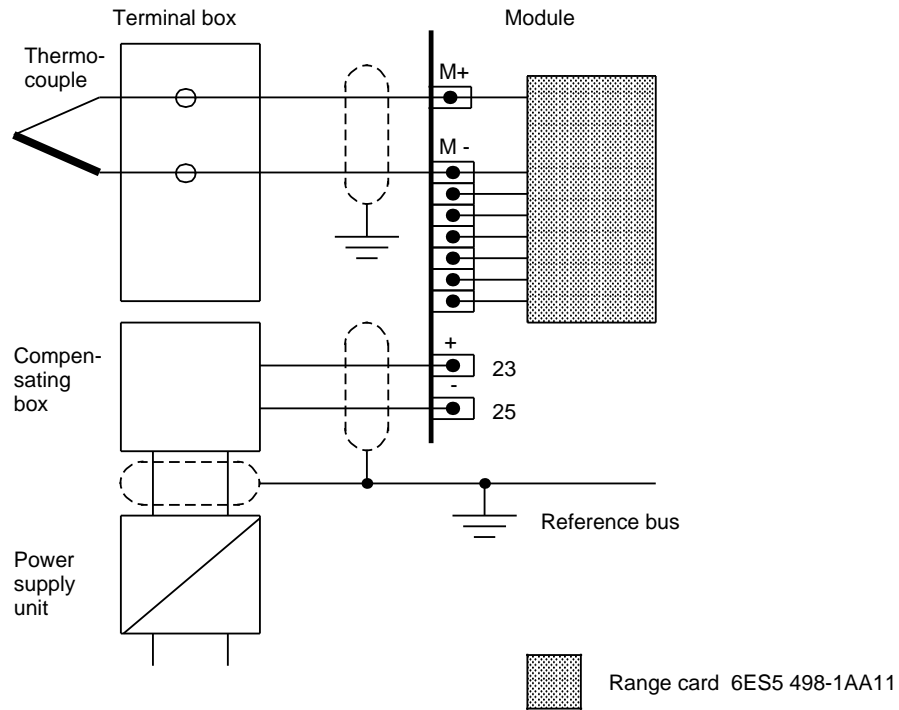


Figure 6-3. Connecting Thermocouples to the 460 Analog Input Module

Consult Catalog MP 11 for information on thermocouples and compensating boxes.

Connecting resistance thermometers (e.g. PT 100)

In the case of 6ES5 460-7LA11 and 6ES5 460 -7LA12:

A constant-current generator supplies series-connected resistance thermometers (maximum 8 x PT 100) with a current of 2.5 mA via pins "S+" and "S-".

If no PT 100 is connected to input channels 4 to 7, other voltages and currents can be measured at these channels with the range cards 498 1AA21, -1AA31, -1AA41, -1AA51, -1AA61 or -1AA71 (Figure 6-4, card 2).

You need not connect short-circuit jumpers to the unused channels if you are using range cards 498-1AA41, -1AA51 or -1AA71. If you are using other range cards, you must connect short-circuit jumpers to the unused input channels (Figure 6-4, channels 5 and 6).

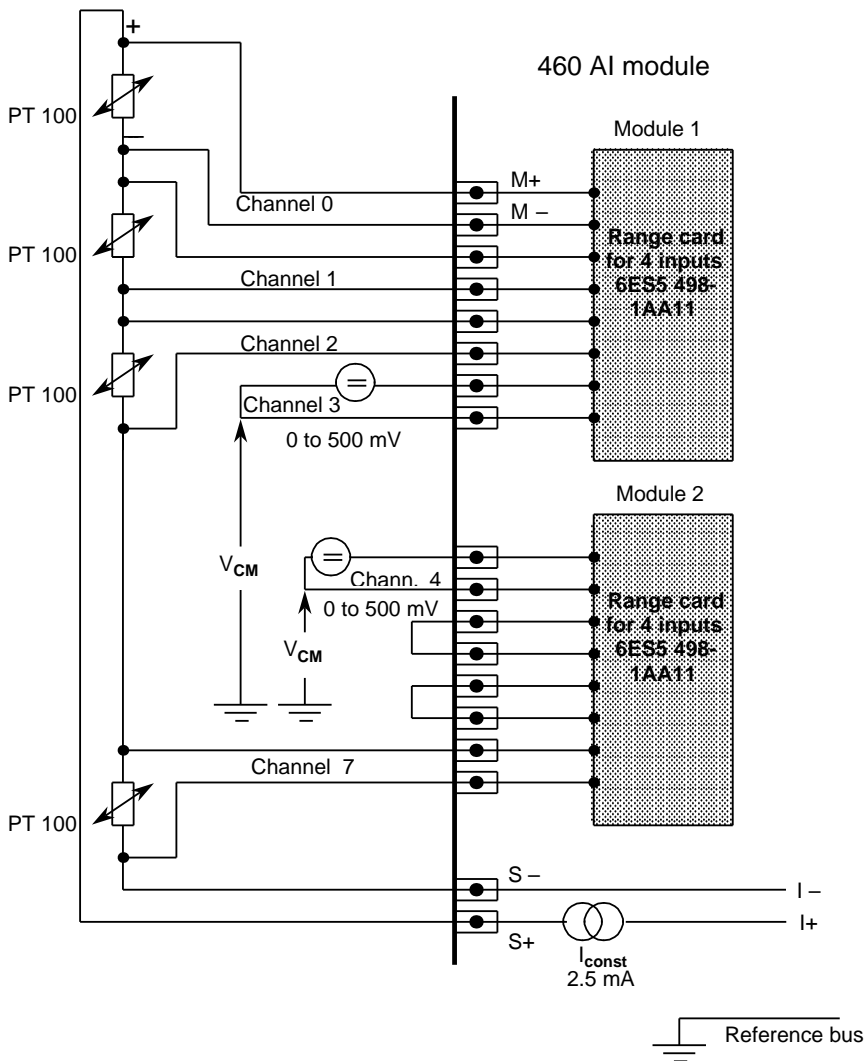
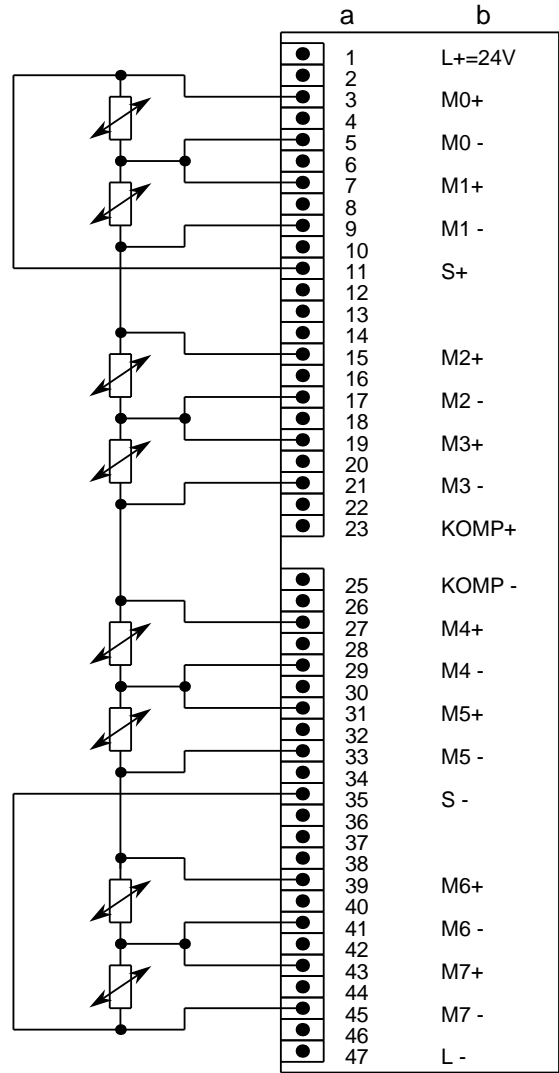


Figure 6-4. Connecting Resistance Thermometers to the 460 Analog Input Module

Front connector terminal assignment

Figure 6-5 shows the input module terminal assignment for resistance thermometers in the case of the 460 analog input module.



460-7LA12

a=Pin No.
b=Assignment

Figure 6-5. Analog Input Module Terminal Assignment in the Case of the 460 Analog Input Module

Connecting transducers

In the case of two-wire transducers, the supply voltage is fed via the range card of the analog input module and is inherently short-circuit-proof.

Four-wire transducers have a separate supply voltage.

Figure 6-6 shows how to connect transducers.

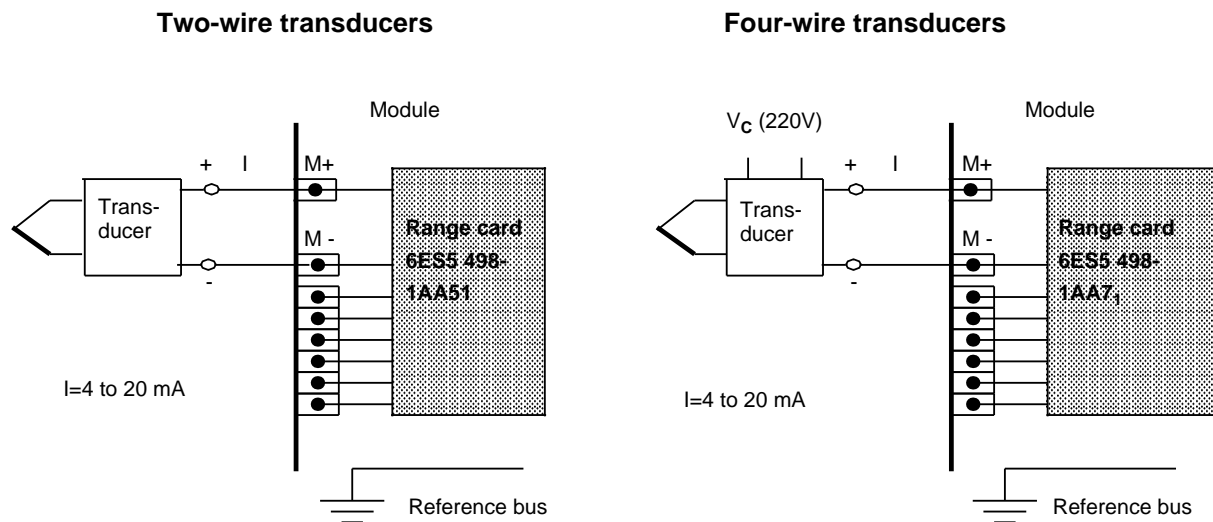


Figure 6-6. Connecting Transducers

6.2.2 Startup of the 460 Analog Input Module

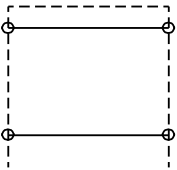
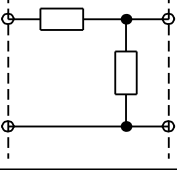
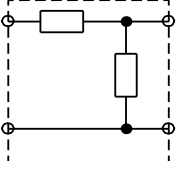
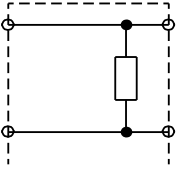
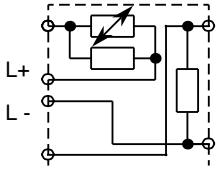
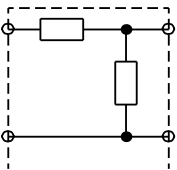
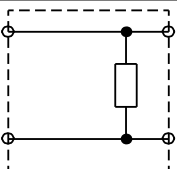
You can set different measuring ranges on the module. For this purpose, voltage dividers or shunts must be plugged into the input module in the form of cards (Table 6-1). They adapt the process signals to the input level of the module.

Plugging in range cards

Two range cards can be plugged into the 460 analog input module. One card defines the measuring range of four inputs.

We offer voltage dividers, shunts and through connection cards for different measuring ranges (Table 6-1).

Table 6-1. Range Card Description

Range Card 6ES5 498-	Module Circuit Diagram (4 inputs each)	Function 500 mV/mA/PT100	Function 50 mV
- 1AA11 (enables detection of hardware wire break)		$\pm 500\text{mV};$ PT 100	$\pm 50\text{ mV}$
- 1AA21		$\pm 1\text{ V}$	$\pm 100\text{ mV}^*$
- 1AA31		$\pm 10\text{ V}$	$\pm 1\text{ V}^*$
- 1AA41		$\pm 20\text{ mA}$	$\pm 2\text{ mA}^*$
- 1AA51		+ 4 to + 20 mA 2-wire transducer	
- 1AA61		$\pm 5\text{ V}$	$\pm 500\text{ mV}^*$
- 1AA71		+ 4 to + 20 mA 4-wire transducer	

* Possible combination in the case of the "50 mV" setting but with greater error.

Note

Unused inputs must be terminated with a voltage divider or shunt card. For through-connection cards 6ES5 498-1AA11, insert jumpers in the front connector.

Various measuring ranges can be set for the 460 analog input module using range cards. You can set various functions for analog input modules by putting the function selector on the back of the module to the position desired (Table 6-2).

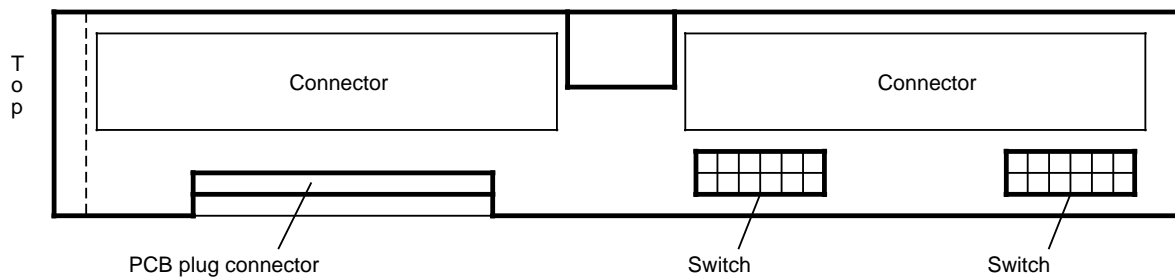


Figure 6-7. Position of the Function Selector Switches of the 460-7LA12 Analog Input Module (Back of the Module)

Note

When selecting functions, set all switches.

Table 6-2. Function Settings on the 6ES5 460-7LA11 Module

Function	Switch	Setting	Switch	Setting
Reference junction compensation			yes 	no
Measuring range* (nominal value)			50 mV 	500 mV
Analog value representation			Two's complement 	Value and sign
Sampling	Cyclic 	Selective 		
Line frequency	50 Hz 	60 Hz 		
Wire break indication	Channels 1 to 3 	Channels 4 to 7 		
No wire break indication	Channels 0 to 3 	Channels 4 to 7 		

* Setting for PT 100: measuring range 500 mV

6.3 463-4U... Analog Input Module

When the AE 463 is used in a central configured ER 701-3 with IM 306 please notice:

- the 705 connecting cable must not longer than 0.5 m
- it is not allowed to use the AE 463 in the third expansion unit (EU)

6.3.1 Connecting Sensors to the 463 Analog Input Module

Connecting sensors

Sensors are connected to the analog input module by shielded cables with a max. length of 200 m (650 ft.). If the cables are run separately from power cables, distances of up to 500 m (1650 ft.) are possible.

Voltage sensors, current sensors, two-wire and four-wire transducers can be connected in any combination. There are four short-circuit proof terminals on the front connector for two-wire transducers.



Important

When two-wire transducers are used, the common input of these channels must be connected to L-. This cancels the galvanic isolation between the channels and the supply voltage L+/L-. (10.11.2)

It must be noted that the module is enabled via the enable lines F+ and F- on the front connector with a 24 V DC signal.

Installing the front connector

You must execute the following steps to install the front connector on the analog input module:

1. Unscrew the connector cover.
2. Hook the front connector into the pivot at the bottom of the module.
3. Swing the front connector up and in until it engages with the module.
4. Tighten the screw at the top of the front connector to secure it.
5. Screw on the connector cover.

Front connector terminal assignment

Figure 6-8 shows the terminal assignment for the 463 analog input module.

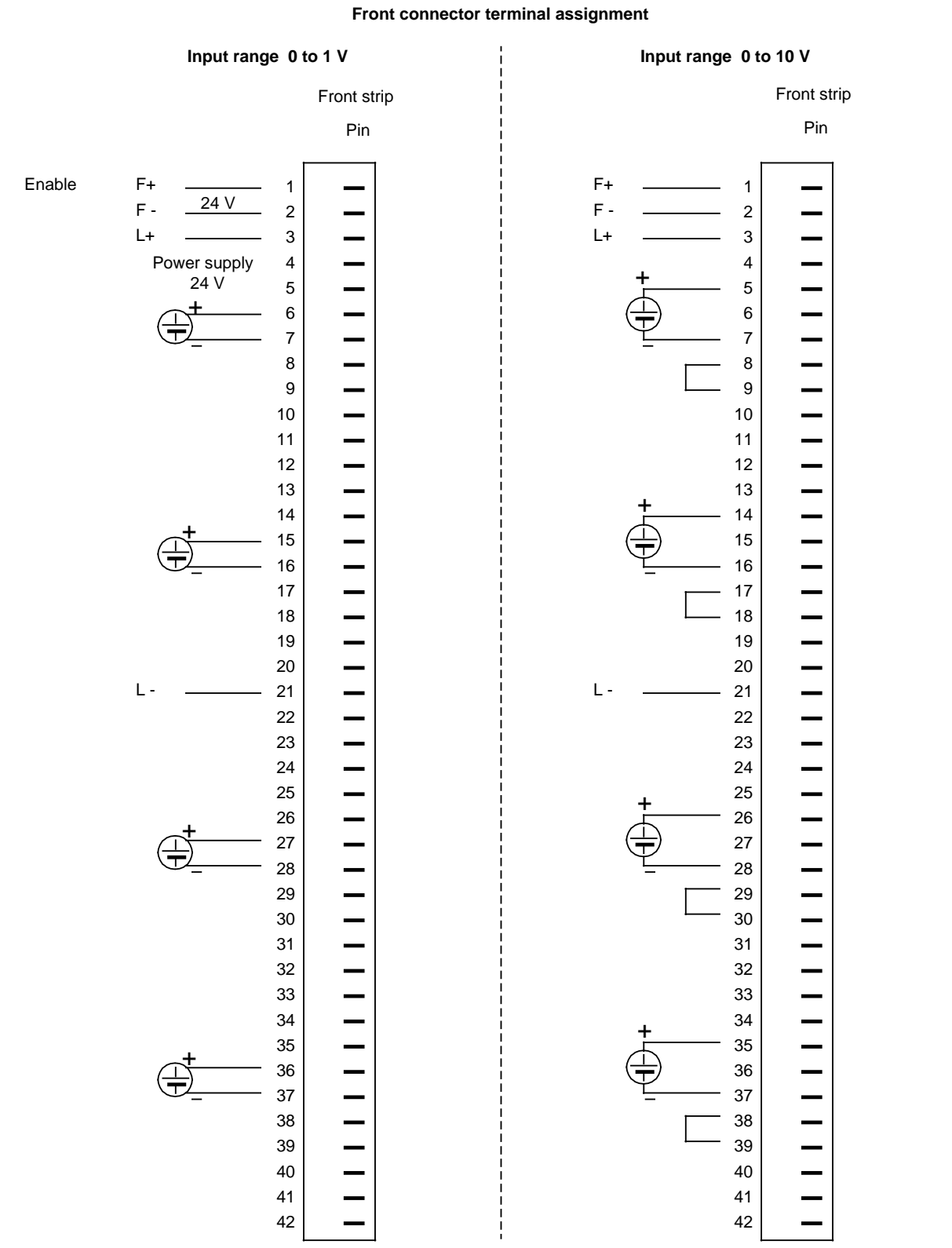


Figure 6-8. Front Connector Terminal Assignment for the 463 Analog Input Module

Front connector terminal assignment

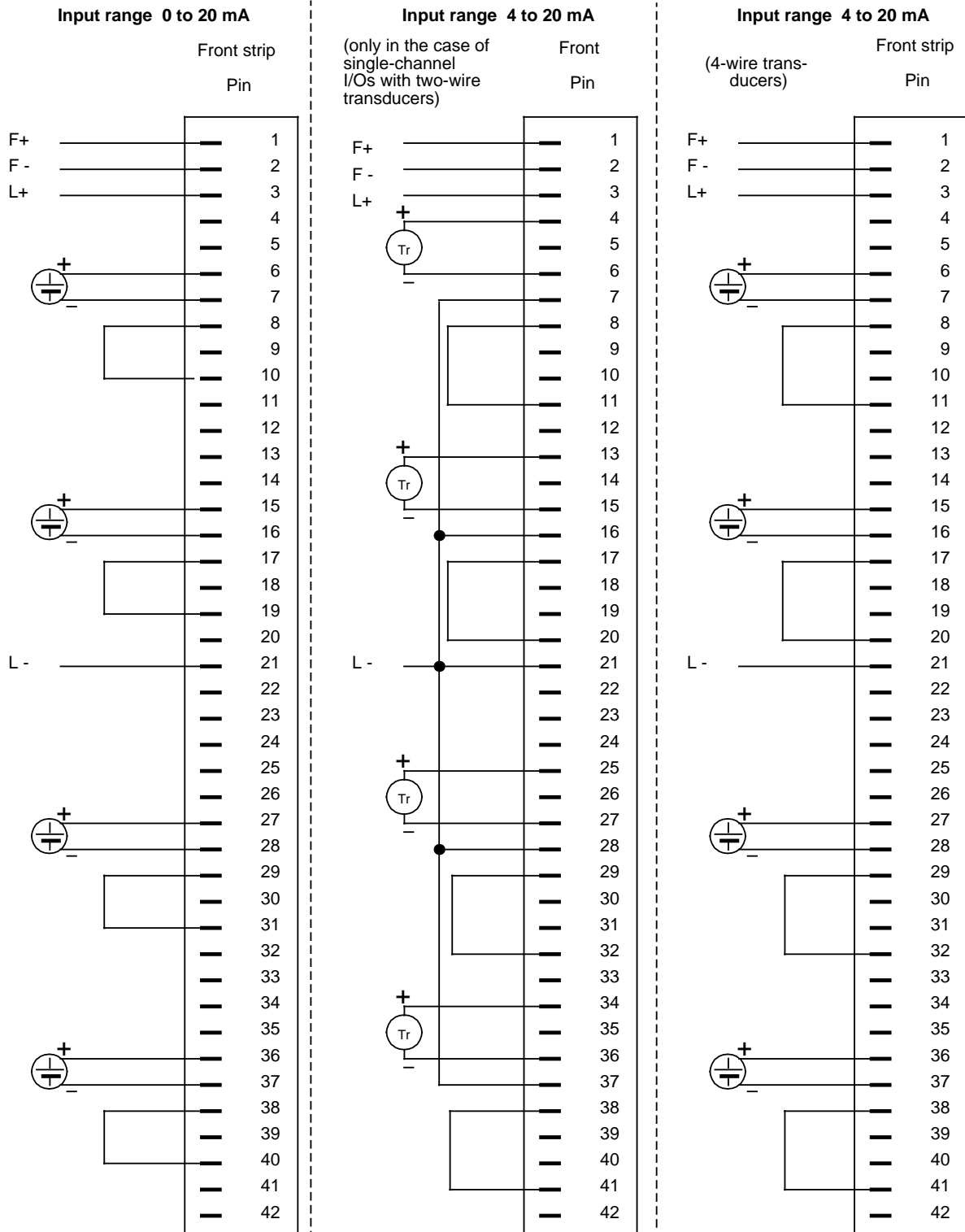


Figure 6-8. Front Connector Terminal Assignment for the 463 Analog Input Module (cont.)

6.3.2 463 Analog Input Module

The various measuring ranges of the 463 analog input module are defined with jumpers.

Setting the data format for the 4 to 20 mA range

When using the 4 to 20 mA inputs, press the relevant switch to select between a resolution of 0 to 1023 units or 256 to 1279 units. Different data formats can be selected for all four input channels.

The relevant switches remain at the off position when using the following inputs

- 0 to 1 V
- 0 to 10 V
- 0 to 20 mA.

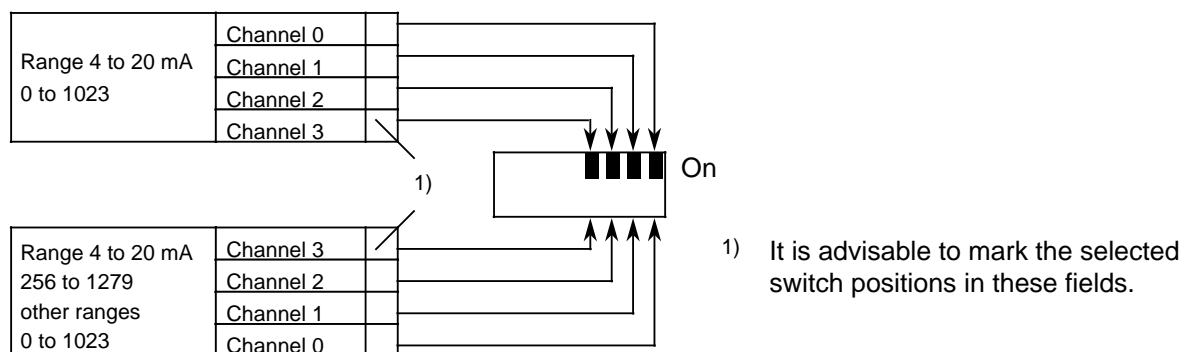


Figure 6-9. Labelling of the Switches on the 463 Module

Address setting

The 463 analog input module has four galvanically isolated input channels. The analog input signals are coded using voltage/frequency converters (V/F) with an integration time of 20 msec.

The sequencer control coordinates the setting of the counters, the duration of the integration time and the transfer of the counter results of the four input channels to the four measured value memories.

The measuring range of each channel is adapted by the relevant sensor connection and by jumpers in the front connector of the module.

The four 16 bit (2 bytes) wide measured value memories can be scanned one after the other by the STEP 5 program using word operations. The 463 analog input module requires eight bytes of address space.

The results of the measurements made on the various channels are stored under the addresses ADB 0 to 2 (Table 6-3).

The module address is set on a switch in the module cover.
The setting on the IM 306 is not significant for this slot.
However, for the sake of clarity, set the same address here.

Table 6-3. Memory Addresses on the 463 Analog Input Module

Module Address	Switch Position	Module Address	Switch Position																												
128	<table border="1"> <tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>OFF</td></tr> <tr><td>■</td><td>■</td><td>■</td><td>■</td><td>■</td><td>■</td><td>ON</td></tr> </table>	7	6	5	4	3	2	OFF	■	■	■	■	■	■	ON	192	<table border="1"> <tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>OFF</td></tr> <tr><td>■</td><td>■</td><td>■</td><td>■</td><td>■</td><td>■</td><td>ON</td></tr> </table>	7	6	5	4	3	2	OFF	■	■	■	■	■	■	ON
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■	■	■	■	■	■	ON																									
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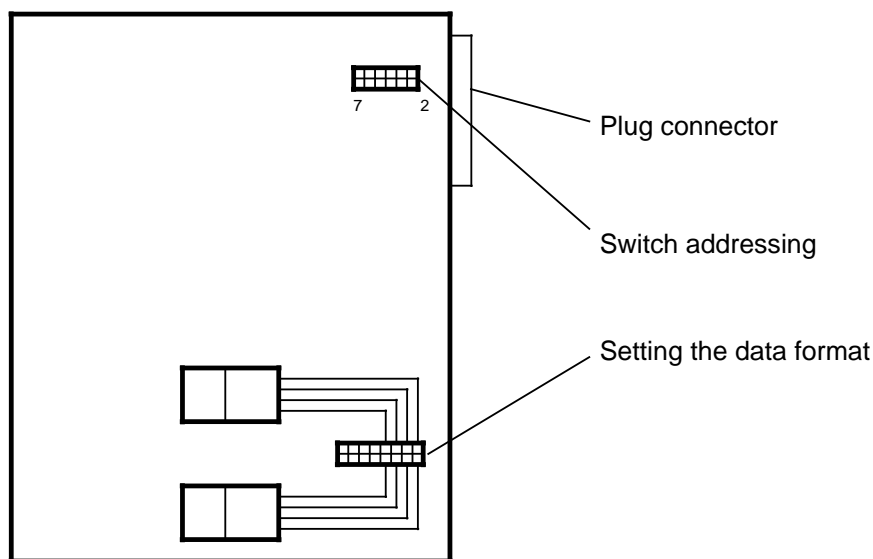


Figure 6-10. Position of the Switches on the 463 Analog Input Module

6.4 Representation of the Digital Input Value

6.4.1 Digital Representation of a Measured Value (460 Analog Input Module)

Note
 The 460 analog module cannot be used in safety-related systems.

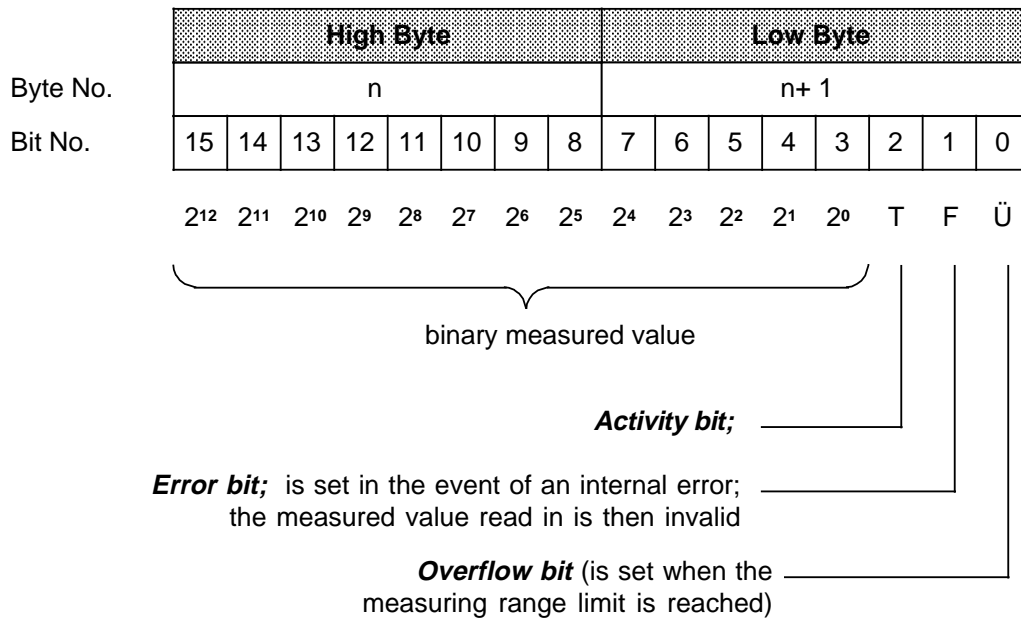


Figure 6-11. Representation of the Digitized Measured Value in the Case of the 460 Analog Input Module

Bits 0 to 2 are insignificant for the measured value. They provide information on the measured value representation. Table 6-4 describes these bits.

Table 6-4. Meaning of Bits 0 to 2 in the Case of the 460 Analog Input Module

Bit	Meaning	Signal State	Meaning of the Signal State
OV	Overflow bit	1	Range exceeded*
F	Error bit	1	Wire break
A	Activity bit	0	Cyclic scan or "Not active" (for selective sampling)
		1	Coding procedure not yet terminated in selective sampling operation

* In the case of overflow at one measuring point, the overflow bits of the other channels remain unaffected; i.e. the values of the other channels are correct and can be evaluated.

The measured value is represented in different number formats. You can define the number format via selector switches.

Table 6-5. 460 AI Module: Digital Representation of Analog Values as a Positive Binary Number (4 to 20 mA), Channel Type 3

Input Current in mA	Units	Input Voltage in mV	Digitized Measured Value											A F OV			Range			
			15	14	13	12	11	10	9	8	7	6	5	4	3	2		1	0	
32.796	4096+OV	1024	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	Overflow
31.992	4095	1023.76	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	Over-range*
24.0	3072	750.0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0		
23.992	3071	749.76	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0		
20.008	2561	625.24	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1		
20.0	2560	625.0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	Nominal range	
16.0	2048	500.0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
4.0	512	125.0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0		
3.992	511	124.76	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	Below nominal range limit	
3.0	384	93.75	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0		
2.992	383	93.5	0	0	0	0	1	0	1	1	1	1	1	1	1	1	0	0	Wire-break	
0.0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

* Short circuit of the two-wire transducer

Explanation of Table 6-5

- Representation: Positive binary number
- Overrange condition at values above the upper nominal value but under double the nominal span (16 mA); no overflow bit set!
- Lower range limit exceeded at values >0 and below the lower nominal value; no overflow bit set!
- Overflow in the case of values exceeding double the nominal span (from 16 mA upwards); overflow bit (OV) set
- Configuration aids
Set the measuring range of the module to 500 mV and plug in the 6ES5 498-1AA71 card.
The measuring range 4 to 20 mA is divided into 2048 units in the interval 512 to 2560 units. For representation in the range 0 to 2048, 512 units must be subtracted per software
- configure channel type 3 with COM 115F
- FB 250 detects wirebreak (6.5).
When the lower limit of 384 units is exceeded, FB 250 ANEI sets error bit F (6.9).
- The 460 AI module can only be used with I/O type 13 (nonsafety-related).

Note

The 31.25-ohm shunt resistor integrated on the 498-1AA71 card prevents the wirebreak signal (F bit is not set). You can therefore only detect a wirebreak by scanning the measured value in the user program for a lower limit. You would then interpret a measured value of less than e.g. 1 mA (=128 units) as a wirebreak.

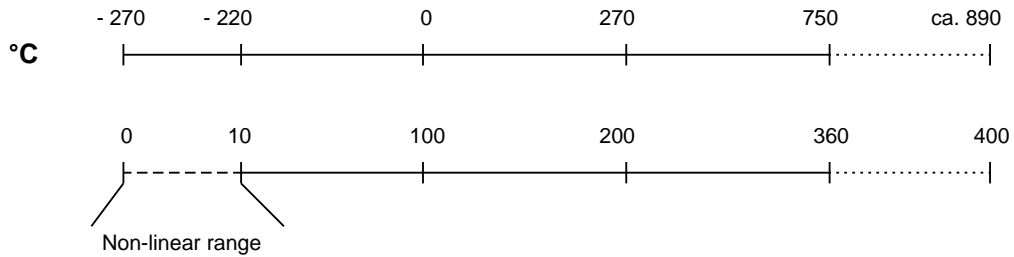
Table 6-6. 460 AI Module: Digital Representation of Analog Values for Resistance-Type Sensors, Channel Type 4

Input Resistance in Ohms	Units	Digitized Measured Value											OV F A			Range			
		15	14	13	12	11	10	9	8	7	6	5	4	3	2		1	0	
400.0	4095	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0/1	0	1	Overflow
399.90	4095	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0/1	0	0	Over-range
200.098	2049	0	1	0	0	0	0	0	0	0	0	0	0	1	0/1	0	0		
200.00	2048	0	1	0	0	0	0	0	0	0	0	0	0	0	0/1	0	0	Nominal range	
199.90	2047	0	0	1	1	1	1	1	1	1	1	1	1	0/1	0	0			
100.0	1024	0	0	1	0	0	0	0	0	0	0	0	0	0/1	0	0			
99.90	1023	0	0	0	1	1	1	1	1	1	1	1	1	0/1	0	0			
0.098	1	0	0	0	0	0	0	0	0	0	0	0	1	0/1	0	0			
0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0/1	0	0			

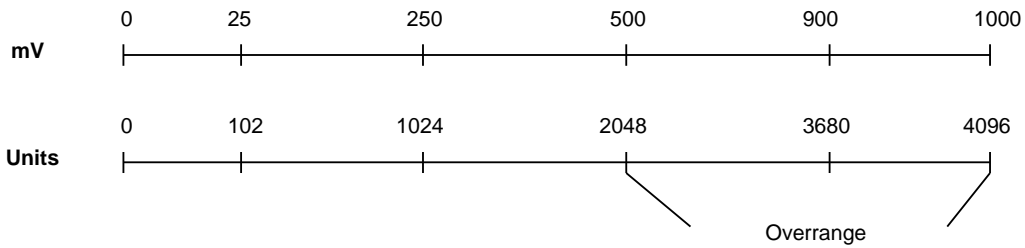
Explanation of Table 6-6

- Representation: Positive binary number (unipolar)
- Resolution of the PT 100 is approximately 1/3° C. 10 units correspond approx. to 1 ohm.
- Overrange condition at values exceeding the nominal range; no overflow bit set
- Overflow at values exceeding the overrange; overflow bit (OV) set
- Configuration aids
 - Plug in the 6ES5 498-1AA11 range card (for 4 channels)
 - Set the jumper switch on the 460 module (6.2.2)
 - Configure channel type 4 with COM 115F
- Wire break is recognized by the hardware (method , 6.5) and causes error bit F to be set. This bit is read by FB 250, which then sets error bit F. This sets the FB error bit of FB 250 (6.9).
- The 460 AI module can only be used with I/O type 13 (nonsafety-related).

Resolution of the PT 100 is approximately 1/3 °C. 10 units correspond approx. to 1 ohm. You can use the assignments in Figure 6-12 for PT 100 resistance-type sensor. The input values are not linearized by the modules. You can only linearize the input values via a relevant software solution.



$U = R \cdot I = R \cdot 2.5 \text{ mA (constant current)}$



Resolution: 10 units = 1
 270 °C : 1024 units = 0.3 °C / unit

Figure 6-12. PT 100 Connected to SIMATIC Analog Input Modules

Table 6-7. 460 AI Module: Digital Representation of Analog Values as Signed Absolute Value (± 50 mV), Channel Type 5

Meas. Value in mV (± 50)	Units	Digitized Measured Value											O V F A			Range			
		15	14	13	12	11	10	9	8	7	6	5	4	3	2		1	0	
100.0	4095+OV	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	Overflow
99.976	4095	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	Overrange
:	:	:																	
50.024	2049	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
50.000	2048	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Nominal range
49.976	2047	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
:	:	:																	
25.000	1024	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
24.976	1023	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
:	:	:																	
0.024	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
+0.000	+0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
-0.000	-0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
-0.024	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
:	:	:																	
-24.976	-1023	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
-25.000	-1024	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
:	:	:																	
-49.976	-2047	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
-50.000	-2048	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
-50.024	-2049	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Overrange
:	:	:																	
-99.976	-4095	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
-100.0	-4095+OV	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Overflow

Explanation of Table 6-7

- Representation: Absolute value as positive binary number with sign
The sign is indicated in bit 7 in the high byte.
The following applies: V=0 positive value; V=1 negative value.
- Overflow at absolute values exceeding the overrange; overflow bit (OV) is set
- Configuration aids
 - Plug in the 498-1AA11 range card (for 4 channels) (also 1AA21 for ± 1 V, 1AA31 for ± 10 V, 1AA41 for ± 20 mA and 1AA61 for ± 5 V).
 - Set the jumper switch on the 460 module to increase the measuring range by a factor of 10 (e.g. to ± 500 mV).
 - Configure channel type 5 with COM 115F
- Wire break is detected by the hardware in the case of the 498-1AA11 range card (method , 6.5). In the case of all other range cards, wire break is recognized by FB 250 with the "DRAK" parameter (method , 6.5). FB 250 sets error bit F (6.9).
- The 460 AI module can only be used with with I/O type 13 (nonsafety-related).

Table 6-8. 460 AI Module: Digital Representation of Analog Values as Two's Complement in the Range ±50 mV, Channel Type 6

Input Voltage in mV (±50)	Units	Digitized Measured Value											O V F A			Range						
		15	14	13	12	11	10	9	8	7	6	5	4	3	2		1	0				
100.0	4095+OV	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0/1	0	1	Overflow	
99.976	4095	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0/1	0	0	Overrange	
: 50.024	: 2049	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0/1	0	0		
50.000	2048	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0/1	0	0	Nominal value	
49.976	2047	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0/1	0	0		
: 25.000	: 1024	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0/1	0	0		
24.976	1023	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0/1	0	0		
: 0.024	: 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0/1	0	0		
0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0/1	0	0		
-0.024	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0/1	0	0		
: -24.976	: -1023	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0/1	0	0		
-25.000	-1024	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0/1	0	0		
: -49.976	: -2047	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0/1	0	0		
-50.000	-2048	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0/1	0	0		
-50.024	-2049	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0/1	0	0		Overrange
: -99.976	: -4095	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0/1	0	0		
-100.0	-4095+OV	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0/1	0	1		Overflow

Explanation of Table 6-8

- Representation: Two's complement
- Overrange condition at absolute values above the nominal value but under double the nominal value; no overflow bit set!
- Overflow at absolute values above the overrange; overflow bit (OV) set!
- Configuration aids
 - 498-1AA11 range card (for 4 channels)
(also 1AA21 for ±1 V, 1AA31 for ±10 V, 1AA41 for ±20mA, 1AA61 for ±5V)
 - Set the jumper switch on the 460 module to increase the measuring range by a factor of 10 (e.g. to ± 500 mV)
 - Configure channel type 6 with COM 115F
- Wire-break recognition
 - Via hardware in the case of the 498-1AA11 range card (method , 6.5)
 - Via FB 250 using the "DRAK" parameter in the case of all other range cards (method , 6.5)
- FB 250 sets error bit F (6.9)
- The 460 AI module can only be used with I/O type 13 (nonsafety-related).

6.4.2 Digital Representation of a Measured Value (463 Analog Input Module)

The 463 AI module has four input ranges

- 4 to 20 mA with wire break monitoring using live zero
- 0 to 20 mA
- 0 to 1 V
- 0 to 10 V

The different measuring ranges are defined with jumpers on the front connector in the case of the 463 analog input module.

Note

Safety-related use of the 463 analog input module is unrestricted in the case of the following:

- Channel type 4 and measuring range 4 to 20 mA
- Channel type 5 and measuring range 0 to 20 mA, 0 to 10 V
- Channel type 6 and measuring range 0 to 20 mA, 0 to 10 V.

Channel type 3 can only be used in safety-related applications in type 16 I/O modules since these do not feedback modules.

After the digital result is converted, it is stored in the RAM of the module. The individual bits of both bytes have the following meaning:

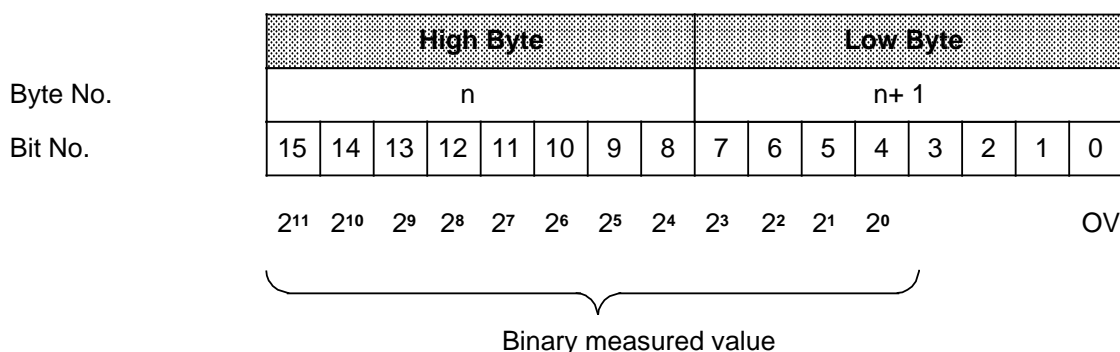


Figure 6-13. Representation of an Analog Measured Value in Digital Form in the Case of the 463 AI Module

The 463 AI module uses only the least significant OV bit as condition code. The following table gives its meaning. Bits 1 to 3 have no significance for the measured value.

Table 6-9. Meaning of the 0 Bit in the 463 Analog Input Module

Bit	Meaning	State	Meaning of the Signal State
OV	Overflow bit	1	Overrange

Table 6-10. 463 AI Module: Digital Representation of Analog Values as Two's Complement (4 to 20 mA, Channel Type 3)

Meas. Value in mA	Units	Digitized Measured Value											OV	Range	
		15	14	13	12	11	10	9	8	7	6	5			4
31.984	2047	0	1	1	1	1	1	1	1	1	1	1	1	1	Overflow
28	1792	0	1	1	1	0	0	0	0	0	0	0	0	1	
27.984	1791	0	1	1	0	1	1	1	1	1	1	1	1	1	
24	1536	0	1	1	0	0	0	0	0	0	0	0	0	1	
23.984	1535	0	1	0	1	1	1	1	1	1	1	1	1	0	Overrange
20.016	1281	0	1	0	1	0	0	0	0	0	0	0	1	0	
20	1280	0	1	0	1	0	0	0	0	0	0	0	0	0	Nominal range
16	1024	0	1	0	0	0	0	0	0	0	0	0	0	0	
12	768	0	0	1	1	0	0	0	0	0	0	0	0	0	
8	512	0	0	1	0	0	0	0	0	0	0	0	0	0	
4	256	0	0	0	1	0	0	0	0	0	0	0	0	0	
3.984	255	0	0	0	0	1	1	1	1	1	1	1	1	0	Overrange
3	192	0	0	0	0	1	0	0	0	0	0	0	0	0	
2.984	191	0	0	0	0	1	0	1	1	1	1	1	1	0	Wire break recognition
2	128	0	0	0	0	1	0	0	0	0	0	0	0	0	
1	64	0	0	0	0	0	1	0	0	0	0	0	0	0	
0.816	51	0	0	0	0	0	0	1	1	0	0	1	1	0	
0.016	1	0	0	0	0	0	0	0	0	0	0	0	1	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
-0.016	-1	1	1	1	1	1	1	1	1	1	1	1	1	0	
-0.816	-51	1	1	1	1	1	1	0	0	1	1	0	1	0	

Explanation of Table 6-10

- Representation: Two's complement with offset
- Configuration aids
 - Set the jumpers on the 463 module for the measuring range (4 to 20 mA) and the nominal range (256 to 1280 units) (6.3.2)
 - Configure channel type 3 with COM 115F
- FB 250 ANEI recognizes wire break if the current is less than 3 mA (method , 6.5).
FB 250 responds to errors depending on the I/O type:
 - I/O type 13 (nonsafety-related): Error bit F of FB 250 ANEI is set. The program is continued.
 - I/O type 16 (safety-related): Error bit F and the OV bit of the FB 250 ANEI are set. The operating system responds according to safety criteria.

Table 6-11. 463 AI Module: Digital Representation in the Case of Current Range 4 to 20 mA, Channel Type 4

Meas. Value in mA	Units	Digitized Measured Value											OV	Range	
		15	14	13	12	11	10	9	8	7	6	5			4
35.982	2047	0	1	1	1	1	1	1	1	1	1	1	1	1	Overflow
32	1792	0	1	1	1	0	0	0	0	0	0	0	0	1	
28	1536	0	1	1	0	0	0	0	0	0	0	0	0	1	
27.982	1535	0	1	0	1	1	1	1	1	1	1	1	1	0	Overrange
24	1280	0	1	0	1	0	0	0	0	0	0	0	0	0	
20.018	1025	0	1	0	0	0	0	0	0	0	0	0	1	0	
20	1024	0	1	0	0	0	0	0	0	0	0	0	0	0	Nominal range
16	768	0	0	1	1	0	0	0	0	0	0	0	0	0	
12	512	0	0	1	0	0	0	0	0	0	0	0	0	0	
8	256	0	0	0	1	0	0	0	0	0	0	0	0	0	
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3.982	-1	1	1	1	1	1	1	1	1	1	1	1	1	0	Overrange
3.018	-63	1	1	1	1	1	1	0	0	0	0	0	1	0	
3	-64	1	1	1	1	1	1	0	0	0	0	0	0	0	
2.982	-65	1	1	1	1	1	0	1	1	1	1	1	1	0	Wire break recognition
2	-128	1	1	1	1	1	0	0	0	0	0	0	0	0	
1	-192	1	1	1	1	0	1	0	0	0	0	0	0	0	
0	-256	1	1	1	1	0	0	0	0	0	0	0	0	0	

Explanation of Table 6-11

- Representation: Two's complement (beginning of nominal range: 0 units)
- Overrange condition in the case of values exceeding the nominal range 4 to 20 mA and values up to roughly 40 % above the upper limit of the nominal value; no overflow bit set
- No error bits are set for values below the nominal range!
- Overflow at values starting at 40 % above the upper limit of the nominal value (28 mA); overflow bit (OV) set
- Configuration aids
 - Set the jumpers on the 463 module for the measuring range (4 to 20 mA) and the nominal range (0 to 1024 units)
 - Configure channel type 4 with COM 115F
- FB 250 ANEI detects wire break if the current is less than 3 mA (method , 6.5).
 FB 250 ANEI responds to errors according to I/O type:
 - I/O type 13 (nonsafety-related): Error bit F of FB 250 ANEI is set. The program is continued.
 - I/O types 14/15/16 (safety-rel.): The error bit F and the OV bit of FB 250 ANEI are set. The operating system responds acc. to safety criteria.

Table 6-12. 463 AI Module: Digital Representation of the Analog Values as Two's Complement in the Voltage Range 0 to 1 V

Meas. Value in mA	Units	Digitized Measured Value											OV	Range	
		15	14	13	12	11	10	9	8	7	6	5			4
1999	2047	0	1	1	1	1	1	1	1	1	1	1	1	1	Overflow
1750	1792	0	1	1	1	0	0	0	0	0	0	0	0	1	
1500	1536	0	1	1	0	0	0	0	0	0	0	0	0	1	
1499	1535	0	1	0	1	1	1	1	1	1	1	1	1	0	Overrange
1250	1280	0	1	0	1	0	0	0	0	0	0	0	0	0	
1001	1025	0	1	0	0	0	0	0	0	0	0	0	1	0	
1000	1024	0	1	0	0	0	0	0	0	0	0	0	0	0	Nominal range
750	768	0	0	1	1	0	0	0	0	0	0	0	0	0	
500	512	0	0	1	0	0	0	0	0	0	0	0	0	0	
250	256	0	0	0	1	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
-1	-1	1	1	1	1	1	1	1	1	1	1	1	1	0	Overrange
-50	-51	1	1	1	1	1	1	0	0	1	1	0	1	0	

Explanation of Table 6-12

- Representation: Two's complement
- Overrange condition for values outside the nominal range
- Overflow for values from 500 mV above the nominal range
- Configuration aids
 - Set the jumpers on the module for the measuring range (0 to 1 V, 0 to 10 V, 0 to 20 mA)
 - Configure channel type 5 or 6 with COM 115F
- This type of measured value representation can also be set for measuring ranges 0 to 10 V and 0 to 20 mA
- FB 250 recognizes wire break with the "DRAK" parameter (method , 6.5)
 FB 250 ANEI responds to errors according to I/O type:
 - I/O type 13 (nonsafety-related): Error bit F of FB 250 ANEI is set. The program is continued.
 - I/O types 14/15/16 (safety-related): The error bit F and the OV bit are set. The operating system responds according to safety criteria.

6.5 Wire-break Signalling and Scanning

Wire-break signalling in the 460 analog input module

There are three methods of detecting wire-break:

Wire-break detection per hardware:

This is implemented with the 498-1AA11 range card. A constant current is briefly switched (1.6 ms) through the input terminals before each coding of the input value and the resulting voltage is checked for a limit. The voltage exceeds the limit value if there is a sensor or line interrupt and wire-break is signalled by setting the condition code bit "F" in data byte 1. This is evaluated by FB 250 ANEI (6.9).

Wire-break monitoring with FB 250 ANEI

The 460 AI module with the range cards 498-1AA51 or 498-1AA71 and the 463 AI module with jumpers set for the range 4 to 20 mA use the live-zero method for detecting wire-breaks:

If the sensors, signal path and input module are all intact, 4 mA is the lowest permissible value.

All values lower than 3 mA are interpreted by FB 250 ANEI as wire-breaks.

Wire-break detection per user program and FB 250 ANEI

All measuring ranges of the two AI modules which do not permit wire-break detection as in and above must use the following procedure supported by the user program.

For this purpose, a wire-break range in the standardized value range must be defined with the ODGR and UDGR parameters.

The error bit "FB" is set in FB 250 in the following cases:

- If the analog value lies within the limits ODGR and UDGR
- If the DRAK bit is set in the control program (6.9).

Using this procedure to test the line for wire-break only makes sense if the analog value lies outside the wire-break limits.

Note

The L PB and L PW operations are not permitted for analog value processing.

Wire-break message for resistance thermometers

A break in the instrument leads to a resistance thermometer is indicated as shown in Table 6-13.

Table 6-13. Wire-Break Message for Resistance Thermometers

Wire-Break at	M+	M -	PT 100 (Resist. Sensor)	S+	S -
Digital analog value	0	0	0	0	0
Status of the error bit*	1	1	1	0	1

* The 460 analog input module encodes the value 0 for unbroken PT 100 resistors and sets error bit F = 0.

If you have chosen the "No wire-break message" function on the module, an interruption in the leads to the resistance thermometer is flagged by overflow. The overflow bit remains set about 1.5 sec. (OV = 1). In cyclic operation, all other measuring points also flag overflow (OV = 1). The situation is the same for single sampling if the interval between two codings 1.5 sec.

Wire-break signalling in the case of the 463 analog input module

The 463 analog input module has no hardware wire-break monitoring facility. Use the life zero measuring range 4 to 20 mA or the software wire-break monitor in FB 250 ANE!

For this purpose, a wire-break range in the standardized value range must be defined with the ODGR and UDGR parameters.

The error bit "FB" is set in FB 250 in the following cases:

- If the analog value lies within the limits ODGR and UDGR
- If the DRAK bit is set in the control program (6.9).

Note

If you use a 4-wire transducer at analog inputs with measuring range 4 to 20 mA, the sensors must already be supplied when the PLC starts up. Otherwise the system responds with a wire-break signal.

Scanning in the case of the 460 module

The 460 module has two different methods of coding analog values using a toggle switch.

Cyclic scanning:

With this function, the module itself handles the coding of all inputs. Coding time in the case of the 460 analog input module is 480 ms.

The digitized measured values are stored in the circulating buffer under the channel-specific address (the high byte under address n, the low byte under address n+1). The measured values can then be read out of the circulating buffer at any time.

Selective scanning:

Coding of the desired analog variable is initiated by the user program. Coding time begins when the module is referenced. FB 250 sets the TBIT to "1" during coding and no further access may occur while coding is in progress.

6.6 Analog Output Modules

6.6.1 Method of Operation of the Analog Output Modules

The CPU processes the digital values which the analog output modules will convert to the required currents and voltages. Different floating modules cover the individual voltage and current ranges.

The CPU transfers the digital value to the module memory. The last coded value is retained in the analog output module even after PLC STOP.

Transfer of the coded value is started by FB 251 ANAU.

6.6.2 Analog Output Modules

When loads are connected, high-resistance sense lines (S+/S-) measure the voltage direct at the load. Then the output voltage is adjusted such that voltage drops on the lines do not invalidate the load voltage.

In this way, voltage drops of up to 3 V per line can be compensated.
Figure 6-14 shows such a circuit.

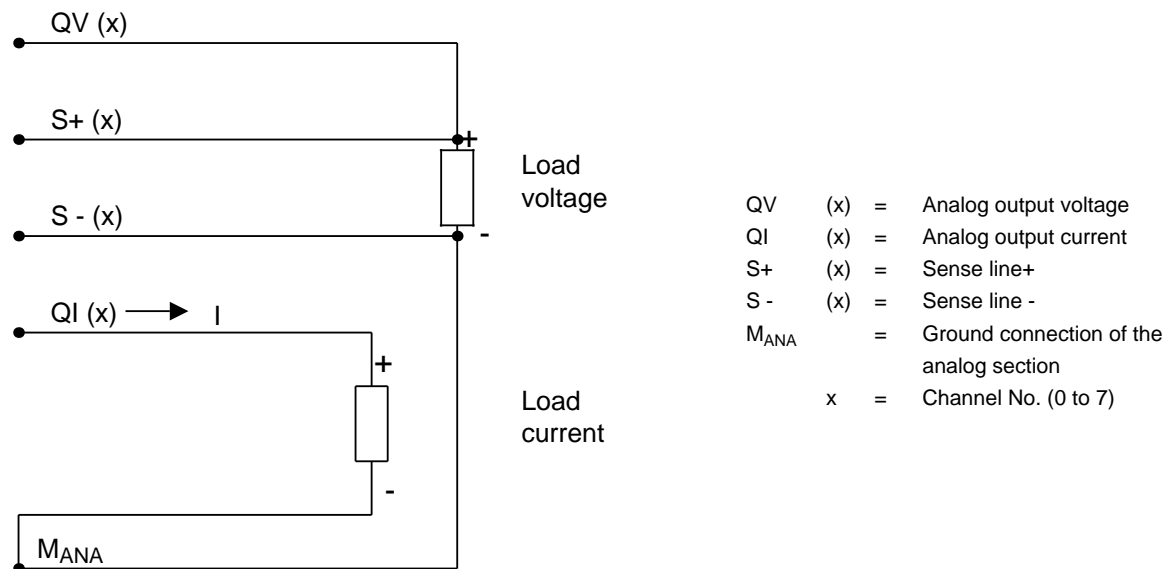


Figure 6-14. Connecting Loads to Analog Output Modules

Equipotential bonding during test switching with the 470 analog output module

If you are using the 470 analog output module as a test analog output module, make the following connection:

The L-terminal (pin 21) of the 463 analog input module to the L-terminal (pin 47) of the 470 analog output module.
This creates a common reference potential.

Connecting loads to current and voltage outputs

Figure 6-15 shows how to connect an analog output module.

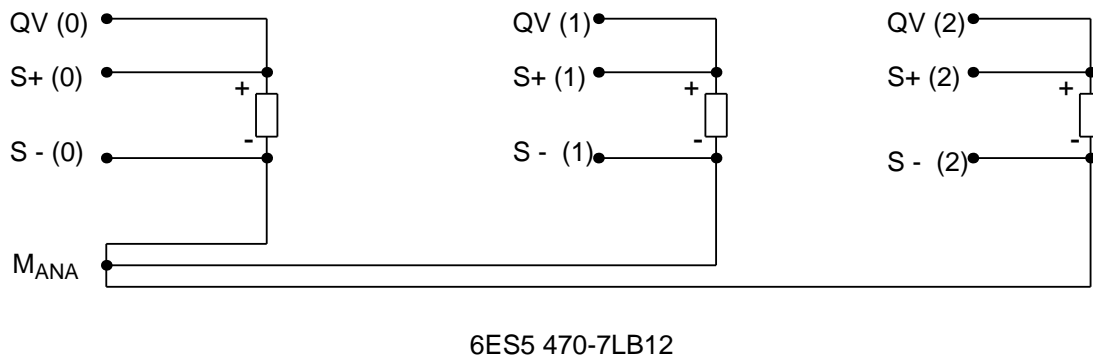
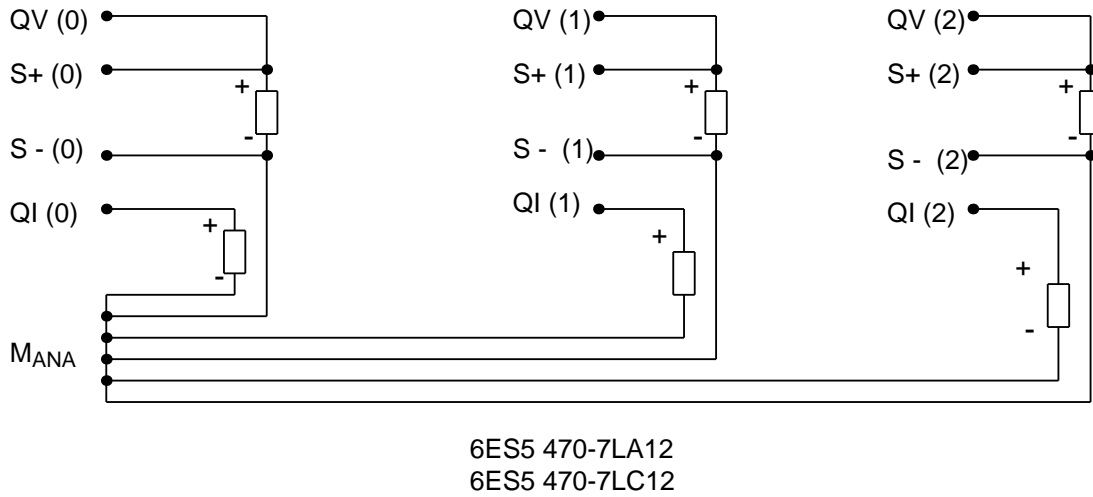


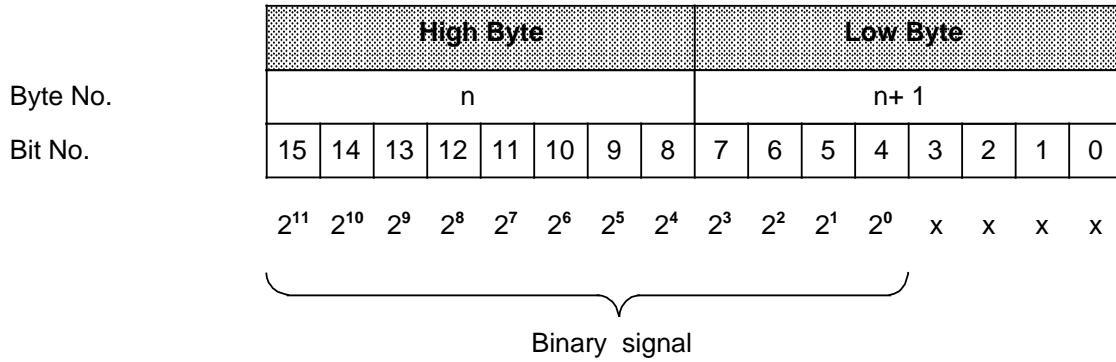
Figure 6-15. Connection of Loads to Current and Voltage Outputs of Analog Output Modules

Note

If voltage outputs are not used or if only current outputs are connected, insert jumpers in the front connector at the voltage outputs that are not connected. Connect QV (x) with S+ (x) and S- (x) with M_{ANA}.

6.7 Digital Representation of an Analog Value

The CPU uses two bytes to represent the value of an output channel. Figure 6-16 explains the individual bits.



x represents an insignificant bit

Figure 6-16. Representation of an Analog Signal in Digital Form

Table 6-14 lists the output voltages or currents of the individual modules.

Table 6-14. Analog Output Signals

Resolution Units	Output Voltages and Currents of the Modules				Digitized Output Value*												
	-7LA/B12 in V	-7LA12 in mA	-7LC12 in V	-7LC12 in mA	2 ¹¹	2 ¹⁰	2 ⁹	2 ⁸	2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰	
+1280	+12.5	25.0	6.0	24.0	0	1	0	1	0	0	0	0	0	0	0	0	Over-range
+1025	+10.0098	20.0195	5.004	20.016	0	1	0	0	0	0	0	0	0	0	0	1	Over-range
+1024	+10.0	20.0	5.0	20.0	0	1	0	0	0	0	0	0	0	0	0	0	Nominal range
+1023	+9.99	19.98	4.995	19.98	0	0	1	1	1	1	1	1	1	1	1	1	
+512	+5.0	10.0	3.0	12.0	0	0	1	0	0	0	0	0	0	0	0	0	
+256	+2.5	5.0	2.0	8.0	0	0	0	1	0	0	0	0	0	0	0	0	
+128	+1.25	2.5	1.5	6.0	0	0	0	0	1	0	0	0	0	0	0	0	
+64	+0.625	1.25	1.25	5.0	0	0	0	0	0	1	0	0	0	0	0	0	
+1	+0.0098	0.0195	1.004	4.016	0	0	0	0	0	0	0	0	0	0	0	0	
0	+0.0	0.0	1.0	4.0	0	0	0	0	0	0	0	0	0	0	0	0	
-1	-0.0098	0.0	0.996	3.984	1	1	1	1	1	1	1	1	1	1	1	1	
-64	-0.625	0.0	0.75	3.0	1	1	1	1	1	1	0	0	0	0	0	0	
-128	-1.25	0.0	0.5	2.0	1	1	1	1	1	0	0	0	0	0	0	0	
-256	-2.5	0.0	0.0	0.0	1	1	1	1	0	0	0	0	0	0	0	0	
-512	-5.0	0.0	-1.0	0.0	1	1	1	0	0	0	0	0	0	0	0	0	
-1024	-10.0	0.0	-3.0	0.0	1	1	0	0	0	0	0	0	0	0	0	0	
-1025	-10.0098	0.0	-3.004	0.0	1	0	1	1	1	1	1	1	1	1	1	1	Over-range
-1280	-12.5	0.0	-5.0	0.0	1	0	1	1	0	0	0	0	0	0	0	0	Over-range

* Insignificant bits 0 to 3 are not included.

Note

In the case of the two's complement, bit 2¹¹ indicates the sign ("0" for a positive value, "1" for a negative value).

6.8 I/O Module Types

There are different types of analog I/Os. These types are suited to the type of sensors and actuators and to the time characteristics of the input/output signals (10.11).

A distinction is made between safety-related and nonsafety-related types.

In the case of nonsafety-related types, a further distinction is made between types for intermittent signals and types for non-intermittent signals.

An analog signal is intermittent if the whole value range relevant to evaluation within the second error occurrence time is run through, read in and coded at least once. In doing so, it is of special importance that those values that lead to a safety response be reached.

For example, an analog input for measuring temperature cannot generally be configured as an intermittent type since the critical temperatures leading to emergency shutdown are never reached in normal operation.

Note

If an intermittent type is selected for a safety-related signal, this signal characteristic must be proved to the licensing authority.

This characteristic is often impossible or difficult to prove. If this is the case, a non-intermittent type should be selected for which no special proof is required.

When configuring I/O modules, define an I/O type for each AI word according to the characteristics of the process signals. There are four different I/O types for analog input modules. (Table 6.15)

Table 6-15. Types of Analog I/O Modules

I/O Type No.	I/O	Safety-related	AI Module	No. of I/O Channels	No. of Sensor/ Actuator Channels	Inter-mittent
13	AI	no	460/463	1	1	-
14	AI	yes	463	2	1	non-interm.
15	AI	yes	463	2	2	non-interm.
16	AI	yes	463	2	1	interm.
16	AI	yes	463	2	2	interm.
18	AQ	no	470	1	1	-

AI=Analog input

AQ=Analog output

I/O types differ according to

- Safety-related aspects
- Number of I/O channels
- Type of connection
- "Intermittent" characteristic
- Feedback type
- Number of feedback channels.

You must configure analog I/O modules with the COM 115F software package.

When configuring I/O modules, an I/O type is assigned to each I/O word.

See Vol. 2/2, Section 1.2 of the manual for a detailed description of configuring analog I/O modules depending on I/O types.

Table 6-16 gives an overview of the assignment of channel types to the relevant I/O types (I/O type 13 to I/O type 16).

Table 6-16. Channel Types for Analog Input Modules (I/O Type 13)

	Module	Switch Position	Range Card (only for 460 AI)	Measuring Range	Nominal Range (decimal units)	CH AQ Module (463 only)
Channel type 3	460-...	500 mV/mA	1AA51 1AA71	4 to 20 mA	+512 to +2560	
	463-...	OFF	Measuring range programmable on the module	4 to 20 mA	+256 to +1280	---
Channel type 4	460-...	500 mV/mA	1AA41 1AA11 1AA21 1AA31 1AA61	0 to 20 mA 0 to 500 mV 0 to 1 V 0 to 10 V 0 to 5 V	0 to +2048	
		50 mV	1AA41 1AA11 1AA21 1AA31 1AA61	0 to 2 mA 0 to 50 mV 0 to 100 mV 0 to 1 V 0 to 500 mV		
	463-...	ON	Measuring range programmable on the module	4 to 20 mA	0 to +1024	---

Table 6-16. Channel Types for Analog Input Modules (I/O Type 13) (Continued)

	Module	Switch Position	Range Card (460 only)	Measuring Range	Nominal Range (decimal units)	CH AQ Module (463 only)
Channel type 5	460-...	500 mV	1AA11 1AA21 1AA31 1AA61	-500 to +500 mV - 1 to + 1 V - 10 to +10 V - 5 to +5 V	0 to +2048	
		50 mV	1AA11 1AA21 1AA31 1AA61	- 50 to +50 mV -100 to +100 mV - 1 to + 1 V -500 to +500 mV		
	463-...	OFF	Measuring range programmable on the module	0 to 20 mA 0 to 1 V 0 to 10 V	0 to +1024	---
Channel type 6	460-...	500 mV	1AA11 1AA21 1AA31 1AA61	- 500 to +500 mV - 1 to + 1 V - 10 to +10 V - 5 to +5 V	- 2048 to +2048	
		50 mV	1AA11 1AA21 1AA31 1AA61	- 50 to +50 mV -100 to +100 mV - 1 to + 1 V -500 to +500 mV		
	463-...	OFF	Measuring range programmable on the module	0 to 20 mA 0 to 1 V 0 to 10 V	0 to +1024	---

Table 6-17. Channel Types for Analog Input Modules (I/O types 14 and 15)

	Module	Switch Position	Range Card (460 only)	Measuring Range	Nominal Range (decimal units)	CH AQ Module (463 only)
Channel type 4	463-...	ON	Measuring range programmable on the module	4 to 20 mA	0 to +1024	470-7LC12
Channel type 5	463-...	OFF	Measuring range programmable on the module	0 to 20 mA 0 to 10 V	0 to +1024	470-7LA12 470-7LA/B12
Channel type 6	463-...	OFF	Measuring range programmable on the module	0 to 20 mA 0 to 10 V	0 to +1024	470-7LA12 470-7LA/B12

Table 6-18. Channel Types for Analog Input Modules (I/O type 16)

	Module	Switch Position	Range Card (460 only)	Measuring Range	Nominal Range (decimal units)	CH AQ Module (463 only)
Channel type 3	463-...	OFF	Measuring range programmable on the module	4 to 20 mA	+256 to +1280	---
Channel type 4	463-...	ON	Measuring range programmable on the module	4 to 20 mA	0 to +1024	---
Channel type 5	463-...	OFF	Measuring range programmable on the module	0 to 20 mA 0 to 1 V 0 to 10 V	0 to +1024	---
Channel type 6	463-...	OFF	Measuring range programmable on the module	0 to 20 mA 0 to 1 V 0 to 10 V	0 to +1024	---

6.9 Analog Value Matching Blocks FB 250 and FB 251

These blocks match the nominal range of an analog module to a standard range that you can specify.

Reading in and scaling an analog value - FB 250 -

Analog input modules convert analog process signals into digital values and store them in the module. From there they are transferred cyclically to the CPU memory and also transferred to the other subunit.

The FB 250 ANEI function block enables two types of access to the analog value:

- Access to the cyclically updated CPU memory
- or
- Direct access to the memory of the analog input module.

Call and parameter assignment:

Parameter	Meaning	Type	Data type	Assignment / Explanation	STL
BG	Module address	D	KF	AI 460: 128 to 240 (16-byte grid) AI 463: 128 to 248 (8-byte grid)	:IU FB 250
KN	Channel number	D	KF	KY = 0 to 7 in AI 460 0 to 3 in AI 463	NAME :AGF: ANEI BG :
OGR	Upper limit of the output value	D	KF	-32768 to+32767	KN : OGR :
UGR	Lower limit of the output value	D	KF	-32768 to+32767	UGR : DRAK :
DRAK	User-controlled wire break monitor active	E	BI	Set DRAK = "1" • if you want to implement wire break monitoring according to method in 6.5 and • if the current analog value lies outside the wire break limits.	ODGR : UGDR : PASS : EINZ : DIR :
ODGR ¹	Wire break upper limit	D	KF	Only relevant if DRAK = 1 Enter the following here: • The limits of the range within which values are interpreted as wire breaks • - 32768 if you have configured a global limit value for wire break in DB1.	XA : FB :
UDGR ¹	Wire break lower limit	D	KF		BU : TBIT : TKON :
PASS	Passivation value	D	KF	When passivating of the module, the safety-related passivation value is written into the result word instead of the AI value read in.	
EINZ	Selective sampling	E	BI	A "1" initiates selective sampling (only in the case of the AI 460)	
DIR	Direct access	E	BI	Set DIR="1" if direct access is desired	
XA	Output value	A	W	The scaled analog value is "0" in the event of a wire break	
FB ²	Error bit	A	BI	Becomes "1" in the event of a wire break	
BU ²	Overrange	A	BI	Becomes "1" if the analog input of one or both subunits exceeds the nominal range	
TBIT	Activity bit of the accessed module	A	BI	Becomes "1" if the accessed module is currently executing selective sampling	
TKON	Time conflict	A	BI	Becomes "1" • if FB 250 accesses an analog input which is currently being tested or • if a discrepancy has resulted in the case of direct access with parameter DIR =1 and the output value XA is assigned the last valid value instead of the current value XA, FB and BU are not updated. Only the old values are available.	

1 Values of the scaled range (UGR to OGR)

2 If bits F and BU are both="1", passivation of the relevant module has taken place. The passivation value is in the value XA.

Standardization schematic:

The FB 250 function block converts the read in value linearly to the upper and lower limits (OGR and UGR). The conversion is depending of the used module.

Analog input module AE 460

The analog output value XA is channel type dependend. It is used

for channel type 3 (4 to 20 mA):

$$XA = \frac{UGR \cdot (2560 - xe) + OGR \cdot (xe - 512)}{2048}$$

for channel type 4 (unipolar representation):

$$XA = \frac{UGR \cdot (2048 - xe) + OGR \cdot xe}{2048}$$

for channel type 5 and 6:

$$XA = \frac{UGR \cdot (2048 - xe) + OGR \cdot (xe + 2048)}{4096}$$

where: XA is the value output by the FB
 xe is analog value read by the module

Analog input module AE 463

The analog output value XA is channel type dependend. It is used

for channel type 3 (4 to 20 mA):

$$XA = \frac{UGR \cdot (1280 - xe) + OGR \cdot (xe - 256)}{1024}$$

for channel type 4 (unipolar representation):

$$XA = \frac{UGR \cdot (1024 - xe) + OGR \cdot xe}{1024}$$

for channel type 5 and 6:

$$XA = \frac{UGR \cdot (1024 - xe) + OGR \cdot (xe + 1024)}{2048}$$

where: XA is the value output by the FB
 xe is analog value read by the module

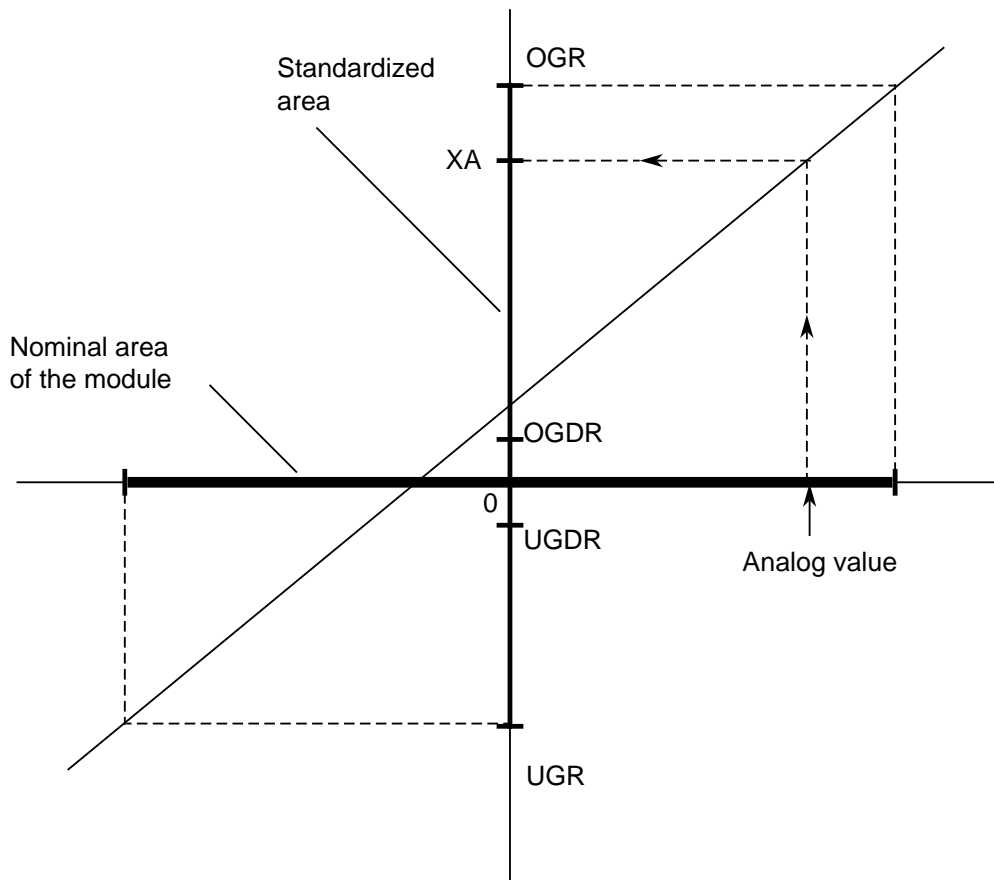


Figure 6-17. Schematic Representation of the Conversion

COM 115F is used to configure the analog value representation of the module (channel type):
 (Vol. 2/2 of the Manual).

Selective sampling

The 460 analog input module permits sampling of analog values

- Cyclically
- Selectively

In the case of cyclic sampling, the analog variables on the module are coded and buffered one after another. The user program has no influence on coding.

In the case of selective sampling, the user program initiates coding of the desired analog variables. Coding begins when the module is referenced.

If you want selective sampling, proceed as follows:

Set the DIP switch on the 460 AI module to selective sampling

Call FB 250 ANEI with Parameter EINZ="1".

During coding, FB 250 ANEI will set the output parameter T BIT="1". The result is available when T BIT="0".

If you want to scan the T BIT parameter, call FB 250 ANEI with EINZ="1".

In the case of programmable controllers with the CPU 942-7UF11:

As long as T BIT="1", you must not active any further selective scanning, even on other AI 460 modules.

Note

Assign different bits to the activity bit when different channels are called. You will then be able to recognize which channel has been activated for coding.

FB 250 produces a value XA within a (scaled) range defined by the user. The user defines the desired range with the "Upper limit (OGR)" and "Lower limit (UGR)" parameters.

Outputting an analog value -FB 251-

Use function block FB 251 to output analog values to analog output modules. Specify the type of analog representation of the module (channel type) in the KNKT parameter. Values from the range between the "lower limit (UGR)" and the "upper limit (OGR)" parameters are converted to the nominal range of the module in question:

for channel type 0 (unipolar representation):

$$xa = \frac{1024 \cdot (XE - UGR)}{OGR - UGR}$$

for channel type 1 (bipolar representation):

$$xa = \frac{1024 \cdot (2 \cdot XE - OGR - UGR)}{OGR - UGR}$$

where: XE is the digital value specified in the FB
xa is value written to the module

Call and parameter assignment:

Parameter	Meaning	Type	Data Type	Assignment	STL
XE	Analog value to be output	E	W	Input value (fixed-point) in the UGR to OGR range	:IU FB 251 NAME :AGF:ANAU XE : BG : KNKT : OGR : UGR : FEH : BU :
BG	Module address	D	KF	128 to 240	
KNKT	Channel number Channel type	D	KF	KY = x,y x = 0 to 7 y = 0;1 0: unipolar representation 1: bipolar fixed-point number	
OGR	Upper limit of the output value	D	KF	-32768 to +32767	
UGR	Lower limit of the output value	D	KF	-32768 to +32767	
FEH	Error when setting the limit value	A	BI	"1" if UGR = OGR, for illegal channel or slot number, or illegal channel type	
BU	Input value exceeds UGR or OGR	A	BI	If "1", XE is outside the range (UGR;OGR). XE assumes the limit value	

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7 Communications Capabilities

7.1 Overview of Communications Capabilities

The S5-115F offers communications capabilities using the SINEC L1 local area network and a programmer. All the communications capabilities of the SIMATIC family are available by interposing a programmable controller of the U range. The CP 523 communications processor is still available for use direct in the S5-115F.

7.2 SINEC L1 Local Area Network

SINEC L1 is a communications system that networks SIMATIC S5 programmable controllers. It operates on the Master-Slave principle. You can connect one master and up to 30 slaves to the SINEC L1 LAN.

Each node, master or slave, needs a BT 777 bus terminal (transceiver) for signal level conversion. Connect the terminal to the programmer port of the slaves or to the SINEC L1 interface of the CP 530. The transceiver is powered by a separate 5 V power supply unit.

Note

Contrary to the information in the SINEC L1 LAN Manual, the BT 777 transceiver must remain as supplied, i.e.

- You must **not** remove jumper Q8
- You must **not** insert the jumper between pins 6 and 7.

Data is transmitted via a 4-wire shielded cable, which connects the individual transceivers to each other.

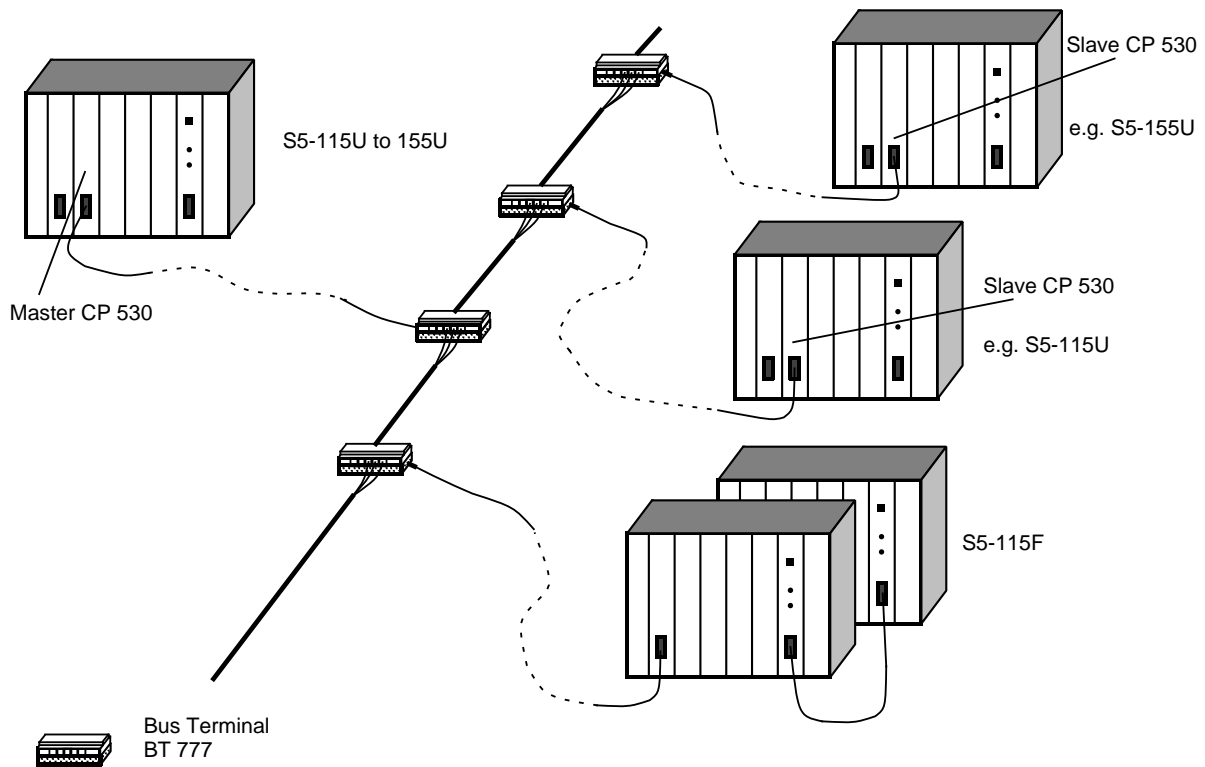


Figure 7-1. PLCs Connected to the SINEC L1 Local Area Network

You can transmit data on the SINEC L1 LAN between any nodes:

- Master Slave (master traffic)
- Slave Master (master traffic)
- Slave Slave (interslave traffic)
- Master all slaves (broadcasting)
- Slave all slaves and master (broadcasting)

The following data can be transmitted:

- Signal states of inputs, outputs and flags
- Contents of data words.

Besides data, you can also transmit programmer functions on SINEC L1. A programmer connected to the master's CP 530 can address individual slaves (SINEC L1 Manual 6ES5 998-7LA21).

Applications of the SINEC L1 LAN for the S5-115F

SINEC L1 LAN applications for the S5-115F can be broken down as follows:

- Nonsafety-related connection between master PLC and slave S5-115F PLC (nonsafety-related traffic with master and nonsafety-related broadcasting from master)
- Safety-related connection between slave S5-115F and S5-95F PLCs via a single or fault-tolerant, double SINEC L1 LAN (safety-related interslave traffic and safety-related broadcasting).

Important for all connections with the S5-115F**Note**

Incoming messages cannot be accepted by the S5-115F until the subunits have been synchronized. You should therefore organize data transmission to the S5-115F so that there is an interval of at least 100 ms between receipt of each message.

7.2.1 Nonsafety-Related Connection between S5-115F Slaves and the Master Controller

Nonsafety-related connection between a master controller of the S5 family and one or more S5-115F slaves is used, for instance, to transmit

- Nonsafety-related input data in connection with operator-process communication
- Nonsafety-related output data in connection with process visualization.

Note

A connection between a number of S5-115F slave PLCs is always safety-related. Nonsafety-related interslave traffic is not possible.

Data traffic

A slave needs the following items to exchange data

- A slave number (1 to 30)
- A Send mailbox
- A Receive mailbox
- Coordination bytes

Send and Receive mailboxes

The Send and Receive mailboxes contain send and receive data and can hold up to 64 bytes for master-slave traffic.

You must configure the following with COM 115F for nonsafety-related connections:

- Length of the mailboxes
- Location of the mailboxes
 - in a data block
 - or
 - in a flag area.

Note

The length of the messages sent by the master must be identical to the mailbox length configured for the slaves. If your master messages are shorter, you must pad them to the configured mailbox length.

The following two figures show the schematic sequence of data traffic between the master and the slave.

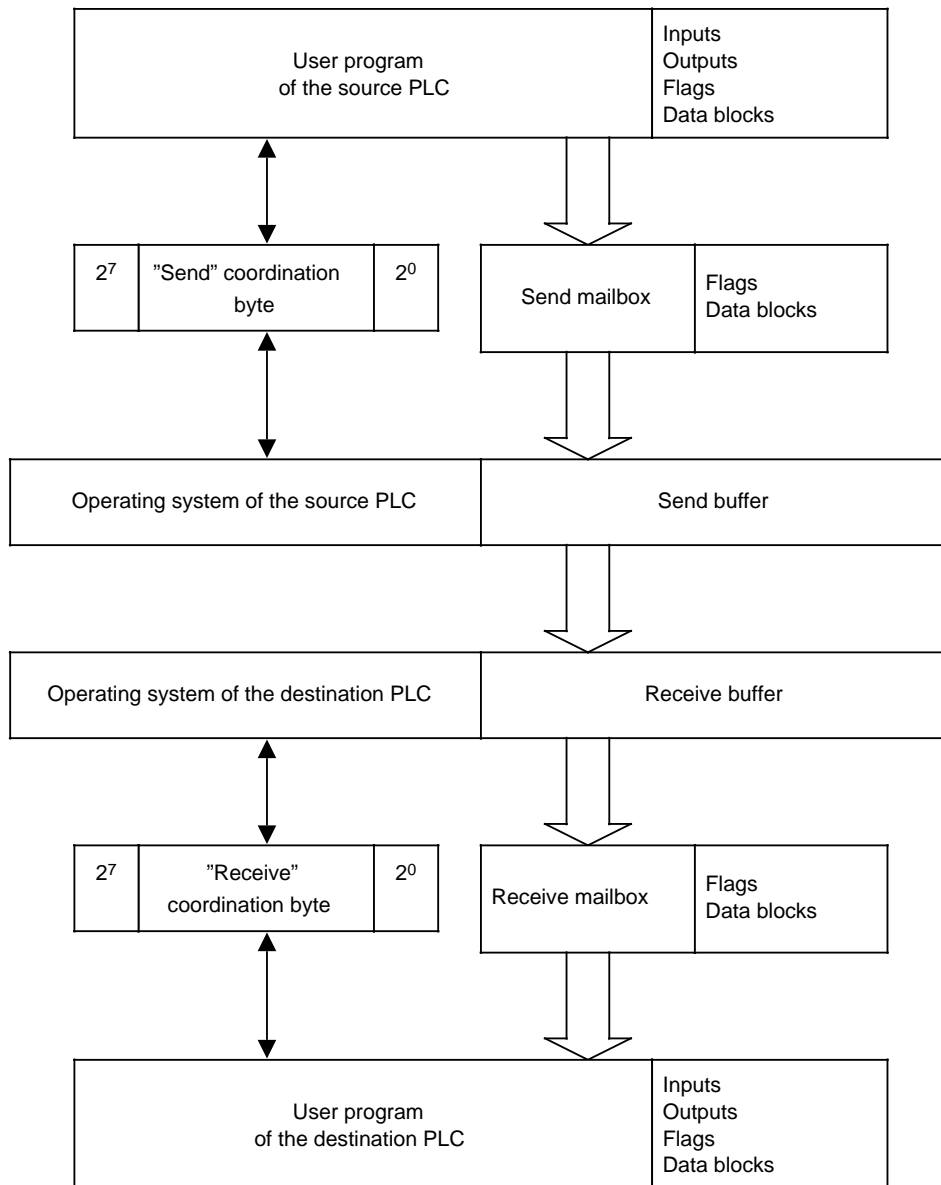
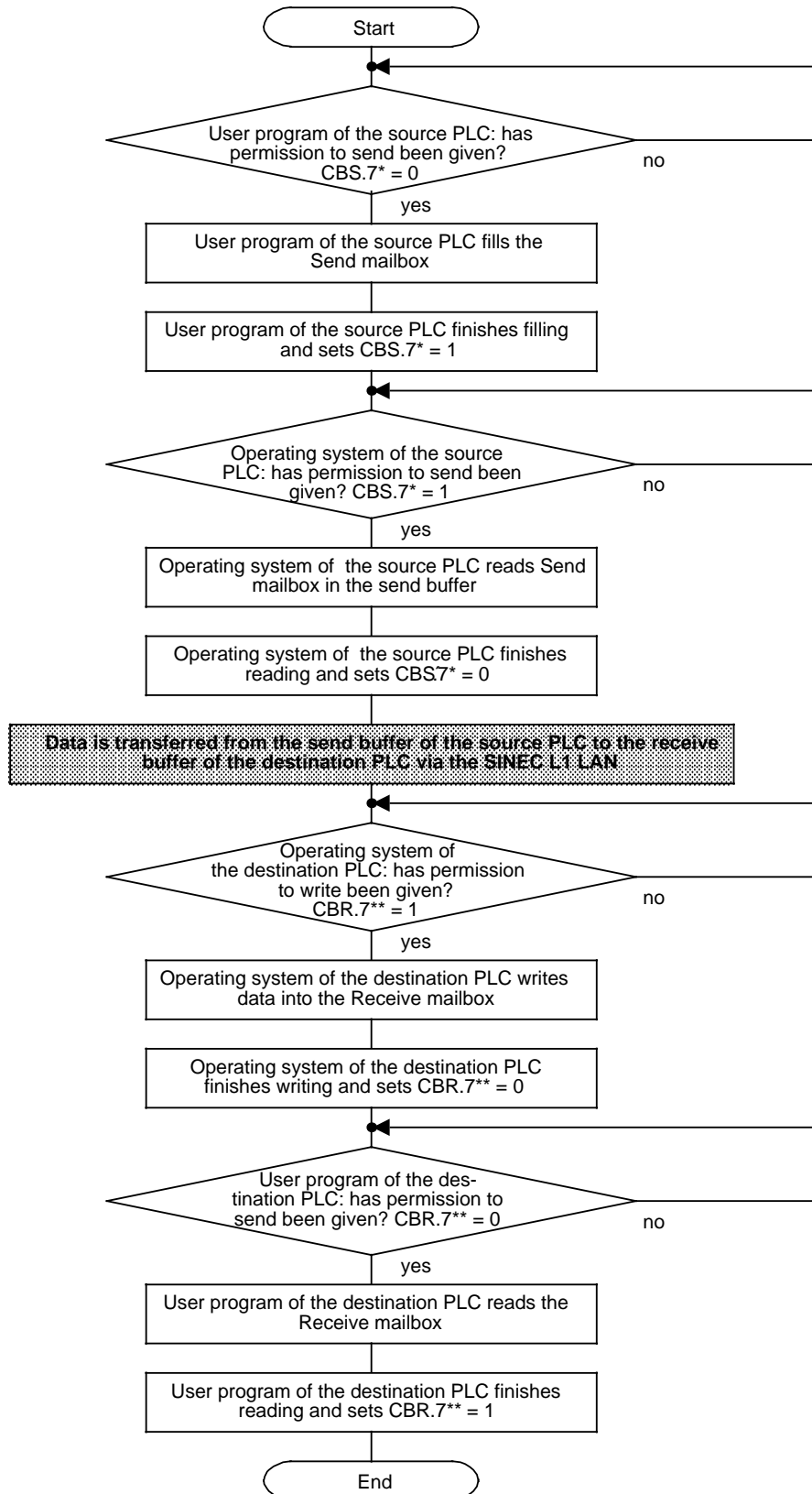


Figure 7-2. Schematic of Master-Slave Data Traffic via SINEC L1 LAN



** CBS.7 = bit 2⁷ of the "Send" coordination byte

** CBR.7 = bit 2⁷ of the "Receive" coordination byte

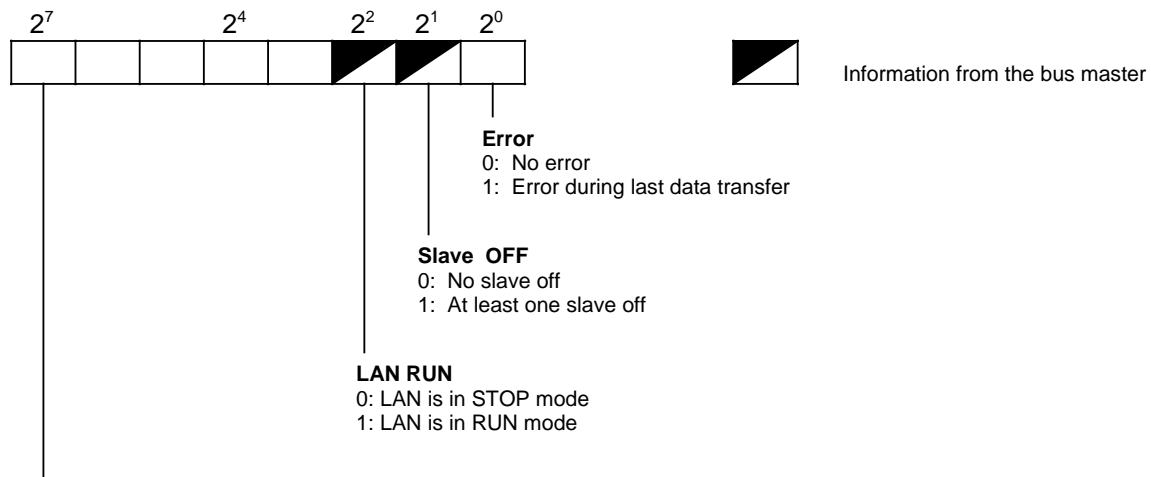
Figure 7-3. Master-Slave Data Transfer Sequence via SINEC L1 LAN

Coordination bytes

Coordination bytes form the interface to the PLC operating system. The programs of the slaves use these bytes to track and influence the flow of LAN traffic. The positions of the coordination bytes are configured using COM 115F.

Figure 7-4 explains the individual bits.

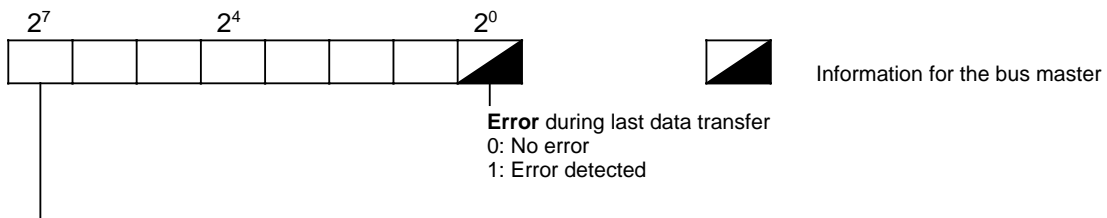
"Receive" Coordination Byte (CBR)



REC-PERM

- 0: The program can fetch data from the Receive mailbox. The operating system has no access.
- 1: The operating system can accept data in the Receive mailbox from the LAN. The program has no access. If REC-PERM = "1", the operating system fills the Receive mailbox with data. The operating system then resets REC-PERM to "0" (=0).

"Send" Coordination Byte (CBS)



SEND-PERM

- 0: The program can process the Send mailbox. The operating system has no access.
- 1: The Send mailbox is enabled to transmit on the LAN. The program has no access. SEND-PERM = "1" causes the operating system to transmit the contents of the Send mailbox. The operating system then resets the SEND-PERM bit to "0".

Figure 7-4. Structure of the "Receive" and "Send" Coordination Bytes

Note the different contents of the master and slave mailboxes in the S5-115F.

The following four tables show the mailbox contents for master traffic.

- Master-PLC with CP 530 sends to slave S5-115F
- Master-PLC without CP 530 sends to slave S5-115F
- Slave S5-115F sends to master PC with CP 530
- Slave S5-115F sends to master PC without CP 530

Table 7-1. Mailbox Contents, Master PLC with CP 530 Sending to Slave S5-115F

Master PLC with CP 530 Sends to Slave S5-115F			
Byte	Contents of master PLC Send mailbox (shared)	Byte	Contents of slave PLC Receive mailbox (source-specific)
0	Status Byte Send		
1	not used		
2	Net data 1	0	Net data 1
3	Net data 2	1	Net data 2
:	:	:	:
:	:	:	:
64	Net data 63	62	Net data 63
65	Net data 64	63	Net data 64

Note

If you are using a master PLC with CP 530, you must allow for the entire contents of the mailbox (net data plus 2 bytes) when assigning parameters to "FB SEND".

Table 7-2. Mailbox Contents, Master PLC without CP 530 Sending to Slave S5-115F

Master PLC without CP 530 Sends to Slave S5-115F			
Byte	Contents of master PLC Send mailbox (shared)	Byte	Contents of master PLC Receive mailbox (source-specific)
0	Length		
1	Destination		
2	Net data 1	0	Net data 1
3	Net data 2	1	Net data 2
:	:	:	:
:	:	:	:
64	Net data 63	62	Net data 63
65	Net data 64	63	Net data 64

Table 7-3. Mailbox Contents, Slave S5-115F Sending to Master PLC with CP 530

Slave S5-115F Sending to Master PLC with CP 530			
Byte	Contents of slave S5-115F Send mailbox (destination-specific)	Byte	Contents of master PLC Receive mailbox (shared)
		0	Status Byte Receive
		1	Length
		2	Source
		3	Reserved
0	Net data 1	4	Net data 1
1	Net data 2	5	Net data 2
:	:	:	:
:	:	:	:
62	Net data 63	66	Net data 63
63	Net data 64	67	Net data 64

Table 7-4. Mailbox Contents, Slave S5-115F Sending to a Master PLC without CP 530

Slave S5-115F Sending to Master PLC without CP 530			
Byte	Contents of slave S5-115F Send mailbox (destination-specific)	Byte	Contents of master PLC Receive mailbox (shared)
		0	Length
		1	Source
0	Net data 1	2	Net data 1
1	Net data 2	3	Net data 2
:	:	:	:
:	:	:	:
62	Net data 63	64	Net data 63
63	Net data 64	65	Net data 64

Point-to-point connection

You can connect an S5-115F direct to other controllers using a point-to-point connection. This saves you additional transceivers or interface modules.

The following table lists possible partners.

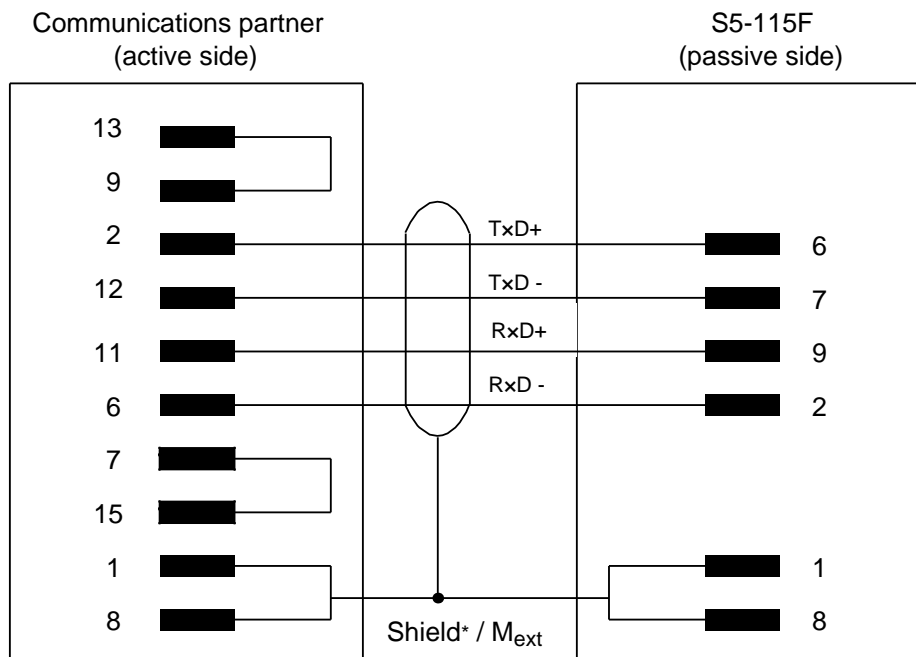
Table 7-5. Communications Partners in Point-to-Point Connection

Partners	Connection
S5-95U	Direct via 2nd serial interface
S5-115U with CPU 943/944	Direct via 2nd serial CPU interface
S5-115U/H, S5-135U, S5-155U/H	Via CP 530

There are two ways of establishing the connection:

- Via a bus cable (LAN) with transceivers (BT 777) or
- Via a direct line if both controllers are less than 100 m / 328 ft. apart. Use a four-wire shielded cable with a cross-section of at least 0.14 mm² (26 AWG). SIMATIC cable 6ES5 707-1AA00 is recommended.

Connect a 15-pin Cannon subminiature D connector with metal shell to each end of the cable. Figure 7-5 shows the connector pin assignment.



* Connect shield also to the connector shell

Figure 7-5. Connector Pin Assignment for Direct Point-to-Point Connection

Operator-process communication and visualization

For operator-process communication and visualization, a communication and visualization PLC must be connected to the S5-115F via the SINEC L1 LAN. The connection is established to subunit B so that the interface of subunit A is free for a programmer. In Figure 7-6 the communication and visualization PLC is the SINEC L1 master with the CP 530 module and the S5-115F with its subunit B is a SINEC L1 slave.

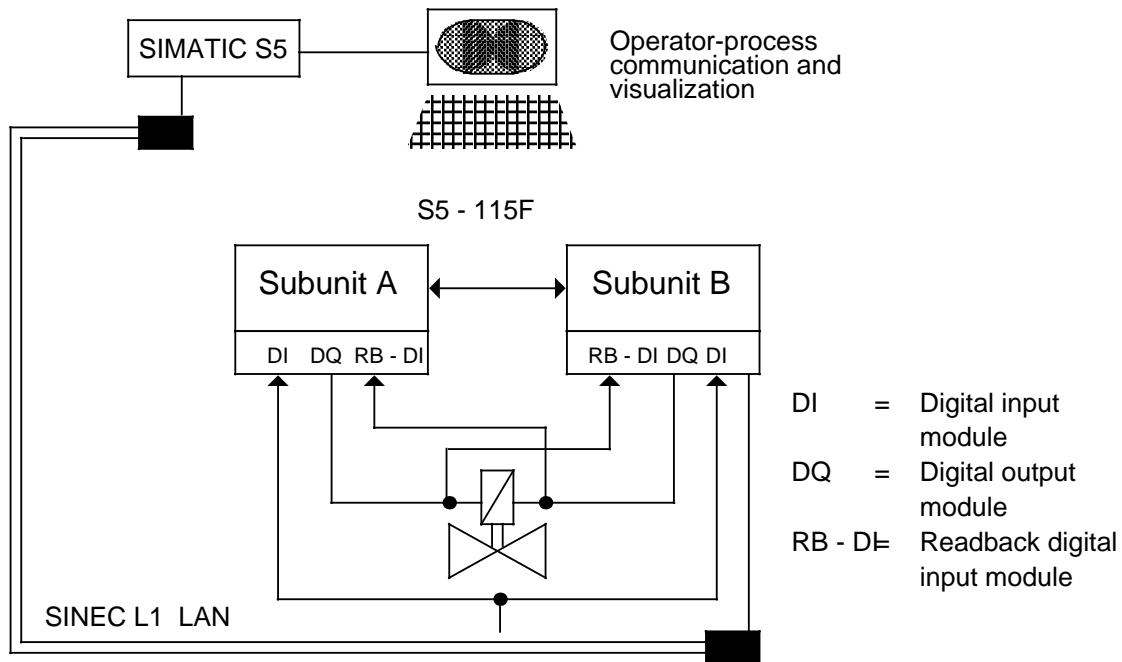


Figure 7-6. Operator-Process Communication and Visualization

Visualization tasks do not influence the program executing in the S5-115F. Operator inputs from the programmer or PLC are only safety-related if they are subjected to a safety test by a user filter program.

During this safety test you must check the validity of the data and transfer it to a data area to which the user program has only read access. You must check the programmer input data in the restart OBs (OB21/OB22).

Transfer of error DBs

Please note the following when programming your SINEC L1 messages:

If a subunit detects a 115F error, the subunit sends the body its error DB (56 bytes) to the SINEC L1 master. In such a case, subunit A sends DB 2 and subunit B sends DB 3. The frame received by the master contains a frame header as well as the actual body of the error DB. The structure of the frame header depends on the type of networking. A distinction is made between:

- Point-to-point connection between an S5-115F as slave and an S5-95U with two interfaces or S5-115U with the CPU 943 or CPU 944 as master. The link is possible via the programmer interface with or without SINEC L1 BT 777 transceivers.
- Connection between several S5-115Fs as slaves and an S5 of the U range with CP 530 as master.

The user program differentiates between error message frames from the operating system and all other frames in the following way in the case of both types of connection:

- Error message frames always have a 56-byte long body. The length of the body is given in the frame header.
- The second byte of the frame body contains the subunit ID of the source
 - in the case of one-channel SINEC L1 LAN: second byte = "B"
 - in the case of two-channel SINEC L1 LAN in the master of LAN A: second byte = "A"
 - in the case of two-channel SINEC L1 LAN in the master of LAN B: second byte = "B"

So that your user programs are not mistaken for error message frames by the operating system, all user message frames which

- have a frame body length of 56 bytes
and also
- have ID "A" or "B" in the second byte of the frame body

are prohibited:

The following two figures show the different structure of both Receive message frames in the master PLC.

In the case of point-to-point connection, the Receive mailbox of the master contains the following frame:

Message header	Byte	0	Length of message body (bytes) = 56
		1	Slave No. of source S5-115F
Message frame body of the error message (error DB body)		2	'C' = B (or A or B in the case of a two-channel SINEC L1 LAN)
		3	
		4	
		:	
		:	
		:	
		56	
	57		
Unassigned		58	
		:	
		:	
		:	
		:	
		:	
		65	

Figure 7-7. SINEC L1 Message Frame with Error Message in the Case of Point-to-Point Connection

In the case of multiple connections with a CP 530 in the master, the Receive mailbox contains the following message frame:

Message header	Byte	0	Status byte
		1	Length of message body (bytes) = 56
		2	Slave No. source S5-115F
		3	Reserved
Frame body of the error message (error DB body)		4	'C' = B (or A or B in the case of a two-channel SINEC L1 LAN)
		5	
		6	
		:	
		:	
		:	
		58	
	59		
Unassigned		60	
		:	
		:	
		:	
		:	
		:	
		67	

Figure 7-8. SINEC L1 Message Frame with Error Message in the Case of Multiple Connections

7.2.2 Safety-Related Connection of Several S5-115Fs

Process automation systems consist of several PLCs if

- The I/O capacity of one PLC is not sufficient
- The user program is too long for one PLC
- A distributed configuration is required (e.g. for availability reasons).

Message structure variants

The message protection mechanism has been extended in the CPU 942-7UF15. Safety-related broadcast messages from the slave and nonsafety-related broadcast messages from the master are now also possible.

You can, of course, still use the CPU with the "old" protection mechanism, because it also supports the message modes of CPU 942-7UF11 ...14. You assign the parameters for the applicable message mode with COM 115F. Please note the differences in the message and mailbox structures.

The following table gives an overview of the three message modes.

Table 7-6. Overview of the Three Message Modes

Message mode	Supported by	Features	Application
115F-13 mode	CPU 942-7UF11 ...15	Data transmission without protective specification of the destination slave number	Only allowed if the mailboxes of the destination slaves are all of different length
115F-14 mode	CPU 942-7UF14 ...15	Data transmission with protective specification of the destination slave number	Communication with S5-115F with CPU 942-7UF14 and S5-95F
115F-15 mode	CPU 942-7UF15	Data transmission with protective specification of the destination slave number and message change monitoring	Standard application, for communication with CPU 942-7UF15 and S5-95F

Important for configuring mailboxes:

Note

When configuring with COM 115F, remember that the length of the Send mailbox must be the same as that of the relevant Receive mailbox.

Safety-related connection of several S5-115F PLCs

Safety-related data exchange is based on the multi-mailbox system. In addition to the two mailboxes described in Section 7.2.1 for master traffic, there is one mailbox per data path in the transmitting slave and one per data path in the receiving slave for interslave communication.

The master PLC can be any SIMATIC S5 PLC in which a CP 530 can be used. The master can also process other, nonsafety-related tasks (e.g. operator-process communication and visualization).

Note

Safety-related data transmission is handled entirely by the operating system. There is no manipulation of coordination bytes.
 You can coordinate data transfer by evaluating reply messages at user level.

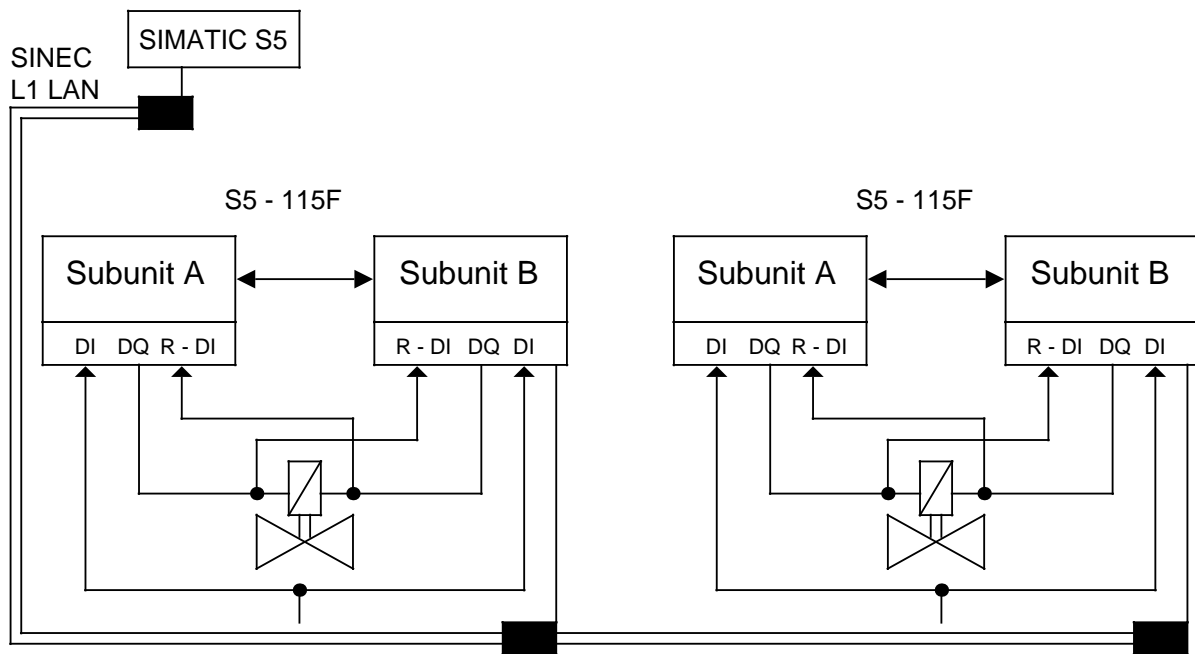


Figure 7-9. Safety-Related Networking of Several S5-115Fs: Single-Channel SINEC L1 LAN

Warning

The sending of a message must not take longer than one SINEC L1 safety time. For this reason, you must not make any changes to the Send mailbox for this length of time. Premature alteration of the contents of the mailbox could lead to the undetected loss of a message. Try to leave as long an interval as possible between two messages.

The following figures show the contents of the mailboxes for safety-related interslave communication in the different message modes.

Table 7-7. Mailbox Contents, S5-115F Slave PLC Sending to S5-115F Slave PLC in 115F-13 Message Mode

Slave S5-115F Sending to Slave S5-115F in 115F-13 Message Mode			
Byte	Contents of the Send mailbox (destination-specific)	Byte	Contents of the Receive mailbox (source-specific)
0	Net data 1	0	Net data 1
1	Net data 2	1	Net data 2
:	:	:	:
:	:	:	:
60	Net data 61	60	Net data 61
61	Net data 62	61	Net data 62

Table 7-8. Mailbox Contents, S5-115F Slave PLC Sending to S5-115F Slave PLC in 115F-14 Message Mode

Slave S5-115F Sending to Slave S5-115F in 115F-14 Message Mode			
Byte	Contents of the Send mailbox (destination-specific)	Byte	Contents of the Receive mailbox (source-specific)
0	Destination slave number	0	Own slave number
1	Not assigned (00 _H)	1	Not assigned (00 _H)
2	Net data 1	2	Net data 1
3	Net data 2	2	Net data 2
:	:	:	:
:	:	:	:
60	Net data 59	60	Net data 59
61	Net data 60	61	Net data 60

Table 7-9. Mailbox Contents, S5-115F Slave PLC Sending to S5-115F Slave PLC in 115F-15 Message Mode

Slave S5-115F Sending to Slave S5-115F in 115F-15 Message Mode			
Byte	Contents of the Send mailbox (destination-specific)	Byte	Contents of the Receive mailbox (source-specific)
0	Destination slave number	0	Own slave number
1	Change byte	1	Change byte
2	Net data 1	2	Net data 1
3	Net data 2	2	Net data 2
:	:	:	:
:	:	:	:
60	Net data 59	60	Net data 59
61	Net data 60	61	Net data 60

Processing Send and Receive mailboxes

The Send and Receive mailboxes can only be processed with SINEC L1 synchronization. Synchronization is performed:

- Automatically by the operating system
- By calling FB 254 with the "SINEC L1 processing" parameter in the user program.

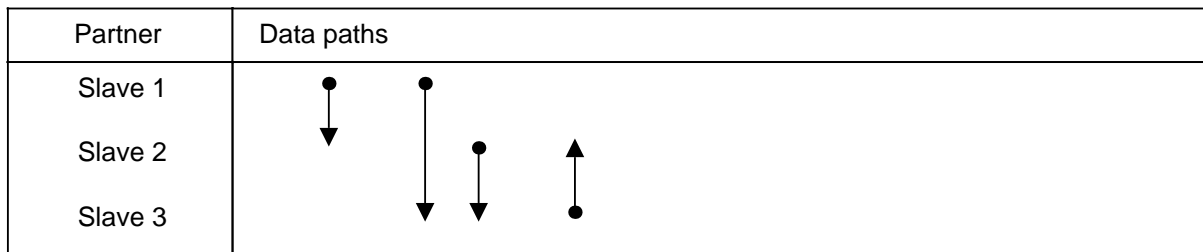
Synchronization of SINEC L1 processing takes place automatically every 30 to 40 ms in the operating system. We therefore recommend that you also carry out synchronization every 30 to 40 ms in the user program by calling FB 254 with the "SINEC L1 processing" parameter.

To maintain data consistency, you should always process the Receive and Send mailbox in a continuous program sequence. Processing must be completed before the next SINEC L1 synchronization takes place.

To ensure that the program sequence is not interrupted, you should inhibit interrupt processing (IA statement).

Example:

There are six possible data paths for interslave communications when using three slaves. Only the following four data paths should be implemented, however:



Slave 1 provides slaves 2 and 3 with information via central control. In addition, data is exchanged between slaves 2 and 3 in both directions. These four data paths correspond to the following mailboxes:

- Slave 1 : Send mailbox for data to Slave 2
Send mailbox for data to Slave 3
No Receive mailbox
- Slave 2 : Send mailbox for data to Slave 3
Receive mailbox for data from Slave 1
Receive mailbox for data from Slave 3
- Slave 3 : Send mailbox for data to Slave 2
Receive mailbox for data from Slave 1
Receive mailbox for data from Slave 2

For the user program in Slave 2 in the example this means:

Slave 2 writes data for slave 3 to receive into the Receive mailbox of slave 3. Note here that writing is completed before the user calls the next FB 254 SYNC. If the SINEC L1 data path is free and if FB 254 "SYNC processing" has been possible in the receiving slave 3, the contents of the mailbox are transferred by calling FB 254 SYNC and arrive in the Receive mailbox of slave 3.

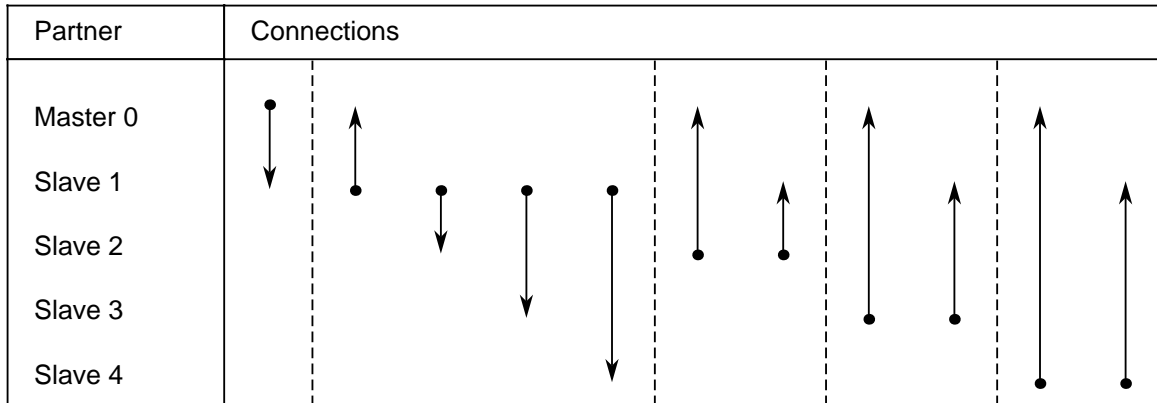
The Send mailbox in slave 2 can be processed with the next FB 254 "SYNC processing", but this is not mandatory.

Example for one-channel SINEC L1 LAN:

In this SINEC L1 LAN programming example, four S5-115Fs are:

- connected together in a safety-related configuration with 115F-14 message mode
- connected to the master S5-115U in a nonsafety-related configuration

The following transfers are implemented:



When an error occurs, Slave 1 sends the body of the error DB (with the error message code) to the master in addition to the normal messages. The master only sends to Slave 1, which exchanges data in both directions with the other three slaves.

The following figure shows the mailbox structure for a one-channel SINEC L1 LAN.

The uppercase letters in the figure refer to the subunits. In the case of Send mailboxes, the digits indicate the destination PLC. In the case of Receive mailboxes, the digits indicate the source PLC. "0" indicates the master and the digits 1 to 4 indicate the slaves.

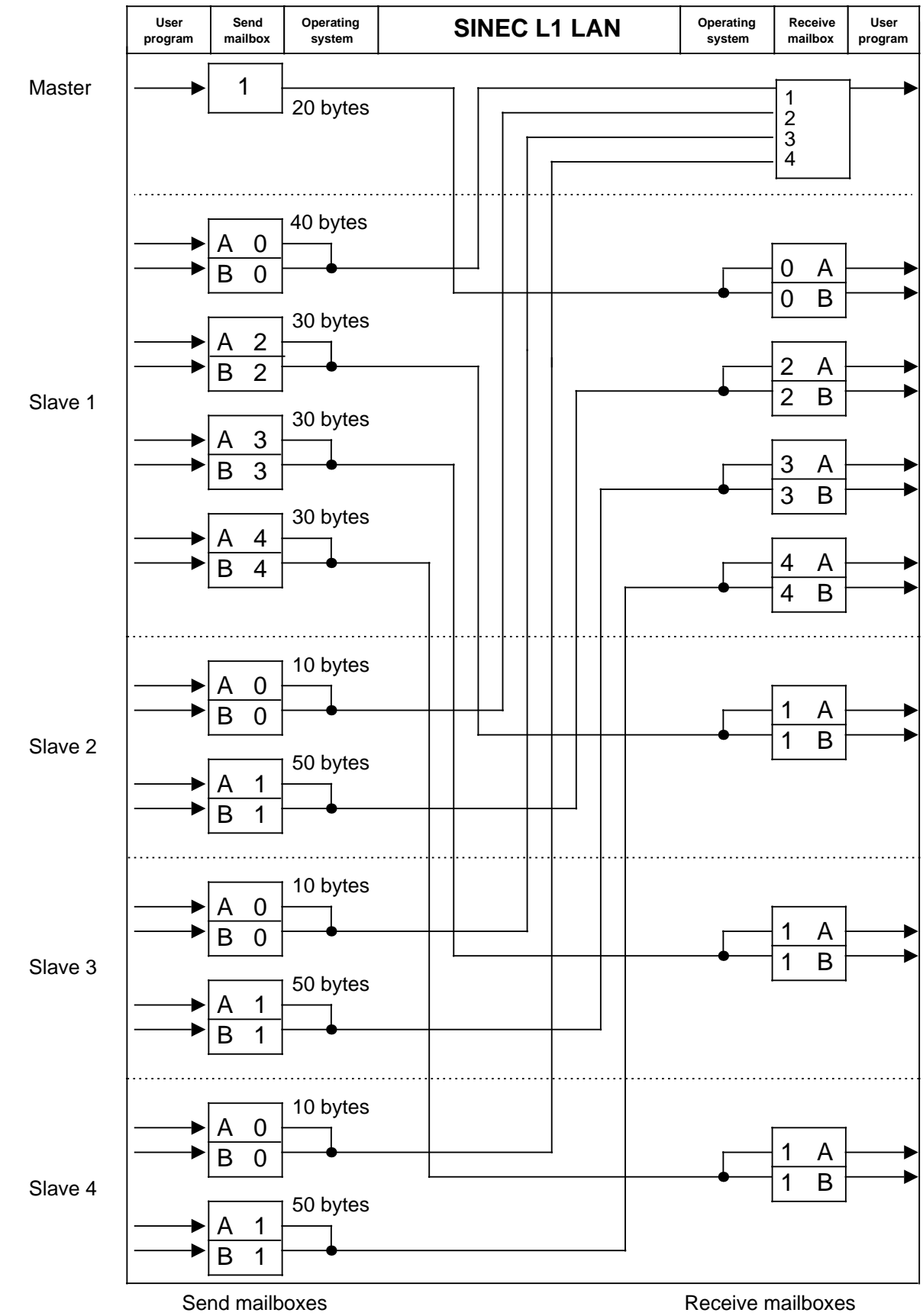


Figure 7-10. Mailbox Structure in the Case of a Single-Channel SINEC L1 LAN

Mailboxes A and B in the slave PLCs indicate identical mailboxes in both subunits. The master PLC, on the other hand, has only one Send mailbox and one Receive mailbox.

Configuring

The mailbox system for the SINEC L1 LAN is configured for the slave (Vol. 2, 1.1.2 of the manual). For this purpose, COM 115F installs a table of Send mailboxes and a table of Receive mailboxes in configuration DB1. Five bytes are reserved for each mailbox. You must also install coordination bytes for the master.

Table 7-10 shows the configuring procedure of the SINEC-L1 structure tailored to the above example:

Table 7-10. Configuration of a SINEC L1 Structure with COM 115F (Example)

COM 115F interrogates/calculates	Example	Configuration in Slave			
		1	2	3	4
SINEC L1 LAN available?		Y	Y	Y	Y
How many SINEC L1 LANs?		1	1	1	1
Own slave No.?		1	2	3	4
Number of elements in the master polling list (=total number of send data paths)?	Slave data paths 1-2, 1-3, 1-4, 2-1, 3-1, 4-1, 1-0, 2-0, 3-0, 4-0	10	10	10	10
SINEC L1 safety time (+10 ms)?		150	150	150	150
Number of data bytes with master traffic Send mailboxes used more than once count each time. SINEC L1 polling time= Number of send data paths of all slaves times 44 ms+ number of data bytes with master traffic times 2 ms < SINEC L1 safety time in ms	0-1: 20 bytes 1-0: 56 bytes* 1-2, 1-3, 1-4: 30 bytes each 2-0, 3-0, 4-0: 10 bytes each 2-1, 3-1, 4-1: 50 bytes each 330 bytes SINEC L1 polling time = 10*44 ms + 346*2 ms = 1132 ms	346	346	346	346
Table for coordination bytes for master traffic?	Coordination bytes in FY 2 and FY 3	'M' 2 - 'M' 3 -	'M' 2 - 'M' 3 -	'M' 2 - 'M' 3 -	'M' 2 - 'M' 3 -

* Length of error message

Table 7-10. Configuration of a SINEC L1 Structure with COM 115F (Continued)

COM 115F interrogates/calculates	Example	Configuration in Slave			
		1	2	3	4
Send mailbox table	Send mailboxes are in DB 100 from DW0 onward	0	0	0	0
		40	10	10	10
		'D'	'D'	'D'	'D'
		100	100	100	100
		0	0	0	0
		2	1	1	1
		30	50	50	50
		'D'	'D'	'D'	'D'
		100	100	100	100
		20	5	5	5
3					
30					
'D'					
100					
35					
4					
30					
'D'					
100					
50					
Receive mailbox table	Receive mailboxes are in DB 101 from DW0 onward	0	0	0	0
		20	30	30	30
		'D'	'D'	'D'	'D'
		101	101	101	101
		0	0	0	0
		2			
		50			
		'D'			
		101			
		10			
3					
50					
'D'					
101					
35					
4					
50					
'D'					
101					
60					

Explanation of Table 7-10

The SINEC L1 LAN is operated with a single channel.

The slave No. is 1 to 4 in the S5-115F programmable controllers.

Our example contains 10 different send data paths from slave to slave and from slave to master. One element must be entered in the SINEC L1 polling list for each send data path.

The polling list could, for example, be: 1-2-3-1-4-2-1-2-1-4.

The process demands that an error in the signals transmitted over the SINEC L1 LAN must be detected within 1.5 seconds (the maximum SINEC L1 safety time is 1.5 s).

The total volume of information transmitted in our example is 346 bytes, which gives a maximum polling time of 1140 ms for slave-to-slave data paths.

The 1.5 s safety time allowed for by the process for the relevant data is viable: the safety time is greater than the SINEC L1 polling time.

In our example, the coordination bytes should be situated in the flag area, flags 2 and 3.

There are six slave-to-slave and four slave-to-master data paths. This means that 10 Send mailboxes must be defined. For example, the following applies to slave 1:

- 1 to 0
- 1 to 2
- 1 to 3
- 1 to 4.

The following must be specified:

- Mailbox length in bytes (40,30,30,30),
- Mailbox location (DB for all four Send mailboxes),
- DB No. (100 for all four Send mailboxes).
- Initial data word No. (0,20,35,50).

In our example there are six slave-to-slave data paths and one master-to-slave data path. This means that seven Receive mailboxes must be defined. For example, four of the mailboxes are allocated to Slave 1:

- 0 to 1
- 2 to 1
- 3 to 1
- 4 to 1

The following must be specified:

- Mailbox length in bytes (20,50,50,50)
- Mailbox location (DB for all four Receive mailboxes)
- DB No. (101 for all four Receive mailboxes)
- Initial data word No. (0,10,35,60).

Note

If you use the function for sending error messages to the SINEC L1 master, you must allow for this send data path and the amount of data required (56 bytes) when calculating the SINEC L1 polling time.

7.2.3 Connecting Several S5-115Fs with S5 PLCs of the U Range

You can also add S5 PLCs of the U range to safety-related networks of several S5-115Fs as SINEC L1 slaves (7.2.2).

The following PLCs can be used as slaves with the CP 530:

- S5-115U/H
- S5-135U
- S5-150U
- S5-155U/H

The following PLCs can be used as slaves without the CP 530:

- S5-90U
- S5-95U
- S5-100U with CPU 102 or CPU 103
- S5-101U (Order No. 6ES5 101-8UA13)
- S5-115U

Data transfers with an S5 of the U range as source or destination are not safety-related.

Please note the following points:

- Interrupt messages are prohibited
- Safety-related broadcast messages are only possible in systems with the CPU 942-7UF15.
- Messages from the S5-115F have a special structure. The receiving user program in the S5-U controller must take this structure into account when reading the message.
- Messages from S5-U controllers to an S5-115F must have the S5-115F-specific message structure. There must also be a guarantee that at least one message reaches an S5-115F within the SINEC L1 safety time. Data traffic must be organized by the user program.
- Messages between S5s of the U range are possible. It is not necessary here to observe either the signature extension or the time condition with regard to the SINEC L1 safety time.

The S5-115F has the following for interslave communications:

- A Send mailbox for each destination PLC
- A Receive mailbox for each source PLC

The Send and Receive mailboxes are configured with COM 115F.

Coordination bytes are not manipulated.

The mailboxes can be read or overwritten at any time.

Data exchange in the U system has been retained unchanged for slave S5-115Us:

- Common Send mailbox for all destination PLCs
- Common Receive mailbox for all source PLCs
- Coordination bytes (CBR and CBS).

The mailboxes are enabled each time FB 254 SYNC is called with the "SINEC L1 processing" parameter

- for sending a message and
- for receiving a message

Mailbox contents in 115F-13 message mode

Note the different contents of the mailboxes in the slave S5 of the U range and in the slave S5-115F.

The following four figures show mailbox contents for interslave communications in 115F-13 message mode:

- Slave PLC of the S5-U range with CP 530 sending to slave S5-115F
- Slave PLC of the S5-U range without CP 530 sending to slave S5-115F
- Slave S5-115F sending to slave PLC of the S5-U range with CP 530
- Slave S5-115F sending to slave PLC of the S5-U range without CP 530

Table 7-11. Mailbox Contents, Slave PLC of the S5-U Range with CP 530 Sending to Slave S5-115F

Slave PLC of the S5-U Range with CP 530 Sending to Slave S5-115F			
Byte	Contents of the Send mailbox of the slave S5-U PLC (shared)	Byte	Contents of the Receive mailbox of the slave S5-115F (source-specific)
0	0		
1	0		
2	Signature (high byte)		
3	Signature (low byte)		
4	Net data 1	0	Net data 1
5	Net data 2	1	Net data 2
⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮
64	Net data 61	60	Net data 61
65	Net data 62	61	Net data 62

Table 7-12. Mailbox Contents, Slave PLC of the S5-U Range without CP 530 Sending to Slave S5-115F

Slave PLC of the S5-U Range without CP 530 Sending to Slave S5-115F			
Byte	Contents of the Send mailbox of the slave S5-U PLC (shared)	Byte	Contents of the Receive mailbox of the slave S5-115F (source-specific)
0	Length		
1	Destination		
2	Signature (high byte)		
3	Signature (low byte)		
4	Net data 1	0	Net data 1
5	Net data 2	1	Net data 2
⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮
64	Net data 61	60	Net data 61
65	Net data 62	61	Net data 62

Table 7-13. Mailbox Contents, Slave S5-115F Sending to PLC of the S5-U Range with CP 530

Slave S5-115F Sending to PLC of the S5-U Range with CP 530			
Byte	Contents of the Send mailbox of the slave S5-115F (destination-specific)	Byte	Contents of the Receive mailbox of the slave S5-U PLC (shared)
		0	CBR
		1	Length
		2	Source
		3	Reserved
		4	Signature (high byte)
		5	Signature (low byte)
0	Net data 1	6	Net data 1
1	Net data 2	7	Net data 2
:	:	:	:
:	:	:	:
66	Net data 61	66	Net data 61
67	Net data 62	67	Net data 62

Table 7-14. Mailbox Contents, Slave S5-115F Sending to PLC of the S5-U Range without CP 530

Slave S5-115F Sending to PLC of the S5-U Range without CP 530			
Byte	Contents of the Send mailbox of the slave S5-115F (destination-specific)	Byte	Contents of the Receive mailbox of the slave S5-U PLC (shared)
		0	Length
		1	Source
		2	Signature (high byte)
		3	Signature (low byte)
0	Net data 1	4	Net data 1
1	Net data 2	5	Net data 2
:	:	:	:
:	:	:	:
60	Net data 61	64	Net data 61
61	Net data 62	65	Net data 62

Mailbox contents in 115F-14 message mode

Note the different contents of the mailboxes in the slave S5 of the U range and in the slave S5-115F. The following four figures show the mailbox contents for interslave communications using 115F-14 message mode:

- Slave PLC of the S5-U range with CP 530 sending to slave S5-115F
- Slave PLC of the S5-U range without CP 530 sending to slave S5-115F
- Slave S5-115F sending to slave PLC of the S5-U range with CP 530
- Slave S5-115F sending to slave PLC of the S5-U range without CP 530

Table 7-15. Mailbox Contents, Slave PLC of the S5-U Range with CP 530 Sending to Slave S5-115F

Slave PLC of the S5-U Range with CP 530 Sending to Slave S5-115F			
Byte	Contents of the Send mailbox of the slave S5-U PLC (shared)	Byte	Contents of the Receive mailbox of the slave S5-115F (source-specific)
0	0		
1	0		
2	Signature (high byte)		
3	Signature (low byte)		
4	Destination slave number	0	Own slave number
5	Not assigned (00 _H)	1	Not assigned (00 _H)
6	Net data 1	2	Net data 1
7	Net data 2	3	Net data 2
⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮
64	Net data 59	60	Net data 59
65	Net data 60	61	Net data 60

Table 7-16. Mailbox Contents, Slave PLC of the S5-U Range without CP 530 Sending to Slave S5-115F

Slave PLC of the S5-U Range without CP 530 Sending to Slave S5-115F			
Byte	Contents of the Send mailbox of the slave S5-U PLC (shared)	Byte	Contents of the Receive mailbox of the slave S5-115F (source-specific)
0	Length		
1	Destination		
2	Signature (high byte)		
3	Signature (low byte)		
4	Destination slave number	0	Own slave number
5	Not assigned (00 _H)	1	Not assigned (00 _H)
6	Net data 1	2	Net data 1
7	Net data 2	3	Net data 2
⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮
64	Net data 61	60	Net data 61
65	Net data 62	61	Net data 62

Table 7-17. Mailbox Contents, Slave S5-115F Sending to PLC of the S5-U Range with CP 530

Slave S5-115F Sending to PLC of the S5-U Range with CP 530			
Byte	Contents of the Send mailbox of the slave S5-115F (destination-specific)	Byte	Contents of the Receive mailbox of the slave S5-U PLC (shared)
		0	CBR
		1	Length
		2	Source
		3	Reserved
		4	Signature (high byte)
		5	Signature (low byte)
0	Destination slave number	6	Own slave number
1	Not assigned (00 _H)	7	Not assigned (00 _H)
2	Net data 1	8	Net data 1
3	Net data 2	9	Net data 2
⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮
66	Net data 59	66	Net data 59
67	Net data 60	67	Net data 60

Table 7-18. Mailbox Contents, Slave S5-115F Sending to PLC of the S5-U Range without CP 530

Slave S5-115F Sending to PLC of the S5-U Range without CP 530			
Byte	Contents of the Send mailbox of the slave S5-115F (destination-specific)	Byte	Contents of the Receive mailbox of the slave S5-U PLC (shared)
		0	Length
		1	Source
		2	Signature (high byte)
		3	Signature (low byte)
		4	Own slave number
		5	Not assigned (00 _H)
0	Destination slave number	6	Net data 1
1	Not assigned (00 _H)	7	Net data 2
2	Net data 1	⋮	⋮
3	Net data 2	⋮	⋮
⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮
60	Net data 59	64	Net data 61
61	Net data 60	65	Net data 60

Mailbox contents in 115F-15 message mode

Note the different contents of the mailboxes in the slave S5 of the U range and in the slave S5-115F. The following four figures show the mailbox contents for interslave communications using 115F-15 message mode:

- Slave PLC of the S5-U range with CP 530 sending to slave S5-115F
- Slave PLC of the S5-U range without CP 530 sending to slave S5-115F
- Slave S5-115F sending to slave PLC of the S5-U range with CP 530
- Slave S5-115F sending to slave PLC of the S5-U range without CP 530

Table 7-19. Mailbox Contents, Slave PLC of the S5-U Range with CP 530 Sending to Slave S5-115F

Slave PLC of the S5-U Range with CP 530 Sending to Slave S5-115F			
Byte	Contents of the Send mailbox of the slave S5-U PLC (shared)	Byte	Contents of the Receive mailbox of the slave S5-115F (source-specific)
0	0		
1	0		
2	Signature (high byte)		
3	Signature (low byte)		
4	Destination slave number	0	Own slave number
5	Change byte	1	Change byte
6	Net data 1	2	Net data 1
7	Net data 2	3	Net data 2
⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮
64	Net data 59	60	Net data 59
65	Net data 60	61	Net data 60

Table 7-20. Mailbox Contents, Slave PLC of the S5-U Range without CP 530 Sending to Slave S5-115F

Slave PLC of the S5-U Range without CP 530 Sending to Slave S5-115F			
Byte	Contents of the Send mailbox of the slave S5-U PLC (shared)	Byte	Contents of the Receive mailbox of the slave S5-115F (source-specific)
0	Length		
1	Destination		
2	Signature (high byte)		
3	Signature (low byte)		
4	Destination slave number	0	Own slave number
5	Change byte	1	Change byte
6	Net data 1	2	Net data 1
7	Net data 2	3	Net data 2
⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮
64	Net data 61	60	Net data 61
65	Net data 62	61	Net data 62

Table 7-21. Mailbox Contents, Slave S5-115F Sending to PLC of the S5-U Range with CP 530

Slave S5-115F Sending to PLC of the S5-U Range with CP 530			
Byte	Contents of the Send mailbox of the slave S5-115F (destination-specific)	Byte	Contents of the Receive mailbox of the slave S5-U PLC (shared)
0	Destination slave number	0	CBR
1	Change byte	1	Length
2	Net data 1	2	Source
3	Net data 2	3	Reserved
⋮	⋮	4	Signature (high byte)
⋮	⋮	5	Signature (low byte)
66	Net data 59	6	Own slave number
67	Net data 60	7	Change byte
		8	Net data 1
		9	Net data 2
		⋮	⋮
		⋮	⋮
		66	Net data 59
		67	Net data 60

Table 7-22. Mailbox Contents, Slave S5-115F Sending to PLC of the S5-U Range without CP 530

Slave S5-115F Sending to PLC of the S5-U Range without CP 530			
Byte	Contents of the Send mailbox of the slave S5-115F (destination-specific)	Byte	Contents of the Receive mailbox of the slave S5-U PLC (shared)
0	Destination slave number	0	Length
1	Change byte	1	Source
2	Net data 1	2	Signature (high byte)
3	Net data 2	3	Signature (low byte)
⋮	⋮	4	Own slave number
⋮	⋮	5	Change byte
60	Net data 59	6	Net data 1
61	Net data 60	7	Net data 2
		⋮	⋮
		⋮	⋮
		64	Net data 61
		65	Net data 60

Special features of the message structure

The messages of a slave S5-115F PLC must have a special header. The message header is necessary for protecting the message data and consists of a 16-bit signature, a destination slave protection byte and a message change byte. The message header is always transmitted automatically by the S5-115F before the net data.

The messages of a PLC of the S5-U range do not have the S5-115F message header. For this reason, you must take note of the following when exchanging data between a slave S5-115F PLC and a slave PLC of the S5-U range:

Sending a message from a slave PLC of the S5-U range to a slave S5-115F PLC

Messages are only accepted by the slave S5-115F PLC if the complete message header is written to the Receive mailbox. The message header contains information to protect the message, such as the length of the message sent, the destination slave number, signature and message change byte (Tables 7-11 and 7-12).

To calculate the signature you would require special information which is beyond the scope of this manual. If you want to send messages from a slave PLC of the S5-U range to a slave S5-115F PLC, please consult your local Siemens regional office.

Safety note

- Inclusion of the security information ensures the correct transmission path. The net data sent is nonsafety-related data, since it comes from a nonsafety-related programmable controller. If you want to use the net data transmitted for safety-related processing, you must subject the data received to a validity check.
- To ensure that a message received from a PLC of the S5-U range is not delivered to the mailbox of a different partner if the destination address is corrupted, you must choose a message length which is not used by any other node.

Sending a message from a slave S5-115F to a slave of the S5-U range

The PLC of the S5-U range receives the message header and the actual net data. Evaluation of the message header is not necessary and is left to the user's discretion.

7.2.4 Safety-Related and Fault-Tolerant Networking

A safety-related network consisting of several S5-95Fs and S5-115Fs is fault-tolerant if two SINEC L1 LANs are installed with two SIMATIC S5 PLCs.

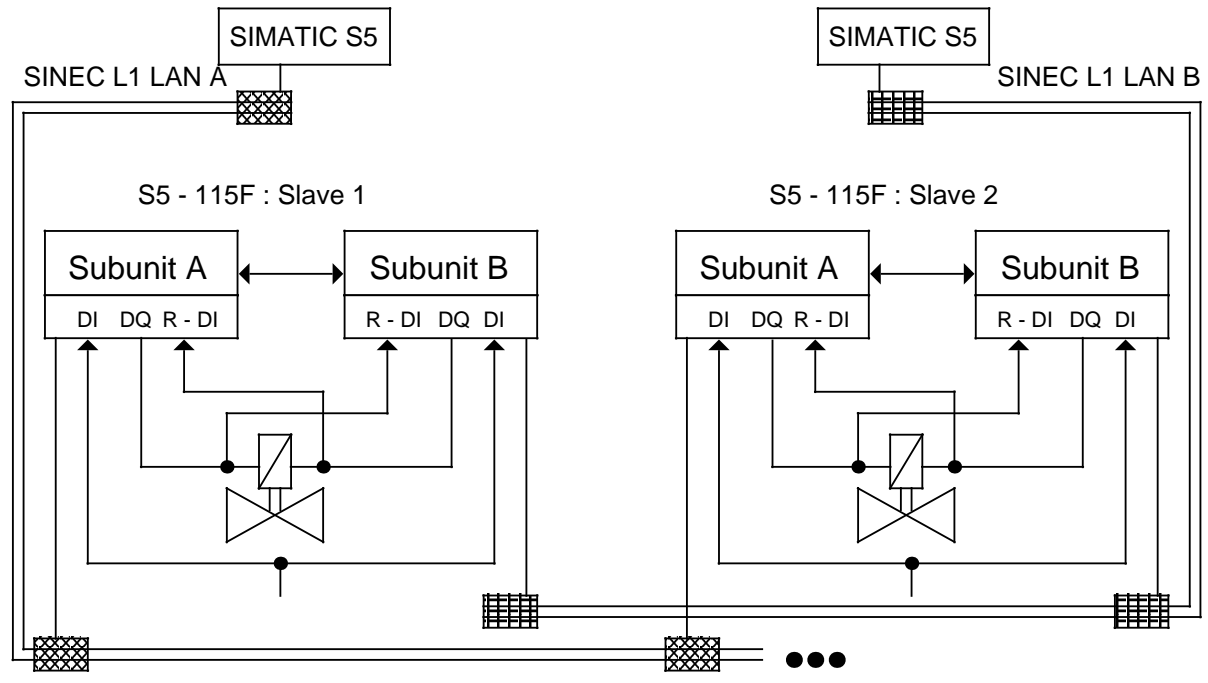


Figure 7-11. Safety-Related and Fault-Tolerant Networking of Several S5-115Fs

The multimailbox system of the single-channel SINEC L1 LAN is the basis of this configuration. This system has a separate mailbox for every data path, which is updated by synchronizing FB 254 SYNC with the "SINEC L1 processing" identifier once during the SINEC L1 safety time.

In contrast to the single-channel SINEC L1 LAN in the S5-115F, the two-channel SINEC L1 LAN has two Receive mailbox systems, one for LAN A, and one for LAN B. It has, however, only one Send mailbox system.

The two SINEC L1 LANs are not synchronized with one another, so that the nonsafety-related data in the two SINEC L1 masters are independent of one another from the point of view of both time and content.

If you have configured the function for sending an error message to the SINEC L1 master, the body of the error DB with the error message code will be sent to both SINEC L1 masters in the event of a fault.

Method of operation:

Both subunits always have the same contents in all Send mailboxes common to SINEC L1 LAN A and SINEC L1 LAN B. Since the SINEC L1 LANs are not synchronized with each other, they send the individual messages from one Send mailbox at different times. However, the time difference is, at the most, equal to the SINEC L1 safety time. Since the Receive mailbox is available in both subunits, it follows that both subunits have the same data in their Receive mailboxes.

If you wish to make use of the high availability or fault tolerance of the two-channel SINEC L1 LAN, call FB 253 MBXT before you access the mailbox of LAN B. FB 253 copies the contents of the mailbox into the mailbox of the other LAN if an error has been reported in connection with its data traffic. If both LANs have faults, an error message results followed by STOP.

Your program must additionally evaluate the error information via the SINEC L1 LANs in Block 1 of error DBs 2 or 3 (Vol. 2, 5.4.2 of the manual) and issue an operator message.

Please note the following differences in initializing and configuring single and two-channel SINEC L1 LANs compared with the "normal" operating mode of the LAN system (7.2.1):

- You must set up a Send mailbox in the source slave and a Receive mailbox in the destination slave for both the send and receive end of every data path. There are two Receive mailboxes and one Send mailbox per data path in each subunit for a two-channel SINEC L1 LAN and two Send mailboxes per subunit for the master traffic.
- Send mailboxes can also be used repeatedly if identical data is sent to different destination slaves.
- Data is written to, and read from, the mailboxes by the operating system or by FB 254 SYNC with the "SINEC L1 processing" identifier (Vol. 2, 5.1.5 of the manual). For this reason, no coordination is required in the user program.
- The mailboxes need not be cleared in order to receive the next transfer. Data is written into them regularly for safety reasons even when no change has taken place.
- The mailboxes for interslave data traffic can accommodate messages with a maximum of 62 bytes of useful data when using message mode 115F-13 and 60 bytes when using message modes 115F-14 or 115F-15.
- The mailboxes for master-slave data traffic can accommodate messages with a maximum of 64 bytes.
- Depending on the message mode configured, safety-related messages are provided with high-level protection for the destination slave number and a change byte for message protection.

7.2.5 The Mailbox Transfer Block FB 253

When you have installed a SINEC L1 LAN, it is connected to subunit B of the relevant S5-115F. The user program accesses the Receive mailbox direct without interposing the FB 253.

If you have installed a two-channel SINEC L1 LAN, you have two Receive mailboxes (LAN A, LAN B). If you want to use the high availability of the two-channel SINEC L1 LAN, call the mailbox transfer block 253 MBXT. FB 253 copies the contents of the Receive mailbox of LAN A into the Receive mailbox of LAN B if an error has been signalled for the data traffic of LAN B. Your program must then access the Receive mailbox of LAN B. An error message results if there is also a fault in the other LAN and the system stops.

Call and parameter setting

Parameter	Meaning	Type	Data Type	Assignment	STL
QSLN	Source slave No.	D	KF	KF = 1 to 30 Any number between 1 and 30 can be given as the source slave no. except the slave's own number. A Receive mailbox for both SINEC L1 LANs must be defined for each source slave.	: JU FB 253 Name : AGF:MBXT QSLN :

7.3 Programmers for the S5-115F

Use of a programmer for the program test has been described in Chapter 4 of the COM 115F manual and the role of the programmer in error diagnostics can be found in Chapter 5 of the COM 115F manual. The procedure for entering data during safety operation is explained in 10.18.2.

The following chapter describes how the programmer can be connected to the S5-115F.

7.3.1 Programmer Connected to the Serial Interface of the CPU

A programmer can be connected to the serial port of each subunit A and B. Please note the following priorities:

- Restart after STOP
Programmer input data to A are copied to B
- RUN in test mode
FORCE.VAR commands are copied to B by the operating system or the synchronization calls of the program.
- The programmer can be used to read data from both subunits.

7.3.2 Programmer Connected to SINEC L1 Master

You can service the programmer from the master via

- a single-channel SINEC L1 LAN
- or
- a two-channel SINEC L1 LAN

You need a SINEC L1 LAN connected to all subunits to enable the operator to perform both read and write functions.

Proceed as follows if you want to operate the subunits with a programmer via the SINEC L1 master in the case of a single-channel SINEC L1 LAN:

- Configure a two-channel SINEC L1 LAN because the configuration of a single-channel SINEC L1 LAN is reserved for direct programmer operation of subunit A.
- Implement only a single-channel SINEC L1 LAN with subunit A.

Proceed as follows in the case of two-channel SINEC L1 LANs:

- Configure a two-channel SINEC L1 LAN
- Implement SINEC L1 LAN A and B.
SINEC L1 LAN A is disabled during programmer operation.
However, data traffic continues uninterrupted on SINEC L1 LAN B since the two-channel SINEC L1 LAN is fault-tolerant.

7.4 CP 523 Serial I/O Module

In the following section you will find some special features required for using the CP 523 in safety-related S5-115Fs. See the CP 523 Manual for further information on the design and principle of operation of the CP 523.

The following additional functions are available to you if you use the CP 523 serial I/O module:

- Printout of error messages
- Input and output of data via the terminal
- Point-to-point connection using the serial interface

The CP 523 can be used in "Print mode" and "Communications mode". It has its own hardware clock backed up by the battery of the power supply module. The clock data can be read by the CPU and used in the user program for date-dependent and time-dependent tasks.

Print mode

Message texts can be printed out in this mode. This allows you to list process states and process faults.

- Printers with TTY or RS-232-C (V.24) interfaces can be connected
- The printer interface can be configured (baud rate, BUSY signal, etc.)
- The format of the page to be printed can be configured (headers, footers, margins, etc.)
- Configuration of up to 4095 different message texts in data blocks on a memory submodule
- You can provide for the following when configuring message texts:
 - Insertion of the date or time of day in the printout
 - Insertion of current variables in the printout (pressure, temperature, etc.)
 - Transfer of printer control parameters (double-width type on/off, boldface type, etc.)

Communications mode

The module can exchange data with peripheral devices in this mode. The CP 523 offers the following communications features in Communications mode:

- Communication with a terminal device (data terminal, barcode reader, keyboard, etc.)
- Point-to-point connection to another CP 523, or an S5-115U with a CPU 944.

In communication mode the following drivers are possible:

- open ASCII driver (transparent mode)
- Procedure 3964 (R) (interpreter mode, without RK512)

The CP 523 must be configured with COM 115F like all other modules. In doing so, the CP 523 is treated as a Type 13 analog input module.

7.4.1 Settings on the CP 523 Module

The CP 523 module has a jumper header and a DIP switch. The following figure shows the position of these components.

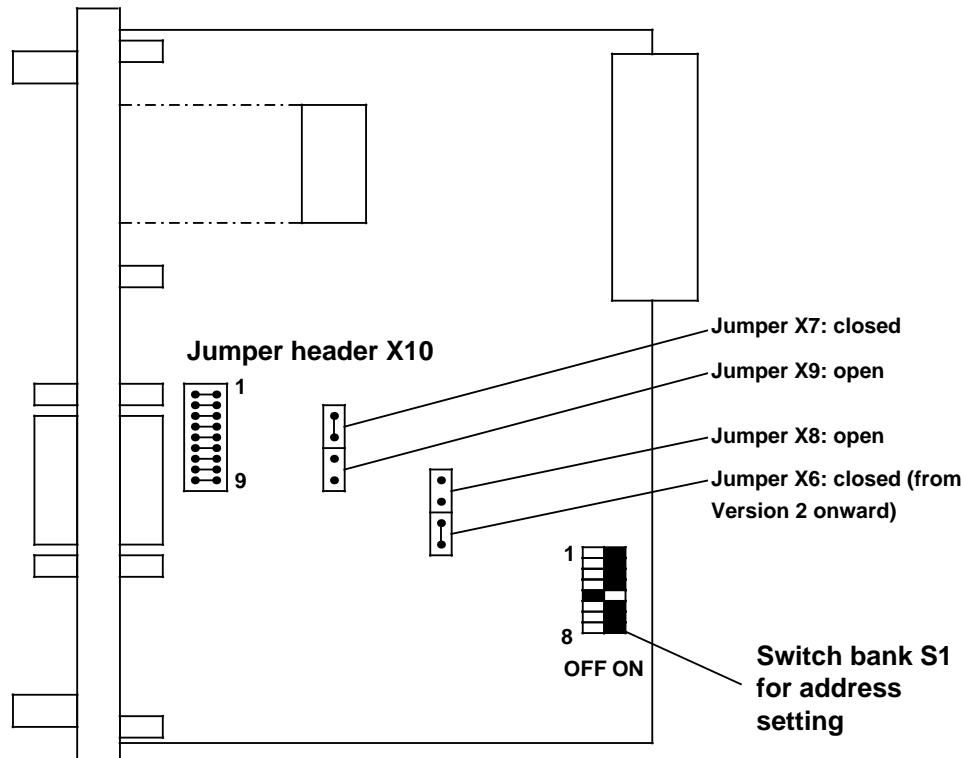


Figure 7-12. Location of Address Switch and Jumper Header on the CP 523 Module

Jumper settings

There are nine jumpers in jumper header X10. The signal cables from the printed circuit board are connected to the interface connector via these jumpers.

The 20 mA current supply of the active TTY interface is switched on with jumpers 1 and 2.

Jumpers 3 to 8 connect the signal cables of the RS-232-C (V.24) interface to the interface connector. Jumper 9 connects the ground with the interface connector.

Note

Note the different safety characteristics of the TTY and RS-232-C (V.24) interfaces. The current-driven TTY interface contains an optocoupler which guarantees reliable galvanic isolation between the 220 V supply of the operator panel and the CP 523. The voltage-driven RS-232-C (V.24) interface contains *no* such galvanic isolation.

DIP switches for addressing

The CP 523 uses an address area of eight bytes and is addressed from initial address 128 like an analog module. You must set the desired initial address via DIP switches on switch bank S1. See the following table for the switch settings for defining the initial address:

Table 7-23. Switch Settings on Switch Bank S1 for Defining the Initial Address

Initial Address	Switch Setting Switch Bank S1							
	1	2	3	4	5	6	7	8
128	☐	☐	☐	☐	☑	☐	☐	☐
136	☑	☐	☐	☐	☑	☐	☐	☐
144	☐	☑	☐	☐	☑	☐	☐	☐
152	☑	☑	☐	☐	☑	☐	☐	☐
160	☐	☐	☑	☐	☑	☐	☐	☐
168	☐	☑	☐	☐	☑	☐	☐	☐
176	☑	☐	☑	☐	☑	☐	☐	☐
184	☑	☑	☐	☐	☑	☐	☐	☐
192	☐	☑	☐	☐	☑	☐	☐	☐
200	☑	☐	☑	☐	☑	☐	☐	☐
208	☐	☑	☐	☐	☑	☐	☐	☐
216	☑	☑	☐	☐	☑	☐	☐	☐
224	☐	☐	☑	☐	☑	☐	☐	☐
232	☑	☑	☐	☐	☑	☐	☐	☐
240	☐	☑	☐	☐	☑	☐	☐	☐
248	☑	☑	☐	☐	☑	☐	☐	☐

☑ =on ☐ =off

The CP 523 is only used in single-channel mode in the S5-115F. The addresses used must also be kept free in the other subunit. These assigned addresses must also not be used by single-channel analog input modules or analog output modules in the subunit.

Note

The modules are supplied with initial addresses 128 set in the works. Make sure before startup that there are not several modules occupying the same address space. Check the address settings on the IM 306, CP 523 and 463 AI module for this reason.

7.4.2 Use of the CP 523 in Print Mode

You can print out all texts stored on the memory submodule of the CP 523 in print mode. You can use the CP 523 in the S5-115F for the following:

- Plaintext printout of operating system error messages (message module)
- Printout of messages from the user program.

Printout of messages from the user program is described in detail in the CP 523 Manual. For this reason, we concentrate here on the use of the CP 523 for printing out operating system error messages in plaintext.

Printing out operating system error messages in plaintext

If you configure the CP 523 as a message module, you can print out the operating system error messages in plaintext.

The CP 523 interprets the error message frames of the operating system and then outputs the error message texts to the printer in plaintext.

The information required for interpretation is contained in data blocks on the memory submodule of the CP 523. If you want to print standard error texts, you need only transfer both data blocks from the COM 115F S5CQ59ST.S5D file to an EPROM or EEPROM memory submodule.

Proceed as follows if you are using the CP 523 as a message module:

- Insert the CP 523 module into the subrack
- Configure the CP 523 module as a message module (I/O type 13)
- Transfer DB 1 (interface parameters) and DB 255 (data for error texts) from the COM 115F S5CQ59ST.S5D file to an EPROM or EEPROM memory submodule.
- Plug the memory submodule into the CP 523
- Connect the printer with the interface initialized in DB 1

The printer must have a TTY interface with the following parameters:

- Baud rate 9600 bps
- Carriage return = 0A_H
- Line feed = 0D_H
- Even parity
- 7 data bits
- No XON/XOFF character
- BUSY signal not evaluated

If you want to operate a printer with a different interface or different parameters, you must adapt the parameters of the CP 523 interface according to the CP 523 Manual. (DB 1 on the memory submodule of the CP 523 must be modified for this purpose).

Note

Note that the data blocks in the S5CQ59ST.S5D file are for the memory submodule of the CP 523 only. Do not confuse these data blocks (DB 1 and DB 255) with the COM 115F configuration blocks

The following table shows examples of standard error texts that have been stored in DB 255 of the COM 115F S5CQ59ST.S5D file.

Table 7-24. Standard Error Message Texts

Typical Standard Error Message Texts						
23.07.89	11:26:42	CPU ERROR				– 030,003
23.07.89	11:26:42	CPU/IM304/IM324 ERROR				– 051,005
23.07.89	11:26:42	USER SUBMODULE ERROR				– 050,001
23.07.89	11:26:42	OPERATING SYSTEM EPROM ERROR				– 049,001
23.07.89	11:26:42	BATTERY FAULT				– 102,004
23.07.89	11:26:42	SINEC L1 ERROR SLAVE 011, LAN B				
23.07.89	11:26:42	WARM RESTART ERROR				– 100,005
23.07.89	11:26:42	POWER OFF				– 102,018
23.07.89	11:26:42	STOP SWITCHED				– 109,012
23.07.89	11:26:42	CONFIGURING/PROGRAMMING ERROR				– 252,010
23.07.89	11:26:42	I/O ERROR	DI BIT	002,001	SIGNAL GR. 16–	016,001
23.07.89	11:26:42	I/O ERROR	DQ BIT	089,007	SIGNAL GR. 02–	028,002
23.07.89	11:26:42	I/O ERROR	AI WORD	160,000	SIGNAL GR. 10–	250,009
23.07.89	11:26:42	TIMEOUT	???????	000		– 103,004
23.07.89	11:26:42	TIMEOUT	DI WORD	060		– 016,005
23.07.89	11:26:42	TIMEOUT	DQ WORD	012		– 028,008
23.07.89	11:26:42	TIMEOUT	AI WORD	190		– 017,001
23.07.89	11:26:42	TIMEOUT	AQ WORD	240		– 033,003
23.07.89	11:26:42	ERROR CAN NOT BE EVALUATED				– 054,008

Generating nonstandard error message texts

If you want to evaluate the operating system error messages yourself and store your own error message texts on the memory submodule of the CP 523, please read the following information on the structure of error message frames.

You can change error texts as you wish. Generation of message texts is described in detail in the CP 523 Manual.

Error message frames from the operating system to the CP 523 are always four words long. The job number and message text number of all error message frames is output in the first word. The job number has the value "4_b", i.e. the CP 523 message texts output by the CP 523 are printed without line feed. The subsequent three words contain additional information, which you can insert in the message text as variables.

The message text number output by the operating system always applies to the relevant error group. See the following table for the assignment of message text numbers to relevant error groups.

Table 7-25. Assignment of Message Text Number to Error Group

Message Text Number	Error	Error Group
3851	I/O error: DI, CH-DQ	8, 9, 10
3852	I/O error: DQ, R-DI	8, 9, 10
3853	I/O error: AI, CH-AQ, CH-DQ	8, 9, 10
3854	I/O error: QVZ (time-out)	19
3846	SINEC L1 error	
3841	CPU error	2, 3, 7, 13, 15
3842	IM 304/324 or CPU error	1, 4, 20, 23
3843	USER MEMORY submodule error	6, 24, 30
3844	Operating system EPROM error	5
3845	Battery fault	25
3847	Error: warm restart required	17
3848	Error: power off in restart	18
3849	STOP switched by user program	26
3850	Handling error	12, 14, 16, 21, 31
3855	Unassigned	0, 22, 27, 28, >31

The subsequent information in words 2 to 4 varies according to the message text number. The message text numbers and the relevant IDs are given in the following overviews.

I/O error without QVZ (message text Nos. 3851, 3852, 3853)

1st word	Bits 12 - 15: Bits 0 - 11:	4 _D (Job number) Message text number
2nd word	In the high byte: In the low byte:	Number of the I/O word Number of the bit
3rd word	Number of the signal group plus 3888 _D	
4th word	In the high byte: In the low byte:	Error-detecting program Current error number

I/O error with QVZ (message text No. 3854)

1st word	Bits 12 - 15: Bits 0 - 11:	4 _D (Job number) Message text number
2nd word	Where the QVZ is unspecifiable: In the case of QVZ on the DI module: In the case of QVZ on the DQ module: In the case of QVZ on the AI module: In the case of QVZ on the AQ module:	3872 _D 3873 _D 3874 _D 3875 _D 3876 _D
3rd word	Where the QVZ is unspecifiable: For all other QVZs:	255 _D Number of the I/O word
4th word	In the high byte: In the low byte:	Error-detecting program Current error number

SINEC L1 error (message text No. 3846)

1st word	Bits 12 - 15: Bits 0 - 11:	4 _D (Job number) Message text number
2nd word	Slave number	
3rd word	In the case of errors on the SINEC L1 LAN A: In the case of errors on the SINEC L1 LAN B:	65 _D = 41 _H 66 _D = 42 _H
4th word	No information	All bits reset

All other errors

1st word	Bits 12 - 15: Bits 0 - 11:	4 _D (Job number) Message text number
2nd word	In the high byte: In the low byte:	Number of the I/O word Number of the bit
3rd word	No information:	All bits reset
4th word	In the high byte: In the low byte:	Error-detecting program Current error number

Terminal diagrams for print mode

The CP 523 assumes a printer with a TTY interface or an RS-232-C (V.24) interface as the peripheral device.

CP 523 (passive TTY) to PT 88 (active TTY) without BUSY signal

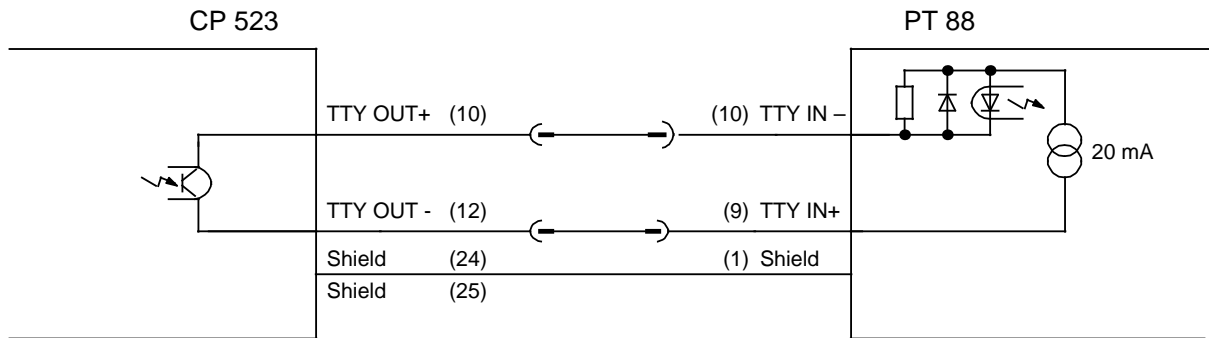


Figure 7-13. Pin Assignments for CP 523 (Passive TTY) to PT 88 (Active TTY) without BUSY Signal

CP 523 (passive TTY) to PT 88 (active TTY) with BUSY signal

Printer setting: Printer not ready to receive = no current

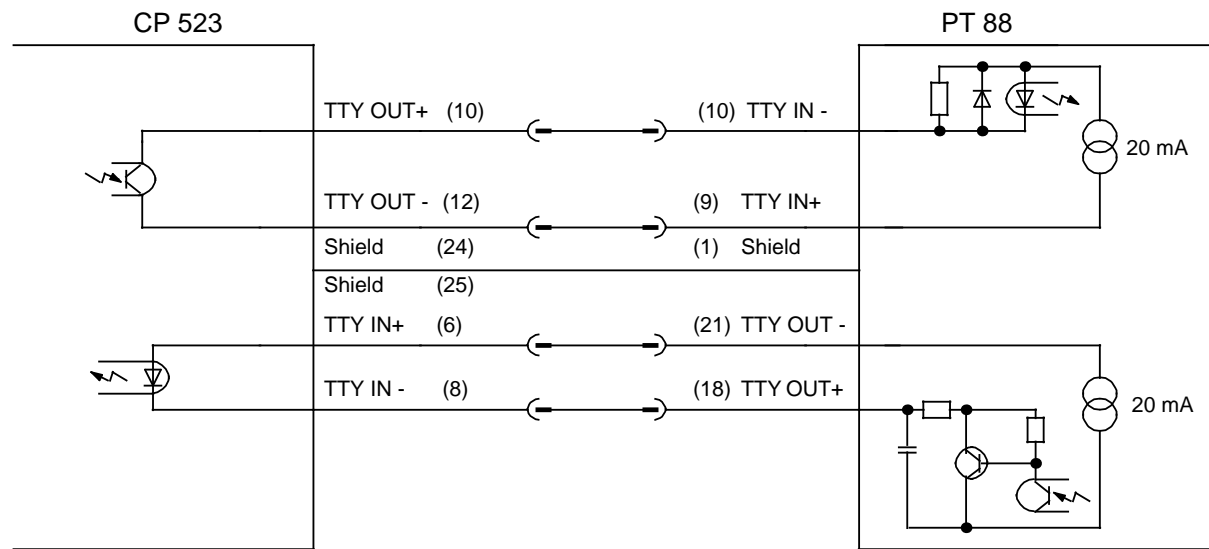


Figure 7-14. Pin Assignments for CP 523 (Passive TTY) to PT 88 (Active TTY) with BUSY Signal

Note

If you are using the CP 523 with an active TTY interface, please note the voltage drop over the cable lengths as well as the Send and Receive elements of the module.

RS-232-C (V.24) interface

Printer setting: Printer not ready to receive = no current

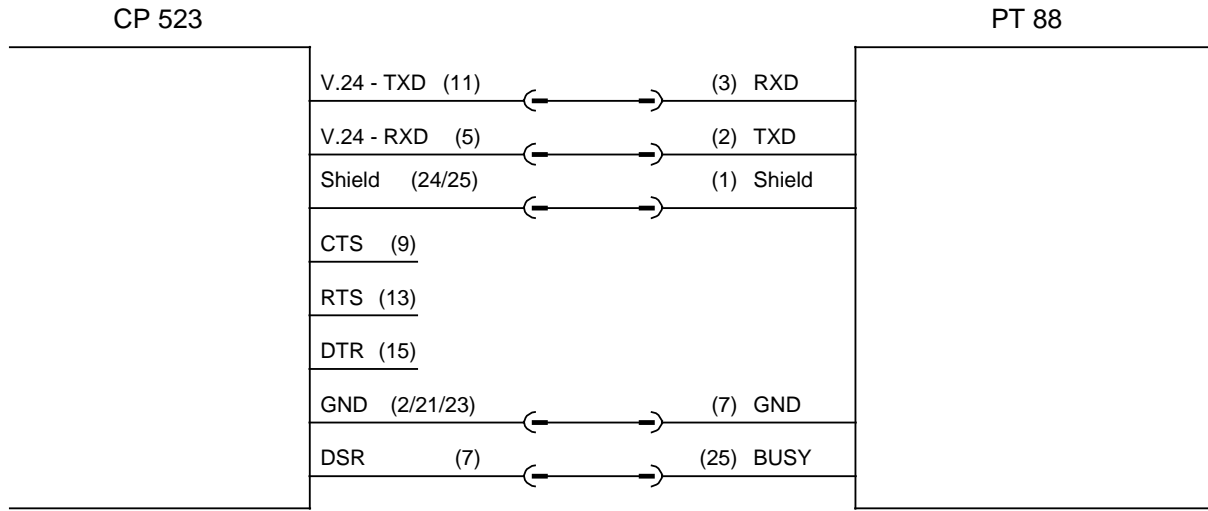


Figure 7-15. Pin Assignment of the RS-232-C (V.24) Interface (Print Mode)

Pin Assignments of the 25-way subminiature D connector

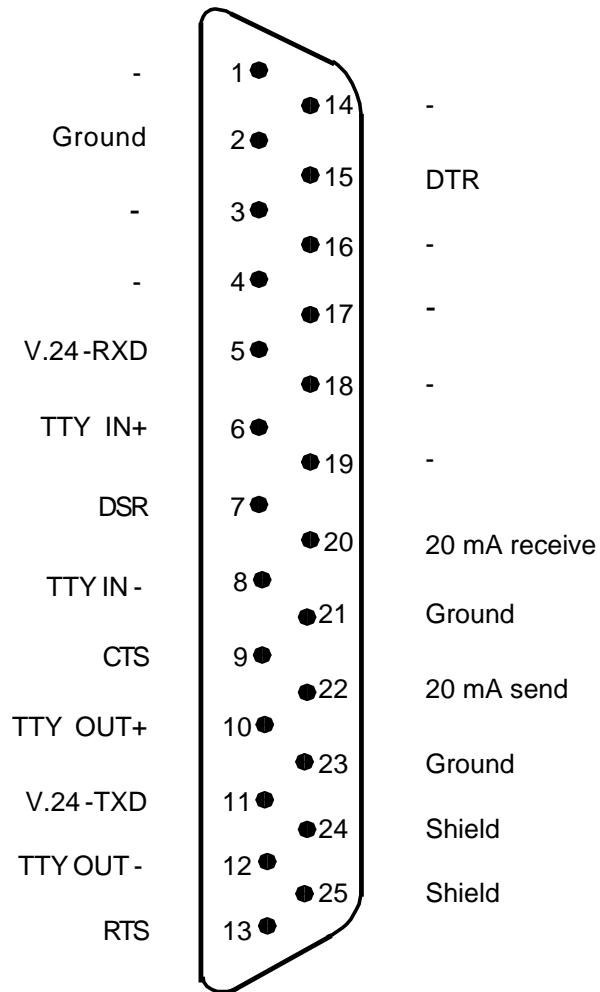


Figure 7-16. Pin Assignments of the 25-Way Subminiature D Connector

Note

If you are using the CP 523 with an active TTY interface, please note the voltage drop over the cable lengths as well as the Send and Receive elements of the module.

7.4.3 Use of the CP 523 in Communications Mode

Message frames of up to 256 bytes in length can be transferred between the CPU and a peripheral device connected to the CP 523 module. The CP 523 offers you the following:

- Communications with a terminal device (terminal, operator-process communication and visualization units)
- Point-to-point connection with another CP 523 or a CPU 944

You can choose between:

- Transparent Communications mode
The CP 523 does not interpret any characters in Transparent Communications mode.
 - No XON/XOFF protocol is possible.
 - Messages can only be sent or received with a fixed length.
- Interpretive Communications mode
The CP 523 evaluates the following characters in Interpretive Communications mode:
 - RUB OUT (7F_H)
 - BACKSPACE (08_H)
 - XON/XOFF character (if programmed)
 - Character end code (if programmed)

In Communications mode, the CPU initiates data exchange between the CPU and the CP by sending a job request.

The CP 523 handles data transfer with the peripheral devices autonomously.

See the CP 523 Manual for a detailed description of the data exchange procedure.

The FB 252 BLUE function block integrated in the CPU 942-7UF12 allows user-friendly handling and control of data exchange. See 7.4.5 for a description of FB 252 BLUE.

The time of day can be read from the integral clock by the CPU also in Communications mode and used in the application program for date-dependent and time-dependent tasks.

Message text printout and editing as in Print mode is not possible in Communications mode. For this reason, no memory submodule is required in Communications mode.

S5 bus and transfer memory

The data between the CPU and the CP 523 is transferred via the S5 bus. The data is stored on the CP 523 in a transfer memory of eight bytes. The addresses for the transfer memory are derived from the initial address of the module and an offset of 0 to 7.

The CP 523 only reads the data in the transfer memory and updates the transfer memory with current data after the entire data block (four words) has been written into the transfer memory by the user program. The current data can then be read by the user program.

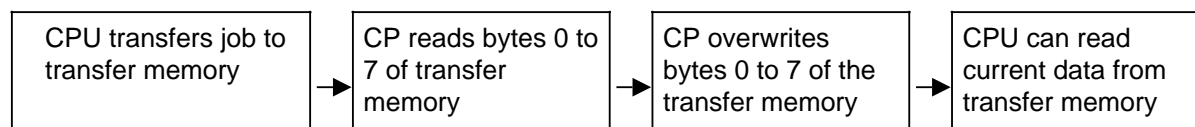


Figure 7-17. Using the Transfer Memory

Rules for galvanic isolation

In order to guarantee safe galvanic isolation between the S5-115F and the CP 523, you must

- Select a suitable interface
- Make settings on jumper X10.

The following table gives an overview of the permissible interfaces.

Table 7-26. Jumper Settings for Safe Galvanic Isolation

On the Device Connected to the CP 523	Galvanic Isolation to the 5 V Supply to VDE 160	Permissible Interface	Jumper Setting on Jumper Block X10 of the CP 523 (Figure 7-17)	Remarks
Printers and operator panels	no	TTY passive	Remove all jumpers	Galvanic isolation via optocoupler
Printers and operator panels	yes	V.24 (RS-232-C)	Plug in jumpers 1 to 9	
		TTY active	Plug in jumpers 1, 2, 9 Remove jumpers 3 to 8	
		TTY passive	Remove all jumpers	
CP 523 in a PLC of the S5-U range	no	TTY passive	Remove all jumpers	Galvanic isolation via optocoupler
CP 523 in an S5-115F	yes	V.24 (RS-232-C)	Plug in jumpers 1 to 9	
		TTY active	Plug in jumpers 1, 2, 9 Plug in jumpers 3 to 8	
		TTY passive	Remove all jumpers	

Terminal diagrams for communications mode

The CP 523 assumes the following as peripheral device:

- Data terminal equipment, e.g. CP 521, CP 523, CPU 944
- Data communications equipment, e.g. a MODEM

CP 523 - CP 523 (TTY interface)

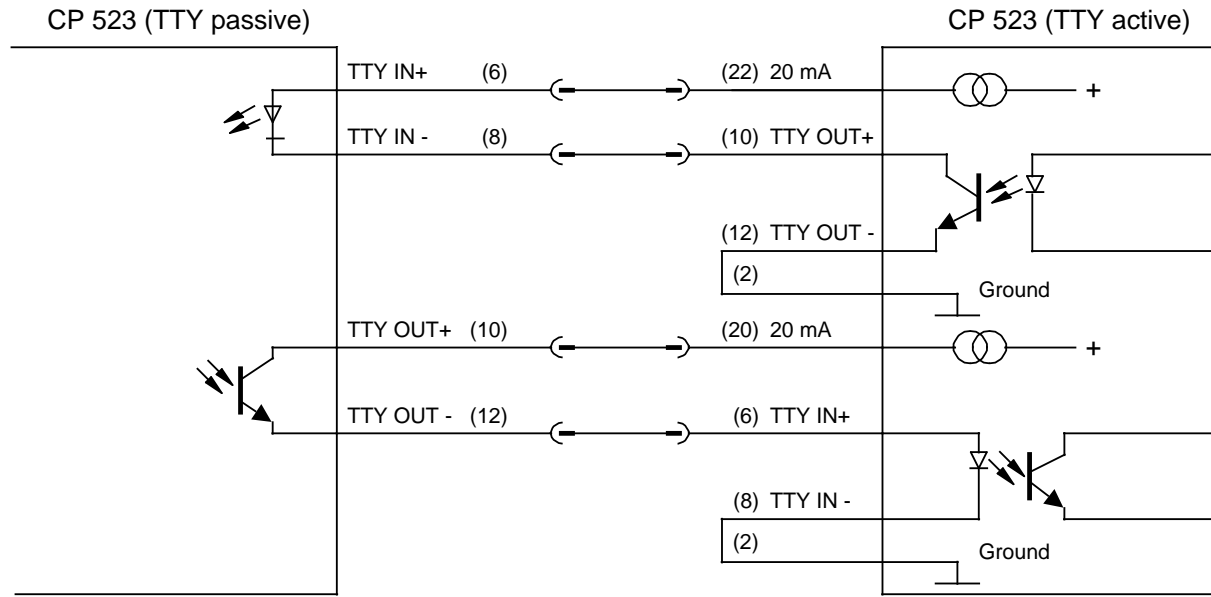


Figure 7-18. Pin Assignments for CP 523 to CP 523 (TTY Interface)

CPU 944 (TTY active) - CP 523 (TTY passive)

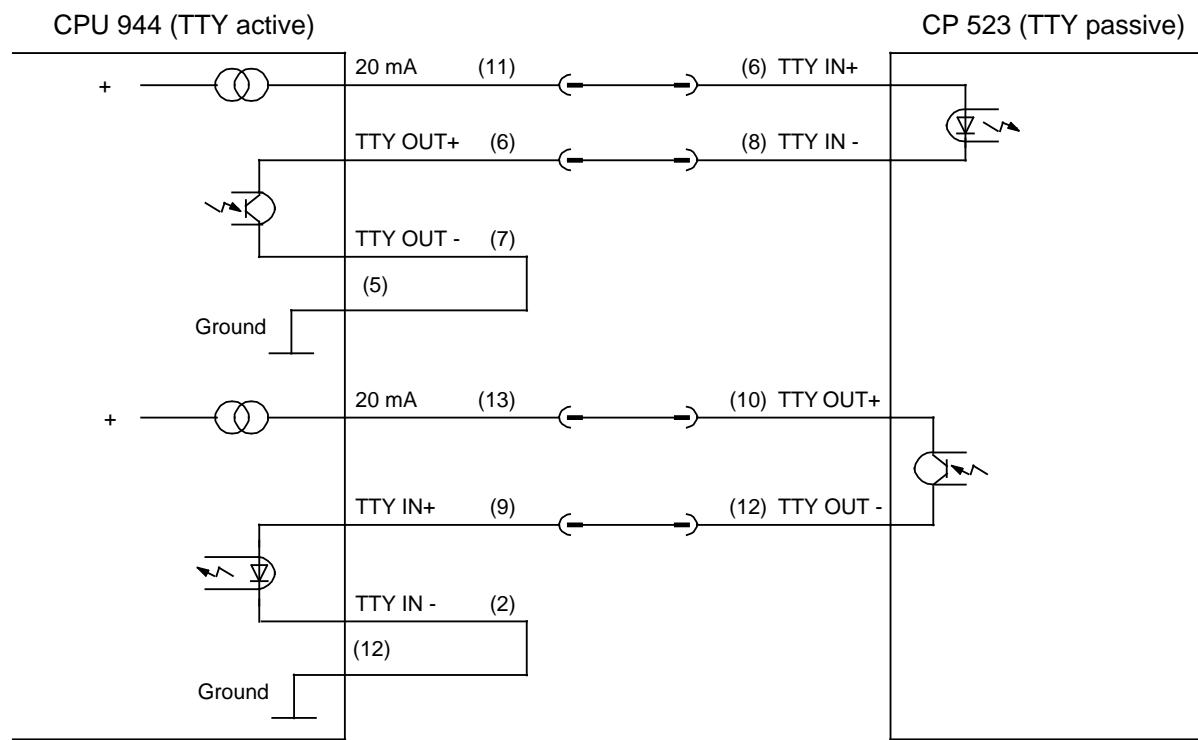


Figure 7-19. Pin Assignments for CPU 944 (TTY Active) to CP 523 (TTY Passive)

Connecting a data terminal to a communications terminal

An example using CP 523 to Modem (SIEMENS 2425 B DX)

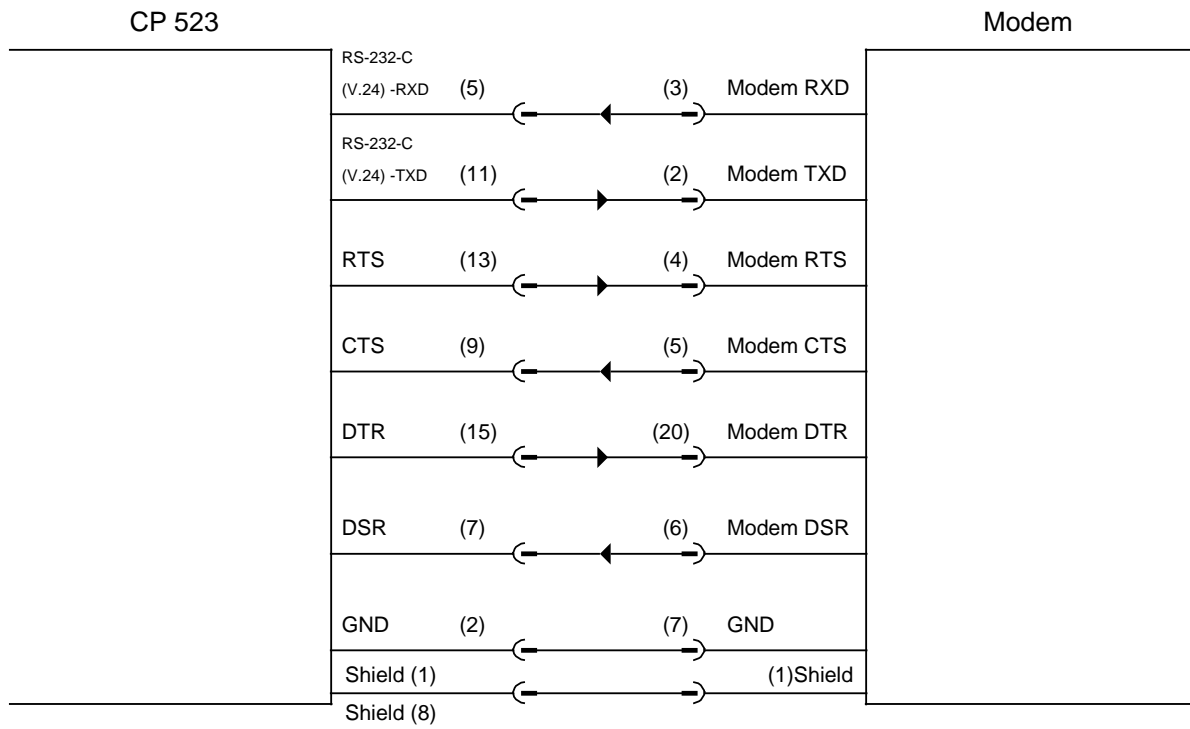


Figure 7-20. Pin Assignments for CP 523 to Modem

Note

If you use the 3964(R) procedure in communications mode, the control cables for the **DSR**, **DTR**, **CTS** and **RTS** signals need not be connected.

7.4.4 Failsafe Characteristics of the CP 523

The CP 523 is only used in single-channel configuration in the S5-115F. Operation of the CP 523 with FB 252 BLUE is not failsafe a standard. The operating system does **not** check the received or sent data for validity or for error-free reception.

The control program must contain safety functions for failsafe data transfer. For this reason, use a point-to-point connection over the CP 523 in such cases and the prototype-tested standard function blocks (Catalog ST57).

Note

Make sure that no addresses have been duplicated before starting up the S5-115F. Check the address settings on the IM 306, CP 523 and AI 463 modules.

7.4.5 FB 252 Integral Function Block

The FB 252 is integrated in the operating system of the S5-115F. It handles control of data transfer between the CPU and the CP 523 serial I/O module. The FB 252 transfers fixed-length data. Up to 32 data blocks of eight bytes each are read from or written to a memory area per call. Memory areas are data blocks or flag areas.

The CPU always initiates each data transfer by calling the FB 252. The user can specify whether he wants to send or receive data with the FB.

You must specify the following when calling FB 252:

- Initial address of the CP 523
- FB 252 function
You specify here whether you want to send or receive
- Memory type
In the case of a send job, specify here whether the data is in a flag area or a data block.
In the case of a receive job, specify here whether the data is to be stored in a flag area or a data block.
- Number of the data block
- Number of the source data word, or number of the destination data word
- Number of eight-byte data blocks to be transferred

Parameter	Meaning	Type	Data type	Assignment	STL
BADR	Initial module address	D	KF	128 to 248 (in 8-byte-steps)	: JU FB 252 NAME : AGF: BLUE
FUNK	Function	D	KC	S: = Send data E: = Receive data	BADR : FUNK : TYP : DBNR : ANFA : BLCK :
TYP	Source / destin. memory type in the case of S/R	D	KC	D : = Data block F : = Flag area XX : = Indirect block initialization (the block parameters are stored in a data block)	
DBNR	Block number	D	KF	In the case of data block: 4 to 255 In the case of flag area: 0 In the case of indirect block initialization: 0; 4 to 255	
ANFA	Initial address of the block	D	KF	0 to 252 data word number 2 to 248 flag byte number	
BLCK	Number of blocks	D	KF	1 to 32 Number of 8-byte data blocks to be transferred	

Indirect assignment of FB 252 parameters

If you want to assign the FB 252 parameters indirectly, you must store the data for assigning the block parameters in a DB. For this purpose, write the parameter assignments in six consecutive data words. You must note the order of the parameters!

You must specify the following when calling FB 252:

- The value "XX" for the TYP parameter
- The number of the DB (DB 4 to 255) with the block parameter assignments for the DBNR parameter
or
the value "C" for the DBNR parameter if the last opened DB contains the block parameter assignments
- The number of the data word containing the first block parameter (BADR parameter) for the ANFA parameter.

The BADR, FUNK and BLCK parameters must be assigned permissible values but the values themselves are insignificant in this case.

Sending and receiving data in communications mode

Data transfer must be coordinated before you can send a message frame to the CP 523. For this reason, message frame transfer can be divided into three steps.

1st step

The CPU transfers the "Send message" or "Receive message" job request to the CP 523. The CP reads the job request from its transfer memory and writes transfer information autonomously into the transfer memory.

2nd step

The CPU reads the coordination information from the transfer memory and evaluates it. The actual message can be sent or received when the CP 523 has accepted the job.

3rd step

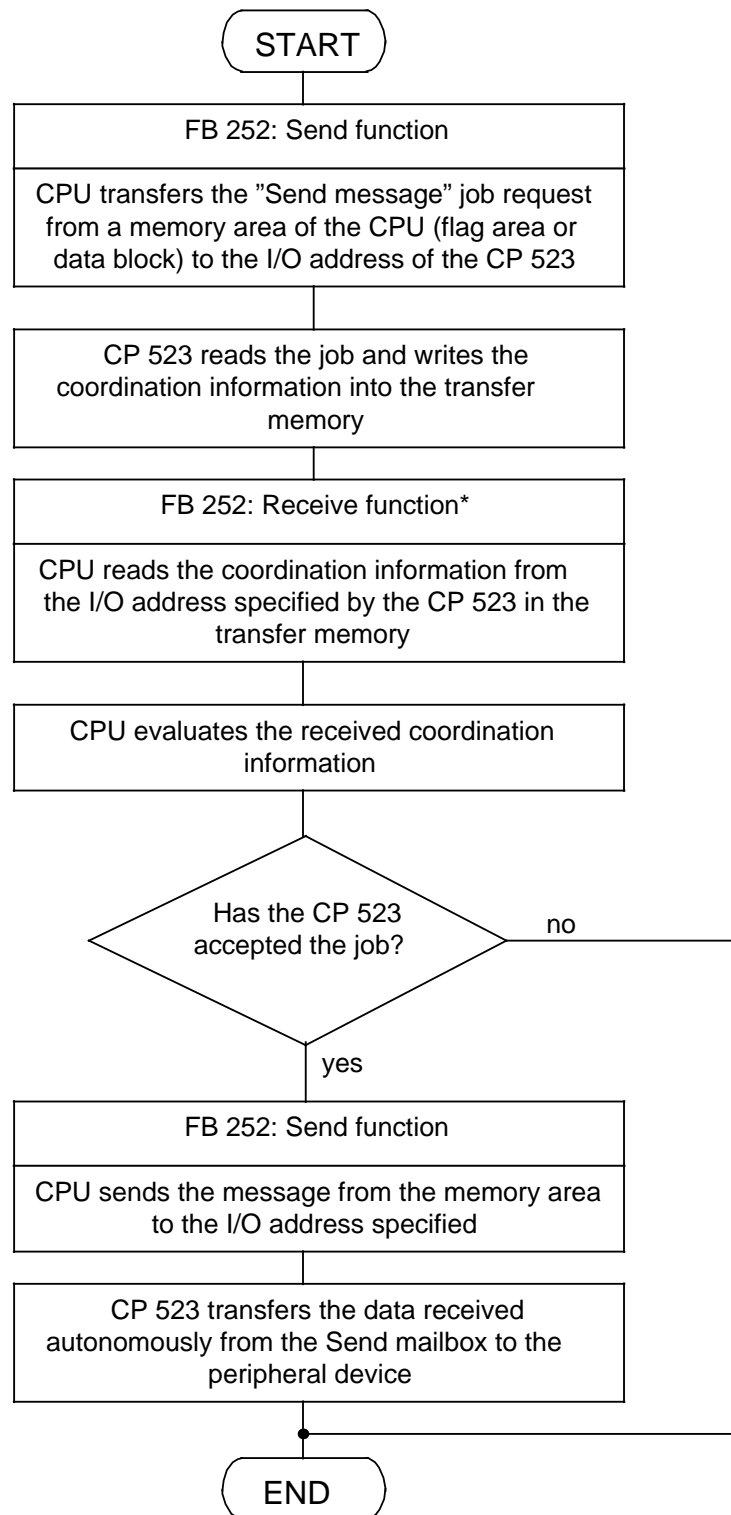
The CPU sends or receives the message of up to 32 eight-byte data blocks.

To make the user program as clear as possible, FB 252 BLUE should be called with the relevant function for each of the above steps.

Note

Function blocks FB 200 and FB 201 described in the CP 523 Manual cannot be used in the S5-115F.

The following flowchart shows data transfer with three FB 252 BLU calls for the "Send message" job.



* You can also read the coordination information with the L PW operation

Figure 7-21. Flowchart for Sending a Message to the CP 523

8 Technical Specifications

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8 Technical Specifications

8.1 General Technical Specifications

Climatic Environmental Conditions	Mechanical Environmental Conditions
<p>Temperature</p> <p>Operating</p> <ul style="list-style-type: none"> - open design Air intake temperature (measured at the bottom of the modules) 0 to+55° C - cabinet design (Where cabinet design is concerned, the dissipatable heat loss depends on the type of construction, the ambient temperature, and the arrangement of the devices.) Air intake temperature (measured at the bottom of the modules) 0 to+55° C <p>Nonoperating - 40 to+85° C</p> <p>Temperature change</p> <ul style="list-style-type: none"> - operating max. 10 K / h - nonoperating max. 20 K / h <p>Relative humidity</p> <ul style="list-style-type: none"> - operating 95% (acc. to DIN 40040) - nonoperating 95% (noncondensing) <p>Atmospheric pressure</p> <ul style="list-style-type: none"> - operating 860 to 1060 hPa ¹ - nonoperating 660 to 1060 hPa ¹ <p>Pollutants</p> <ul style="list-style-type: none"> - SO₂ 0.5 ppm, (rel. humidity 60%, noncondensing) - H₂S 0.1 ppm, (rel. humidity 60%, noncondensing) 	<p>Vibration</p> <ul style="list-style-type: none"> - tested with to IEC 68-2-6 10 to 57 Hz, (const. amplitude 0.15 mm) 57 to 150 Hz, (const. acceleration 2 g) <p>Shock</p> <ul style="list-style-type: none"> - tested with to IEC 68-2-27 12 shocks (half sine 15 g / 11 msec.) <p>Free fall</p> <ul style="list-style-type: none"> - tested with to IEC 68-2-32 height of fall 1 m (3.3 ft.)

¹ For use under 900 hPa (=1000 m above sea-level), check with the manufacturer on the cooling requirements.

Electromagnetic Compatibility (EMC) Noise Immunity	IEC / VDE Safety Information												
<p>Damped oscillatory wave test to IEC 255-4</p> <ul style="list-style-type: none"> - AC power supply modules 2.5 kV - DC power supply modules 1 kV - output 24 V DC 1 kV - input 115 V AC / 230 V AC 2.5 kV - digital input/output modules 2.5 kV - analog input/output modules 1 kV - communications interfaces 1 kV <p>Fast transient burst test to IEC 65 (Sec) 87</p> <ul style="list-style-type: none"> - power supply modules 2 kV - digital input/output modules 2 kV - analog input/output modules 1 kV - communications interfaces 1 kV <p>Electrostatic discharge test to IEC 801-2 (Discharge to all parts accessible to the operator in normal operation)</p> <ul style="list-style-type: none"> - power supply modules 5 kV - digital input/output modules 5 kV - analog input/output modules 5 kV - communications interfaces 5 kV <p>Radiated electromagnetic field test to IEC 801-3</p> <ul style="list-style-type: none"> - test field strength 3 V/m <p>Fast transient burst to IEC 801-4</p> <ul style="list-style-type: none"> - power supply modules - digital input/output modules - analog input/output modules - communications interfaces 	<p>Degree of protection to IEC 529</p> <ul style="list-style-type: none"> - type IP 20 - class to IEC 536 <p>Insulation rating</p> <ul style="list-style-type: none"> - between electrically independent circuits and with circuits connected by a central grounding point to VDE 0160 - between all circuits and central grounding point (standard mounting rail) to VDE 0160 <p>Test voltage sine, 50 Hz</p> <p>for a rated voltage V_e of the circuits (AC / DC)</p> <table border="0" style="width: 100%;"> <tr> <td style="padding-right: 20px;">$V_e = 0$ to 50 V</td> <td>500 V</td> </tr> <tr> <td>$V_e = 50$ to 125 V</td> <td>1250 V</td> </tr> <tr> <td>$V_e = 125$ to 250 V</td> <td>1500 V</td> </tr> </table> <p>Impulse voltage to IEC 255-4</p> <p>for a rated voltage V_e of the circuits (AC / DC)</p> <table border="0" style="width: 100%;"> <tr> <td style="padding-right: 20px;">$V_e = 0$ to 50 V</td> <td>1 kV, 1.2 / 50 μs</td> </tr> <tr> <td>$V_e = 50$ to 125 V</td> <td>1 kV, 1.2 / 50 μs</td> </tr> <tr> <td>$V_e = 125$ to 250 V</td> <td>3 kV, 1.2 / 50 μs</td> </tr> </table> <p>RI specification to VDE 0871</p> <ul style="list-style-type: none"> - limit class A <p>Note: AC output modules are not interference suppressed!</p>	$V_e = 0$ to 50 V	500 V	$V_e = 50$ to 125 V	1250 V	$V_e = 125$ to 250 V	1500 V	$V_e = 0$ to 50 V	1 kV, 1.2 / 50 μ s	$V_e = 50$ to 125 V	1 kV, 1.2 / 50 μ s	$V_e = 125$ to 250 V	3 kV, 1.2 / 50 μ s
$V_e = 0$ to 50 V	500 V												
$V_e = 50$ to 125 V	1250 V												
$V_e = 125$ to 250 V	1500 V												
$V_e = 0$ to 50 V	1 kV, 1.2 / 50 μ s												
$V_e = 50$ to 125 V	1 kV, 1.2 / 50 μ s												
$V_e = 125$ to 250 V	3 kV, 1.2 / 50 μ s												

8.2 Description of the Modules

8.2.1 Mounting Racks (CRs, ERs)

Mounting Rack CR 700-0 for Central Controller

(6ES5 700-0LB11)

	Technical Specifications	
	Number of input/output modules that can be plugged in	max. 6
	Number of expansion units that can be connected	max. 3
	- distributed up to 600 m (1969 ft.)	max. 2 x 4
	- distributed up to 1000 m (3281 ft.)	max. 3
Dimensions w x h x d (mm (in.))	353 x 303 x 47 (13.8 x 11.9 x 1.8)	
Weight	4 kg (8.8 lbs.)	

Mounting Rack CR 700-2F for Central Controller

(6ES5 702-2LA22)

	Technical Specifications	
	Number of input/output modules that can be plugged in	max. 6
	Number of expansion units that can be connected	max. 3
	- distributed up to 600 m	max. 2 x 4
	Dimensions w x h x d (mm (in.))	483 x 303 x 47 (19 x 11.9 x 1.8)
Weight	5 kg (11 lbs.)	

Mounting Rack ER 701-1 for Expansion Unit 1

(6ES5701-1LA12)

	Technical Specifications	
	Number of input/output modules that can be plugged in	max. 9
	Interface module - central connection	IM 306
	Interrupt evaluation	not possible
	Dimensions w x h x d (mm (in.))	483 x 303 x 47 (19 x 11.9 x 1.8)
	Weight	5 kg (11 lbs.)

Mounting Rack ER 701-2 for Expansion Unit 2

(6ES5 701-2LA12)

	Technical Specifications	
	Number of input/output modules that can be plugged in	max. 7
	Interface module - distributed connection	IM 306 IM 304 / IM 314
	Interrupt evaluation	not possible
	Dimensions w x h x d (mm (in.))	483 x 303 x 47 (19 x 11.9 x 1.8)
	Weight	5 kg (11 lbs.)

Mounting Rack ER 701-3 for Expansion Unit 3

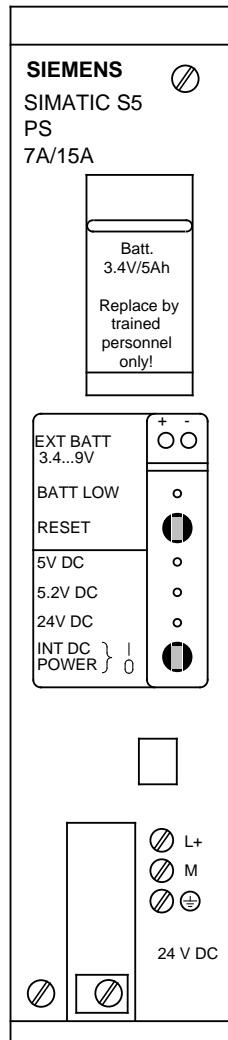
(6ES5 701-3LA12)

	Technical Specifications	
	Number of input/output modules that can be plugged in	max. 7
	Interface module	
	- central connection	IM 306
	- distributed connection	IM 304 / IM 314
	Interrupt evaluation	not possible
Dimensions w x h x d (mm (in.))	483 x 303 x 47 (19 x 11.9 x 1.8)	
Weight	5 kg (11 lbs.)	

8.2.2 Power Supply Module

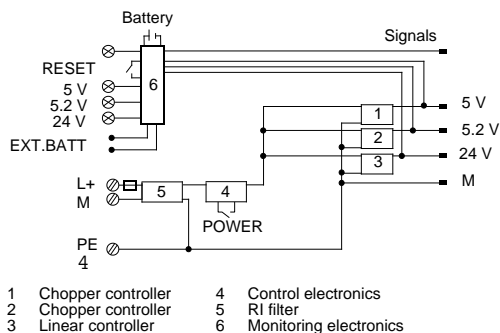
PS 951 Power Supply Module 24 V DC; 5 V, 7 A

(6ES5 951-7ND21)



Technical Specifications

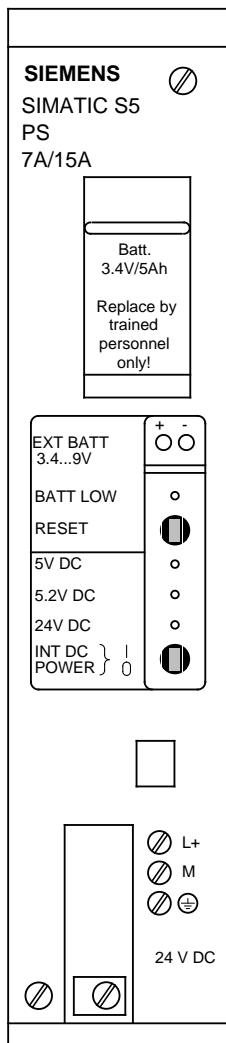
Input voltage L+		
- rated value		24 V DC
- permissible range		19.2 to 30 V
Input current at 24 V		
- rated value		5.4 A
- inrush current	max.	132 A
- I ² t		16 A²s
Power consumption		130 W
Output voltage		
- rated value		5 V
- tolerance		±2%
Output current		
- rated value		7 A
- permissible range		0.3 to 7 A
Backup battery		
- Backup time	min.	Li battery, size C (3.6 V/5 Ah) 1 year (at 0.3 mA, 25 °C and uninterrupted backup supply)
Short-circuit protection		electronic
Fault indicator		no
Fuse (primary circuit)		integral
Class of protection		class 1
Floating		no
Insulation rating		electrical separation to VDE 0160 500 V DC
- tested with		
RI specification		A+14 dB to VDE 0871
Power loss of the module	typ.	34 W
Weight		approx. 1.9 kg (4.2 lbs.)



Block diagram

PS 951 Power Supply Module 24 V DC; 5 V, 7 A

(6ES5 951-7ND31)



Technical Specifications

Input voltage L+
 - rated value 24 V DC
 - permissible range 19.2 to 30 V

Input current at 24 V
 - rated value 5.4 A
 - inrush current max. 132 A
 - I²t 16 A²s

Power consumption 130 W

Output voltage
 - rated value 5 V
 - tolerance ±2%

Output current
 - rated value without fans 7 A
 - permissible range 0.3 to 7 A

Backup battery Li battery, size C
 - Backup time min. 1 year (at 0.3 mA, 25 °C and uninterrupted backup supply)

Short-circuit protection electronic

Fault indicator no

Fuse (primary circuit) integral

Class of protection class 1

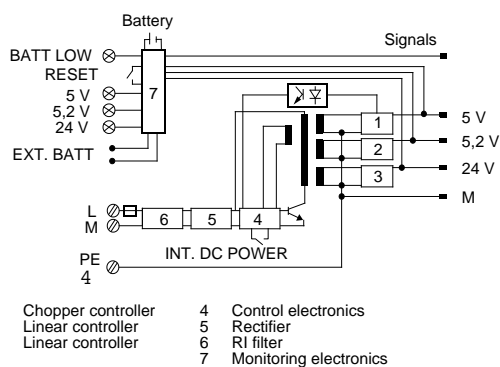
Floating yes

Insulation rating electrical separation to VDE 0160
 - tested with 500 V DC

RI specification A+14 dB to VDE 0871

Power loss of the module typ. 34 W

Weight approx. 1.9 kg (4.2 lbs.)



Block diagram

PS 951 Power Supply Module 24 V DC; 5 V, 7 A

(6ES5 951-7ND41)

Technical Specifications

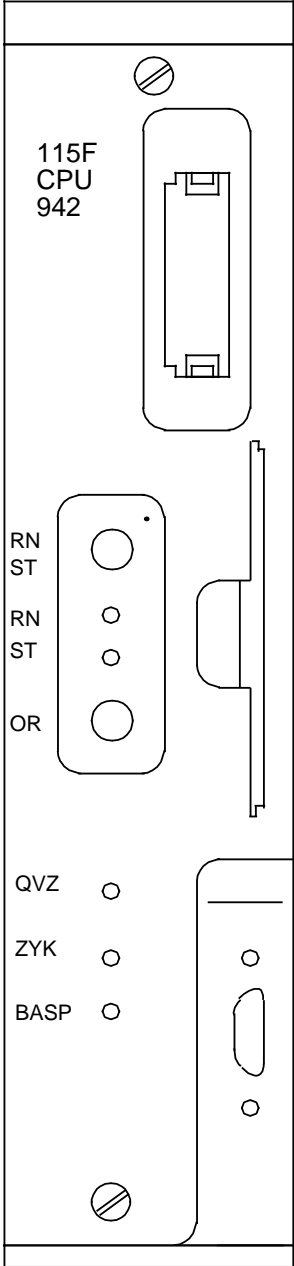
Input voltage L+		
- rated value		24 V DC
- permissible range		19.2 to 30 V
Input current at 24 V		
- rated value		5.6 A
- inrush current	max.	$15 \times I_N$
- I^2t		4.5 A ² s
Power consumption		134.4 W
Output voltage		
- rated value		5 V
- tolerance		±1.5%
Output current		
- rated value without fans		7 A
- rated value with fans		15 A
- permissible range		0.3 to 15 A
Output voltage (programmer/OP)		
- rated value		5.2 V
- tolerance		±1.5%
Output current		max. 2.5 A
Backup battery		
		2 Li batteries, size AA (3.6 V/2 x 1.75 Ah)
- Backup time	min.	1 year (at 0.3 mA, 25 °C and uninterrupted backup supply)
Mains buffering (at L+_{min})	min.	20 ms
Output voltage (auxiliary supply)		
- rated value		24 V
- tolerance		±5%
Output current		max. 0.35 A
Short-circuit protection		electronic
Fault indicator		no
Fuse (primary circuit)		integral
Class of protection		class 1
Floating		yes
Insulation rating		electrical separation to VDE 0160
- tested with		2700 V DC
RI specification		A to VDE 0871
Power loss of the module	typ.	38 W
Weight		approx. 1.7 kg (3.7 lbs.)

Block diagram

8.2.3 Central Processing Unit

Central Processing Unit CPU 942F

(6ES5 942-7UF15)



The diagram shows a vertical rectangular module with the following components and labels from top to bottom:

- Top: A screw and a large rectangular component.
- Label: "115F CPU 942"
- Left side: A vertical panel with labels "RN ST", "RN ST", and "OR" next to three circular indicators.
- Right side: A vertical panel with a handle and a rectangular slot.
- Bottom: Three circular indicators labeled "QVZ", "ZYK", and "BASP" on the left, and a vertical panel with a slot and a screw on the right.

Technical Specifications

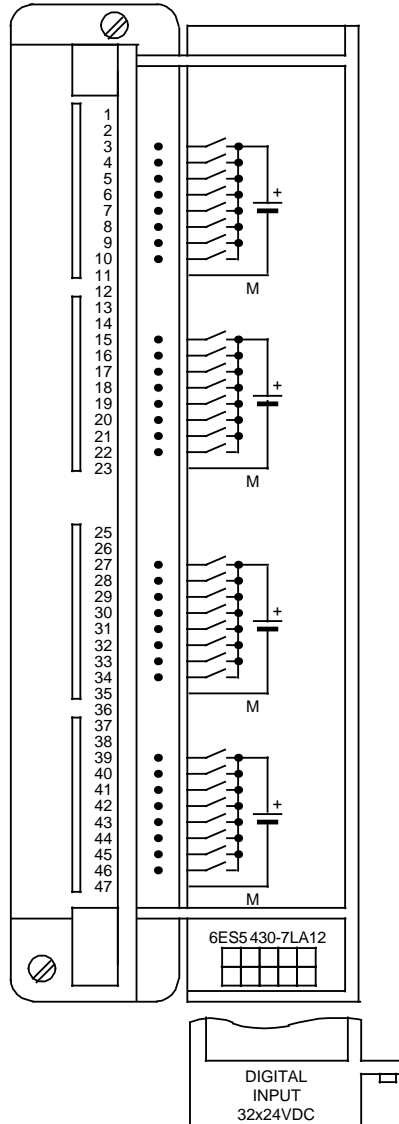
Memory capacity (total)	max.	18944 statements
- internal memory	max.	2560 statements
- memory submodule (RAM)*	max.	16384 statements
- memory submodule (EPROM)*	max.	16384 statements
- memory submodule (EEPROM)*	max.	8192 statements
Execution time		
- per binary operation	approx.	1.6 µs
- per word operation	approx.	1.6 µs to 1.4 ms
Scan time monitoring		configurable
Flags		2048**
Timers		
- number		128
- range		0.01 to 9990 s
Counters		
- number		128
- range		0 to 999 (count up, count down)
Digital inputs	max.	1024
Digital outputs	max.	1008
Analog inputs		
Analog outputs - total	max.	128
Organization blocks	max.	256
Program blocks	max.	256
Function blocks	max.	256 (can be assigned parameters)
Sequence blocks	max.	256
Data blocks	max.	252
Operations set	approx.	170 operations
Current consumption		
- from 5 V (internal)		0.8 A
Power losses of the module		
	typ.	4 W
Weight	approx.	1.5 kg (3.3 lbs.)

* Permissible memory submodules (Section 2.3.2)

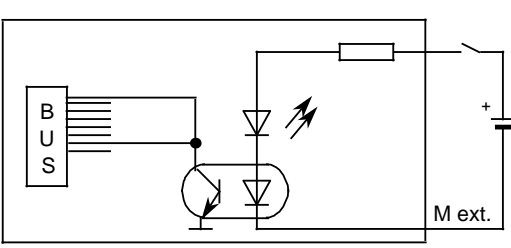
** FW 0 is reserved for the logical program counter.
 FW 2 to FW 198 (F 2.0 to F 199.7) permissible for user program.
 FW 200 to FW 254 (F 200.0 to F 255.7) are only permissible in blocks as scratch flags. Scratch flags must be defined, set or reset at the start of block execution and also after conditional or unconditional block calls. This avoids data exchange with other blocks.

8.2.4 Digital Input Modules

Digital Input Module 8 x 24 V DC (with P Interrupt), Floating, Safety-Related (6ES5 430-7LA12)



Terminal assignment



Simplified schematic

Technical Specifications

Number of inputs		32
Floating		yes (optocoupler)
- isolated in groups of		8
Input voltage L+		24 V DC
- rated value		24 V DC
- for "0" signal		-30 to +2,5 V
- for "1" signal		13 to 30 V
Input current at "1" signal	typ.	8.5 mA
Response time		
- from "0" to "1"	typ.	2.2ms; max. 4.6 ms
- from "1" to "0"	typ.	4.5ms; max. 12 ms
Cable length		
- shielded	max.	1000 m (3281 ft.)
- unshielded	max.	600 m (1969 ft.)
Insulation rating		to VDE 0160
Rated insulation voltage (between groups)		30 V
- insulation group		C
- tested with		500 V
Rated insulation voltage (L+ to \perp)		30 V
- insulation group		C
- tested with		500 V
Connection of 2-wire BERO proximity switches		possible
- quiescent current		1.5 mA
Current consumption		
- from 5 V (internal)		5 mA
Power losses of the module	typ.	6,5 W
Weight	approx.	0.7 kg (1.54 lb.)

Digital Input Module 8 x 24 V DC (with P Interrupt), Floating, Safety-Related (6ES5 434-7LA12)

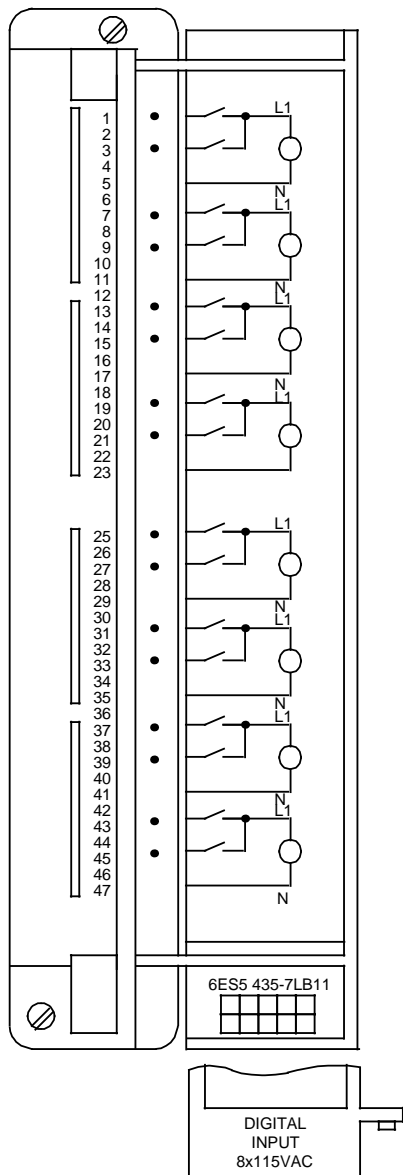
Technical Specifications	
Number of inputs	8
Floating	yes (optocoupler)
- isolated in groups of	1
Input voltage L+	24 V DC
- rated value	-30 to + 2.5 V
- for "0" signal	13 to 30 V
- for "1" signal	
Input current at "1" signal	typ. 8.5 mA
- for 24 V DC	
Response time	0.5 to 1.5 msec.
- from "0" to "1"	0.5 to 1.5 msec.
- from "1" to "0"	
Interrupt signal (external)	latching relay contact
- permissible load	max. 0.2 A; 100 V DC
- switching capacity	max. 20 W or 35 VA
Interrupt signal (internal)	via bus line PRAL-N
Acknowledgement	external via input reset 24 V DC
Cable length	
- shielded	max. 1000 m (3281 ft.)
- unshielded	max. 200 m (656 ft.)
Insulation rating	to VDE 0160
Rated insulation voltage (between groups)	30 V
- insulation group	C
- tested with	500 V
Rated insulation voltage (L+ to \perp)	30 V
- insulation group	C
- tested with	500 V
Connection of 2-wire BERO proximity switches	possible
- quiescent current	max. 1.5 mA
Current consumption	< 70 mA
- from 5 V (internal)	
Power losses of the module	typ. 2 W
Weight	approx. 0.7 kg (1.54 lb.)

Terminal assignment

Simplified schematic

Digital Input Module 16 x 115 V DC, Floating, Safety-Related

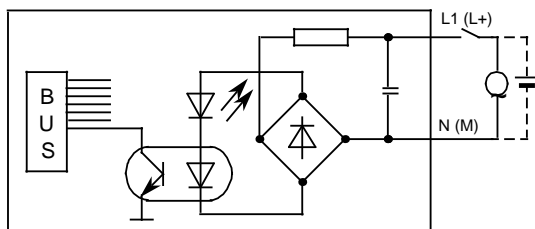
(6ES5 435-7LB11)



Technical Specifications

Number of inputs	16
Floating	yes (optocoupler)
- in groups of	2
Input voltage L1	
- rated value	115 V UC
- frequency	47 to 63 Hz
- for "0" signal	0 to 40 V
- for "1" signal	85 to 135 V
Input current at "1" signal	
- at AC, 50 Hz	typ. 10 mA
- at DC	typ. 6 mA
Response time	
- from "0" to "1"	2 to 13 msec.
- from "1" to "0"	10 to 25 msec.
Cable length	
- shielded	1000 m (3281 ft.)
- unshielded	600 m (1969 ft.)
Insulation rating	to VDE 0160
Rated insulation voltage ¹⁾ (between groups)	250 V
- insulation group	C
- tested with	1500 V
Rated insulation voltage (L1 to \perp)	250 V
- insulation group	C
- tested with	1500 V
Connection of 2-wire BERO proximity switches	possible
- quiescent current	5 mA
Current consumption	
- from 5 V (internal)	5mA
simultaneity factor (each group, L1=135 V)	
- at 25°C	100%
- at 55°C	75%
Power losses of the module	typ. 5,5 W
Weight	approx. 0.7 kg (1.54 lb.)

Terminal assignment



Simplified schematic

¹ Connection of different phases ist permissible

Digital Input Module 8 x 230 V AC, Floating, Safety-Related

(6ES5436-7LC11)

	Technical Specifications	
	<p>Number of inputs 8</p> <p>Floating yes (optocoupler)</p> <p>- isolated in groups of 1</p> <p>Input voltage L1</p> <p>- rated value 230 V AC</p> <p>- frequency 47 to 63 Hz</p> <p>- for "0" signal 0 to 100 V</p> <p>- for "1" signal 177 to 242 V</p> <p>Input current at "1" signal typ. 16 mA</p> <p>Response time</p> <p>- from "0" to "1" 2 to 13 msec.</p> <p>- from "1" to "0" 10 to 25 msec.</p> <p>Cable length</p> <p>- shielded 1000 m (3281 ft.)</p> <p>- unshielded 600 m (1969 ft.)</p> <p>Insulation rating to VDE 0160</p> <p>Rated insulation voltage ¹⁾ (between groups)</p> <p>- insulation group 250 V</p> <p>- tested with C</p> <p>- tested with 2700 V</p> <p>Rated insulation voltage (L1 to \perp)</p> <p>- insulation group 250 V</p> <p>- tested with C</p> <p>- tested with 2700 V</p> <p>Connection of 2-wire BERO proximity switches</p> <p>- quiescent current possible</p> <p>5 mA</p> <p>Current consumption</p> <p>- from 5 V (internal) 5 mA</p> <p>Power losses of the module typ. 5 W</p> <p>Weight approx. 0.7 kg (1.54 lb.)</p>	

Terminal assignment

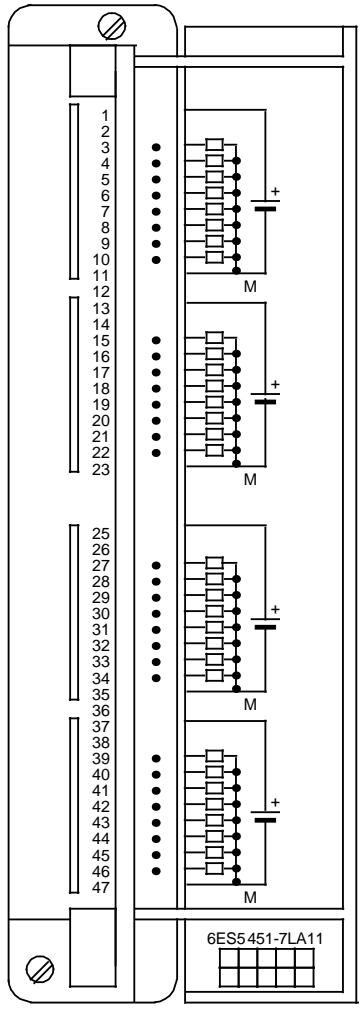
Simplified schematic

¹ Connection of different phases is not permissible

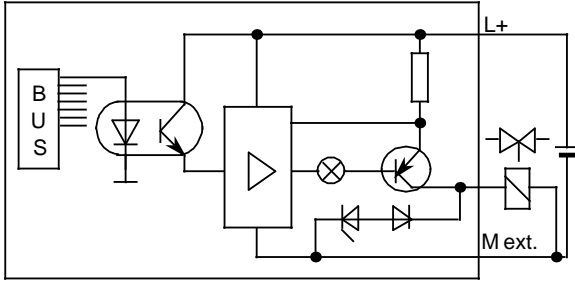
8.2.5 Digital Output Modules

Digital Output Module 32 x 24 V DC; 0.5 A Floating, Reaction-Free

(6ES5 451-7LA11)



Terminal assignment



Simplified schematic

Technical Specifications

Number of outputs	32
Floating	yes (optocoupler)
- isolated in groups of	8
Load voltage L+	
- rated value	24 V DC
- permissible range	20 to 30 V
- surge voltage at t = 0.5 sec.	35 V
Output voltage	
- at "1" signal	min. L + - 2.5 V
Output current at "1" signal	
- rated value	0.5 A
- lamp load	max. 5 W
Leakage current at "0" signal	max. 1 mA
Parallel connection of outputs	not possible
Permissible total current of outputs	
	100% at 25°C and 50% at 55°C (referred to the sum of the currents of a group)
Short-circuit protection	electronic
Limitation of the voltage induced on circuit interruption	- 15 V
Switching frequency	
- inductive load	max. 0.5 Hz
- resistive load	max. 100 Hz
Cable length	
- shielded	max. 1000 m (3281 ft.)
- unshielded	max. 600 m (1969 ft.)
Insulation rating	to VDE 0160
Rated insulation voltage (between groups)	30 V DC
- isolation group	C
- tested with	500 V AC
Rated insulation voltage (L+ to ground)	30 V DC
- insulation group	C
- tested with	500 V AC
Current consumption	
- from 5 V (internal)	100 mA
- from L+ (without load)	17 mA / per group
Power losses of the module	typ. 20 W
Weight	approx. 0.7 kg (1.54 lb.)

Digital Output Module 16 x 24 V DC; 2A, Floating, Reaction-Free

(6ES5 454-7LA11)

Technical Specifications

Number of outputs	16
Floating	yes (optocoupler)
- isolated in groups of	4
Load voltage L+	
- rated value	24 V DC
- permissible range	20 to 30 V
- surge voltage at t 0.5 sec.	35 V
Output voltage	
- at "1" signal	min. L + - 3 V
Output current at "1" signal	
- rated value	2 A
- lamp load	max. 10 W
Leakage current at "0" signal	max. 1 mA
Parallel connection of outputs	not possible
Permissible total current of outputs, per group	50% (referred to the sum of the currents of a group)
Short-circuit protection	electronic
Limitation of the voltage induced on circuit interruption	- 15 V
Switching frequency	
- inductive load	max. 0.27 Hz
- resistive load	max. 100 Hz
Cable length	
- shielded	max. 1000 m (3281 ft.)
- unshielded	max. 600 m (1969 ft.)
Insulation rating	to VDE 0160
Rated insulation voltage (between groups)	30 V DC
- insulation group	C
- tested with	500 V AC
Rated insulation voltage (L+ to ---)	30 V DC
- insulation group	C
- tested with	500 V AC
Current consumption	
- from 5 V (internal)	50 mA
- from L + (without load)	8.5 mA / per group
Power losses of the module	typ. 20 W
Weight	approx. 1.1 kg (2.43 lb.)

Terminal assignment

Simplified schematic

Digital Output Module 8 x 24 V DC; 2 A, Floating, Reaction-Free

(6ES5 454-7LB11)

6ES5 454-7LB11

DIGITAL
OUTPUT
8x24V DC

Technical Specifications

Number of outputs	8
Floating	yes (optocoupler)
- isolated in groups of	1
Load voltage L+	
- rated value	24 V DC
- permissible range	20 to 30 V
- surge voltage at t 0.5 sec.	35 V
Output voltage	
- at "1" signal	min. L + - 3 V
Output current	
- rated value	2 mA
- lamp load	max. 10 W
Leakage current	
at "0" signal	max. 1 mA
Parallel connection of outputs	possible
- maximum current	1 x rated
Permissible total current of outputs, per group	100% at 25°C and 50% at 55°C (referred to the sum of the currents of a group)
Short-circuit protection (for each group)	with FF 2.5 A fuse (e.g., Wickmann 19231)
Limitation of the voltage included on circuit interruption	typ. -21 V
Switching frequency	
- inductive load	max. 0.27 Hz
- resistive load	max. 100.00 Hz
Cable length	
- shielded	max. 1000 m (3281 ft.)
- unshielded	max. 600 m (1969 ft.)
Insulation rating	to VDE 0160
Rated insulation voltage (between groups)	30 V DC
- insulation group	C
- tested with	500 V AC
Rated insulation voltage (L+ to \perp)	30 V DC
- insulation group	C
- tested with	500 V AC
Current consumption	
- from 5 V (internal)	max. 50 mA
Power losses of the module	typ. 20 W
Weight	approx. 0.8 kg (1.76 lb.)

Terminal assignment

Simplified schematic

Digital Output Module 8 x 115 to 230 V AC; 2 A, Floating, Safety-Related

(6ES5 456-7LB11)

6ES5 456-7LB11

DIGITAL
OUTPUT
8x115/230V DC

Technical Specifications

Number of outputs	8
Floating	yes (optocoupler)
- in groups of	1
Load voltage L1	
- rated value	115 to 230 V AC
- frequency	47 to 63 Hz
- permissible range	89 to 264 V
Output voltage	
- at "1" signal	min. L1 - 7 V
Output current at "1" signal	
- rated value	2 A
- permissible range	40 mA to 2 A
- lamp load	50 W
Leakage current at "0" signal	typ. 3 to 5 mA¹
Parallel connection of outputs	not possible
Making capacity	depends on the fuse
Permissible total current of outputs	100%
Short-circuit protection (for each group)	4 A FF fuse (e.g., Wickmann 19231)
Fault indication (red LED for each group)	defective fuse
Switching frequency	max. 10 Hz
Cable length	
- shielded	max. 1000 m (3281 ft.)
- unshielded	max. 300 m (984 ft.)
Insulation rating	to VDE 0160
Rated insulation voltage (between groups)	250 V AC
- insulation group	C
- tested with	2700 V AC
Rated insulation voltage (L1 to \perp)	250 V AC
- insulation group	C
- tested with	2700 V AC
Current consumption - from 5 V (internal)	max. 35 mA
Power losses of the module	typ. 16 W
Weight	approx. 1.1 kg (2.43 lb.)

Terminal assignment

Simplified schematic

1 Please note the drop-out current of the connected loads (relays of the range 3TJ1 to 3TJ5 and relays of the SIMICOMT range cannot be driven)!

Relay Output Module for Measuring Currents 16 x 24 V DC, Reaction-Free (6ES5 458-7LA11)

Terminal assignment

Simplified schematic

Technical Specifications

Number of outputs	16
- contact bridge	no
- floating	yes
- isolated in groups of	1
- relay type	3700-2501-011 (Günther)
Limiting continuous current per contact	0.5 A
Parallel connection of outputs	possible
Permissible total current of outputs	100%
Switching frequency	
- inductive load	max. 100 Hz
- resistive load	not permissible
Switching voltage	max. 30 V DC
Switching capacity of the contacts	
- resistive load	10 W at 0.5 A
- inductive load	not permissible
Number of contact operating cycles according to VDE 0660, Part 200	
- DC 11	1 x 10 ⁹
Supply voltage L + (for relay)	
- rated value	24 V DC
- permissible range	20 to 30 V
- surge voltage at t < 0.5 sec.	35 V
- ripple	max. 3.6 V
Cable length	
- shielded	1000 m (3281 ft.)
- unshielded	300 m (984 ft.)
Insulation rating	to VDE 0160
Rated insulation voltage (between contacts)	30 V DC
- insulation group	C
- tested with	500 V AC
Rated insulation voltage (contacts to L +)	30 V DC
- insulation group	C
- tested with	500 V AC
Rated insulation voltage (contacts to ground)	30 V DC
- insulation group	C
- tested with	500 V AC
Current consumption	
- from 5 V (internal)	max. 50 mA
- from L + (for relay)	240 mA
Power losses of the module	typ. 5 W
Weight	approx. 0.8 kg (1.76 lb.)

Relay Output Module 8 x 30 V DC / 60 V AC, Safety-Related

(6ES5 458-7LB11)

6ES5 458-7LB11

DIGITAL OUTPUT
8x60VUC Relay

Technical Specifications

Number of outputs	8
- contact bridge	varistor SIOV-S07-K275
- floating	yes
- isolated in groups of	1
- relay type	V23157-006-A402 (Siemens)
Limiting continuous current per contact	5 A
Parallel connection of outputs	possible
Permissible total current of outputs	100%
Switching capacity of the contacts	
- resistive load	5 A at 250 V AC 2.5 A at 30 V DC
- inductive load	1.5 A at 250 V AC 0.5 A at 30 V DC
Switching voltage is limited to 60 V AC in the S5-115F	
Switching frequency	max. 10 Hz
Number of contact operating cycles according to VDE 0660, Part 200	
- AC 11	1.5 x 10 ⁶
- DC 11	0.5 x 10 ⁶
Supply voltage L+ (for relay)	
- rated value	24 V DC
- permissible range	20 to 30 V
- surge voltage at t 0.5 s	35 V
- ripple	max. 3.6 V
Insulation rating	to VDE 0160
Rated insulation voltage (between contacts)	250 V AC
- insulation group	C
- tested with	1500 V AC
Rated insulation voltage (contacts to L+)	250 V AC
- insulation group	C
- tested with	1500 V AC
Rated insulation voltage (contacts to \perp)	250 V AC
- insulation group	C
- tested with	1500 V AC
Current consumption	
- from 5 V (internal)	max. 50 mA
- from L+ (for relay)	200 mA
Power losses of the module	typ. 4 W
Weight	approx. 0,8 kg (1.76 lb.)

Terminal assignment

Simplified schematic

8.2.6 Digital Input/Output Modules

Digital Input/Output Module 32 x 24 V DC; 0.5 A, Reaction-Free

(6ES5 482-7LA11)

Terminal assignment

Technical Specifications

Number of inputs	16
Floating	yes (optocoupler)
- isolated in groups of	8
Input voltage	24 V DC
- rated value	

The technical specifications for the inputs correspond to those of the 6ES5 430-7LA11 digital input module.

Number of outputs	16
Floating	yes (optocoupler)
- isolated in groups of	8
Output current at "1" signal	0.5 A
- rated value	

The technical specifications for the outputs correspond to those of the 6ES5 451-7LA11 digital output module.

Output	0...3 and 4...7	can be switched in parallel
	8...11 and 12...15	
Parallel current		0.8 x I _{rated}
Permissible current of outputs		100 % at 35 °C 50 % at 55 °C (referred to the sum of the currents of a group)
Current consumption	- from 5 V (internal)	max. 50 mA
Power loss		typ. 18 W
Weight		approx. 0.7 kg (1.54 lb.)
Setting for IM 306		16-channel

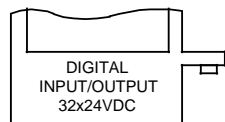
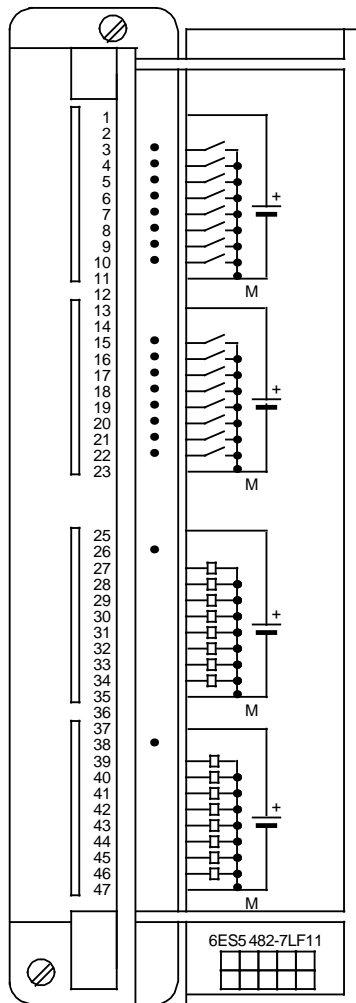
The inputs and outputs are referenced under the same address (e.g. I 0.0 to I 1.7 and Q 0.0 to Q 1.7).

Example: For module start address "0", you must address as follows:

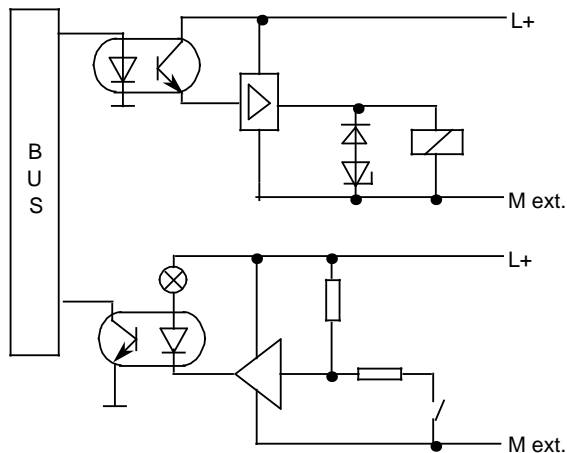
Simplified schematic

Digital Input/Output Module 32 x 24 V DC; 0.5 A, Safety-Related

(6ES5 482-7LF11)



Terminal assignment



Simplified schematic

Technical Specifications

Number of inputs	16, for reading: M potential
Floating	yes (optocoupler)
- isolated in groups of	8, connected to common P potential
Input voltage	24 V DC
- rated value	24 V DC
- permissible range	20 to 30 V
- value at t 0.5 sec.	35 V
Input current	
- at "1" signal	typ. 0.8 mA
Response time	
- from "0" to "1"	1.4 to 5 msec
- from "1" to "0"	1.4 to 5 msec

Note:
Inputs can only be used as read-back inputs by 24 V safety-oriented outputs in the other subunit!

Number of outputs	16, for output: P potential
Floating	yes (optocoupler)
- isolated in groups of	8
Output current at "1" signal	
- rated value	0.5 A

The technical specifications for the outputs correspond to those of the 6ES5 451-7LA11 digital output module.

Output 0 to 3 and 4 to 7 can be switched in parallel
8 to 11 and 12 to 15

Parallel current 0.8 x I_{rated}

Permissible current of outputs
100% at 35°C and 50% at 55°C (referred to the sum of the currents of a group)

Cable length
- shielded max. 100 m (328 ft.)
- unshielded max. 60 m (197 ft.)

Insulation rating to VDE 0160

Rated insulation voltage (between groups)
- insulation group C
- tested with 500 V

Rated insulation voltage (L+ to \perp)
- insulation group C
- tested with 500 V

Current consumption
- from 5 V (internal) max. 50 mA

Power loss typ. 18 W

Weight approx. 0.7 kg (1.54 lb.)

The inputs and outputs are referenced under the same address (e.g. I 0.0 to I 1.7 and Q 0.0 and Q 1.7).

Digital Input/Output Module 32 x 24 V DC; 0.5 A, Safety-Related

(6ES5 482-7LF21)

Technical Specifications

Number of inputs	16, for reading: P potential
Floating - isolated in groups of	yes (optocoupler) 8, connected to common M potential
Input voltage	
- rated value	24 V DC
- permissible range	20 to 30 V
- value at t 0.5 sec.	35 V
Input current	
- at "1" signal	typ. 0.8 mA
Response time	
- from "0" to "1"	1.4 to 5 ms
- from "1" to "0"	1.4 to 5 ms

Note:
Inputs can only be used as read-back inputs by 24 V safety-related outputs in the other subunit!

Number of outputs	16, for output: M potential
Floating - isolated in groups of	yes (optocoupler) 8
Output current at "1" signal	
- rated value	0.5 A

The technical specifications for the outputs correspond to those of the 6ES5 451-7LA11 digital output module.

Output	0 to 3 and 4 to 7 8 to 11 and 12 to 15	can be switched in parallel
Parallel current		0.8 x I _{rated}
Permissible current of outputs		100% at 35°C and 50% at 55°C (referred to the sum of the currents of a group)

Cable length		
- shielded	max.	100 m (328 ft.)
- unshielded	max.	60 m (197 ft.)
Insulation rating		to VDE 0160
Rated insulation voltage (between groups)		30 V
- insulation group		C
- tested with		500 V
Current consumption - from 5 V (internal)	max.	50 mA
Power loss	typ.	18 W
Weight	approx.	0.7 kg (1.54 lbs.)

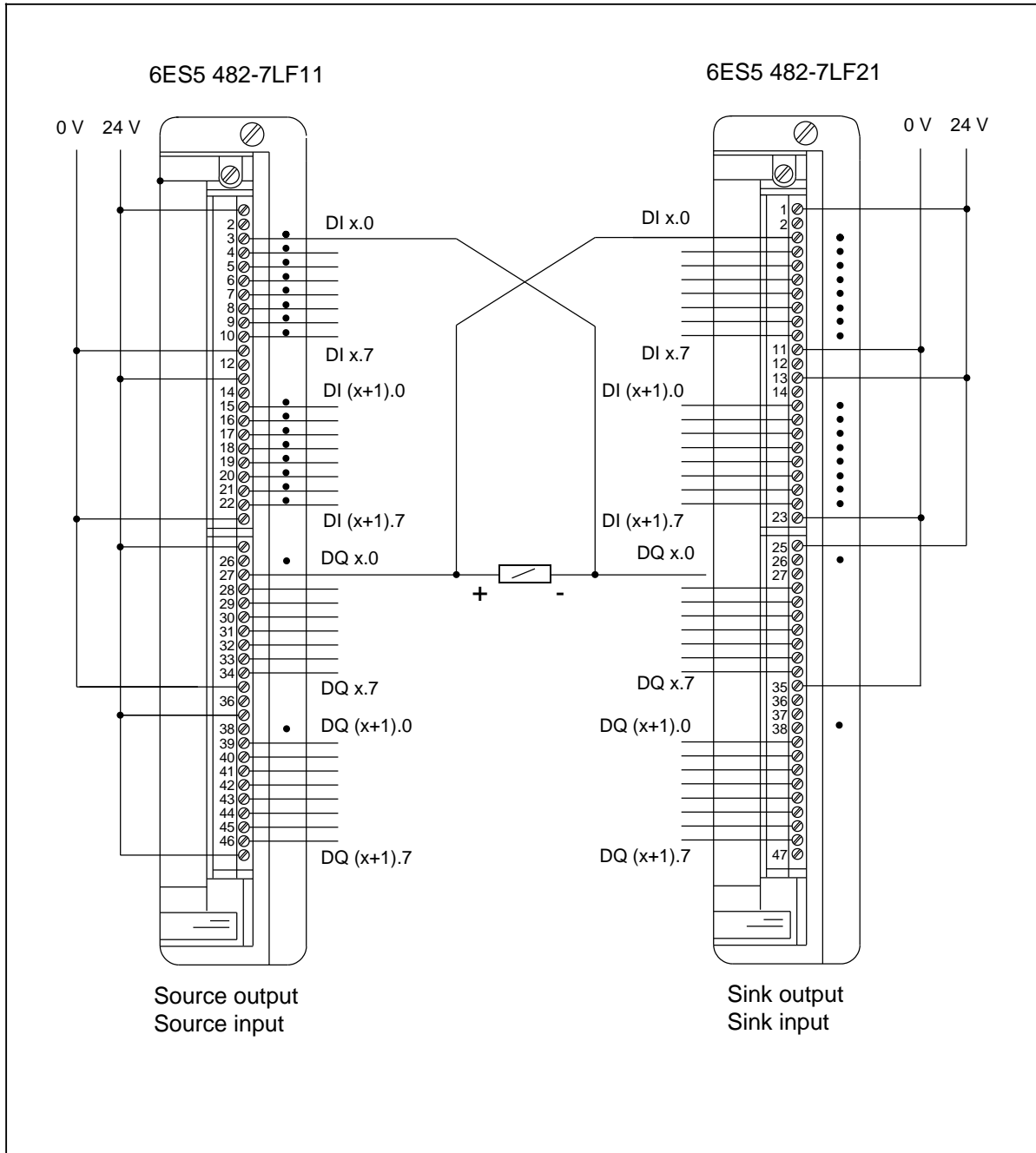
The inputs and outputs are referenced under the same address (e.g. I 0.0 to I 1.7 and Q 0.0 and Q 1.7).

Terminal assignment

Simplified schematic

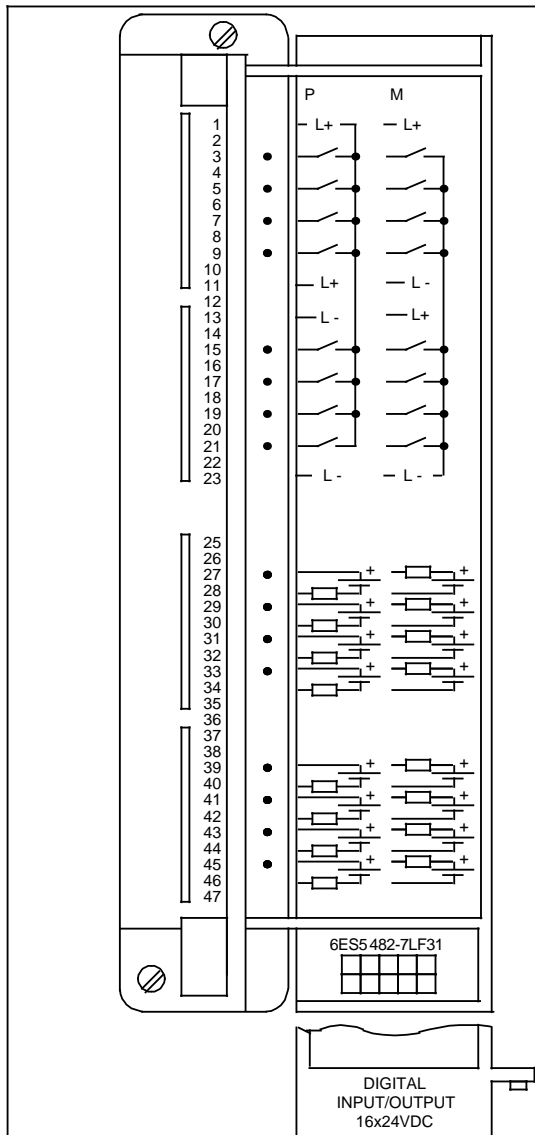
Example: Connection of an actuator via the modules 482-7LF11 and 482-7LF21

The following figure shows how an actuator is triggered via the modules 482-7LF11 and 482-7LF21. The byte address of the inputs and outputs is marked with an *x*; it corresponds to the start address of the module.



Digital Input/Output Module 16 x 24 V DC; 2.5 A, safety-related

(6ES5 482-7LF31)

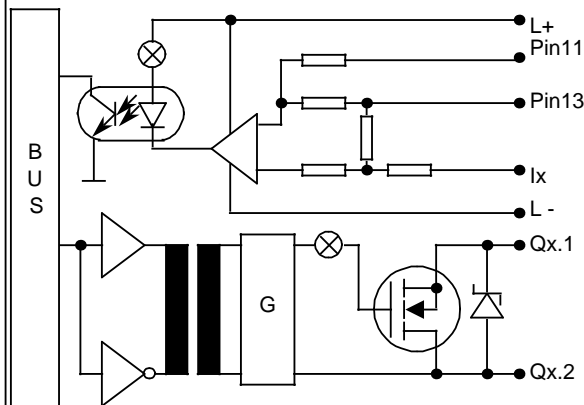


Technical Specifications

Current consumption	
- internal (5 V)	max. 150 mA
- external (24 V, without load)	max. 95 mA
Supply voltage for inputs and outputs	
- rated direct voltage	L+
- reference potential	L-
Max. permissible supply voltage	
Rated voltage 24 V- (L+/L-)	20 to 30 V 35 V for 500 ms
Inputs:	
Number of inputs	8, M or P potential
- in groups of	8
Galvanic isolation	yes (optocoupler)
Input voltage	
- Nominal value	24 V DC
- Signal "1" P switch (> 19 V)	corresponding to the signal to be read back
- Signal "1" M switch (< 5 V)	
Nominal input current	typ. 0.8 mA
Delay	1,4 to 5 ms
Input resistance	typ. 30 k
Permissible cable length	
- shielded	max. 100 m (328 ft.)
- unshielded	max. 60 m (197 ft.)
Insulating rating	to VDE 0160
Outputs:	
Number of outputs	8, P or M potential
Galvanic isolation	yes (transformer)
Supply voltage V_p (load)	
- rated value	24 V DC
- ripple V_{pp} max.	3.6 V
- range (including ripple)	20 to 30 V
- value at $t < 0.5$ s	max. 35 V
Fuse	electronic
Output voltage	
- signal "1" P switch	$V_p < -1.0$ V
- signal "1" M switch	$M < +1.0$ V
Switching current (ohmic inductive load)	5 mA to 2.5 A
Output leakage current	max. 0.5 mA
Summed switching current	20 A
Lamp load	max. 40 W
Power loss	11 W
Switching frequency	
- with ohmic load	max. 100 Hz (10 ms)
- with lamps	max. 8 Hz (125 ms)
- with inductive load	0.5 Hz at 2 A (2 s)
Delay	
- in	30 μ s
- out	150 μ s
Permissible cable length	
- shielded	max. 1000 m (3280 ft.)
- unshielded	max. 600 m (1968 ft.)
Weight	approx. 0.7 kg (1.54 lb)
The inputs and outputs are referenced under the same address (e.g. I 0.0 to E 1.7 and Q 0.0 to Q 1.7).	

Terminal assignment

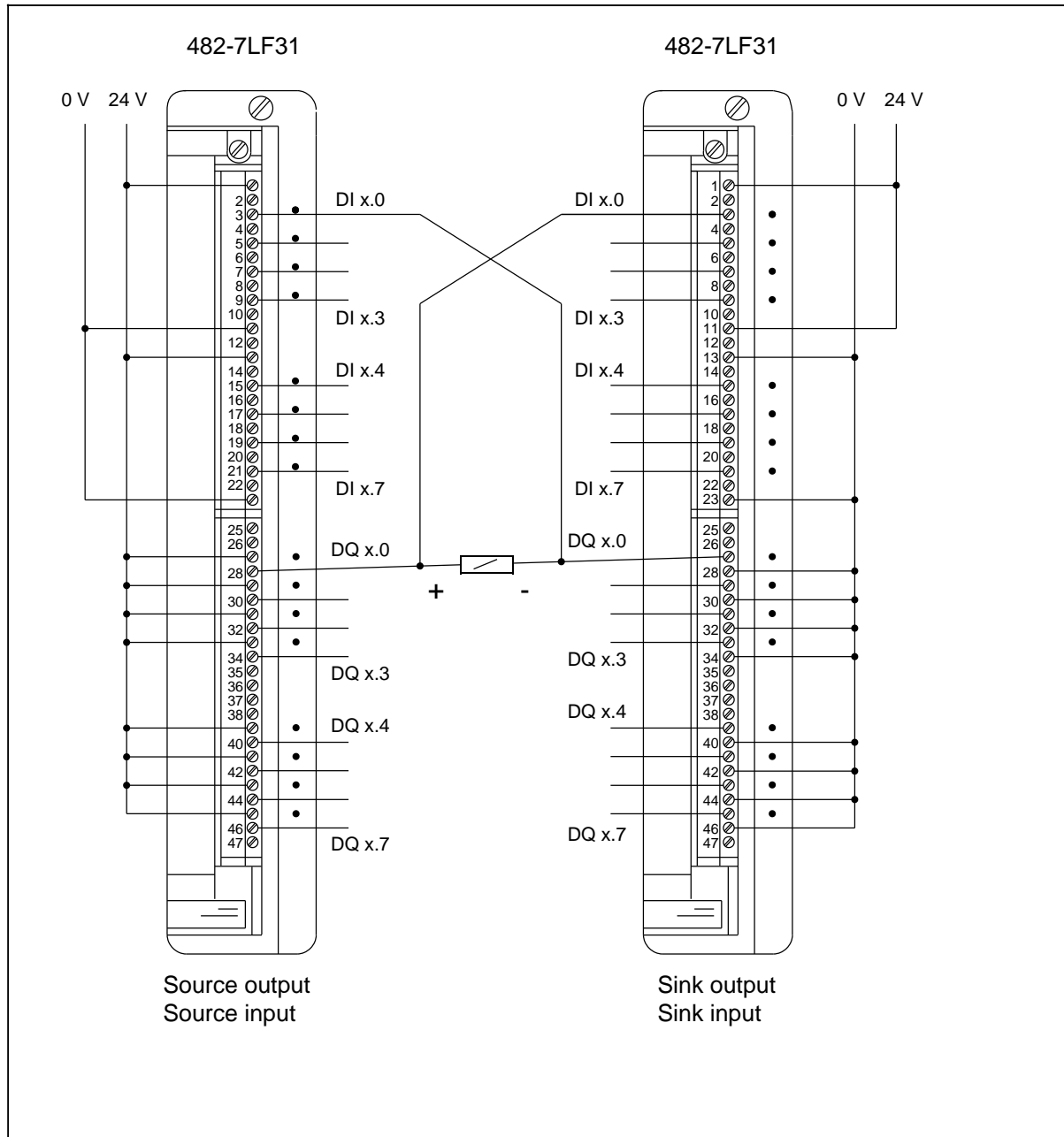
If L+ at pin 11 and L- at pin 13 then inputs P potential and outputs M potential
 If L- at pin 11 and L+ at pin 13 then inputs M potential and outputs P potential



Simplified schematic

Example: Connection of an actuator via two modules 482-7LF31

The following figure shows how an actuator is triggered via two modules 482-7LF31. The byte address of the inputs and outputs is marked with an x; it corresponds to the start address of the module.



8.2.7 Analog Input Modules

Analog Input Module 8 x I/O/PT, Floating, Reaction-Free

(6ES5 460-7LA12)

Terminal assignment of the front connector

a	b
1	L+=24V
2	
3	M0+
4	
5	M0 -
6	
7	M1+
8	
9	M1 -
10	
11	
12	
13	
14	
15	M2+
16	
17	M2 -
18	
19	M3+
20	
21	M3 -
22	
23	KOMP+
24	
25	KOMP -
26	
27	M4+
28	
29	M4 -
30	
31	M5+
32	
33	M5 -
34	
35	
36	
37	
38	
39	M6+
40	
41	M6 -
42	
43	M7+
44	
45	M7 -
46	
47	L -

a = Contact pin no.
b = Assignment

(Connection possibilities 3.3.3)

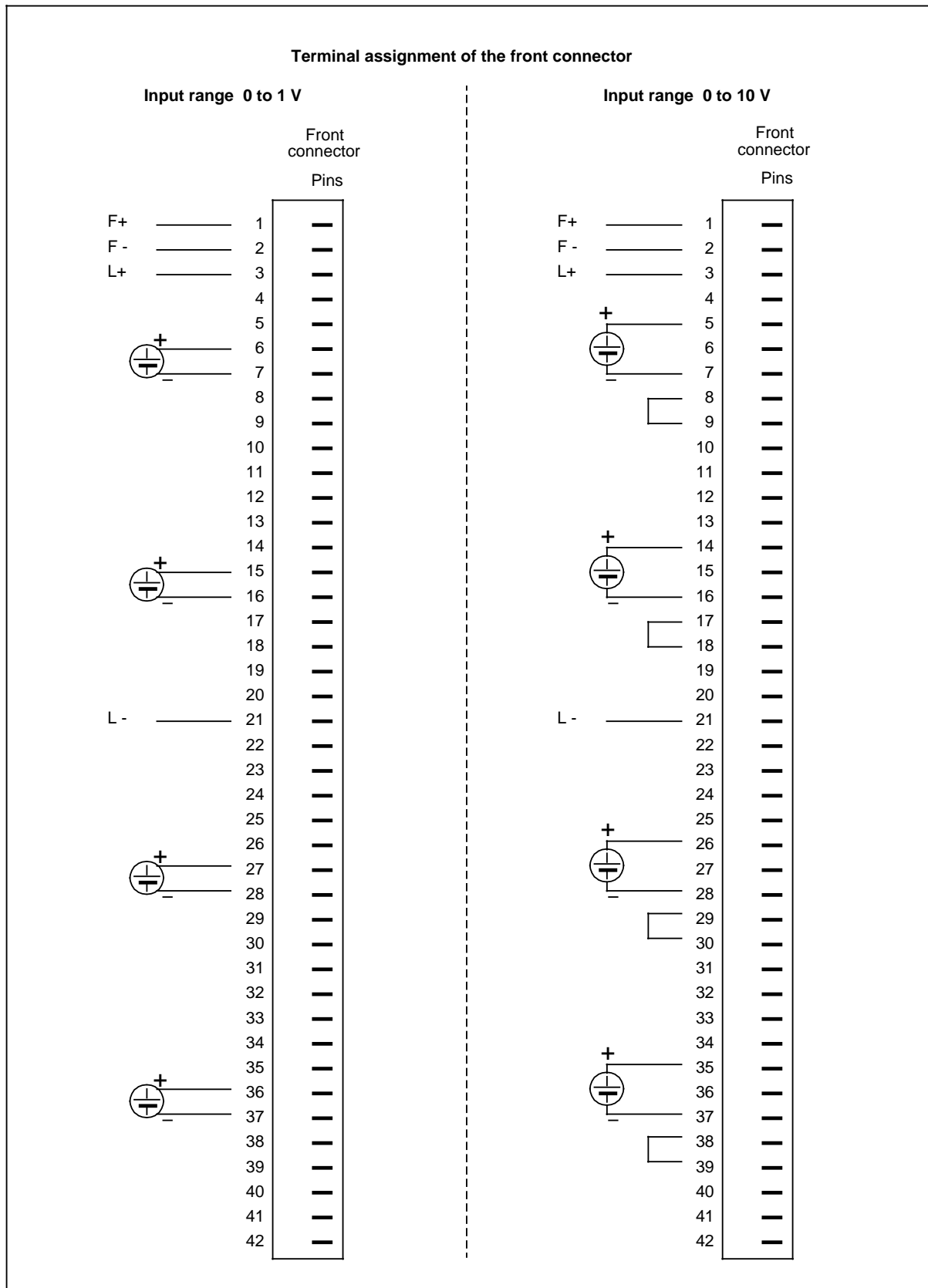
Analog Input Module 8 x I/O/PT, Floating, Reaction-Free

(6ES5 460-7LA12)

Technical Specifications			
Number of inputs	8 voltage/current inputs or 8 inputs for Pt 100 yes (not for Pt 100)	Error indication for - overranging	yes (exceeding 4095 units)
Floating		- wire break in the sensor line	can be designed for the ranges 50 mV, 500 mV and Pt 100 (only measuring leads)
Input ranges (rated values)	±50 mV; ±500 mV; Pt 100; ±1 V; ±5 V; ±10 V; ±20 mA; +4 to 20 mA (can be selected for four channels at a time using range cards)	Noise suppression for $f=n \times (50/60 \text{ Hz} \pm 1\%)$ $n=1, 2, \dots$	
Input resistance	± 12.5 mV: 10 M ± 50 mV: 10 M ± 500 mV: 10 M Pt 100: 10 M ± 1 V: 90 k ; 0.2 % ± 5 V: 50 k ; 0.2 % ± 10 V: 50 k ; 0.2 % ± 20 mA: 25 ; 0.1 % ± 4 to 20 mA: 31.25 ; 0.1 %	- common mode noise ($V_p < 1 \text{ V}$)	min. 100 dB
Type of connection for sensors	two-wire connection; four-wire connection for Pt 100	- series mode noise (peak noise value < rated value of the range)	min. 40 dB
Digital representation of the input signal	12 bits plus sign or 13 bits two's complement (2048 units = rated value)	Basic error limits	± 50 mV : ± 0.2% ± 500 mV : ± 0.15% Pt 100 : ± 0.2% ± 1 V : ± 0.35% ± 5 V : ± 0.35% ± 10 V : ± 0.35% ± 20 mA : ± 0.25% + 4 to 20 mA : ± 0.25%
Measuring principle	integrating	Operational error limits (0 to 55°C)	± 50 mV : ± 0.5% ± 500 mV : ± 0.45% Pt 100 : ± 0.5% ± 1 V : ± 0.77% ± 5 V : ± 0.77% ± 10 V : ± 0.77% ± 20 mA : ± 0.67% + 4 to 20 mA : ± 0.67%
Conversion principle	voltage-time conversion (dual-slope)	Cable length	
Integration time (adjustable for optimum noise suppression)	20 msec. at 50 Hz 16.6 msec. at 60 Hz	- shielded	max. 200 m (656 ft.); 50 m (164 ft.) for ± 50 mV
Coding time (single coding for 2048 units)	max. 60 msec. at 50 Hz 50 msec. at 60 Hz	Front connector	46 pin
Cycle time for - 8 inputs	0.48 sec. at 50 Hz	Insulation rating	to VDE 0160
Permissible voltage between inputs and central grounding point (destruction limit)	max. 30 V or 60 V for max. 1 msec. and a duty cycle of 1 : 20	Rated insulation voltage (channel to channel) - tested with	500 V
Permissible voltage between the reference potential of a nonfloating sensor and the central grounding point	max. 60 V DC/24 V AC	Rated insulation voltage (channel to $\underline{\underline{\text{---}}}$) - tested with	500 V
		Power supply	
		- rated value	24 V DC
		- ripple V_{pp}	3.6 V
		- permissible range (including ripple)	20 to 30 V
		Current consumption	
		- from 5 V (internal)	typ. 0.15 A
		- from 24 V (external)	typ. 0.1 A
		Power losses of the module	typ. 3 W
		Weight	approx. 0.4 kg (0.88 lb.)

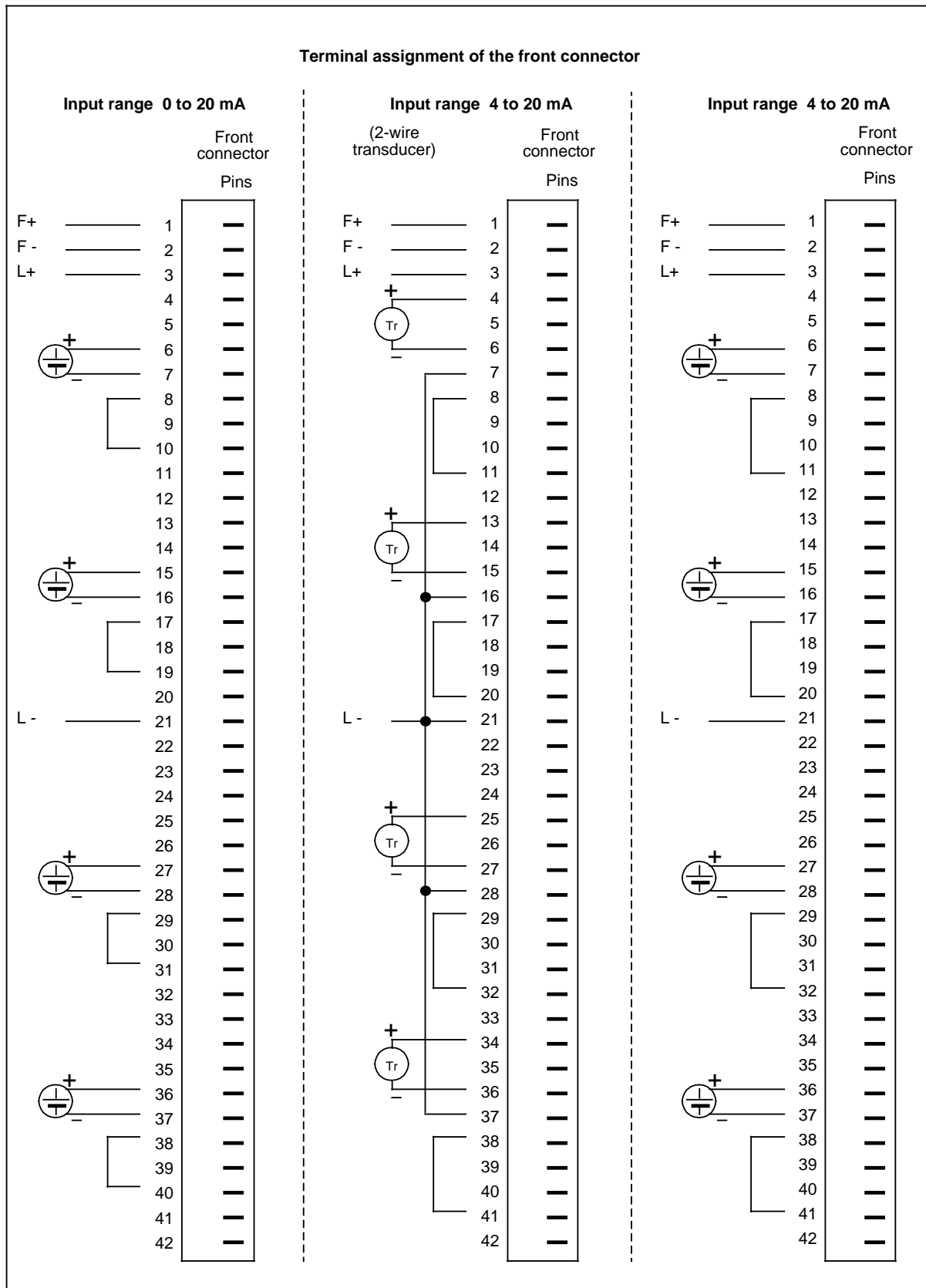
Analog Input Module 4 x I/O, Floating, Safety-Related

(6ES5 463-4UA12, 6ES5 463-4UB12)



Analog Input Module 4 x I/O, Floating, Safety-Related

(6ES5 463-4UA11, 6ES5 463-4UA12, 6ES5 463-4UB11, 6ES5 463-4UB12)



Analog Input Module 4 x I/O, Floating, Safety-Related

(6ES5 463-4UA11, 6ES5 463-4UA12, 6ES5 463-4UB11, 6ES5 463-4UB12)

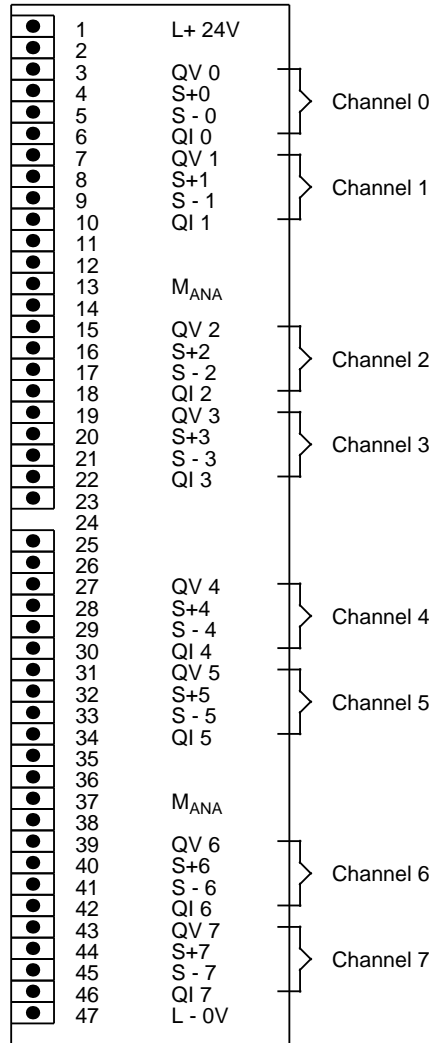
Technical Specifications		Basic error limits	0.11 ‰
Number of inputs	4 voltage/current inputs	Operational error limits (0° to 55°C)	0.37 ‰
Floating	yes	Enable input	+24 V
Input ranges (rated values)	0 to 1 V; 0 to 10 V; 0 to 20 mA +4 to 20 mA for 2-wire and for 4-wire transducers	Power supply	+24 V
Input resistance in the individual ranges	1 V: 10 M; 10 V: 90 k 20 mA: 50 4 to 20 mA: 62.5	Current consumption	
Type of connection sensors	Two-wire connection	- internal (from 5 V)	typ. 0.2 A
Digital representation of the input signal	11 bits two's complement (2024 units = rated value)	- external (from 24 V)	typ. 0.15 A
Measuring principle	integrating	Space requirements	1 slot
Conversion principle	voltage-frequency conversion	Weight	approx. 0.4 kg (0.88 lb.)
Integration time (adjustable for optimum noise suppression)	20 msec. at 50 Hz 16.6 msec. at 60 Hz		
Coding time (single coding possible)	max. 20 msec. at 50 Hz 16.6 msec. at 60 Hz		
Cycle time for 4 inputs	20 msec. at 50 Hz, 16.6 msec. at 60 Hz		
Permissible voltage between inputs and between inputs and central grounding point (destruction limit)	max. 30 V or 75 V for max. 1 msec. and a duty cycle of 1 : 10		
Permissible voltage between the reference potential of a nonfloating sensor and the central grounding point	max. 60 V DC/60 V AC		
Error indication for			
- overranging	at 150 % of rated value		
- wire break of the sensor line	no		
Noise suppression for $f = n \cdot (50/60 \text{ Hz} \pm 1\%)$ $n = 1, 2, \dots$			
- common mode noise ($V_p < 1 \text{ V}$)	min. 80 dB		
- series mode noise (peak noise value < rated value of the range)	min. 40 dB		

8.2.8 Analog Output Modules

Analog Output Modules 8 x ± 10 V; 0 to 20 mA; Floating, Reaction-Free

(6ES5 470-7LA12)

Terminal assignment of the front connector



- M_{ANA} = common reference point of all current and voltage channels
- QV x = voltage output channel x
- QI x = current output channel x
- S+x = sensor line + channel x
- S - x = sensor line - channel x

Analog Output Module 8 x±10 V; 0 to 20 mA; Floating, Reaction-Free

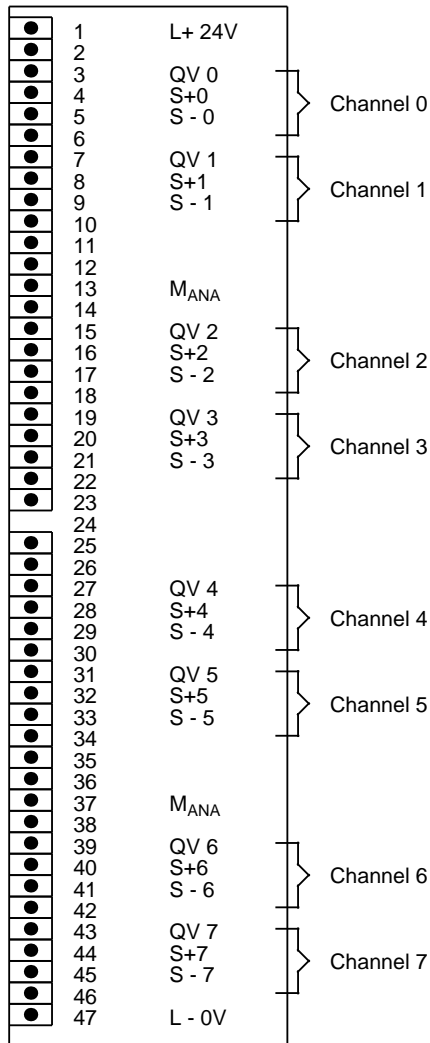
(6ES5 470-7LA12)

Technical Specifications		
Number of outputs	8 voltage and current outputs	Power supply - rated value 24 V DC - ripple Vpp 3.6 V - permissible range (including ripple) 20 to 30 V
Floating	yes (not between the inputs)	
Output ranges (rated values)	± 10 V; 0 to 20 mA	Current consumption - from 5 V (internal) typ. 0.25 A - from 24 V (external) typ. 0.30 A
Load resistance - for voltage outputs - for current outputs	min. 3.3 k max. 300	
Load connection	load to M _{ANA} terminal	Power losses of the module typ. 8.5 W
Digital representation of the output signal	11 bits plus sign (1024 units = rated value)	Weight approx. 0.4 kg (0.88 lb.)
Conversion time	1 msec.	
Permissible overload capability	approx. 25 % (up to 1280 units)	
Short-circuit protection	yes	
Short-circuit current	approx. 25 mA (for a voltage output)	
Open-circuit voltage	approx. 18 V (for current output)	
Voltage between the reference potential of the load (M _{ANA} terminal) and the housing	min. 60 V AC/75 V DC	
Linearity in the rated range	± 0.25 % ± 3 units	
Operational error limits (0 to 55°C)	± 0.6 %	
Cable length - shielded	max. 200 m (656 ft.)	
Front connector	46 pin	
Insulation rating	to VDE 0160	
Rated insulation voltage (outputs to \perp) - tested with	500 V	

Analog Output Module 8 x ± 10 V; Floating, Reaction-Free

(6S5 470-7LB12)

Terminal assignment of the front connector



- M_{ANA} = common reference point of all current and voltage channels
- QV x = voltage output channel x
- S+x = sensor line+ channel x
- S - x = sensor line - channel x

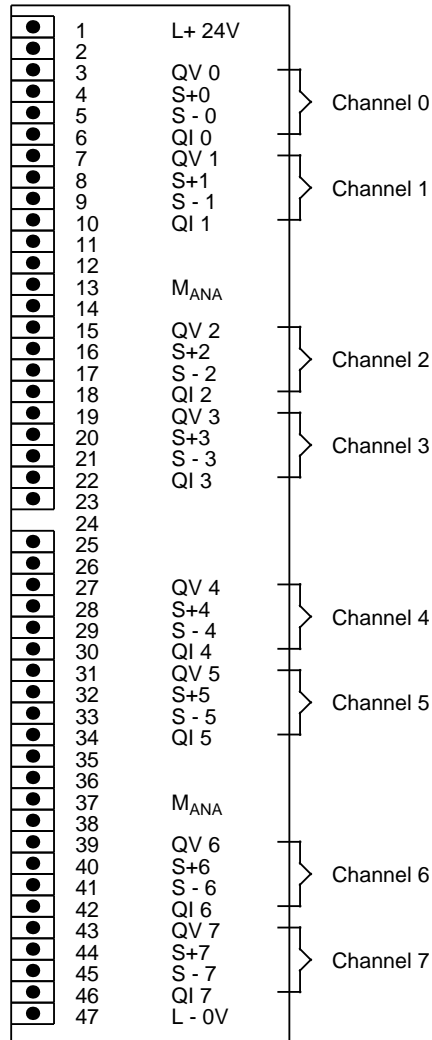
Analog Output Module 8 x ± 10 V; Floating, Reaction-Free

(6ES5 470-7LB12)

Technical Specifications			
Number of outputs		8 voltage outputs	
Floating		yes (not between the inputs)	
Output ranges (rated values)		± 10 V	
Load resistance	min.	3.3 k	
Load connection		load to M _{ANA} terminal	
Digital representation of the output signal		11 bits plus sign (1024 units = rated value)	
Conversion time		1 msec.	
Permissible overload capability	approx.	25 % (up to 1280 units)	
Short-circuit protection		yes	
Short-circuit current	approx.	25 mA	
Voltage between the reference potential of the load (M_{ANA} terminal) and the housing	max.	60 V AC/75 V DC	
Linearity in the rated range		± 0.25 % ± 3 units	
Operational error limits (0 to 55°C)		± 0.6 %	
Cable length - shielded	max.	200 m (656 ft.)	
Front connector		46 pin	
Insulation rating		to VDE 0160	
Rated insulation voltage (outputs to \perp) - tested with		500 V	
Power supply			
- rated value			24 V DC
- ripple V _{pp}			3.6 V
- permissible range (including ripple)			20 to 30 V
Current consumption			
- from 5 V (internal)	typ.		0.25 A
- from 24 V (external)	typ.		0.30 A
Power losses of the module	typ.		8.5 W
Weight	approx.		0.4 kg (0.88 lb.)

Analog Output Module 8 x +1 to 5 V; +4 to 20 mA; Floating, Reaction-Free (6ES5 470-7LC12)

Terminal assignment of the front connector



- M_{ANA} = common reference point of all current and voltage channels
- QV x = voltage output channel x
- QI x = current output channel x
- S+x = sensor line + channel x
- S - x = sensor line - channel x

Analog Output Module 8 x +1 to 5 V; +4 to 20 mA; Floating, Reaction-Free (6ES5 470-7LC12)

Technical Specifications		
Number of outputs		8 voltage and current outputs
Floating		yes (not between the inputs)
Output ranges (rated values)		+1 to 5 V; +4 to 20 mA
Load resistance		
- for voltage outputs	min.	3.3 k
- for current outputs	max.	300
Load connection		load to M_{ANA} terminal
Digital representation of the output signal		11 bits plus sign (1024 units = rated value)
Conversion time		1 msec.
Permissible overload capability	approx.	25 % (up to 1280 units)
Short-circuit protection		yes
Short-circuit current	approx.	25 mA (for a voltage output)
Open-circuit voltage	approx.	18 V (for current output)
Voltage between the reference potential of the load (M_{ANA} terminal) and the housing	max.	60 V AC/75 V DC
Linearity in the rated range		± 0.25 % ± 3 units
Operational error limits (0 to 55°C)		± 0.6 %
Cable length - shielded	max.	200 m (656 ft.)
Front connector		46 pin
Insulation rating		to VDE 0160
Rated insulation voltage (outputs to \perp)		
- tested with		500 V
		Power supply
		- rated value
		24 V DC
		- ripple V _{pp}
		3.6 V
		- permissible range (ripple included)
		20 to 30 V
		Current consumption
		- from 5 V (internal)
	typ.	0.25 A
		- from 24 V (external)
	typ.	0.30 A
		Power losses of the module
	typ.	8.5 W
		Weight
	approx.	0.4 kg (0.88 lb.)

8.2.9 Communications Modules

CP 523 Serial I/O Module, Reaction-Free

(6ES5 523-3UA11)


	Technical Specifications		
	Galvanic isolation	TTY signals are floating	
	Memory submodule	EPROM/EEPROM	
	Serial interface	V.24 (RS-232-C)/TTY passive	
	Transmission mode	asynchronous	
		7-bit mode=char. frame of 11 bits (1 start bit, 7 data bits, 1 parity bit, 2 stop bits)	
		8-bit mode=char. frame of 11 bits (1 start bit, 8 data bits, 1 parity bit, 1 stop bit)	
	Transmission rate	110 to 9600 baud	
	Permissible cable length		
	- TTY	voltage drop receiver typ. 1.5 V sender typ. 0.9 V at 20 mA 15 m/49 ft.	
	- RS-232-C (V.24)		
	Battery backup	Lithium AA	
		3.6 V / 850 mAh	
	Battery backup time	at least 1 year	
	Degree of protection	IP 20	
Permissible ambient temperature			
- vertical	0 to 60°C		
- horizontal	0 to 40°C		
Relative humidity	15% to 95%		
Current consumption from +9 V (CPU)	typ.	130 mA	
Power losses of the module	typ.	1.2 W	
Weight	approx.	300 g (0.7 lb.)	
LEDs			
2 green LED	RCV	CP 523 receiving data	
	SEN	CP 523 sending data	


8.2.10 Interface Modules

IM 304 Interface Module

(6ES5 304-3UB11)

Technical Specifications	
Current consumption (at 5 V)	max. 1.5 A
Weight	approx. 0.3 kg (0.7 lb.)




SIEMENS | SIMATIC 6ES5 304-3UA11 1|2|3|4|5|6|7|8|9|10|

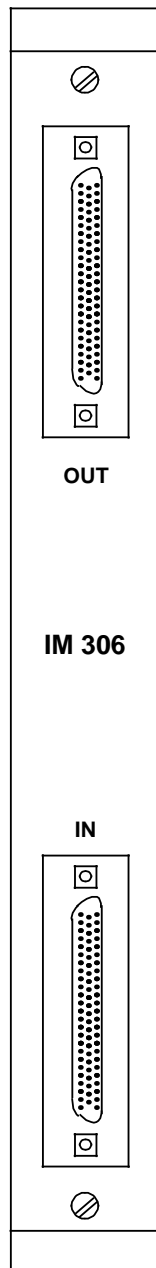
The IM 304 interface module is used in combination with the IM 314 interface module for distributed connection (up to 600 m, or 1969 ft.) of expansion units (EUs) to a central controller (CC). (also Chapter 3).

IM 306 Interface Module**(6ES5 306-7LA11)****Technical Specifications**

Current supplied to the EU	max.	2 A
Current consumption (5 V; own consumption)		50 mA
Weight	approx.	0.6 kg (1.3 lb.)

Accessories

705 connecting cable		
	0.50 m (1.5 ft.)	6ES5 705-0AF00
	1.25 m (3.9 ft.)	6ES5 705-0BB20
	1.50 m (4.7 ft.)	6ES5 705-0BB50
	2.50 m (7.8 ft.)	6ES5 705-0BC50
(Catalog ST 52.3)		



The IM 306 interface module is used for central connection of up to three expansion units (EUs) to a central controller (CC). (also Chapter 3).

IM 314 Interface Module

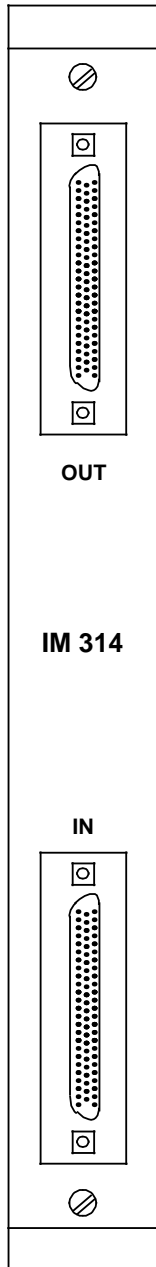
(6ES5 314-3UA11)

Technical Specifications

Current consumption (at 5 V)	max.	1.0 A
Weight	approx.	0.3 kg (0.7 lb.)

Accessories

Adapter casing	6ES5 491-0LB11
Termination connector for IM 314	6ES5 760-1AA11
721 connecting cable (Catalog ST 52.3)	



▶ | SIEMENS | SIMATIC 6ES5 314-3UA11 | 1|2|3|4|5|6|7|8|9|10|

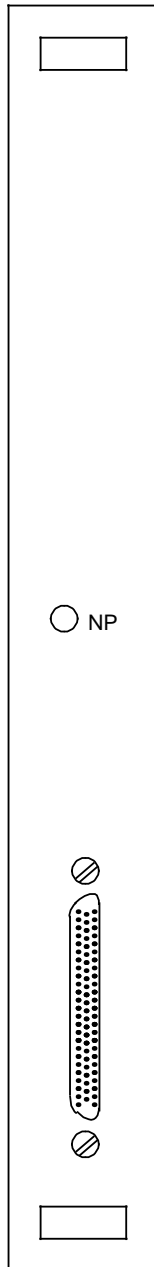
The IM 314 interface module is used in combination with the IM 304 interface module for distributed connection (up to 600 m, or 1969 ft.) of expansion units (EUs) to a central controller (CC). (also Chapter 3).

IM 324 Parallel Interface**(6ES5 324-3UA12)****Technical Specifications**

Current consumption (at 5 V) max. 1.0 A

Weight approx. 0.3 kg
(0.7 lb.)**Accessories**

Adapter casing 6ES5 491-0LB11

721 connecting cable
(Catalog ST 52.3)

SIEMENS

SIMATIC

6ES5 324-3UA11

1 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

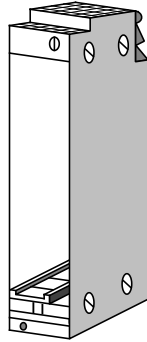
The IM 324 parallel interface is used in conjunction with the IM 304 for linking both subunits of the S5-115F system.

The IM 324 may only be connected to the IM 304.

8.3 Accessories

Adapter Casing for Printed Circuit Boards

(6ES5 491-0LB12)

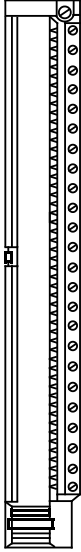
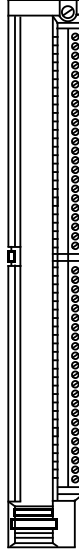
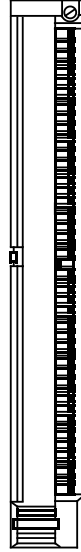


Technical Specification

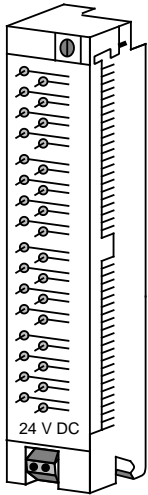
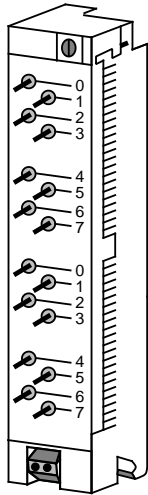
Dimensions w x h x d (mm (in.))	43 x 303 x 187
Weight	0,9 kg (2 lbs.)

Use adapter casing to fasten printed circuit boards which are not build as block-type modules in the S5-115F.

Front Connector

Screw-Type	Crimpp Snap-In	Spring-loaded connection	Technical Specifications
24 polig	46 polig	46 polig	Front connector 490 -for screw-type terminals - 24 pin - 46 pin 6ES5 490-7LB11 6ES5 490-7LB21
			763 jumper comb (for use with screw-terminal front connectors) 6ES5 763-7LA11
			for crimp snap-in connections 46 pin - without crimp contacts 6ES5 490-7LA21 - with 50 crimp contacts 6ES5 490-7LA11
			for spring-loaded connection - 46polig 6ES5 490-7LC11
			Front connector 497 42 pin - for screwtype terminals 6ES5 497-4UB11 - for crimp snap-in 6ES5 497-4UA22 (ohne Crimpkontakte)
			Crimp contacts (250 per package) 6XX3 070 Crimping tool for crimping the crimp contacts 6XX3 071 Extraction tool for crimp contacts 6ES5 497-4UC11

Simulator

		Technical Specifications	
		<p>Simulator</p> <ul style="list-style-type: none"> - 32 switches/buttons DC 24 V can be plugged into 6ES5 490-7SA11 6ES5 420-7LA11 6ES5 430-7LA11 - 16 switches/buttons AC/DC 24/48/60/115/230 V can be plugged into 6ES5 490-7SA21 6ES5 431-7LA11 6ES5 432-7LA11 6ES5 435-7LA11 6ES5 435-7LB12 6ES5 436-7LA11 6ES5 436-7LB12 	

Back-Up Battery for PS 951-7ND21...31 Power Supply Module

(6EW1 000-7AA)

Technical Specifications

Lithium battery (3.6 V/5.2 Ah)

- backup time (at 25 °C and constant backup of the CPU with memory submodule) approx. 2 years
- service life (at 25°C) approx. 5 years
- external battery backup 3.4 to 9 V

Back-Up Battery for PS 951-7ND41 Power Supply Module

(6EW1 000-7AA)

Technical Specifications

Lithium battery (3.6 V/1.75 Ah)

- backup time (at 25 °C and constant backup of the CPU with memory submodule) approx. 1 years
- service life (at 25°C) approx. 5 years
- external battery backup 3.4 to 9 V

Types of Fuses

Wickmann 19231	2.5 A FF	6ES5 980-3BC21
	4 A FF	6ES5 980-3BC51
	10 A FF	6ES5 980-3BC41
Gould GAB4		
Bussmann ABC4		

Types of Relays

Siemens V23042 B201 B101
Günther 3700-2501-011
Siemens V23157-006-A402

9 Reliability, Availability and Safety of Electronic Control Systems

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9 Reliability, Availability and Safety of Electronic Control Systems

The terms reliability, availability and safety of electronic control systems are not always clear and sometimes even misinterpreted. This can be explained on the one hand by the different failure characteristics of electronic control systems compared with conventional systems. On the other hand, some of the safety regulations have been made considerably more stringent in a number of application areas in the course of the last few years.

The following chapter is intended to familiarize you with the basics of this problem complex and to show how optimal reliability is achieved in the S5-115F.

9.1 Reliability of Electronic Control Systems

Reliability is the capability of an electronic control system to satisfy, over a specified period and within the specified limits, the requirements placed upon it by its application.

Despite all the measures taken to prevent failures, there is no such thing as 100 % reliability.

The failure rate is a measure of the reliability.

$$= \frac{n}{N_0 \times t} \quad \text{and} \quad \begin{array}{l} n = \text{Number of failures during time } t \\ N_0 = \text{Remaining components} \end{array}$$

9.1.1 Failure Characteristics of Electronic Devices

The failure-rate-versus-time curve can be broken down roughly into three periods of time.

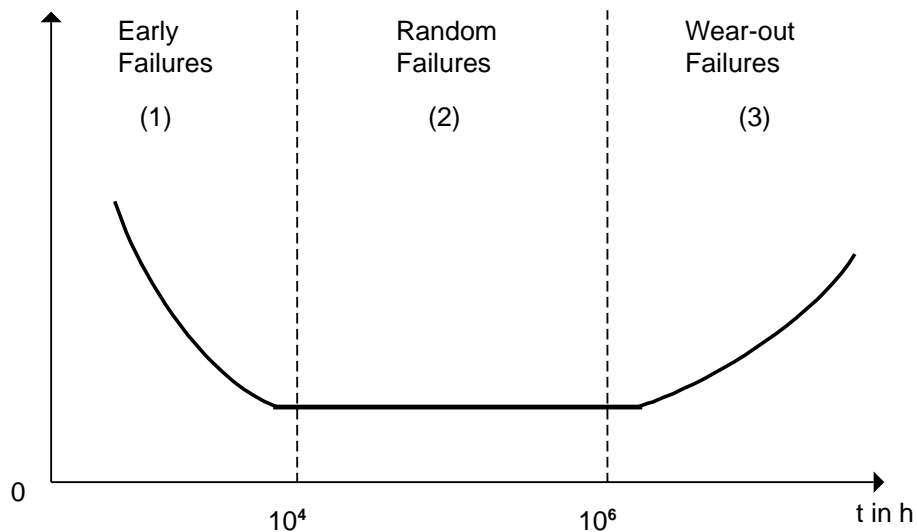


Figure 9-1. Failure Characteristics of Electronic Devices ("Bathtub" Curve)

- (1) Early failures are caused by material and manufacturing defects and the failure rate falls steeply during the initial period of operation.
- (2) The random failure phase is characterized by a constant failure rate. Provided the systems are used in accordance with the specifications, only random failures occur during this period. This period covers the normal behaviour of system components and is the basis for the calculation of all reliability parameters.
- (3) The failure rate increases with time. Wear-out failures become more frequent, indicating that the end of the useful life is approaching. The transition to this phase is gradual. There is no sudden increase in the failure rate.

9.1.2 Reliability of SIMATIC S5 Programmable Controllers and Components

A very high degree of reliability can be achieved by taking the following extensive and cost-intensive measures during the development and manufacture of SIMATIC S5 systems.

- The use of high-quality components;
- Worst-case design of all circuits;
- Systematic and computer-controlled testing of all components supplied by subcontractors;
- Burn-in of all LSI circuits (e.g. processors, memories etc.);
- Measures to prevent static charge building up when handling MOS ICs;
- Visual checks at different stages of manufacture;
- In-circuit testing of all components, i.e. computer-aided testing of all components and their interaction with other components in the circuit;
- Continuous heat-run test at elevated ambient temperature over a period of several days;
- Careful computer-controlled final testing;
- Statistical evaluation of all failures during testing to enable the immediate initiation of suitable corrective measures.

9.1.3 Failure Distribution

Despite the extensive measures described above, one must still reckon with the occurrence of failures. Experience has shown that, in installations with programmable controllers, failures can be distributed approximately as follows:

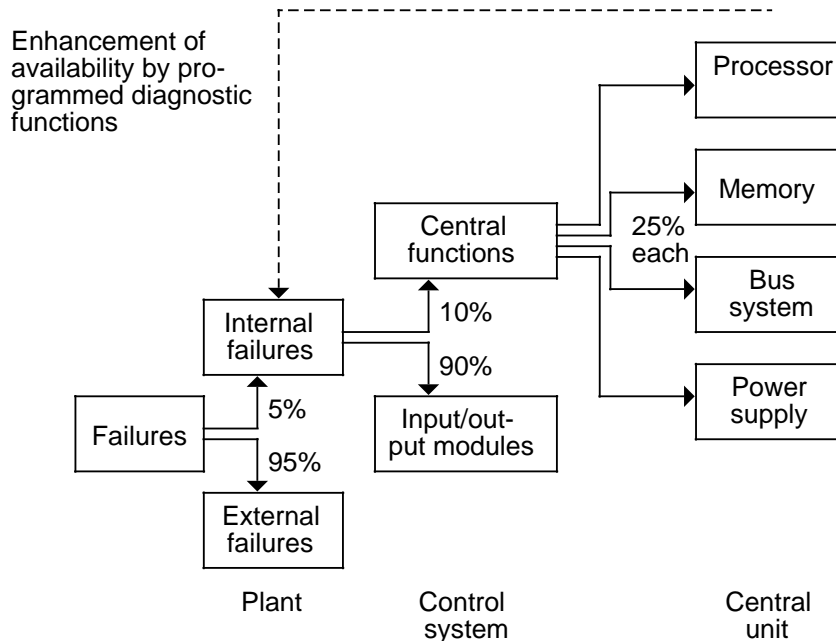


Figure 9-2. Distribution of Failure Occurrences in Installations Incorporating Programmable Controllers

Significance of failure distribution:

- Only a small number (approx. 5 %) of failures occur inside the electronic control system. These can be broken down as follows:
 - CPU failures (about 10 %, i.e. only 0.5 % of all failures); these failures are evenly divided among the processor, memory, bus system and power supply.
 - I/O module failures (about 90 %, i.e. only 4.5 % of all failures)
- The highest number of all failures (about 95 %) occur in the sensors, actuators, drives, cabling etc.

9.2 Availability of Electronic Control Systems

9.2.1 Overview

Availability "V" is the probability of finding a system in a functional state at a specified point in time.

$$V = \frac{MTBF}{MTBF + MTTR}$$

MTBF = Mean time between failures;
MTTR = Mean time to repair;

Ideal availability, i.e. $V=1$, can never be attained owing to the residual failure probability that always exists.

Availability can also be enhanced by reducing the mean time to repair. Such measures include, for instance:

- The stocking of spare parts
- The training of operating personnel
- Fault indicators on the devices
- Higher memory and software overhead for implementing programmed diagnostic functions

9.2.2 Availability of the S5-115F Programmable Controller

The priority of the S5-115F is safety: it cuts out in the event of a fault. The hardware and the operating system are designed accordingly. The following have been included in the design of the S5-115F in order to increase availability:

- Passivation of I/O modules
- SINEC L1 LAN redundancy

You can improve the availability of your system by networking several S5-115Fs with the same function via the SINEC L1 LAN.

Passivation of I/O modules (Vol 1, 10.16)

You have the choice of four variations on I/O module error tolerance:

- Variation 1: All I/O module errors cause the PLC to stop, just like central errors.
- Variation 2: An I/O module error causes passivation (shutdown) of all I/O modules belonging to the same signal group as the defective module. Your program recognizes the passivation and can respond to it by activating a reserve signal group.
- Variation 3 and 4: An I/O module error causes an error message. This variation is only permissible during supervised operation and if two message paths are assured.

Example: Burner control with passivation of the I/O module (variation 2 to 4)

A boiler has several groups of burners with four burners to a group. If four burner controls are contained in an S5-115F controller, each burner is assigned a different signal group number and program block number. All burners can be active in normal mode. In the event of an I/O module error, the defective burner is switched off, or a reserve burner can be activated if available. Even if the inputs and outputs of a given signal group are not only distributed among different modules but also accommodated in different racks and assigned different load power supplies, each burner can still be shut down both physically and in software terms. Your program queries all signal groups and skips processing when it finds a passivated status.

To simplify the example, it should be possible to set all outputs immediately to zero when a burner is passivated. If not, a signal group number must be defined for both the operation program and the shutdown program.

SINEC L1 LAN redundancy

If you are operating several S5-115F controllers linked together, shutdown of the PLCs due to a failure of the SINEC L1 LAN would be a disadvantage.

The redundant arrangement of the SINEC L1 LAN solves this problem. In the event of a LAN fault B, the mailbox transfer FB 253 MBXT transfers the relevant Receive mailbox of the SINEC L1 LAN A to Receive mailbox B.

PLC redundancy

There are hierarchical systems in which a higher-level S5-115F generates centralized enable functions for all lower-level S5-115Fs. Failure of this higher-level PLC would lead to a shutdown of the whole system. Redundancy of the SINEC L1 LAN and of the higher-level S5-115F with enable functions solves this problem.

For this purpose, the Enable signals of both Enable PLCs are sent on the SINEC L1 LAN and ORed in the destination S5-115Fs.

9.3 Safety of Electronic Control Systems

The S5-115F is designed so that a hardware failure will not constitute a danger.

There must be two paths, connected in series, for switching off safety-related actuators. The failure of one is tolerable, provided the defect is detected within the second error occurrence time so that any further defects will not affect the cutout ability.

Special attention must be given to hidden errors not detected within the safety time. They do not constitute any danger provided they occur singly. However, they must be detected within the second error occurrence time in order to prevent error bursts leading to dangerous states. All error responses lead to the safe quiescent state.

9.3.1 Safe Inputs

Safe inputs are implemented with "safe" two-channel input modules.

If permanently failsafe sensors are available for the relevant process signals, one sensor branched to two input modules will be sufficient. Otherwise, two valid sensors are used which are each connected to one input module of a subunit.

A comparison check is made on the dual-channel inputs once per cycle or, in the case of direct access, during access. Nonidentical inputs are subjected to a discrepancy analysis. In the case of binary inputs, the discrepancy must disappear at the latest then the individual discrepancy time has elapsed. In the case of analog inputs, the system must return to within a tolerable deviation at the latest after the unified discrepancy time has elapsed.

This measure is sufficient for input variables which change frequently during operation (intermittent). These are binary variables, which change status several times during the second error occurrence time, and analog variables, which cover the relevant range several times during the second error occurrence time.

Input variable comparison is not sufficient in the case of input variables which change infrequently. These variables must be changed artificially by the supplementary PLC test. Check-back modules are required for this purpose (10.9.5).

The active sensor signal is interrupted in the case of binary inputs, and two programmable check values are injected in the case of analog input. This procedure results in analog inputs which are safeguarded at two values and can be used for safety-related limit value processing.

The sensors must be designed so that

- a zero signal will occur in the event of a wire break or power failure
- 0 is the status for the safe quiescent state.

(Example: the emergency switch requires the emergency "0" position and the "ON" operation switch requires an active signal with "1" level).

9.3.2 Safe Binary Outputs

Safe outputs are dual-channel in one of the following ways:

- Both poles (e.g. +/-) of the signal to the load are switched
- Two interface relays are controlled, which in turn also switch both poles of the signal to the load. Errors are recognized by reading back separate inputs and by comparing the inputs.

Comparison of readback inputs is sufficient for outputs which change their status frequently. In the case of output statuses which change infrequently, a check pulse is output and read back additionally in the supplementary test.

The 0 signal, which occurs in the event of wire break or power failure, must shut down all the command actuators of the process (examples: ON command for a motor must be active with "1", ON command for a brake must be active with "0").

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10 Rules Governing the Use of the S5-115F in Safety-Related Applications

In Chapter 9 you will have learnt the principles of the safety-related structure of the S5-115F. In Chapter 10 you will find all those rules that must be observed when using that part of the S5-115F requiring official approval.

These rules must be observed in order to avoid

- Danger to life and limb and
- Controller malfunctions.

10.1 The User Memory

- Both subunits, A and B, require the same memory configuration.
If you use memory submodules, they must both have the same order number.
- The S5-115F automatically operates in safety mode when EPROM or EEPROM submodules are plugged in. You can, however, only use EEPROM submodules with the express consent of the inspector at the individual acceptance test. If you operate the S5-115F without memory submodules or with a RAM submodule, it automatically switches to test mode.
- The backup batteries are essential. Error information can be lost without battery backup for the RAM.
Replace the backup batteries every year.
- Nonsafety-related programs must be reaction-free:
 - Operations which change the memory must have no effect on safety-related data.
 - The degree to which the system is reaction-free can be demonstrated using data flowcharts or cross-reference lists.

10.2 The Logical Program Counter

Using the logical program counter (LPLZ), the operating system can check that the same number of program sections have been processed in both subunits.

The following sequence of operations increments the LPLZ

```
L  FW 0
L  KF  +1
+  F
T  FW 0
```

Insert this sequence of operations at the following points in your program:

- At the beginning of every program block (OB, PB, SB and loadable FBs)
- After a BLD 255 segmentation operation.

You must insert these segmentation operations in your program at intervals of not more than approximately 128 operations. If you have programmed several BLD 255 operations within 128 operations, the sequence of operations for incrementing the LPLZ will be executed only after the last BLD 255 (execution time!).

Note

Flag word FW 0 is reserved for the LPLZ, and must not be used for any other purpose.

10.3 Response Times

The user must be able to demonstrate specific response times when planning the automation of a process requiring an authorization permit. Response time is defined here as the time that elapses between a change in an input signal on the CPU side and the output response on the CPU side.

The response time is dependent on the procedure used:

- Cyclic reading in and output
- Direct access in the user program
- Direct access in OB 13 (time interrupt OB)
- Direct access in OB 2 (process interrupt OB)
- Networking via the SINEC L1 LAN

In addition, the response times of the I/O modules, sensors and actuators must be taken into account (inherent module delay).

The following is a demonstration of the calculation of worst-case response times, which the user can regard as safety times. The following abbreviations are used.

- $T_{PC\ cycle}$ = PLC cycle time (execution time for user program and operating system program)
- $T_{proc.}$ = Processing time between two operations
- $T_{OB\ 13}$ = Time interrupt interval
- $T_{synchr.}$ = Interval between two FB 254 SYNC calls
- T_{OS} = Response time of the OS to process interrupts
- $T_{SINEC\ poll}$ = SINEC L1 polling time
- $T_{SINEC\ safety}$ = SINEC L1 safety time
- Additional footnotes: R = Receiver S = Sender

10.3.1 Response Time in the Case of Cyclical Reading In and Output via the Process I/O Image

If input signals are read in via the process input image (PII) (e.g. using the A I 1.0 operation), and the response is output via the process output image (PIQ) (e.g. using the S Q 4.0 operation), this results in the following response time:

$$T_R = 2 * T_{PLC \text{ cycle}}$$

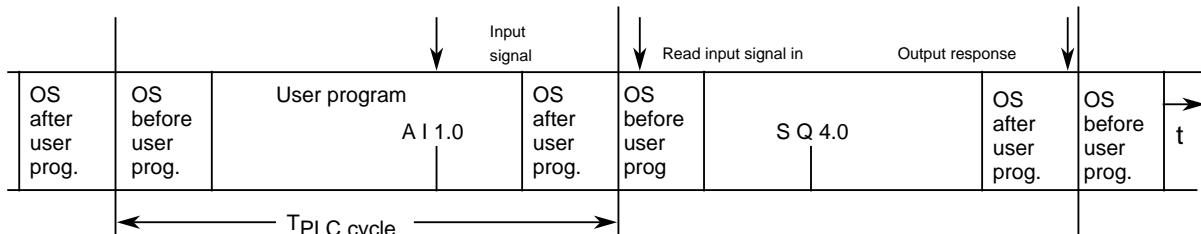


Figure 10-1. Response Time in the Case of Cyclical Read-In of Process Signals

Explanation of Figure 10-1

If input signal changes during the user program, the change is recognized in the next PLC cycle when this signal is read in. The user program processes the input signal and triggers the output response in the operating system.

10.3.2 Response Time in the Case of Direct Access in the Cyclic Program

If the input signal is read from the input module by direct access (e.g. using the L PW operation) and the response is output by direct access to the output module (e.g. using the T PW operation), the following response time results:

$$T_R = T_{PLC \text{ cycle}} + T_{proc.}$$

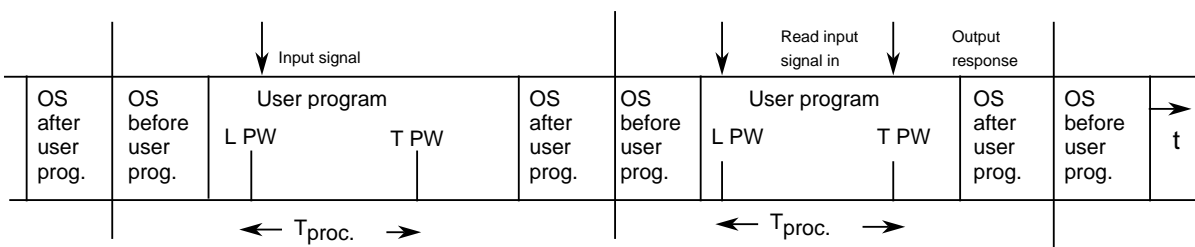


Figure 10-2. Response Time in the Case of Direct Access without OB 2/OB 13

Explanation of Figure 10-2

If input signal changes after the relevant direct access, the change will be recognized in the next PLC cycle after reading in the signal with direct access. The user program scans the input signal and responds by directly accessing the output module.

10.3.3 Response Time in the Case of Direct Access in the Time Interrupt OB (OB 13)

If the inputs are read in and the outputs are activated by direct access in the time interrupt OB, the following applies for the response time:

$$T_R = T_{OB\ 13} + T_{synchr.} + T_{proc.}$$

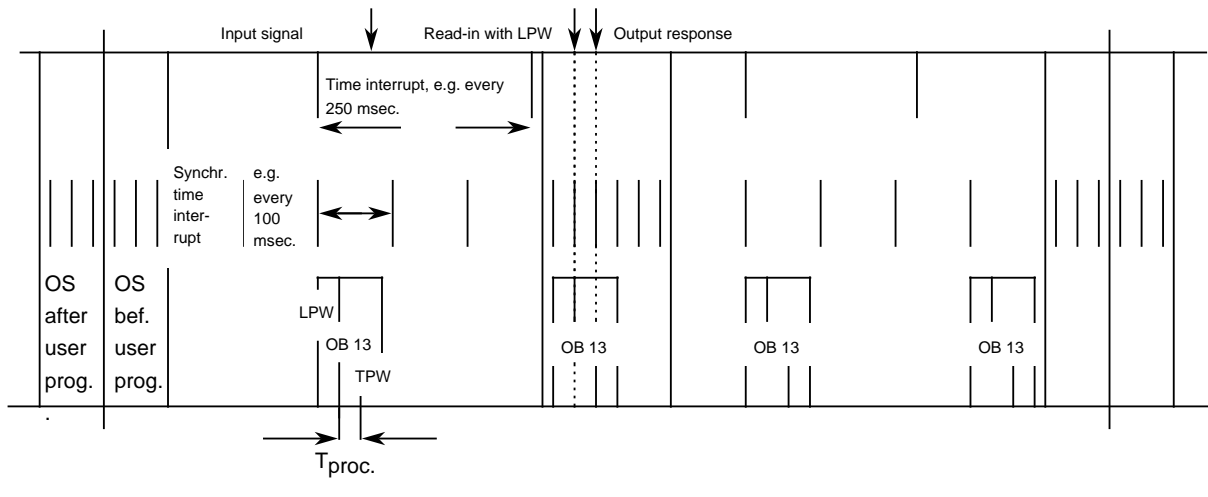


Figure 10-3. Response Time in the Case of Direct Access in Time Interrupt OB 13

Explanation of Figure 10-3

If input signal changes after the relevant direct access in OB 13, the change will be recognized in the next possible OB 13 call. It is possible in the following cases:

- When the interval time for OB 13 has elapsed (250 msec. in the example)
- When the next synchronization point has been reached (100 msec. in the example or 20 msec. in general).

10.3.4 Response Time in the Case of Direct Access in the Process Interrupt OB (OB 2)

If the inputs are connected to a module with interrupt capability and the outputs are directly accessed in the process interrupt OB, the following applies for the response time to a falling edge at the input:

$$T_R = T_{synchr.} + T_{proc.} + T_{OS}$$

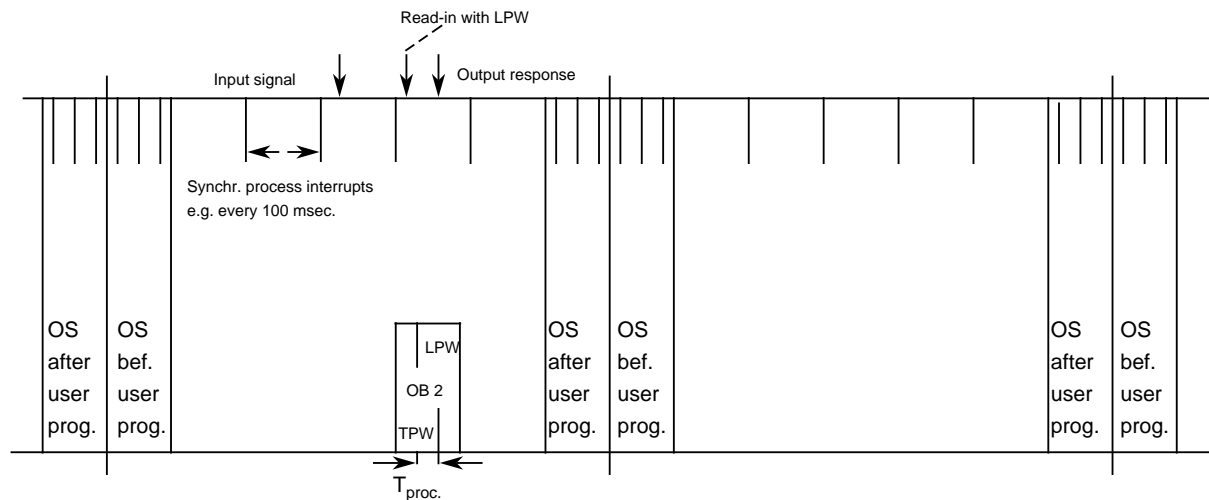


Figure 10-4. Response Time in the Case of Direct Access in the Interrupt OB 2

Explanation of Figure 10-4

OB 2 is started and the signal change is recognized if

- input signal has changed and
- a synchronization point for process interrupts has been reached (at the latest after 100 msec. in the example) .

10.3.5 Response Times With the SINEC L1 LAN

The SINEC L1 LAN has a polling time which is a function of the number of data paths and the sum of all transfer bytes. In addition, the SINEC L1 LAN has a safety time which must be greater than the polling time. The safety time depends on the following criteria:

- Desired error tolerance (the longer the safety time, the greater the error tolerance)
- Desired response time in the event of an error (the shorter the safety time, the less error tolerance).

The SINEC L1 response time consists of the following:

- The intervals between the synchronization calls for SINEC L1
 - - SINEC L1 polling time (bus intact)
 - or
 - - SINEC L1 safety time (bus defective).

The Receive mailbox is read out

- at long intervals in the PLC cycle
- at short intervals in OB 13.

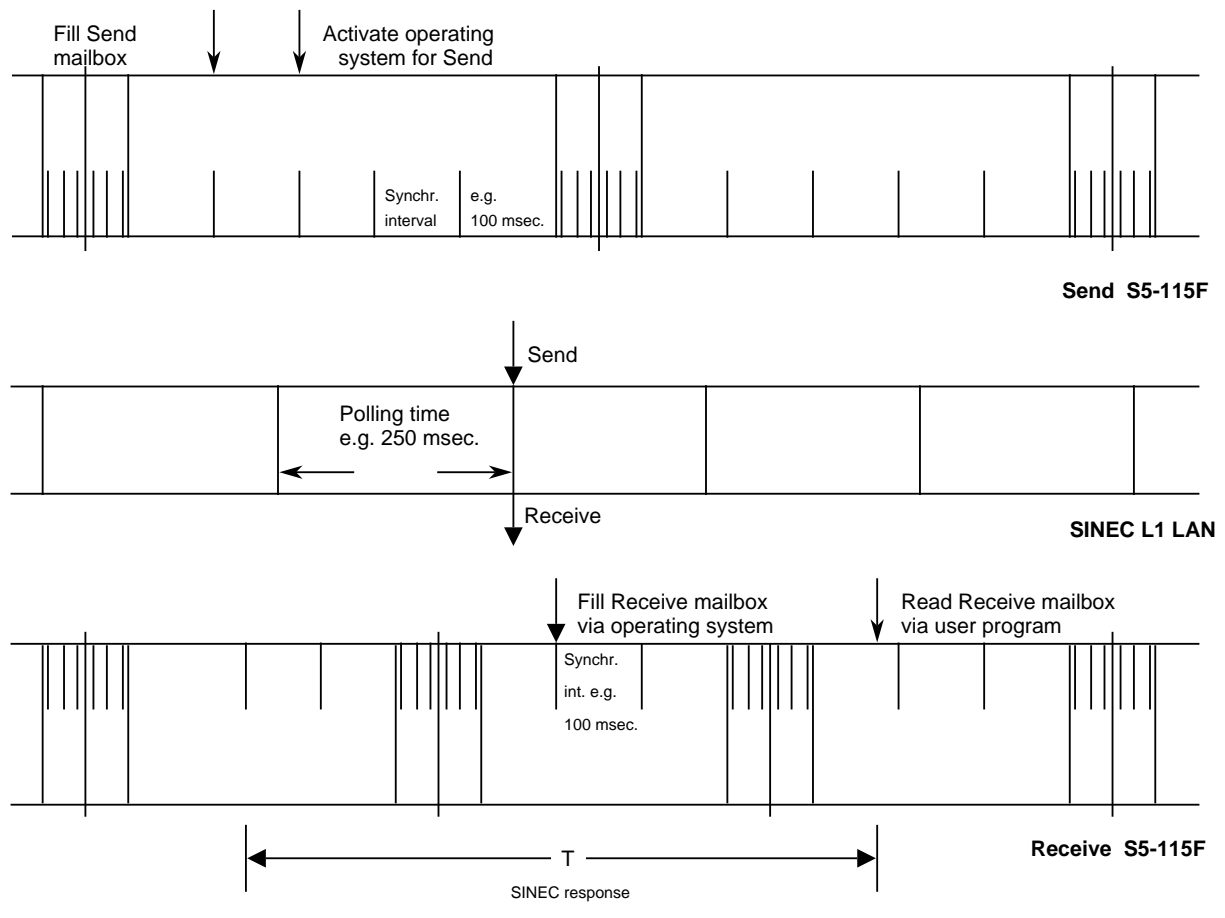


Figure 10-5. SINEC L1 Response Time

Explanation of Figure 10-5

Figure 10-5 describes a typical data exchange via SINEC L1.

The Send S5-115F enters the data in the Send mailbox of the desired data path.

The operating system attempts to buffer the message.

The message is sent from the buffer before the SINEC L1 polling time has elapsed (at the latest).

Please make sure the polling list is properly organized.

The Receive mailbox is filled in the receiving PLC at the next synchronization call.

The user program reads the data out of the Receive mailbox.

This results in the following in error-free operation:

$$T_{\text{SINEC L1 response time}} = T_{\text{synchr. S}} + T_{\text{SINEC poll}} + T_{\text{synchr. R}} + T_{\text{PLC cycle time R}}$$

In the case of an error, the SINEC L1 response time increases to:

$$\text{SINEC L1 response time} = \text{SINEC L1 response time in error-free operation} + (T_{\text{SINEC safety}} - T_{\text{SINEC poll}})$$

The following applies if you use OB 13 to evaluate the Receive mailbox:

$$\text{SINEC L1 response time} = T_{\text{synchr. S}} + T_{\text{SINEC poll}} + T_{\text{synchr. SINEC R}} + T_{\text{OB13}} + T_{\text{synchr. OB 13}}$$

This response time only includes the time between sending a message and its arrival at the receiver. If an input signal is transferred from an S5-115F via the SINEC L1 LAN to another S5-115F, the time required for detecting the signal change at the input and for responding at the output must be taken into account.

10.4 Defining the PLC Cycle Time

The PLC cycle time is a safety variable. It is instrumental in defining the response time of the PLC, which, in turn, is an essential component of the safety time.

The following applies:

- PLC response time = 2 · maximum PLC cycle time
- Safety time = PLC response time
 - + Response time of electromechanical components (relays, sensors)
 - + Response time of mechanical parts (press rams, etc.)

For this reason, you must be able to define the worst-case cycle time.

The worst case cycle time consists of

- The program execution time
- The operating system execution time.

You can determine your program execution time by summing the execution times of the STEP 5 statements constituting the program.

The maximum operating system execution time can be estimated with the help of the following guidance values:

- 60 to 80 msec. Basic execution time depending on configuration with user timers in conjunction with the IA (Interrupt Inhibit) operation.
- 70 to 90 msec. Basic execution time without IA operation
- 0 to 30 msec. (30 msec. for short discrepancy time) for the configured short discrepancy time for cyclic updating of digital input modules without interrupt capability
- 5 to 10 msec. For supplementary PLC self-test in the case of normal test slice size
or
15 to 140 msec. In the case of larger-than-normal test slices. This test consists of several components that depend on the I/Os. The test runs serially and executes normal and larger-than-normal test slices.
Larger-than-normal slices are:
 - 25 to 70 msec. for the DI module test (type 3)
 - 15 to 140 msec. for the DQ module test depending on the type of control (direct or indirect) and the inertia of the 24 V/220 V module
 - 50 to 120 msec. for the AI module test (type 14, 15)

The PLC cycle time can be extended by

- Process interrupt servicing with OB 2
- Time interrupt servicing with OB 13
- Synchronization of the SINEC L1 LAN.

It can be calculated as follows:

$$T_{\text{PLC cycle (OB 2, OB 13, SINEC)}} = T_{\text{PLC cycle}} \frac{100}{100 - Q}$$

where: $Q = Q_2 + Q_{13} + Q_{\text{SINEC}}$

Q_2 = OB 2 execution time component of the total S5-115F execution time

Q_{13} = OB 13 execution time component of the total S5-115F execution time

Q_{SINEC} = SINEC L1 LAN execution time component of the total S5-115F execution time

e.g.

	Call interval	Execution time	Execution time Q_i
OB 2	40 msec.	4 msec.	10 %
OB 13	100 msec.	8 msec.	8 %
Number of SINEC L1 LAN slaves			= 2
Max. message length			= 62 bytes
Execution time component Q_{SINEC} ,			1 LAN = 20%
			2 LANs = 30%
Total execution time component $Q_2 + Q_{13} + Q_{\text{SINEC}}$ (2 LANs)			= 48 %

Note

- Avoid $Q > 50\%$
- Under worst-case conditions, please note:
Direct access commands to the interrupt DI in OB 2 may be extended by the relevant short discrepancy time.

Example

The operating system execution time is

- 60 to 100 msec. for
 - Limited configuration with 24 V I/O modules
 - Directly driven actuators
 - 30 msec. short discrepancy time
- 80 to 250 msec. for
 - Extended configuration with 220 V I/O modules
 - Indirectly driven actuators
 - 30 msec. short discrepancy time

You can determine the PC cycle time in a relatively easy way in Test mode. Add a flag word to your cyclic program and count, for example, 1000 cycles with it. If you measure the time required for this, the mean cycle time can be determined exactly.

10.5 Monitoring Times for Synchronization FB Calls (FB 254 SYNC)

The subunits must be synchronized for the following purposes:

- Updating of user times
- Servicing of process interrupts (OB 2)
- Servicing of time interrupts (OB 13)
- SINEC L1 processing
- Programmer operation

The program for the operating system is organized so that it synchronizes the two subunits automatically at intervals of

- 20 ms, if no SINEC L1 LAN is installed
- 40 ms, if a single or double, redundant, SINEC L1 LAN is installed.

In the user program you must make your own arrangements for synchronizing the two subunits. You do this by calling FB 254 SYNC in the user program.

The S5-115F monitors the interval between the synchronization calls because they are of crucial importance for the accuracy of user timers, the accuracy of the response to interrupts and for the transmission times of the SINEC L1 LAN.

Synchronization of times in the user program

The accuracy of times in the user program depends on the intervals between synchronization calls. The absolute error is:

- maximum 20 ms+synchronization call interval
- mean 5 ms+half the synchronization call interval

If the interval for updating user timers configured by COM 115F is exceeded as a result of too few synchronization calls in the user program, the S5-115F will enter the STOP mode.

Synchronization for time and process interrupts

The response time for time and process interrupts also depends on the intervals between synchronization calls. The response time to a process interrupt (OB 2) is:

- maximum 10 ms+synchronization call interval
- minimum 30 ms

The interval between time interrupts is programmable from 100 msec. upward. The deviation from the programmed interval is:

- maximum 20 ms+synchronization call interval
- mean 5 ms+half the synchronization call interval

Synchronization call intervals for interrupt processing are monitored by the S5-115F operating system with a configurable time interval. If the monitoring time is exceeded, the S5-115F stops.

Synchronization for SINEC L1 LAN

Data traffic via the SINEC L1 LAN is also monitored with a configurable safety time. Data traffic with all configurable communications partners (except the master PC) must be completed within this safety time, otherwise the Receive mailbox is deleted for safety reasons. If you use the SINEC L1 LAN, we recommend that you call FB 254 every 30 to 40 ms, if possible.

Note

- Interval monitoring for user timer updating calls is deactivated if the value 16383 is entered for "User timer updating: Max. interval" when the operating system parameters are set via COM 115F.
- Interval monitoring for interrupt processing calls is deactivated if the value 255 is entered for "Interrupt processing: Max. interval" when the operating system parameters are set via COM 115F.

10.6 Discrepancy Times

I/O accesses are monitored for discrepancy times. I/O read accesses are monitored for signal discrepancies in both subunits in order to detect hardware faults.

The discrepancies must reach permissible values within the programmed discrepancy times: Binary signals must be identical in both subunits. The analog values of both subunits must lie within a programmable tolerance range.

- Short discrepancy times (Vol. 2, 1.1.1 of the Manual) are configured uniformly for certain modules. They lie between 10 msec. and $255 * 10$ msec. An input is scanned either until the time has elapsed or the values match.
- Long discrepancy times (Vol. 2, 1.2.3 of the Manual) are configured separately for each input. They lie between 100 msec. and 27 min 19 sec. The value of the last scan is transferred to the process input image until either the time has elapsed or the values match. During this time, the program continues to be scanned.

You will find an overview of discrepancy times in Table 10-1.

Table 10-1. Programmable Discrepancy Times

Module	Type of access	Discrepancy time
Digital input with interrupt capability	Direct	Short discrepancy time for DI with interrupt capability
Digital input without interrupt capability	Cyclic	Short discrepancy time for DI without interrupt capability or long discrepancy times
Digital input without interrupt capability	Direct	No discrepancy analysis. The uniform value is not derived from the current values, but the last valid value is used. The user is not informed of the use of this substitute value.
Analog input	FB 250 ANEI	PLC cycle time
Readback digital input		Short discrepancy time for DI without interrupt capability

Note

You must note the following when configuring the short discrepancy time for without interrupt capability DIs

- Time discrepancies of the sensors
- Time discrepancies of the readback digital inputs, conditioned by
 - output modules
 - coupling relays and
 - readback input modules.

Note

If the response time of the "slowest" DQ modules (output module, coupling relay, readback DI) 30 msec., the discrepancy time for DIs must be calculated as follows:
 Short discrepancy time Response time of the DQ modules - 30 msec.
 This value must be configured as an operating system parameter (Vol. 2, 1.1.1 of the Manual).

10.7 Limitations of STEP 5 Programming

In order to guarantee the safety of plants requiring official approval, certain STEP 5 operations must be limited in their application or completely forbidden.

10.7.1 Access to I/O Modules

The following table gives you an overview of the permissible accesses to the I/O area.

Table 10-2. Permissible Accesses to the I/O Area

Permissible Access	Modules			
	DI	DQ	AI	AQ
To the process I/O image	L IB, L IW binary operations	T QB, T QW binary operations	FB 250 (FB ANEI)	T QB, T QW FB 251 (FB ANAU)
Direct access	L PY, L PW	T PY, T PW	FB 250 (FB ANEI)	T PY, T PW FB 251 (FB ANAU)



Important

The following are not permissible

- LIR and TNB operations with their source addresses to the I/O area (<1000_H, >EFFF_H) and to the system area (EA0A...EA0E).
(LIR and TIR are word operations. The highest accessible address is therefore EFFE_H and not EFFF_H).
- TIR and TNB operations with destination addresses to the I/O area (<1000_H, >EFFF_H) and to the system area (EA0A...EA0E).
(LIR and TIR are word operations. The highest accessible address is therefore EFFE_H and not EFFF_H).
- L PY and L PW for reading AI modules.

10.7.2 Illegal Memory Area

Direct access to the memory area C400_H to EFFF_H with T IR and T NB is illegal.

This memory area is used by the operating system.

10.7.3 Illegal STEP 5 Operations and Statements

In order to guarantee the safety of plants requiring official approval, the possibility of systematic errors by the user must be eliminated. Systematic errors have the same effect on both subunits.

Note

Organize your programs as clearly as possible!

The following are not permitted

- Trick programming
- T DL, T DR and T DW operations in DB 1, DB 2, DB 3, configuration DBs and DBs stored on the EPROM/EEPROM submodule.
- DO FW; DO DW, DI and JU R operations in safety-related programs.
- Programming of RLO-dependent operations and jump operations within parentheses.
- Accessing system data SD5 to SD7.

10.7.4 Data Blocks Used

The following DBs are reserved in the S5-115F:

- DB 1
- DB 2, DB 3 as error DBs
- Configuration DBs, listed in the directory of DB 1.

You may not assign these DB numbers in your program.

Note

The error DBs (DB 2 and DB 3) are generated and updated by the operating system and cannot be transferred to the PLC, not even in Test mode.

The G DB operation for opening a DB must be checked closely by the acceptance official since its effects cannot usually be detected by the function test.

10.7.5 Jump Operations to Unloaded Blocks

The operating system responds differently to jump operations to nonexistent blocks depending on the operating mode:

- If a jump to a nonexistent block is called in safety mode, the S5-115F enters the STOP mode.
- If a jump to a nonexistent block is called in Test mode, it is not executed and the program processes the next operation. The S5-115F remains in RUN mode. For this reason, it is possible to construct the complete user program in steps in Test mode by loading successive blocks without having to continually rewrite OB 1. This enables you to program OB 1 with all planned block calls.

10.7.6 Loadable Function Blocks

Frequently recurring or particularly complex program sections (e.g. signalling or arithmetic functions) are programmed in function blocks. These can be assigned parameters and have an extended operation set (e.g. jump operations within a block).

The loadable function blocks are subdivided into

- User-written function blocks
- Standard function blocks

User-Written Function Blocks

Function blocks generated by the user - like any other block - must be tested by the inspector.

The minimum requirements of the test are a discussion of the function, functional tests with an examination of possible error states and a code analysis.

Standard Function Blocks

In the S5-115F, standard function blocks may be used only when they have been prototype-tested. The standard FBs for the S5-115F implement the same functions as the standard FBs for the SIMATIC S5 U-range controllers, but have been adapted to the safety requirements. You will find an overview of the standard function blocks which can be used in the S5-115F in Catalog ST 57.

There are reaction-free and failsafe standard FBs. Only failsafe standard FBs may be used to form signals relevant to the system's failsafety. When assigning parameters to the blocks, note that output parameters can only be failsafe if all the input parameters are failsafe.

All standard FBs are identified by a library number which, in conjunction with other measures, protect the blocks against falsifications caused by transfer errors or disk errors.

Note the following when using loadable standard FBs:

- In the safety mode, the operating system checks all standard FBs for integrity
- Standard FBs for the SIMATIC S5 U-range controllers are not allowed, and are rejected in the safety mode
- The authorized inspector's examination of the standard FBs limits itself to
 - a comparison of the library number with the one specified in the report
 - checking for proper use of the standard FBs
 - checking the FB calls for correctness and checking the parameter initialization routine for the FBs as per the block description
 - making sure that the provisions laid down in the report or the requirements of the prototype test have been upheld

Note

If you use standard FBs, you may only use flag words FW 200 to FW 254 in your user program if you save the flag area used before calling the standard FB and retrieve it when the block has been processed.

10.8 I/O Module Types

There are different types of digital and analog I/Os which are suited to the type of sensors and actuators and to the time characteristics of the input/output signals.

A distinction is made between safety-related and nonsafety-related types.

In the case of safety-related types, a further distinction is made between types for intermittent signals and types for non-intermittent signals.

An intermittent digital signal must be subjected to sufficiently frequent changes of state and these must be detected by the CPU. For this purpose, the signal must assume the states "0" and "1" at least once within the second error occurrence time and for a period in each case greater than the PLC cycle time.

Thus, the EMERGENCY OFF input is **not** intermittent since it is activated extremely infrequently.

An analog signal is intermittent if the whole value range relevant to evaluation within the second error occurrence time is run through, read in and coded at least once. In doing so, it is of special importance that those values that lead to a safety response be reached.

For example, an analog input for measuring temperature cannot generally be configured as an intermittent type since the critical temperatures leading to emergency shutdown are never reached in normal operation.

Note

If an intermittent type is selected for a safety-related signal, this signal characteristic must be proved to the licensing authority.

This characteristic is often impossible or difficult to prove. If this is the case, a non-intermittent type should be selected for which no special proof is required.

I/O types differ according to

- Safety-related aspects
- Number of I/O channels
- Features and type of connection
- "Intermittent" characteristic
- Feedback type
- Number of feedback channels.

Table 10-3 gives an overview of the possible I/O types and their characteristics.

Table 10-3. I/O Module Types (Type-Matrix)

I/O Typ. No.	I/O	Safety related	No. of I/O channel	No. of sensor / actuat. channel	Selection	Read Back	Sensor/actuator characteristic	Intermittent	Feedback Type	No. of feedback channel	Figure No.
1	DI	no	1	1	-	-	-	-	-	-	10-6
2	DI	yes	2	1	-	-	-	yes	-	-	10-7
2	DI	yes	2	2	-	-	-	yes	-	-	10-8
3	DI	yes	2	1	-	-	Sensor can be deact.	no	CH-DQ	1	10-9
3	DI	yes	2	2	-	-	Sensor can be deact.	no	CH-DQ	1	10-10
3	DI	yes	2	1	-	-	Sensor cannot be deact.	no	CH-Rel-DQ	1	10-11
3	DI	yes	2	2	-	-	Sensor cannot be deact.	no	CH-Rel-DQ	2	10-12
8	DQ	no	1	1	-	-	-	-	-	-	10-13
9	DQ	yes	2	1	direct	-	24 V	yes	RB-DI	2	10-14
9	DQ	yes	2	1	direct	-	115 V, 230 V	yes	RB-DI	2	10-15
9	DQ	yes	2	2	indirect	at DQ	24 V	yes	RB-DI	2	10-18
9	DQ	yes	2	2	indirect	at DQ	115 V, 230 V	yes	RB-DI	2	10-20
10	DQ	yes	2	1	direct	-	24 V	no	RB-DI	2	10-14
10	DQ	yes	2	1	direct	-	115 V, 230 V	no	RB-DI	2	10-15
10	DQ	yes	2	2	indirect	at DQ	24 V	no	RB-DI	2	10-18
10	DQ	yes	2	2	indirect	at DQ	115 V, 230 V	no	RB-DI	2	10-20
9	DQ	yes	2	1	direct	-	24 V	yes	RB-DI	2	10-14
9	DQ	yes	2	1	direct	-	115 V, 230 V	yes	RB-DI	2	10-15
9	DQ	yes	2	2	indirect	at load circ	24 V / 24 V	yes	RB-DI	2	10-18
9	DQ	yes	2	2	indirect	at load circ	24 V / 115 V, 230 V	yes	RB-DI	2	10-19
9	DQ	yes	2	2	indirect	at load circ	115 V, 230 V / 115 V, 230 V	yes	RB-DI	2	10-20
9	DQ	yes	2	2	indirect	at load circ	V	yes	RB-DI	2	10-21
10	DQ	yes	2	1	direct	-	24 V / 115 V, 230 V	no	RB-DI	2	10-14
10	DQ	yes	2	1	direct	-	24 V	no	RB-DI	2	10-15
10	DQ	yes	2	2	indirect	at load circ	115 V, 230 V	no	RB-DI	2	10-18
10	DQ	yes	2	2	indirect	at load circ	24 V / 24 V	no	RB-DI	2	10-19
10	DQ	yes	2	2	indirect	at load circ	24 V / 115 V, 230 V	no	RB-DI	2	10-20
10	DQ	yes	2	2	indirect	at load circ	115 V, 230 V / 115 V, 230 V	no	RB-DI	2	10-21
13	AI	no	1	1	-	-	-	-	-	-	10-22
14	AI	yes	2	1	-	-	-	no	CH-Rel-DQ, CH-AQ	1*4 1	10-23 10-24
15	AI	yes	2	2	-	-	-	no	CH-Rel-DQ, CHR-AQ	2*4 1	10-25 10-26
16	AI	yes	2	1	-	-	-	yes	-	-	10-27
17	AI	no	2	1	-	-	-	-	-	-	10-28
18	AI	no	2	1	-	-	-	-	-	-	10-29
DI =	Digital input module										
DQ =	Digital output module										
AI =	Analog input module										
AQ =	Analog output module										
					RB-DI =	Readback digital input module					
					CH-Rel-DQ =	Check (relay) digital output module					
					CH-AQ =	Check analog output module					
											10-30

10.9 Digital Inputs

When configuring the I/Os (Vol. 2 of the Manual), you define an I/O type according to the characteristics of the process input signals for every DI.

There are three different DI types.

10.9.1 Implementation of Sensors

Permanently failsafe sensors may have a single-channel connection to a safety-related digital input (requires permit). Other approved sensors must be of the two-channel type.

10.9.2 Requirements to be Met by the Sensor Signals

If the digital inputs are read in cyclically, the sensor signals must maintain a given state for longer than one PLC cycle.

Note

Special conditions and restrictions apply to interrupt DIs (10.9.8).

10.9.3 Type 1 Digital Input Modules

Type 1 DIs have the following characteristics:

- Nonsafety-related
- Can be operated in either subunit A or B (single-channel configuration).
- Can be operated in both subunits in any mix.
- The module address may be set only in the subunit with the DI module. This address must not be used in the other subunit.

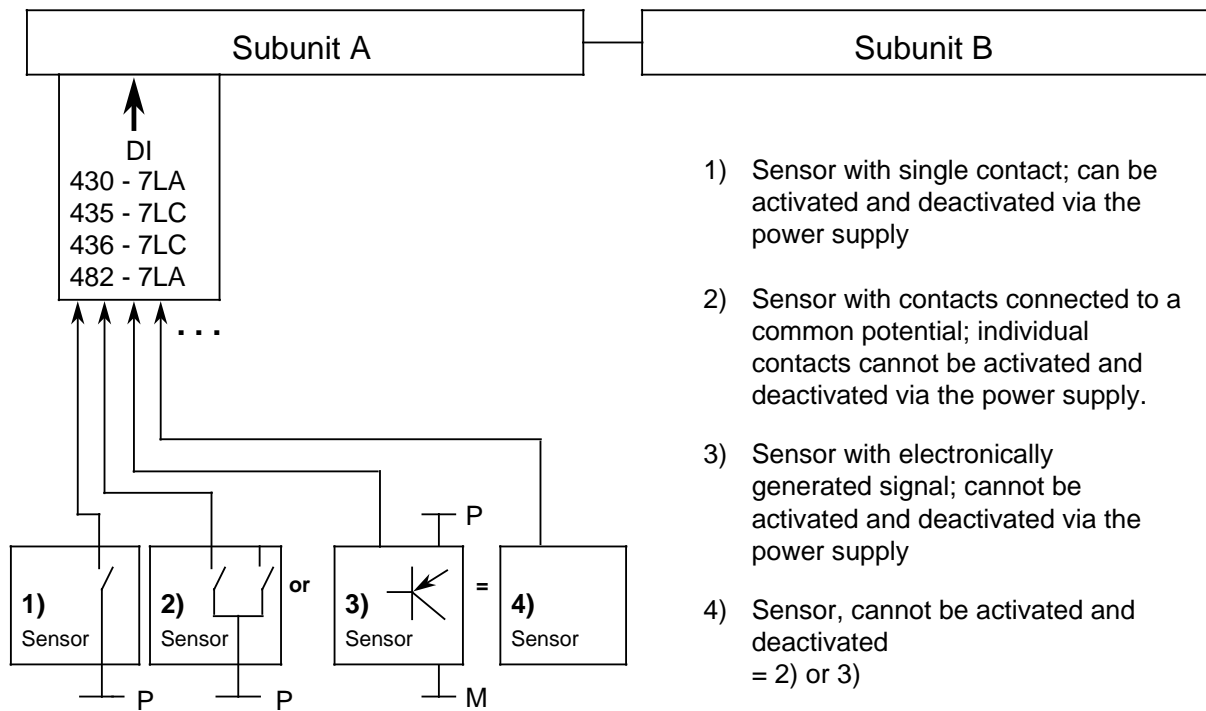


Figure 10-6. Type 1 DI, Nonsafety-Related, Single-Channel

Permissible modules

Module	Characteristics	
430-7LA DI	reaction-free ¹	32 * 24 V, connected to common 0 V potential in groups of 8, P input
435-7LC DI	reaction-free ¹	8 * 115 V, not connected to common 0 V potential
436-7LC DI	reaction-free ¹	8 * 230 V, not connected to common 0 V potential
482-7LA11 DI/DQ	reaction-free	16 * 24 V, 0.5 A, P output + 8 P inputs connected to common 0 V potential

¹ The failsafe module is only implemented in single-channel connection and is therefore only to be regarded as a reaction-free module

10.9.4 Type 2 Digital Input Modules

Type 2 DIs have the following characteristics:

- Safety-related
- Intermittent input signal
- They are operated in subunit A and B (two-channel configuration) and must have the same module address in both subunits.

Figure 10-7 shows the connection of single-channel sensors

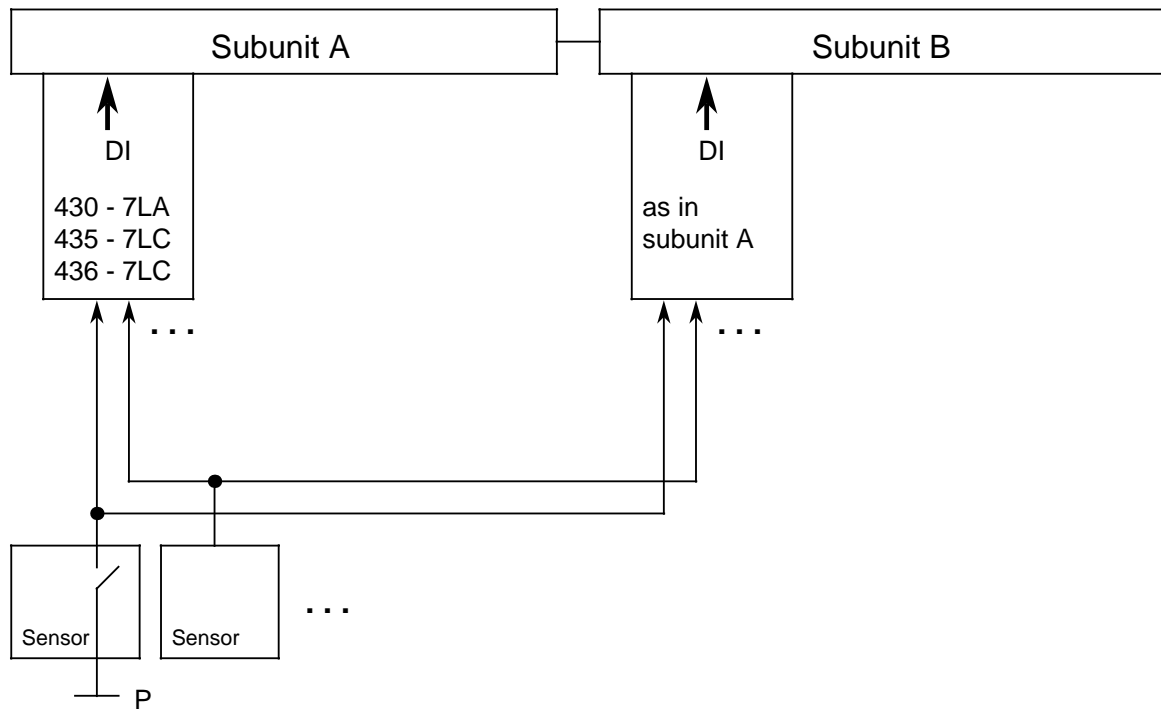


Figure 10-7. Type 2 DI, Safety-Related, Intermittent: Single-Channel Sensor

Permissible modules

Module	Characteristics	
430-7LA DI	failsafe	32 * 24 V, connected to common 0 V potential in groups of 8, P input
435-7LC DI	failsafe	8 * 115 V, not connected to common 0 V potential
436-7LC DI	failsafe	8 * 230 V, not connected to common 0 V potential

Figure 10-8 shows the connection of two-channel sensors. (two-channel configuration throughout).

Corresponding sensors of subunit A and B are connected to DIs with identical addresses and report the same process state.

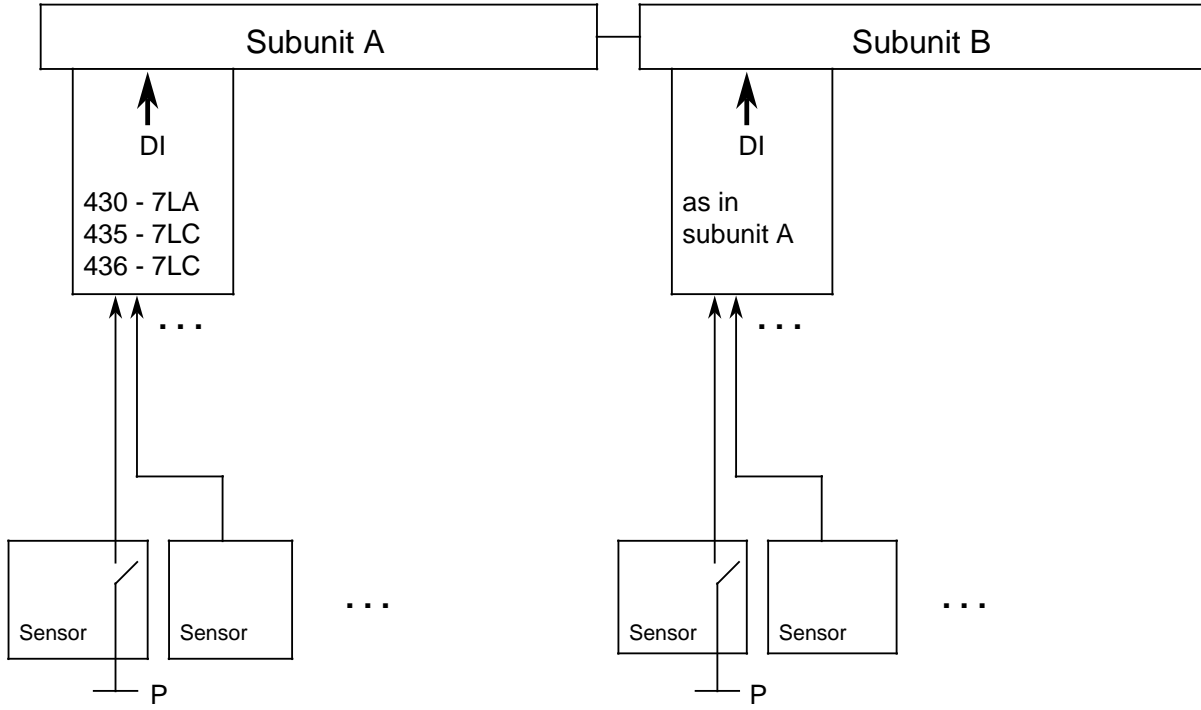


Figure 10-8. Type 2 DI, Safety-Related, Intermittent: Two-Channel Sensors

Permissible modules

Module	Characteristics	
430-7LA DI	failsafe	32 * 24 V, connected to common 0 V potential in groups of 8, P input
435-7LC DI	failsafe	8 * 115 V, not connected to common 0 V potential
436-7LC DI	failsafe	8 * 230 V, not connected to common 0 V potential

Note

After intervals greater than the second error occurrence time, you must check to see whether the Type 2 DI modules can still recognize a low signal. You can save yourself these checks if you configure the module as Type 3.

10.9.5 Type 3 Digital Input Modules

Type 3 DIs have the following characteristics:

- Safety-related
- The input signal can be intermittent or non-intermittent
- They are operated in both subunits A and B (in two-channel configuration) and must have the same module address in both subunits.
- The operating system checks the DI inputs once per test cycle to see if the DI modules can read in a "0" signal. To make the test, the sensor supply to deactivatable sensors is switched off and non-deactivatable sensors are switched back on. Additional check digital output modules (CH DQs) are required for this.
- Read loops with L PY and L PW are illegal in OB 2 and OB 13.

Connecting deactivatable sensors

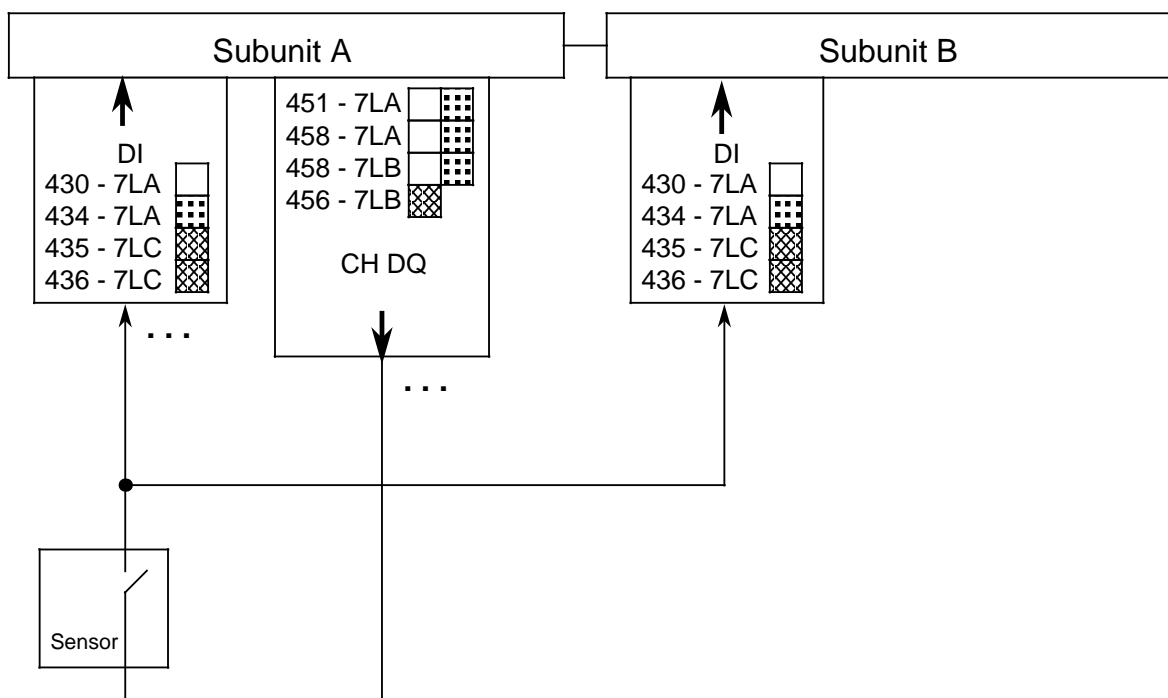


Figure 10-9. Type 3 DI, Safety-Related, Non-Intermittent: Single-Channel, Deactivatable Sensors

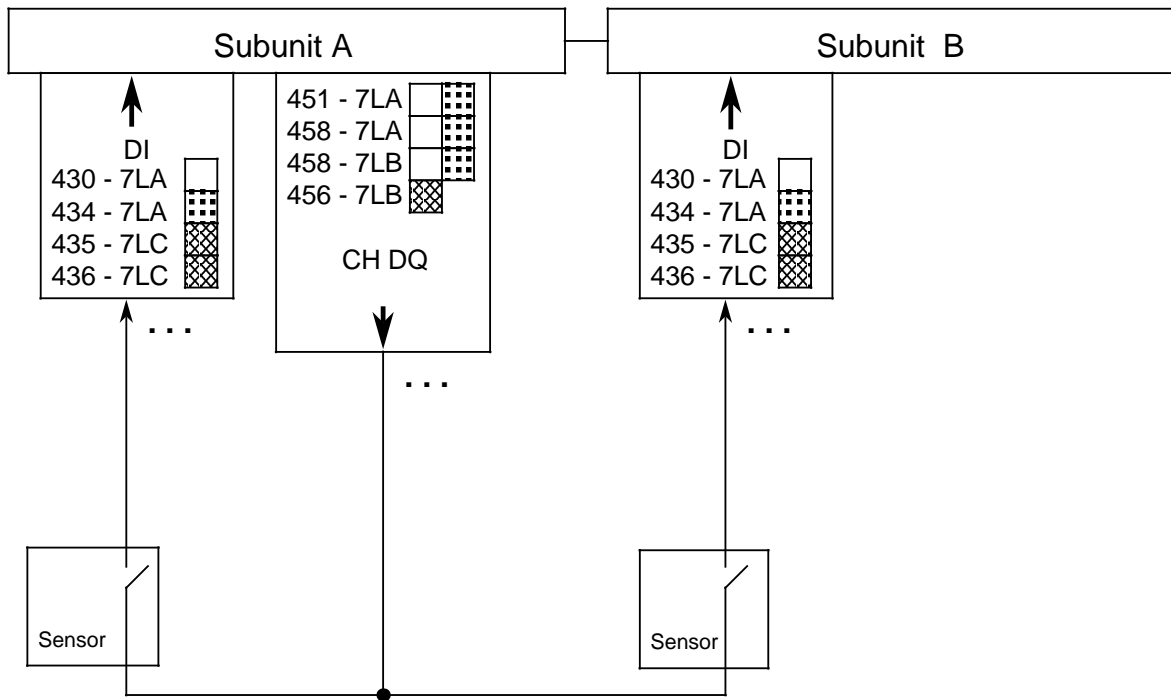


Figure 10-10. Type 3 DI, Safety-Related, Non-Intermittent: Two-Channel, Deactivatable Sensors

Since the active sensor signal is non-intermittent, it must be interrupted in order to check the DIs. For this purpose, a check DQ is used as the sensor supply. This check DQ can be plugged into subunit A or B.

Connecting non-deactivatable sensors

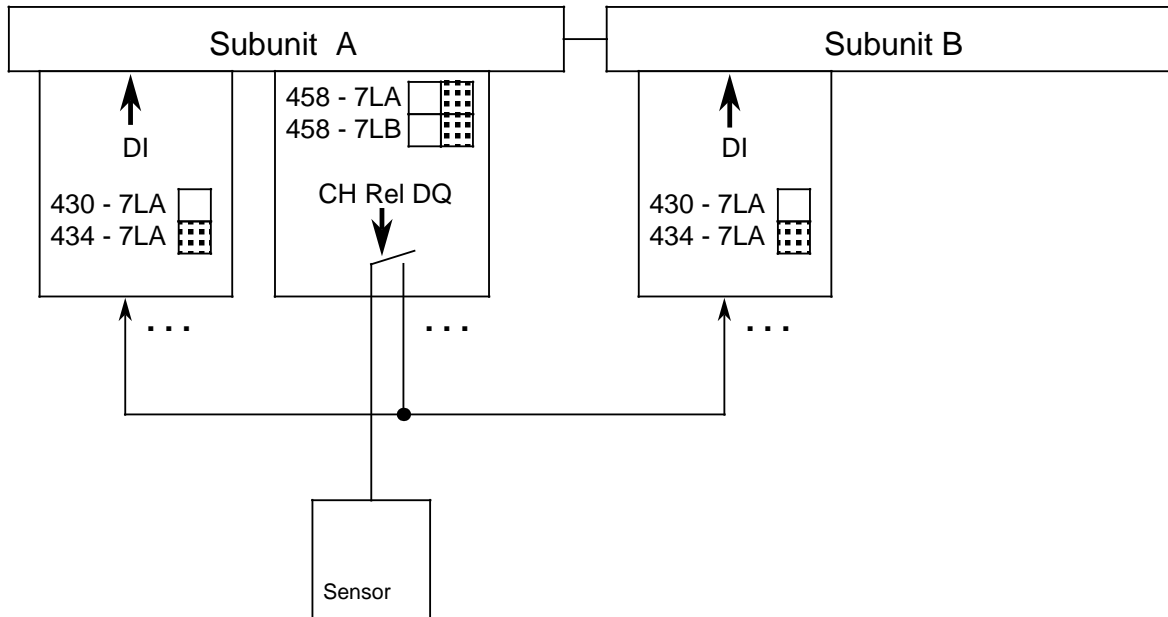


Figure 10-11. Type 3 DI, Safety-Related, Non-Intermittent: Single-Channel, Non-Deactivatable Sensor

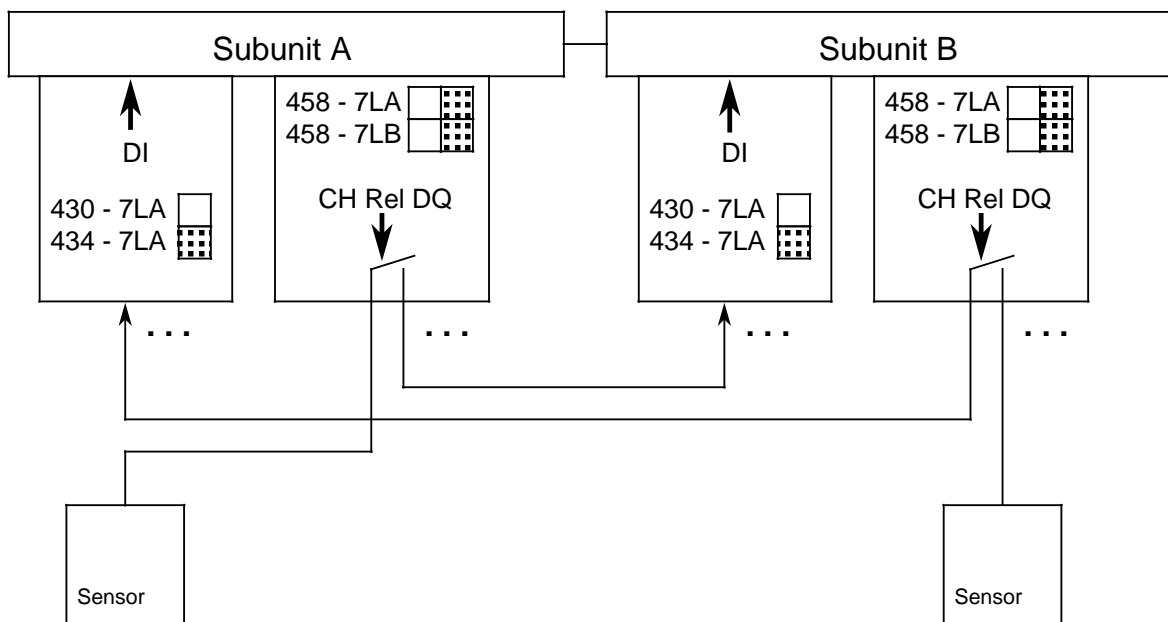


Figure 10-12. Type 3 DI, Safety-Related, Non-Intermittent: Two-Channel, Non-Deactivatable Sensors

These sensors cannot be deactivated for testing. For this reason, the signal must be interrupted:

- In the case of single-channel sensors with one relay, either in subunit A or B.
- In the case of two-channel sensors with two relays, one in subunit A and one in subunit B.

Permissible modules

Module	Characteristics	
430-7LA DI	failsafe	32 * 24 V, Connected to comm. 0 V pot. in groups of 8, P input
434-7LA Interrupt DI	failsafe	8 * 24 V, Not connected to comm. pot., interrupt generating
435-7LC DI	failsafe	8 * 115 V, Not connected to comm. pot.
436-7LC DI	failsafe	8 * 230 V, Not connected to comm. pot.
451-7LA DQ	reaction-free	32 * 24 V / 0.5 A, Connected to comm. 0 V pot. in groups of 8, P output
454-7LA DQ	reaction-free	16 * 24 V / 2.0 A, Connected to comm. 0 V pot. in groups of 4, P output
454-7LB DQ	reaction-free	8 * 24 V / 2.0 A, Not connected to comm. pot., P/M output
458-7LA Rel DQ	failsafe	16 * 24 V / 0.5 A, Not connected to comm. pot., relay output
458-7LB Rel DQ	failsafe	8 * 60 V / 5.0 A, Not connected to
456-7LB DQ	failsafe	

10.9.6 Checking Digital Input Modules in the Case of Non-Intermittent Input Signals

The operating system checks digital input modules. It requires check digital output signals for this purpose in order to simulate intermittence of safety-related, non-intermittent digital and analog input signals.

A digital output module (check DQ) generates the check signals. The check signal switches the sensor supply. The circuit is the same for both the 1- and 2-sensor versions.

A check digital output value is assigned to a 2-channel digital input value for both channels. The bit numbers of the digital input value and the check digital output value are identical.

If you use sensors that cannot be deactivated, you must also use a relay digital output module to generate the check signals.

10.9.7 Direct Read Access to DI Modules

If you want to read the value of a DI word/byte, use the L PW, L PY operations. If any input signal discrepancies are discovered (with reference to subunits A and B), the operating system responds differently depending on the CPU used.

The operating system distinguishes between accessing interrupt DIs and non-interrupt DIs.

- In the case of input signal discrepancies on interrupt DIs, the execution time is increased by the discrepancy analysis. If no errors are detected, the current standard value is output.
- In the case of non-interrupt DI discrepancies, the last valid standard value is output. The system does not wait for the discrepancy to disappear.

10.9.8 Digital Input Module with Interrupt Capability (Interrupt DI)

The 434 interrupt DI is always a Type 3 I/O module

- Safety-related
- Two-Channel
- Non-intermittent.

This saves you the difficulty of having to verify the intermittent nature of the interrupt DI signals. In addition, the frequency at which the signals change is monitored by the operating system. Frequently changing signals are not tested.

Signal characteristics

The sensor signal must maintain a given state for at least 7 msec. for both signal levels. The interval between two interrupts must be at least 30 msec.

Discrepancy time

You must configure the interrupt DI with a uniformly short discrepancy time.

Access

At the start of OB 2, you must read the 434 interrupt DI with a direct access so that the interrupt register can be reset. Access to the interrupt registers in OB 1 and OB 13 is not permissible since the OB 2 functions can be blocked by a random access before a pending OB 2 execution.

The status register can be read at any time and, like the interrupt register, it is not updated cyclically.

The 115F operating system detects false interrupts. These result in the usual error response with PLC STOP or in passivation of the relevant signal group.

Enable/disable initialization

Initialization is enabled/disabled automatically on restart according to the parameters assigned in the configuration form. (Interrupts can only be triggered by negative edges.)

However, the user can still change the initialization enable/disable in the restart OBs (OB 21, OB 22). You can either enable all or some interrupt DI bits assigned with COM 115F. Make sure that you enable only those interrupt DI bits which you have configured with COM 115F.

In the case of write access to the interrupt DIs, the operating system checks that this rule is obeyed.

Edge initialization

The operating system initializes the interrupt DI bits used in the screen form for negative edge. (Interrupts can only be triggered by negative edges.)

However, the user can still change the parameters in the restart OBs (OB 21, OB 22). In doing so, the operating system checks that none of the enabled interrupt DI bits has been assigned a positive edge. This ensures that, if the power supply to a sensor is cut off, it can still initiate the safety function.

Number and location

Only one interrupt DI can be used in each subunit.
The interrupt DIs must be plugged into the central controller.
Their addresses cannot be used for any other modules, including DQ modules.

Process interrupt OB 2

Make sure that OB 2 is correctly executed in the case of process interrupts.

Synchronization FB 254

To service process and time interrupts with the required speed, you must synchronize the control program sufficiently often. For this purpose, you must call synchronization FB 254 with the appropriate parameters (Vol. 2, 6.1.6 of the Manual).
The 115F operating system monitors the maximum intercall interval you have configured with COM 115F (Vol. 2, 1.1.1 of the Manual).

Process interrupt response time

The time taken to respond to a process interrupt depends on the intervals between the FB 254 calls in the user program. The response time corresponds to the interval between the calls plus a maximum of 10 msec. operating system processing time. The minimum response time is 30 msec.

User program without process or time interrupt

Note

If you do not handle any process or time interrupts in the user program, you can shorten the PLC scan time by using the IA "inhibit alarm (interrupt)" operation.

Variants of the interrupt DI test

- Short test on restart
The short test on restart checks all interrupt DI bits with signal level "1" and leaves all bits with signal level "0" untested.
- Supplementary test
All interrupt DI bits which did not report an interrupt in the last cycle are subjected to the supplementary test. The test cannot be carried out if the interrupt DI signal is not "1".
The operating system allows the user to set a "1" in system data word SD 98 for all interrupt bits for which the error response to a non-executable supplementary test did **not** result in PLC STOP.

Example:

If you do not want the PLC to respond by stopping in the case of an error at the interrupt inputs x.0 and x.3, program the following operations in an FB:

```
L KM 00001001 00000000
T RS 98
```

The user and the inspector check the relevant interrupt DI bits according to the following conditions:

- A user test must ensure after system startup that all interrupt DI bits are capable of functioning.
- It must be proved that more than one interrupt occurs for each interrupt DI bit within the second error occurrence time (process-dependent).

The basic state of SD 98 is the "0" word so that the interrupt DI test responds with the usual vigour to interrupt DI bit status "0".

10.10 Digital Output Modules (DQs)

When configuring the I/O modules (Vol. 2 of the Manual), define the I/O type for each DQ according to the process output signal characteristics of each DQ module. There are three different DQ types.

Outputting commands to protective devices

Commands which initiate protection functions, such as emergency off commands, require special care in programming. For this reason, make sure that these commands are not mistakenly rescinded in the program.

Make your program structure as simple and clear as possible. This also simplifies the inspector's work.

Relay DQ 458-7LB11 (8 bits, 60V/5A)

This module can be used at rated voltages up to 60 V.

DQ address 126

Note

The 115F operating system uses DQ address 126 to detect a permanent enable resulting from a defective DQ. DQ address 126 must not be used in the user program.

10.10.1 Type 8 Digital Output Modules (DQs)

Type 8 digital output modules have the following characteristics:

- Non-intermittent
- They are operated either in subunit A or B (single-channel configuration).
- They can be plugged into both subunits in any mix.
- The module address can only be assigned in the subunit containing the DQ module. This address must not be used in the other subunit.

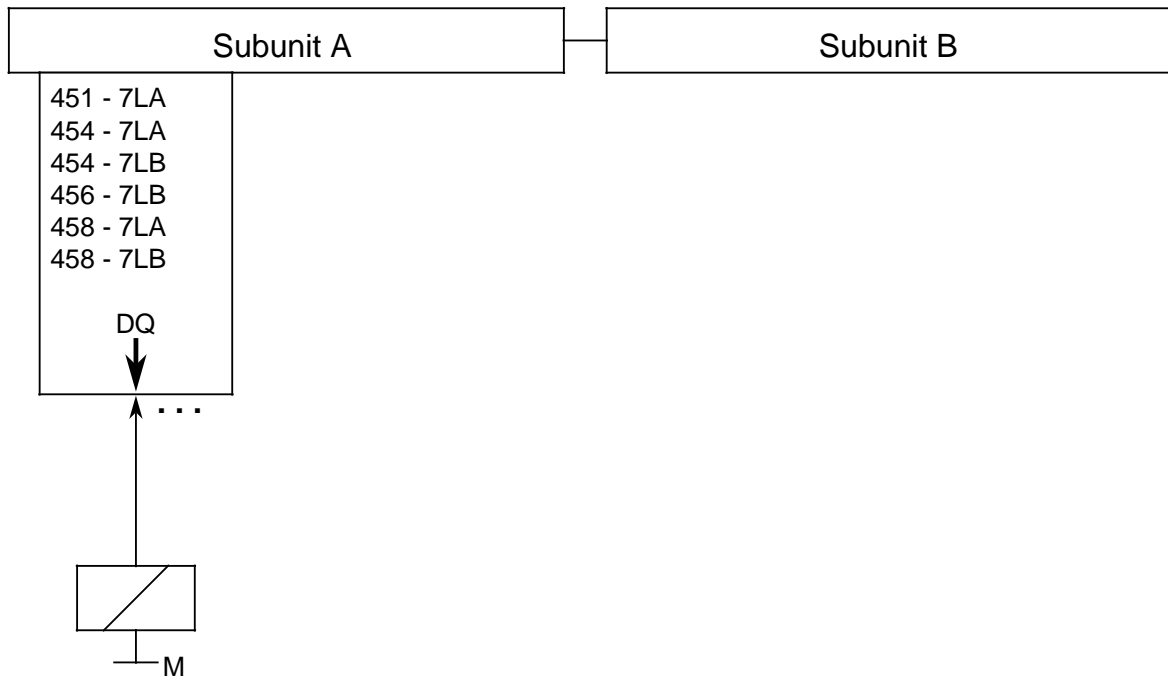


Figure 10-13. Type 8 DQ, Nonsafety-Related, Single-Channel

Permissible modules

Module	Characteristics		
451-7LA DQ	reaction-free	32 *	24 V/0.5 A, Connected to comm. 0 V pot. in groups of 8, P output
454-7LA DQ	reaction-free	16 *	24 V/2.0 A, Connected to comm. 0 V pot. in groups of 4, P output
454-7LB DQ	reaction-free	8 *	24 V/2.0 A, Not connected to comm. pot., P/M output
458-7LA Rel DQ	reaction-free	16 *	24 V/0.5 A, Not connected to comm. pot., relay output
458-7LB Rel DQ	reaction-free ¹	8 *	60 V/5.0 A, Not connected to comm. pot., relay output
456-7LB DQ	reaction-free ¹	8 *	115/230 V/1.5 A, Not connected to comm. pot., P/M output

¹ The failsafe module is used only in a single-channel configuration here and should therefore be treated only as a reaction-free module.

10.10.2 Type 9 and Type 10 Digital Output Modules

Type 9 digital output modules have the following characteristics:

- Safety-related
- Intermittent output signal
- They are operated both in subunit A and subunit B (two-channel configuration) and must have the same module address in both subunits.
- They are combined with readback inputs (R DIs) which monitor the outputs for discrepancy times.
- Type 9 DQs are automatically tested with simulated intermittence during restart. Special checking after extended shutdown periods is therefore not necessary.

Type 10 digital output modules have the following characteristics:

- Safety-related
- Intermittent or non-intermittent output signal
- They are implemented in subunits A and B in two-channel configuration and must have the same module address in both subunits.
They are combined with readback inputs (R DIs), which monitor the outputs for discrepancy times.
- Simulated intermittence of "0" or "1" signals takes place once every test cycle.

Requirements to be met by digital output modules

In the case of safety-related DQ signals, the interval between two edge changes must be greater than the short discrepancy time for DIs without interrupt capability.

10.10.3 Connecting Actuators to Digital Output Modules (DQs) (Types 9 and 10)

You can choose either of the following methods for connecting actuators to digital output modules:

- Direct control, if the module switches the load without an interposing relay
- Indirect control with readback direct at DQ, load is switched by an interposing relay
- Indirect control with readback at load circuit, load is switched by an interposing relay

Choose interposing relays/actuator according to the following criteria:

Table 10.4 Choise of the reaction times for interposing relays and actuator

I/O type	Drop-out delay of the interposing relays	Drop-out delay of the actuator
9	any time	any time
10 direct control	-	Dead time: 24 V: >10 ms 115/230 V: >30 ms
10 indirect control Readback	Dead time: 24 V: >10 ms 115/230 V >30 ms	any time
10 indirect control Readback at load circuit	as fast as possible	24 V:>10 ms +T _{DT interposing relay} 115/230 V:T _{DT interposing relay}

Note

The drop-out delay of the DC interposing relays and DC actuators can be increased by connecting a free-wheeling diode in parallel.

Testing DQs of I/O type 10 results in a dead time. This is

- 7 ms in the case of direct controlled 24 V output modules
- 24 ms in the case of direct controlled 230 V output modules

In the case of indirect controlled output modules, the specified times increase by the pickup delay of the relays used.

Output and readback must not exceed 70 ms otherwise the operating system responds with an error. For this reason, use relays with low pickup delays.

Note

You can use both direct and indirect controlled actuators in one output byte, the dead time of the indirect controlled outputs applies for the **entire byte**.

Note

In the case of safety-related 24 V digital outputs with readback function, please note that the holding current of the load must be greater than 1 mA.

Note

In the case of safety-related 230 V digital outputs with readback function, please note that the holding power of the load must be greater than 5 W; for 115 V digital outputs with readback function, the holding power must be greater than 2.5 W.

If this is not possible because the internal resistance of the load is too high, four diodes must be connected in series in the readback lines. The diodes must be switched so that they conduct from the load to the readback DI. At least two different diode types must be used per branch. The recommended nominal crest working off-state voltage must not be less than 1000 V and the nominal conducting-state current must not be less than 1 A (Figures 10-15, 10-17, 10-19, 10-20). You can also interrupt the readback line with the positive-action contact of an interposing relay as an alternative to diodes (Figure 10-21).

The following figures illustrate the difference between direct and indirect control.

Direct control

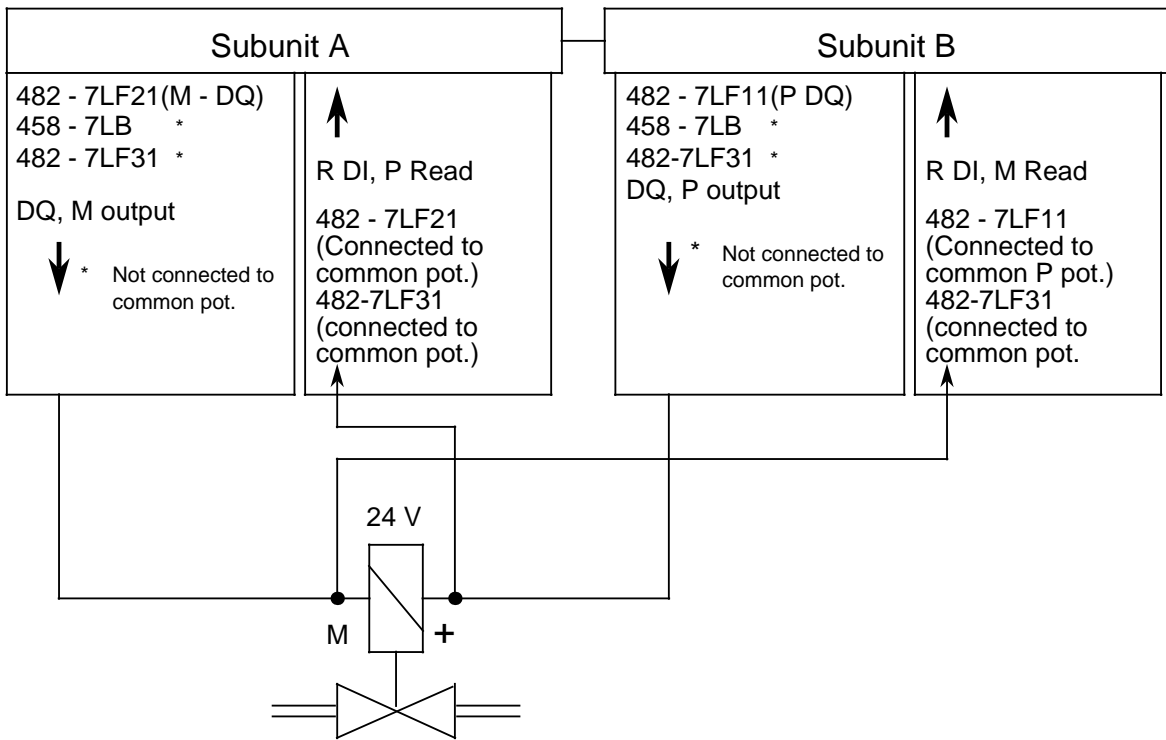


Figure 10-14. Type 9/10 DQ, Safety-Related, Intermittent/Non-Intermittent: Direct Control, 24 V

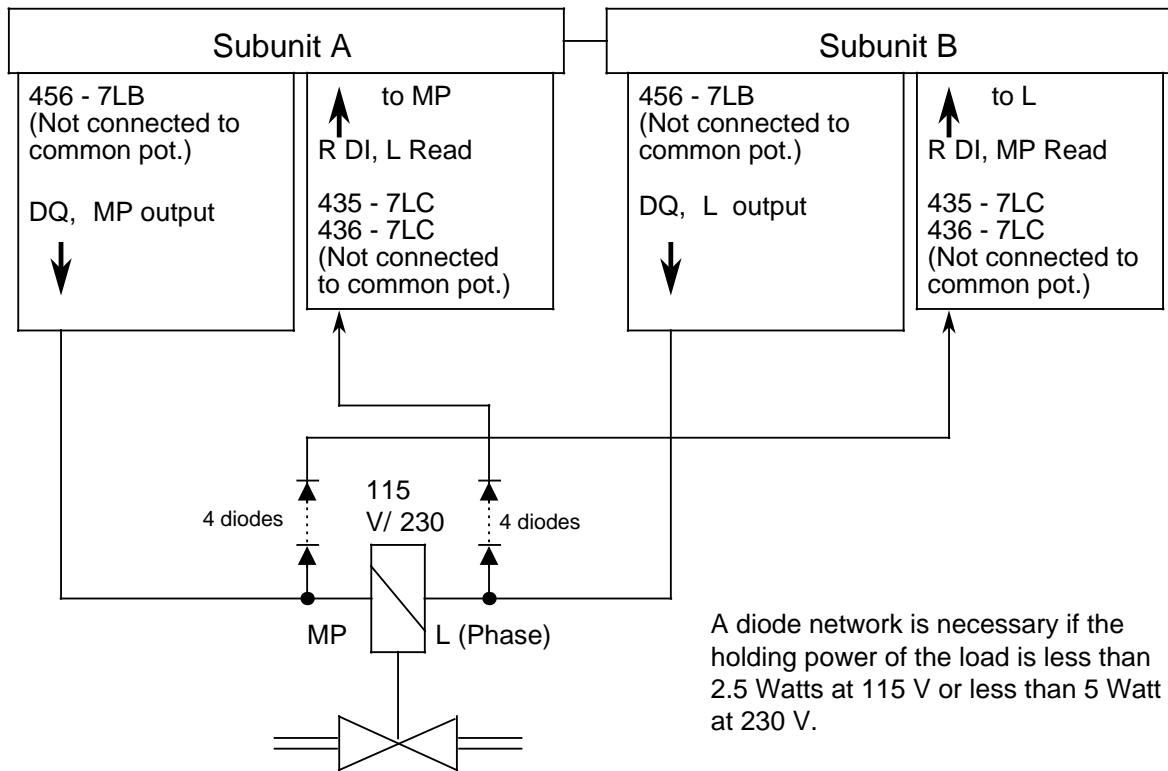


Figure 10-15. Type 9/10 DQ, Safety-Related, Intermittent/Non-Intermittent: Direct Control, 115 V / 230 V

Indirect control

There are two methods of reading back output signals in the case of indirect control:

- Direct at the digital output module
- In the load circuit of the relay

Table 10-5. Advantages of the Various Readback Methods

Connection direct at the output module	Connection to the load circuit of the interposing relay
Only permitted in plants to VDE 0116 if the interposing relays of the main circuits are of redundant and different design	Interposing relay will be tested by S5-115F.
The test period and duration of the disconnection of non-intermittent digital outputs for testing purposes are shortened	The test period and duration of disconnection of non-intermittent digital outputs for testing purposes are increased

Indirect control readback direct at DQ module

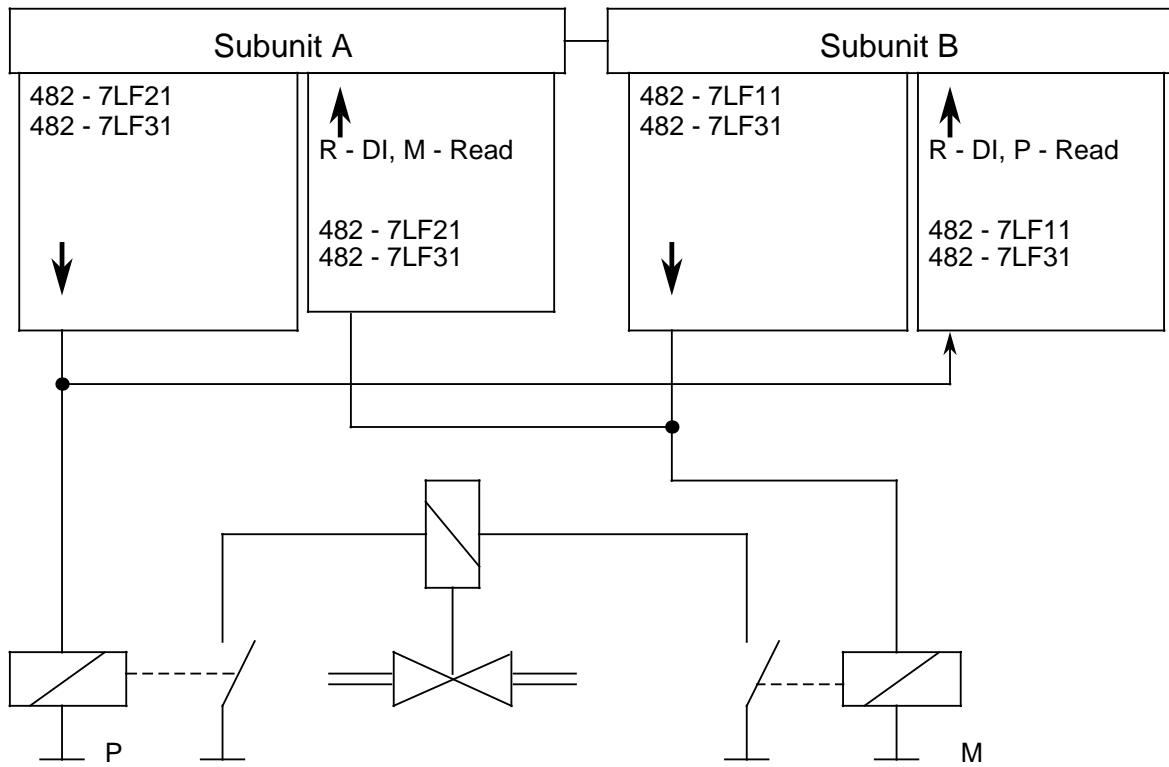


Figure 10-16. Type 9/10 DQ, Safety relevant: Indirect Control, Readback direct at DQ, 24 V

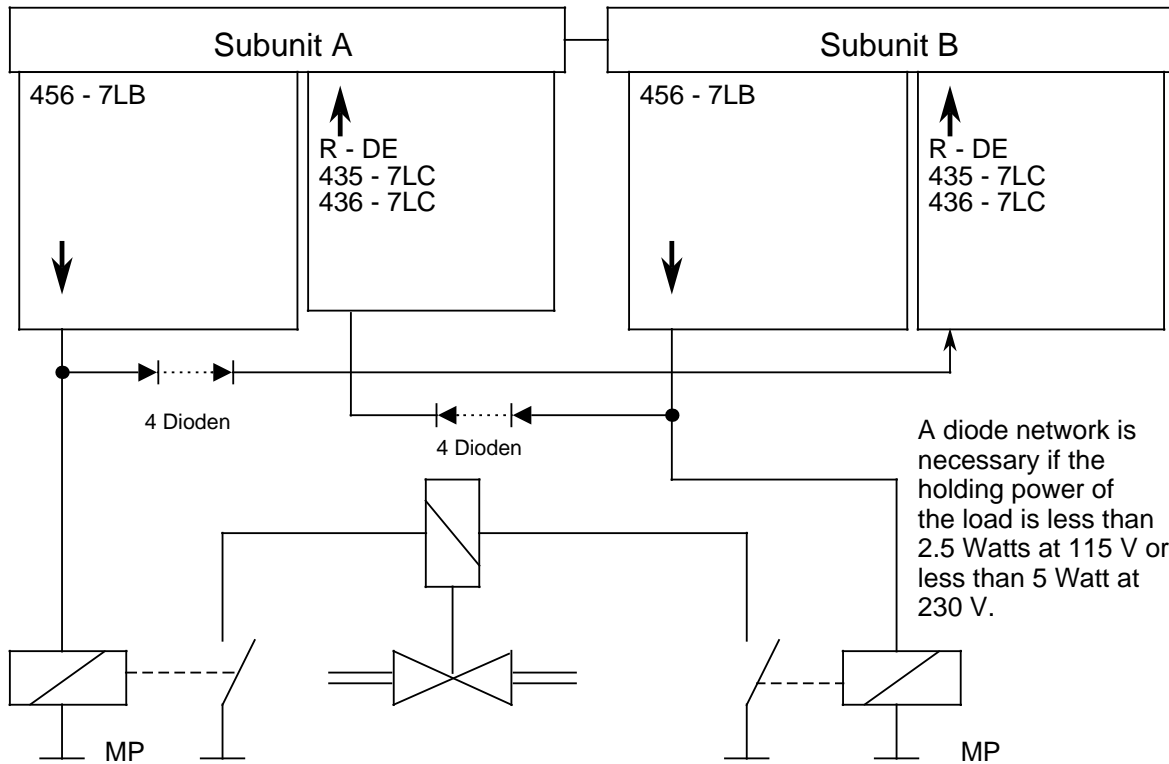


Figure 10-17. Typ 9/10 DQ, Safety relevant: Indirect Control, Readback direct at DQ, Readback direct at DI, 115 V/230 V

Indirect control readback at load circuit

Note

You must use sufficiently fast interposing relays in the case of indirect control of actuators via interposing relays and readback after the interposing relays. The delay between control pulse and the result of the readback function must not exceed 70msec.

Connection direct at the load circuit of the relay is shown in the following figures.

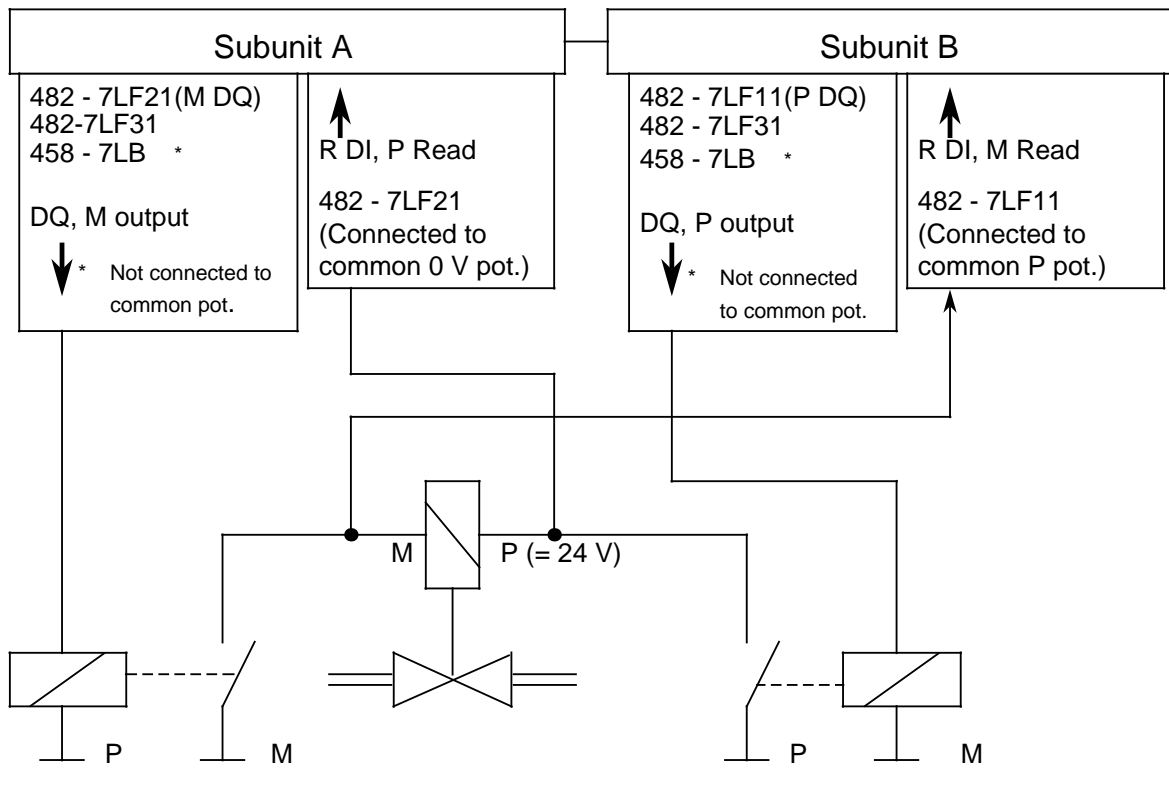


Figure 10-18. Type 9/10 DQ, Safety-Related: Indirect Control, 24 V / 24 V with Readback at load circuit

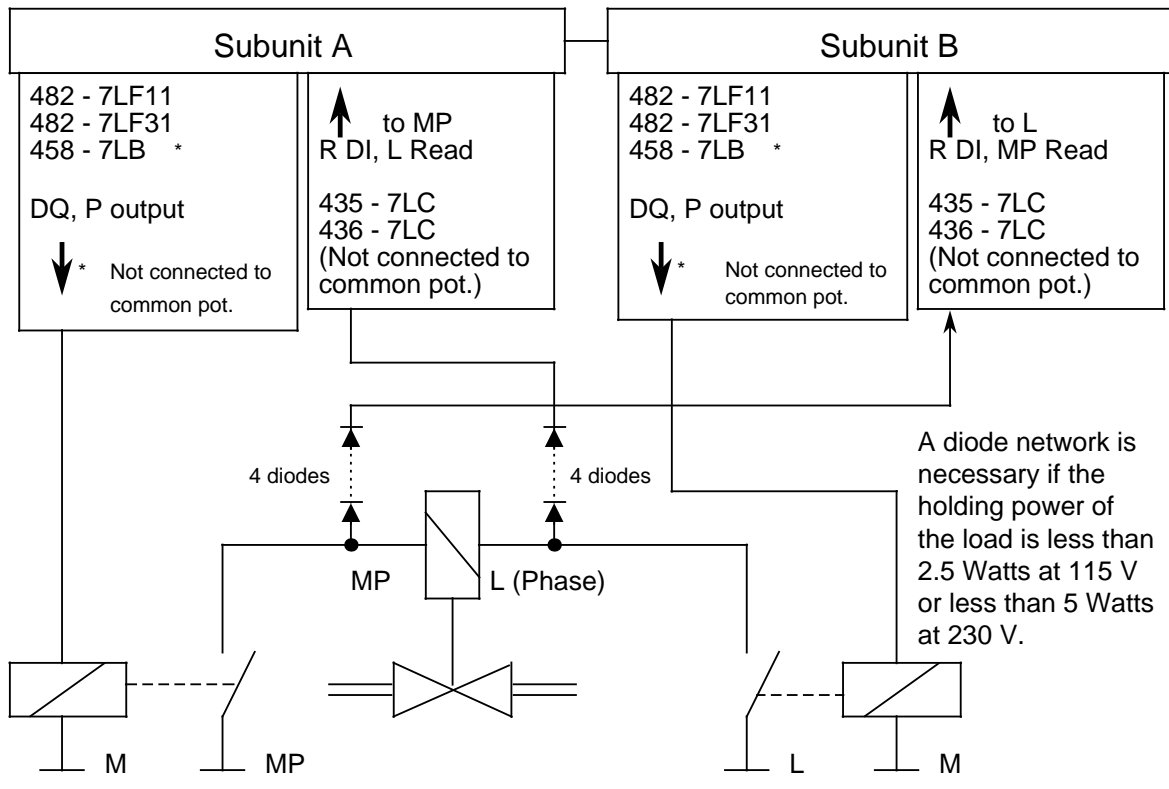


Figure 10-19. Type 9/10 DQ, Safety-Related: Indirect Control, Readback at laod circuit, 24V/115 V or 24 V/230 V

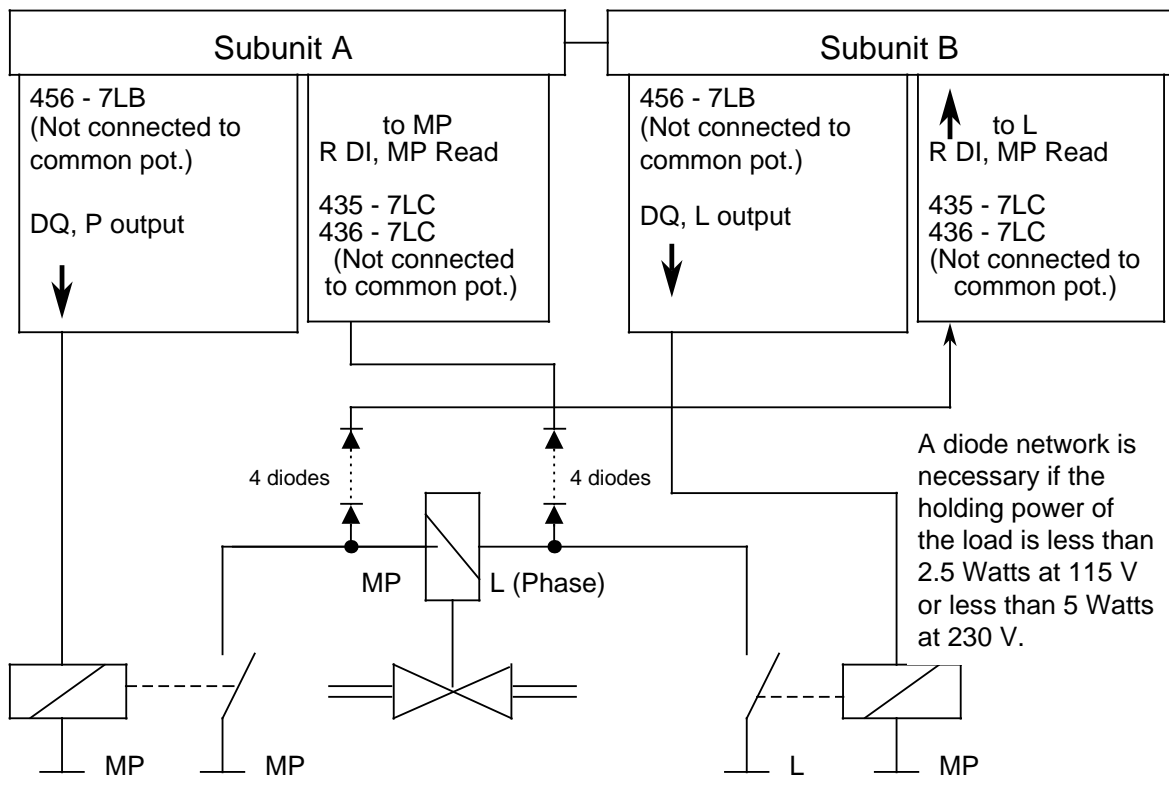


Figure 10-20. Type 9/10 DQ, Safety-Related: Indirect Control, Readback at laod circuit, 115 V/115 V or 230 V / 230 V

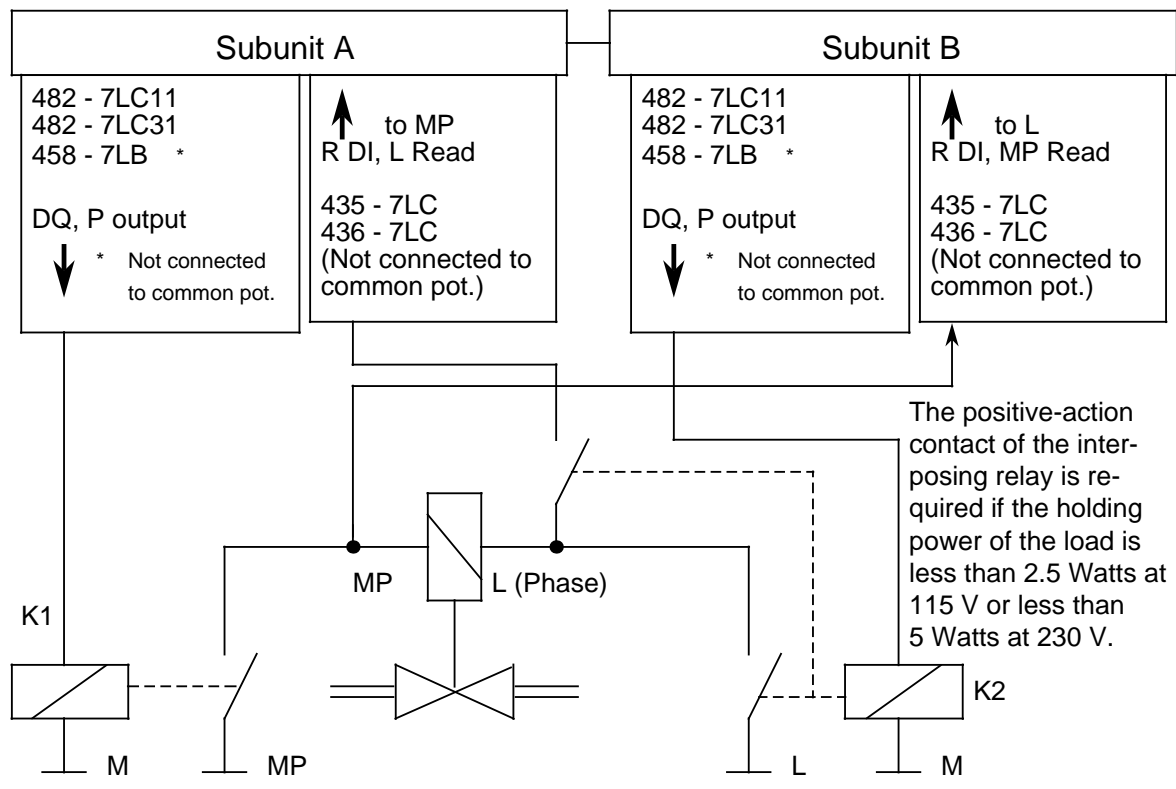


Figure 10-21. Type 9/10 DQ, Safety-Related: Indirect Control, Readback at load circuit, 24 V/115 V or 24 V/230 V

Permissible modules

Modules	Characteristics		
435-7LC DI	failsafe	8 * 115 V	not connected to common pot.
436-7LC DI	failsafe	8 * 230 V	not connected to common pot.
482-7LF11 DI/DQ	failsafe	16 * 24 V, 0.5 A,	P outputs + 8 D inputs connected to common P potential
482-7LF21 DI/DQ	failsafe	16 * 24 V, 0.5 A,	M outputs + 8 M inputs connected to common M (0 V) potential
482-7LF31 DI/DQ	failsafe	8 * 24 V/2.0 A,	M outputs + 4 M inputs connected to common pot., P/M output
458-7LB Rel DQ	failsafe	8 * 60 V/5.0 A,	not connected to common pot., relay output
456-7LB DQ	failsafe	8 * 230 V/1.0 A,	not connected to common pot., P/M output

10.10.4 Checking Digital Output Modules Using Readback Digital Input Modules

A safety-related digital output module must be checked by a two-channel readback digital input module. The 115F operating system compares both input signals and reports an error when they are not identical. Error handling is described in Chapter 10 (10.6). This type of checking does not depend on whether the output signal is intermittent or not.

The readback input channels are assigned diagonally to the two subunits.
The bit numbers of the output channel and the readback input channel must be identical.

10.11 Analog Input Modules

When configuring the I/O modules (Vol. 2 of the Manual), you must define the I/O type for each AI according to the characteristics of the process signals. There are four different analog input types. Only I/O types 14 to 16 are permissible for safety-related use.

Requirements to be met by sensors with current outputs

It must be possible to interrupt sensors that have current outputs for **I/O types 14 and 15**. This is because of the supplementary test carried out by the operating system of the 115F as follows:

- Disconnection of the sensors from the AI module
- Connection of the test AQ to the AI module
- Test
- Disconnection of the test AQ from the AI module
- Connection of the sensors to the AI module

Note

Please ensure that the "short discrepancy time for analog inputs" configured by you with COM 115F is greater than the settling time of your current signal sensors.

460 AI module

The 460 AI module is only permissible for nonsafety-related analog inputs.

463 AI module

The 463 AI module has four input ranges

- 4 to 20 mA with wire-break monitoring by live zero
- 0 to 20 mA
- 0 to 1 V
- 0 to 10 V

Non-intermittent analog input signal (I/O types 14 and 15)

You can only use those input ranges that have an output range identical to that of the test AQ 470. These are as follows:

- 4 to 20 mA with wire-break monitoring by live zero
For this purpose, only channel Type 4 (4 mA=0 units), and not channel Type 3 (4 mA=256 units), may be configured.
- 0 to 20 mA
- 0 to 10 V

Intermittent analog input signal (I/O type 16)

You can use all input ranges.

All Type 16 I/O modules must be subjected to a function test after any extended downtime. You can dispense with the test if you configure Type 14 or 15.

Input ranges without wire-break monitoring by live zero

The following input ranges have no wire-break monitoring by live zero:

- 0 to 20 mA
- 0 to 1 V
- 0 to 10 V

If you use these input ranges, your program must contain a wire-break monitor.

Signal group number of the AI module and the relevant check AQ module

The signal group numbers of the AI module and the relevant check AQ channel must be identical. You may use a check AQ channel for all AI modules of the same type (14 or 15) and the same signal group number. If the AI channels have different signal group numbers, you must use different check AQ channels.

Use of the FB 250 ANEI

You can use the FB ANEI in cyclic and time-driven programs. If you call the FB ANEI from a time-interrupt service routine (OB 13), there are two possibilities available to you. These differ as to the analog value used.

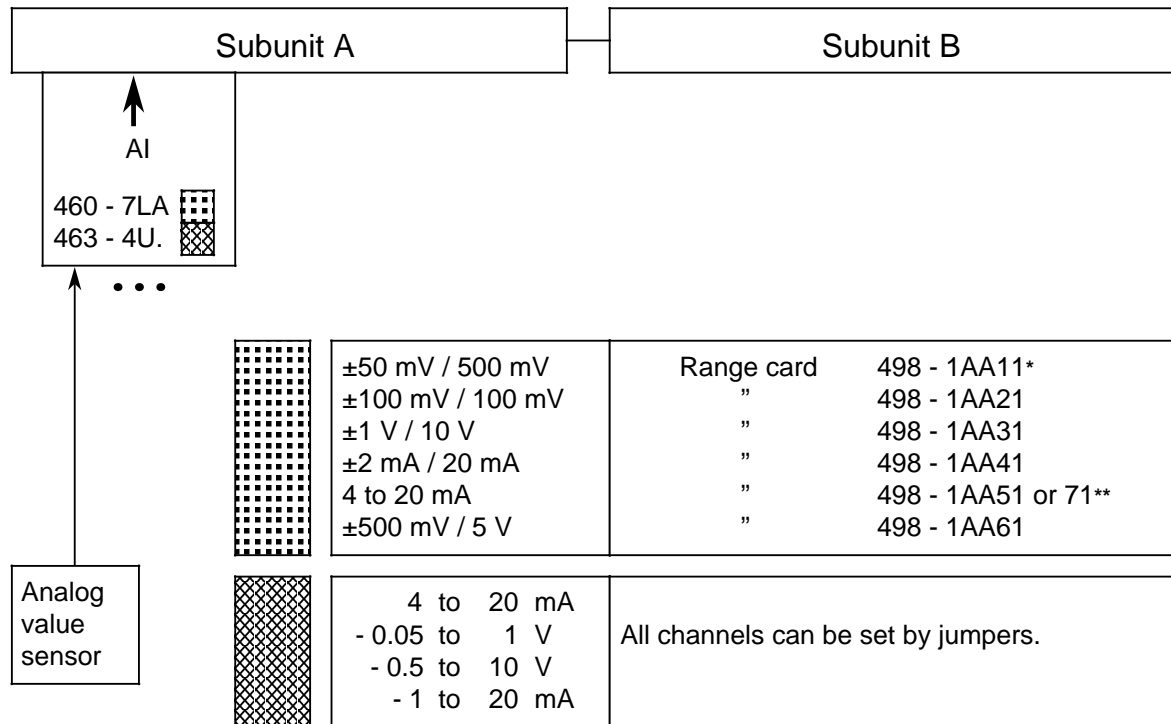
- DIR bit = 0 (FB ANEI)
The FB 250 ANEI accesses the cyclically updated analog value in the PII.
- DIR bit = 1 (FB ANEI)
The FB 250 ANEI reads the analog value direct from the module.

You will find more information on this in Vol. 2, Chapter 6 of the Manual (Vol. 2, 6.1.3).

10.11.1 Type 13 Analog Input Modules

Type 13 analog input modules have the following characteristics:

- Nonsafety-related
- They can be plugged into either subunit A or subunit B.
- They can be connected in any mix in both subunits.
- The module address can only be configured in the subunit containing the AI module. This address cannot be used in the other subunit.



* With hardware wire-break detection (according to procedure , 6.1.1)

** With wire-break detection using FB 250 ANEI (according to procedure , 6.1.1)

Figure 10-22. Type 13 AI, Nonsafety-Related, Single-Channel

Permissible modules

Module	Characteristics	
460-7LA AI	reaction-free	8 channels, 4 channels per 498 range card, possible with all 7 range cards
463-4U.AI	reaction-free*	4 channels, each can be set by jumpers 4 to 20 mA (load impedance = 62.5 Ω, V = 250 to 1250 mV) 0 V to + 1 V 0 V to + 10 V 0 mA to + 20 mA

* The failsafe module is only used as a single channel-module and should therefore be regarded only as a reaction-free module.

10.11.2 Type 14 Analog Input Modules

Type 14 analog input modules have the following characteristics:

- Safety-related.
- Non-intermittent input signal.
- They are plugged into subunits A and B (two-channel configuration) and must have the same module address in both subunits.
- Check relay digital outputs and check analog outputs can be assigned to either subunit A or B. However, both check modules must be plugged into the same subunit.

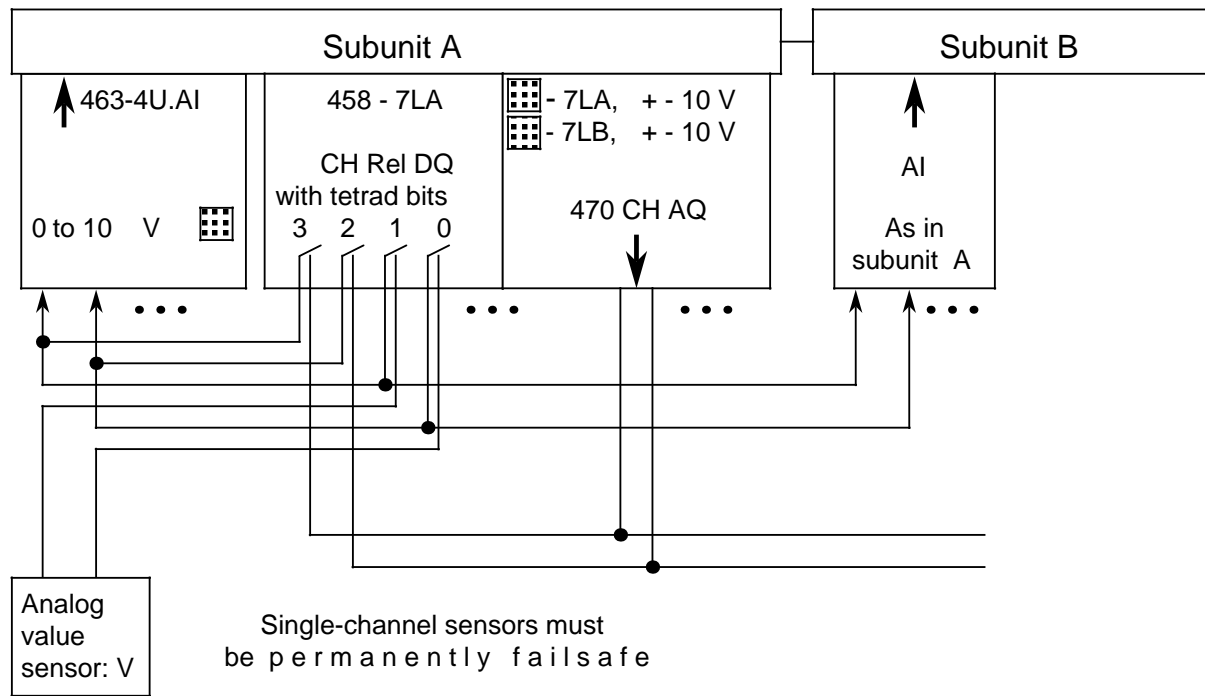


Figure 10-23. Type 14 AI, Safety-Related, Non-Intermittent: Single-Channel Sensor with Voltage Output

Explanation of Figure 10-23

A tetrad of the CH Rel DQ is used for connection. Bits 0 and 1 are used for connecting the sensor and bits 2 and 3 for connecting the 470 check AQ module.

The tetrad (controlled by the operating system) has the value 0011 in normal sensor operation.

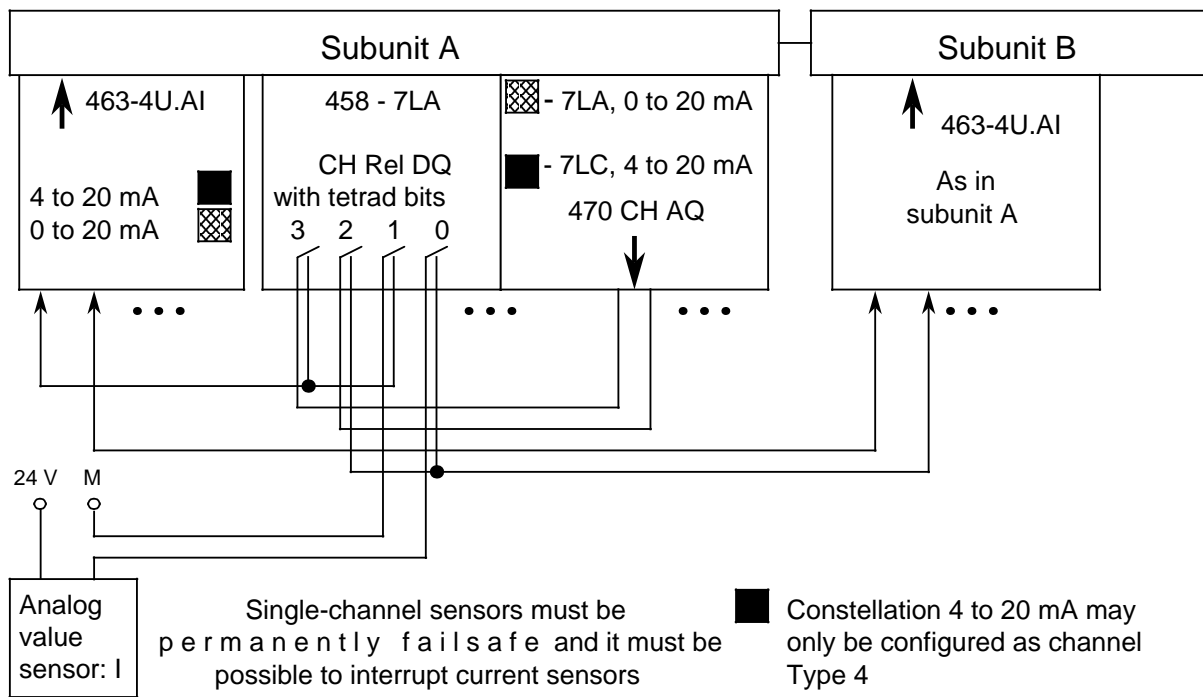
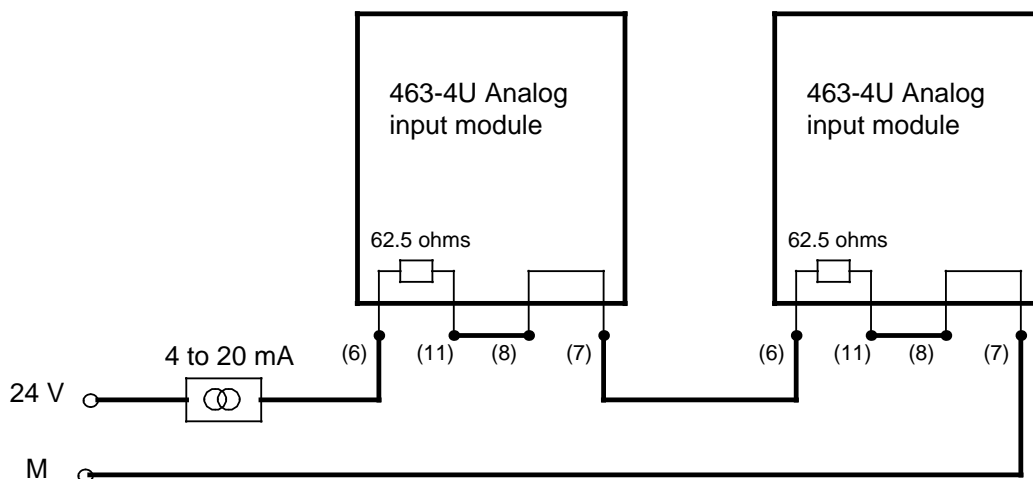


Figure 10-24. Type 14 AI, Safety-Related, Non-Intermittent: Single-Channel Sensor with Current Output; Two-Wire Transducer

The use of two-wire transducers requires a dedicated power supply. The following figure shows the wiring principle for redundant analog input modules with two-wire transducers (channel 0). The necessary test wiring is not shown in the figure.



The number in brackets indicate terminal designations on the front connector of the 463-4U AI.

Figure 10-25. Suggested Wiring of the 463 AI Module When Using Two-Wire Transducers (without Test Wiring)

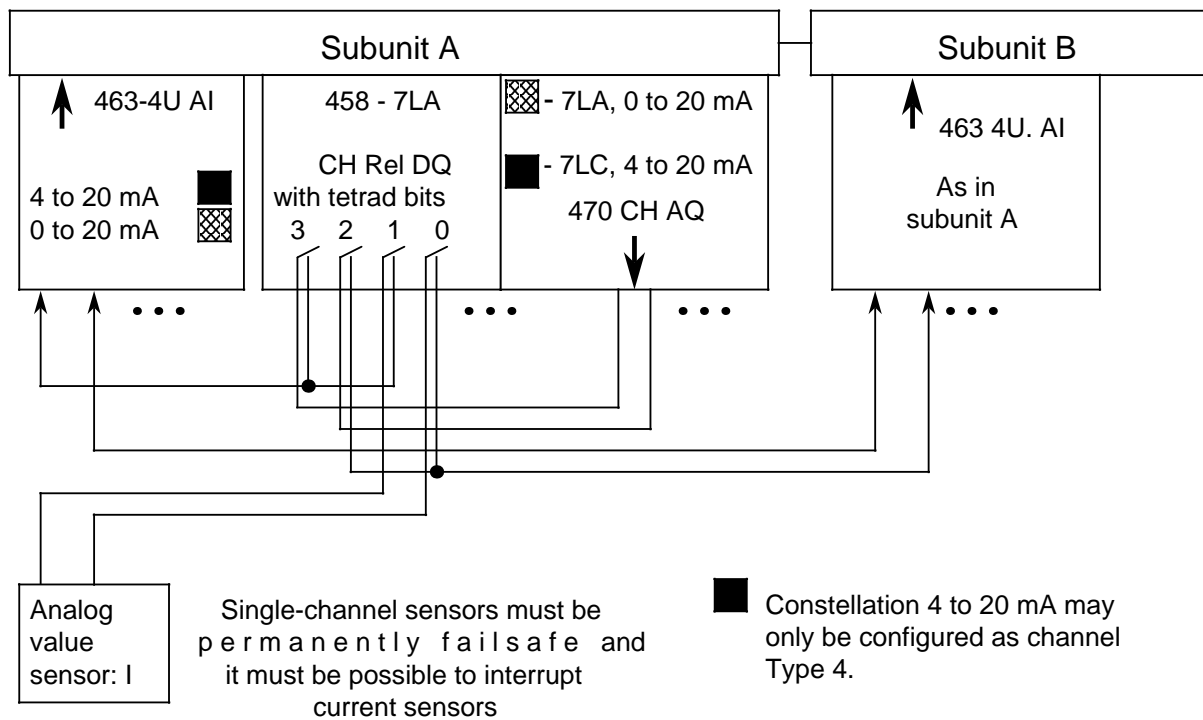


Figure 10-26. Type 14 AI, Safety-Related, Non-Intermittent: Single-Channel Sensor with Current Output; Four-Wire Transducers

Explanation of Figures 10-25 and 10-26

A tetrad of the CH Rel DQ is used for connection. Bits 0 and 1 are used for connecting the sensor and bits 2 and 3 for the 470 check AQ module.

In normal sensor operation, the tetrad (controlled by the operating system) has the value 0011.

Permissible modules

Module	Characteristics	
463-4U.AI	failsafe	4 channels, each can be set by jumpers 4 to 20 mA (load impedance = 62.5 Ω, V = 250 to 1250 mV) 0 V to +10 V 0 mA to +20 mA
470-7LA AQ	reaction-free	8 channels, ±10 V or 0 to 20 mA
470-7LB AQ	reaction-free	8 channels, ±10 V
470-7LC AQ	reaction-free	8 channels, 4 to 20 mA
458-7LA Rel DQ	reaction-free	16 * 24 V/0.5 A, not connected to common potential, relay output

10.11.3 Type 15 Analog Input Modules

Type 15 analog input modules have the following characteristics:

- Safety-related
- The AI signal needs not be intermittent.
- They are plugged into subunits A and B (two-channel configuration) and must have the same address in both subunits.
- Check relay digital output modules and check analog output modules can be assigned to either subunit A or B.

However, both check modules must be plugged into the same subunit.

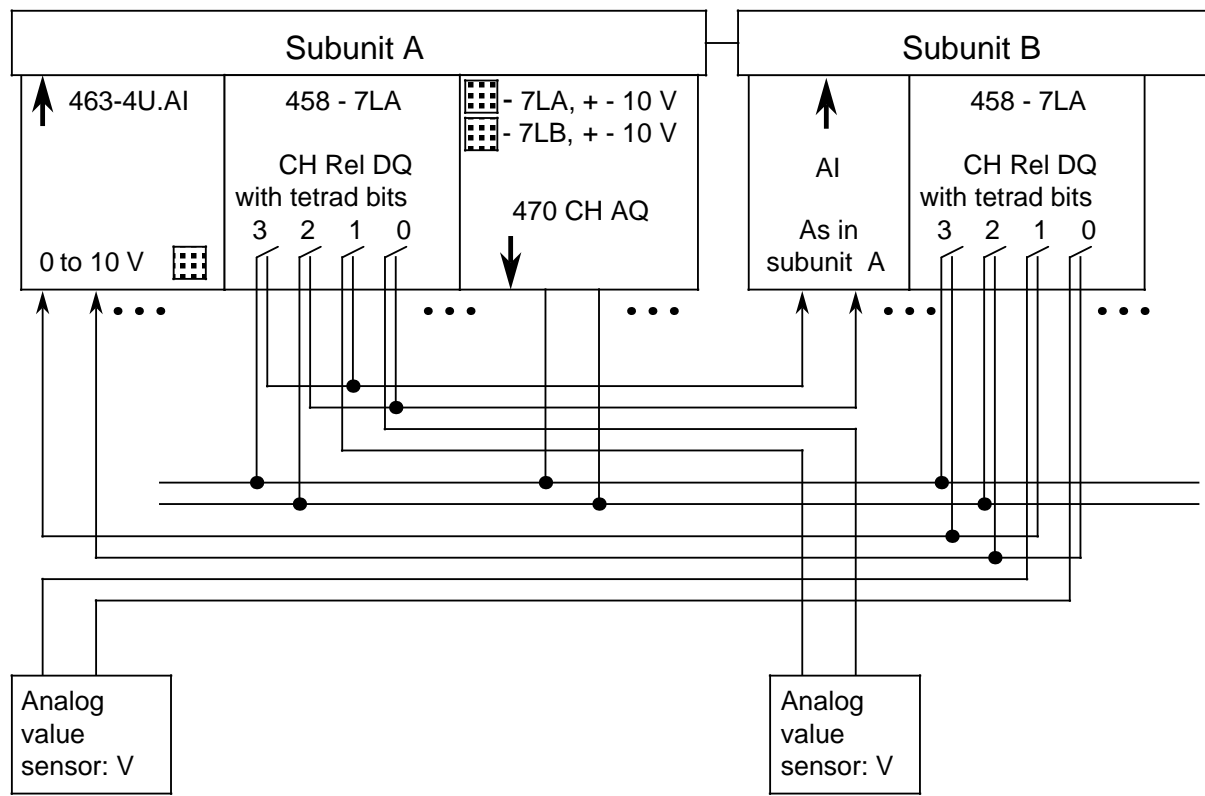
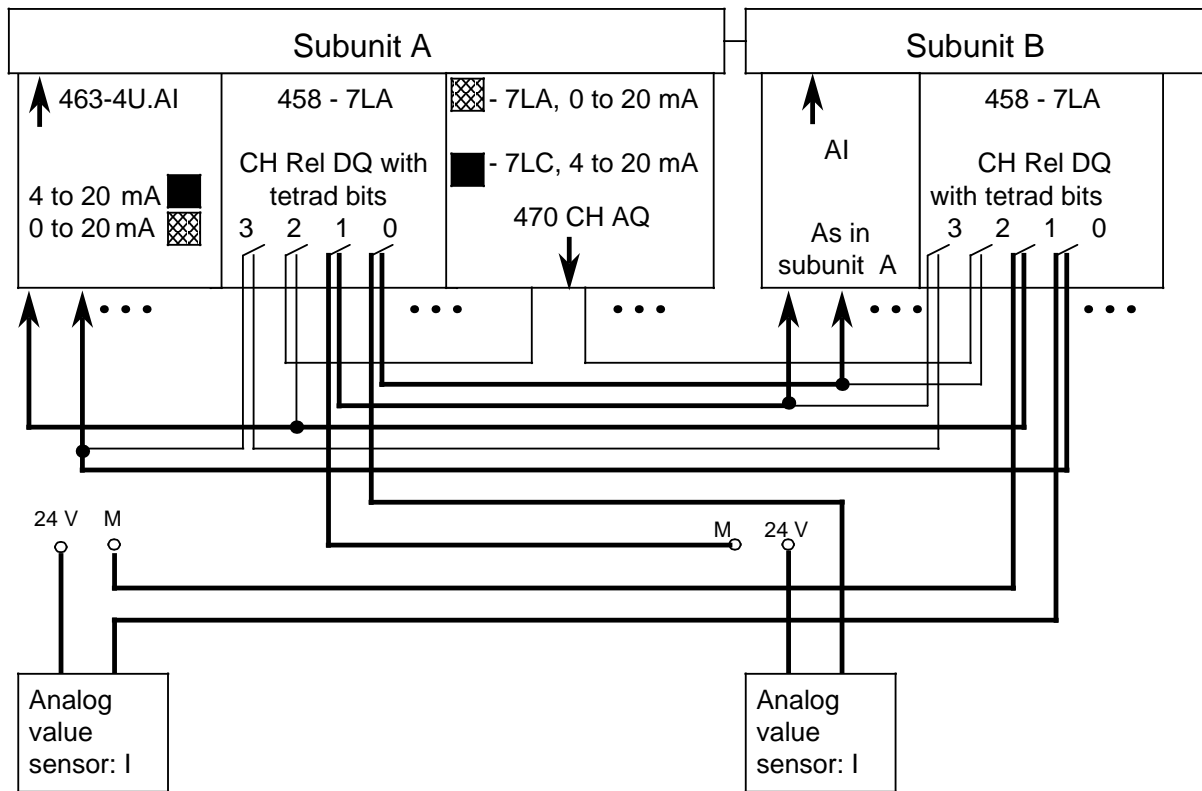


Figure 10-27. Type 15 AI, Safety-Related, Non-Intermittent: Two-Channel Sensor with Voltage Output

Explanation of Figure 10-27

A tetrad of the CH Rel DQ is used for connection. Bits 0 and 1 are used for connecting the sensor and bits 2 and 3 for the 470 check AQ.

In normal sensor operation, the tetrad (controlled by the operating system) has the value 0011.



■ Constellation 4 to 20 mA may only be configured as channel type 4

Figure 10-28. Type 15 AI, Safety-Related, Non-Intermittent: Two-Channel Sensor with Current Output; Two-Wire Transducers

The user of two-wire transducers requires a dedicated power supply (Figure 10-25 for suggested wiring).

Note

Please note that the "short discrepancy time for analog input modules" configured by you with COM 115F is greater than the settling time of your current sensor.

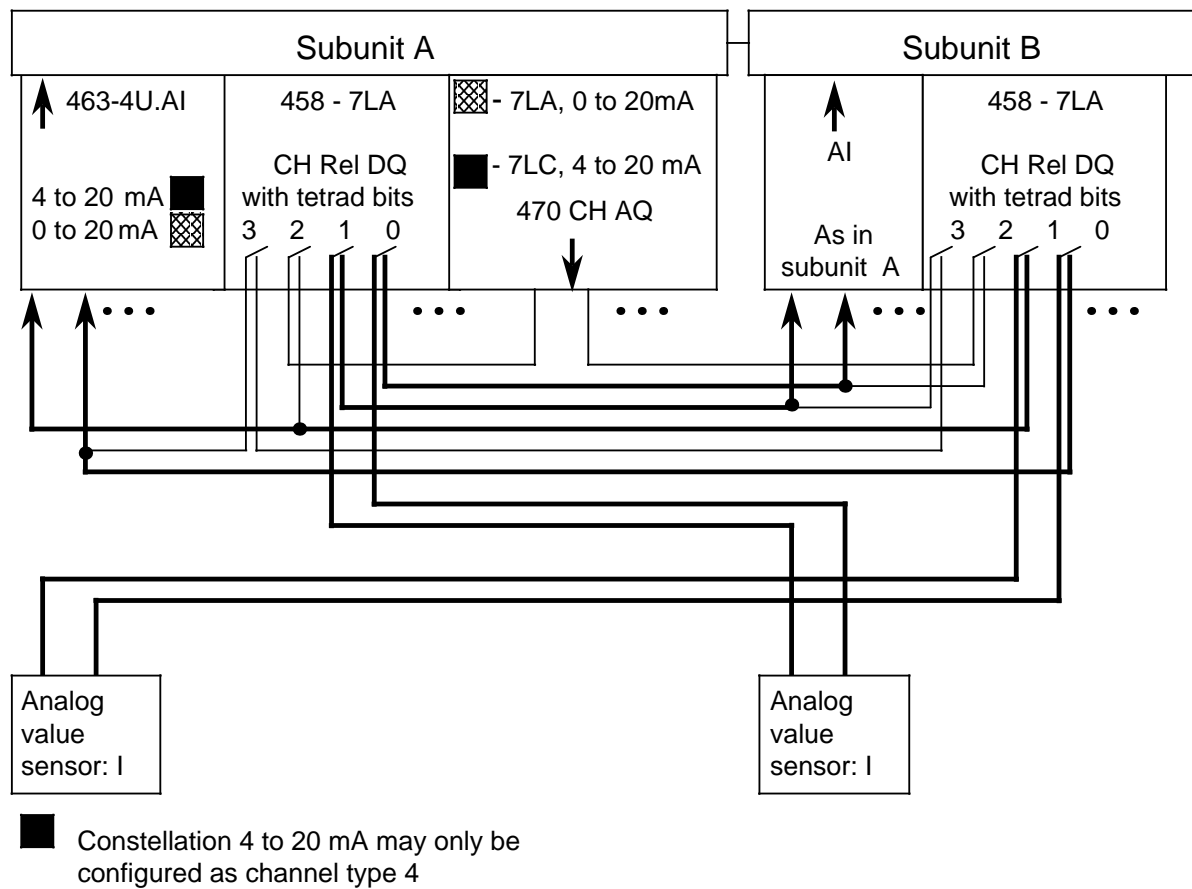


Figure 10-29. Type 15 AI, Safety-Related, Non-Intermittent: Two-Channel Sensor with Current Output; Four-Wire Transducers

Explanation of Figures 10-28 and 10-29

The 470 CH AQ can be connected either to subunit A or B.
 Control of the interposing relay DQ is explained in Figure 10-27.
 Bold type indicates normal sensor operation.

Permissible modules

Module	Characteristics	
463-4U.AI	failsafe	4 channels, each can be set by jumpers 4 to 20 mA (load impedance = 62.5 Ω , V = 250 to 1250 mV) 0 V to +10 V 0 mA to +20 mA
470-7LA AQ	reaction-free	8 channels, ± 10 V or 0 to 20 mA
470-7LB AQ	reaction-free	8 channels, ± 10 V
470-7LC AQ	reaction-free	8 channels, 4 to 20 mA
458-7LA Rel DQ	reaction-free	16 * 24 V/0,5 A, not connected to comm. pot., relay output

10.11.4 Checking Analog Input Modules Using Check Analog Output Modules

The operating system must check non-intermittent analog input modules to establish whether or not they are capable of reading in two configured check values properly. A check AQ module generates these check signals. The AI and check AQ modules must have the same measuring range.

The check AQ module can be connected to either subunit A or B. If you connect several AI modules to one check AQ module, the AI modules must have the same signal group number.

The process limit values from which a safety-related action is to be derived must be defined and configured as check values (Vol. 2, 1.2.3 of the Manual). In the test, the check values are switched to the relevant analog inputs. The values read in must agree with the check values.

Note

You can derive safety-related actions only from these check values.

You require four interposing relays per analog input channel. The relays of a relay DQ module can be used for this purpose.

If you use single-channel sensors, you can connect the check relay DQ module either to subunit A or B.

If you use two-channel sensors, you must connect the interposing relays diagonally to the two subunits.

Note

Analog sensors can be either single-channel or two-channel, but only require one check analog output module.

10.11.5 Type 16 Analog Input Modules

Type 16 analog input modules have the following characteristics:

- Safety-related
- Intermittent input signal
- They are plugged into subunits A and B (two-channel configuration) and must have the same address in both subunits.

Connecting sensors to analog input modules

Single-channel sensors must be permanently failsafe.

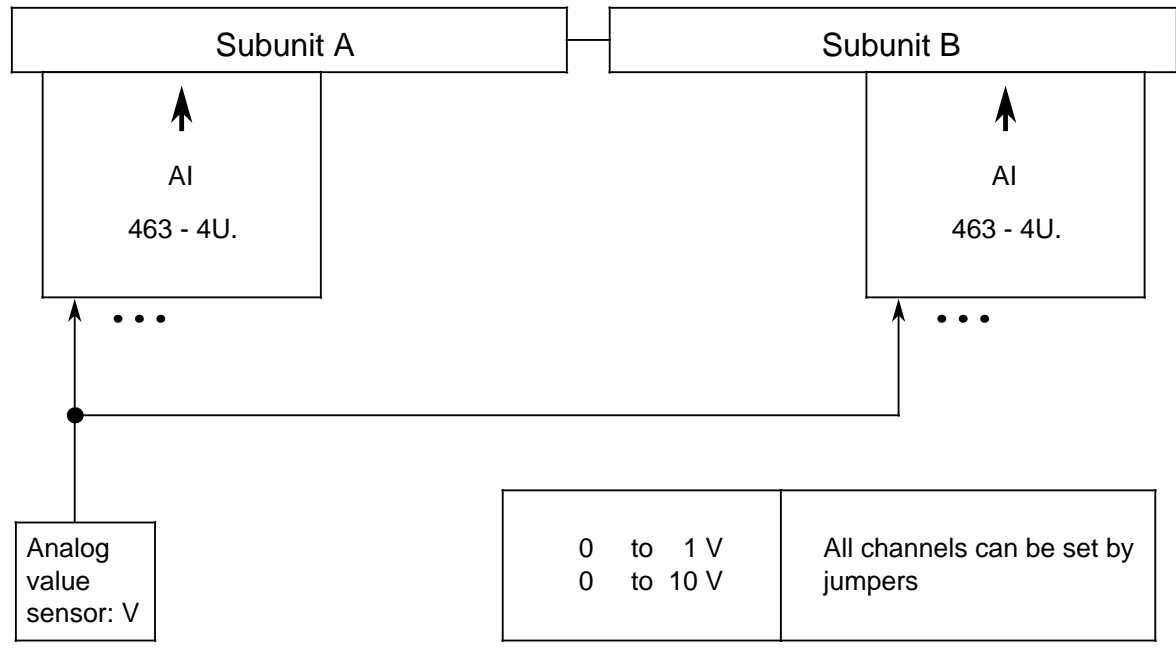


Figure 10-30. Type 16 AI, Safety-Related, Intermittent: Single-Channel Sensor with Voltage Output

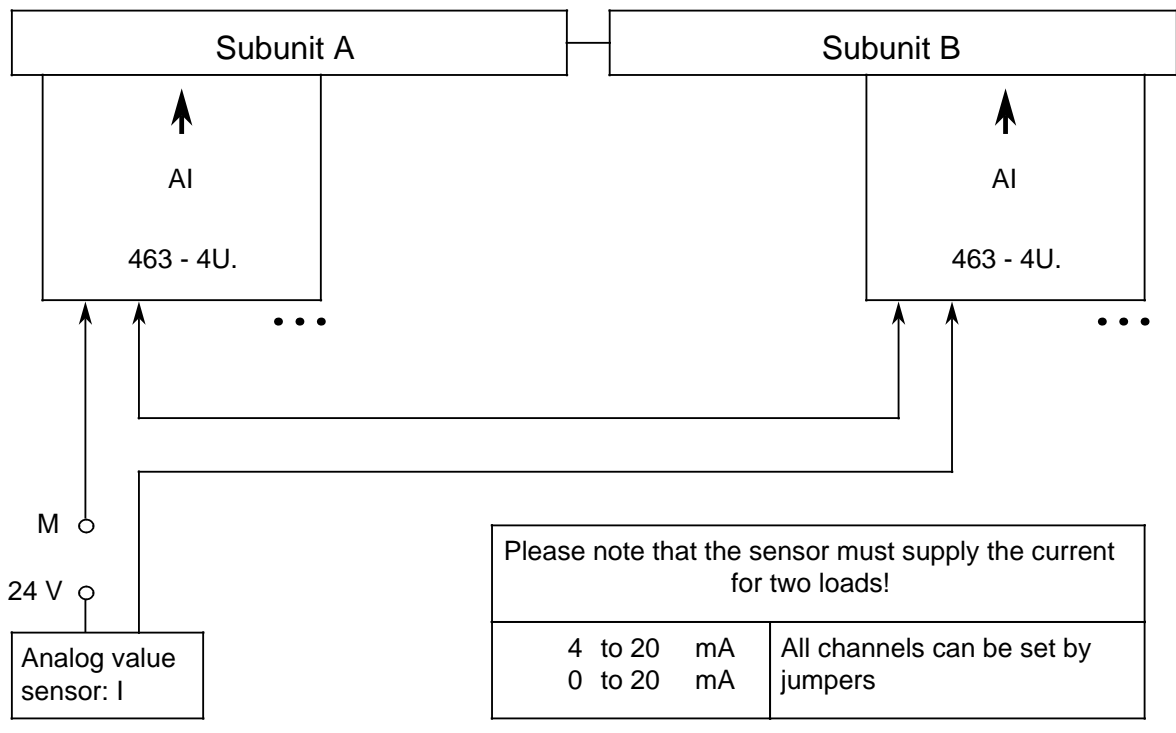


Figure 10-31. Type 16 AI, Safety-Related, Intermittent: Single-Channel with Current Output, Two-Wire Transducers

The use of two-wire transducers requires a dedicated power supply (wiring suggestion Figure 10-25).

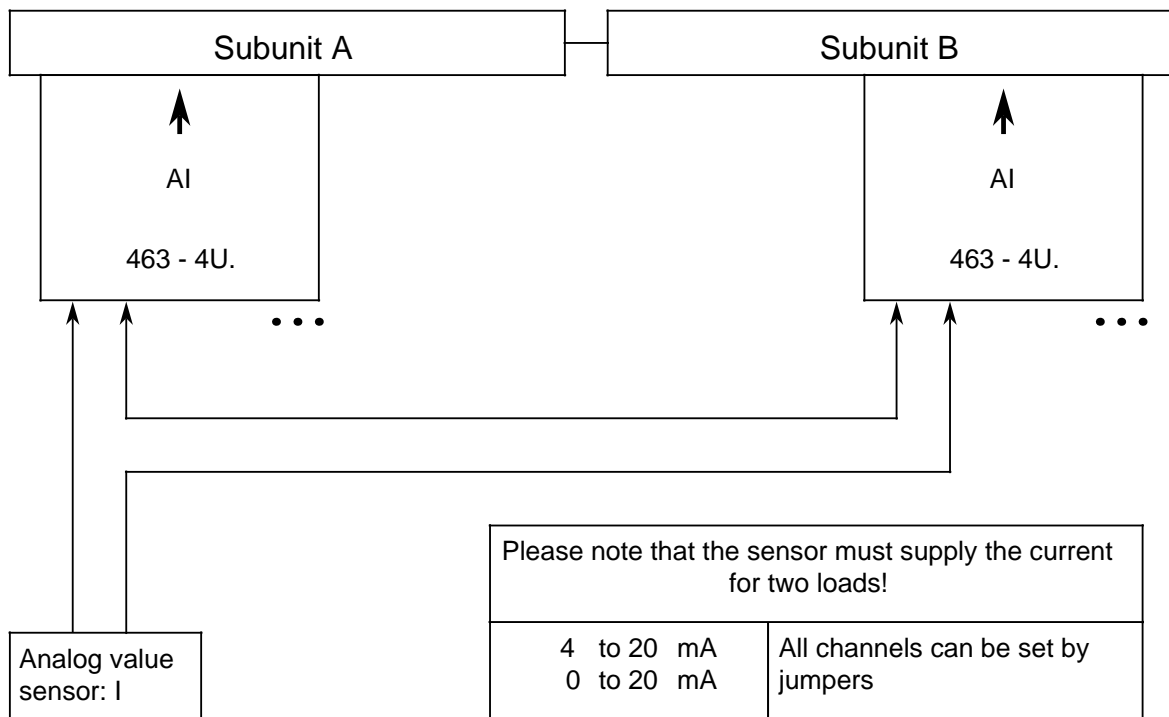


Figure 10-32. Type 16 AI, Safety-Related, Intermittent: Single-Channel Sensor with Current Output; Four-Wire Transducers

Sensors must be two-channel if they are not permanently failsafe.

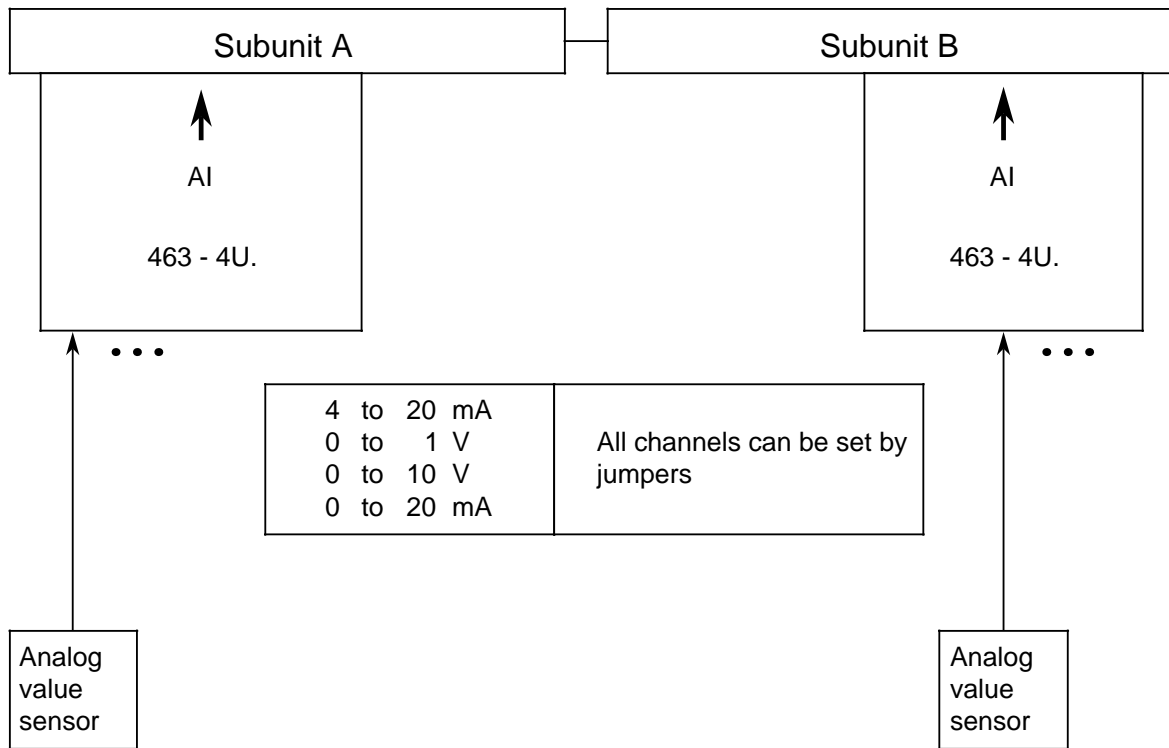


Figure 10-33. Type 16 AI module, Safety-Related, Intermittent: Two-Channel Sensors

Permissible modules

Module	Characteristics	
463-4U.AI	failsafe	4 channels, can be set by jumpers on the front connector: 4 to 20 mA (load impedance = 62.5 , V=250 to 1250 mV) 0 V to +1 V 0 V to +10 V 0 mA to +20 mA

10.12 Analog Output Modules

When configuring the I/O modules (Vol. 2 of the Manual), define I/O type 18 for each AQ word.

10.12.1 Type 18 Analog Output Modules

Type 18 analog output modules have the following characteristics:

- Nonsafety-related
- They are plugged into either in subunit A or B (single-channel configuration).
- They can be plugged into both subunits in any mix.
- The module address must only be set in the subunit containing the AQ module. This address cannot be used in the other subunit.

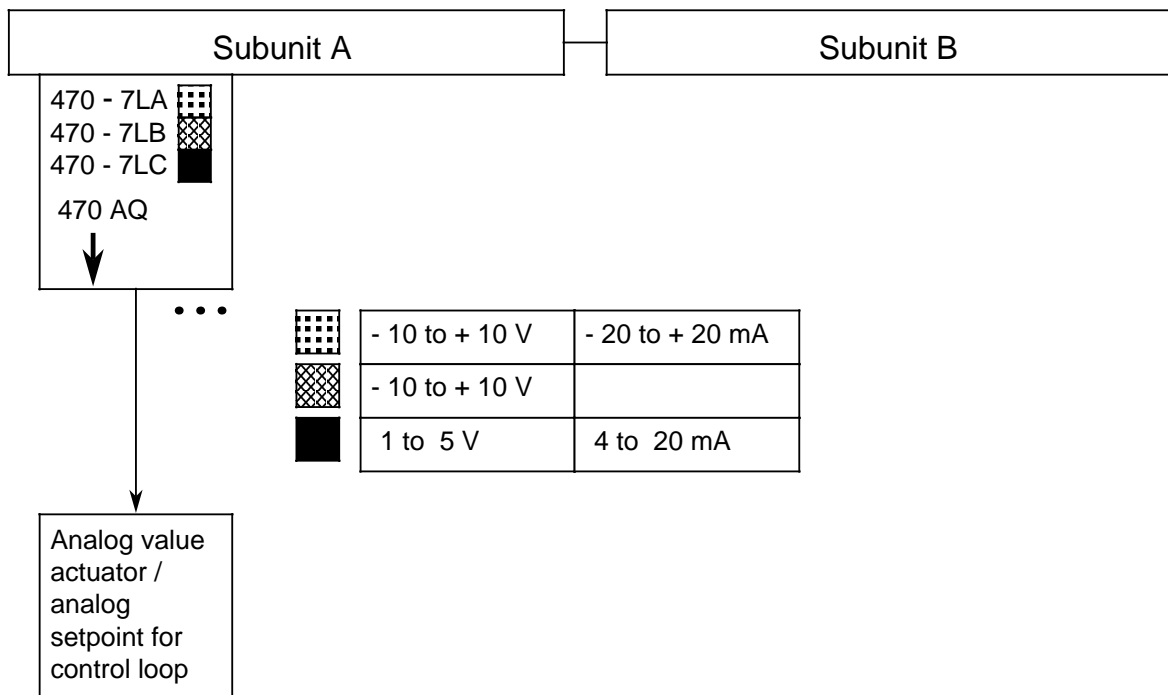


Figure 10-34. Type 18 Analog Output Module, Nonsafety-Related, Single-Channel

Permissible modules

Module	Characteristics	
470-7LA AQ	reaction-free	8 channels, ± 10 V or 0 to 20 mA
470-7LB AQ	reaction-free	8 channels, ±10 V
470-7LC AQ	reaction-free	8 channels, 1 to 5 V or 4 to 20 mA

10.13 I/O Type Assignment of Unused Digital Words

32-bit DI/DQ modules require two I/O words. You must define the I/O type for each I/O word. This must also be done for an I/O word even if you do not use the relevant bits. Assign the unused I/O words to the simplest I/O type.

Table 10-6. Typical I/O Type Assignments of Unused I/O Words of 32-Channel DI/DQ Modules

Module	Used as	I/O type of the free word
DI 430	Type 1 I/O	Type 1 I/O
DI 430	Type 2 I/O	Type 2 I/O
DI 430	Type 3 I/O	Type 3 I/O
DQ 451	Type 8 I/O	Type 8 I/O
DQ 451	CH DQ for type 3 I/O	Type 8 I/O

10.14 I/O Type Assignment of Unused Analog Channels

You must assign an I/O type to each channel of an AI/AQ module. Assign the simplest I/O type to the unused channels.

Table 10-7. Typical I/O Type Assignments of Unused Channels of AI/AQs

Module	Used as	I/O type of the free channel
AI 460	Type 13 I/O	Type 13 I/O
AI 463	Type 13 I/O	Type 13 I/O
AI 463	Type 14 I/O	Type 16 I/O
AI 463	Type 15 I/O	Type 16 I/O
AI 463	Type 16 I/O	Type 16 I/O
AQ 470	Type 18 I/O	Type 18 I/O

Note

The current or voltage inputs of unused AI channels must be short-circuited.

10.15 I/O Type Mixes

Do not mix safety-related and nonsafety-related I/O types within one I/O module.

The following table shows permissible I/O type mixes.

Table 10-8. I/O Type Mixes

The following modules can be mixed ¹			
CH Rel DQ for Type 14	CH Rel DQ for Type 15	DQ Type 8	2
AI Type 14	AI Type 15	AI Type 16	3
CH AQs for AI Type 14	CH AQs for AI Type 15	AQ Type 18	3

- 1 All I/O types in one line can be mixed.
- 2 DI/DQ type mixes are permissible on a 32-bit module if the different DI/DQ types belong to different DI/DQ words. DI/DQ type mixes within one DI/DQ word are usually illegal with the exception of the cases described here.
- 3 You can allocate several I/O types to one analog module.

10.16 Module Addressing

10.16.1 Relationship Between Byte and Word Addressing

A byte is eight bits long, the bits being identified from right to left by bit addresses 0 to 7. You can assign byte addresses to the following:

- Digital inputs from 0 to 127
- Digital outputs from 0 to 125
- Flags* from 0 to 255

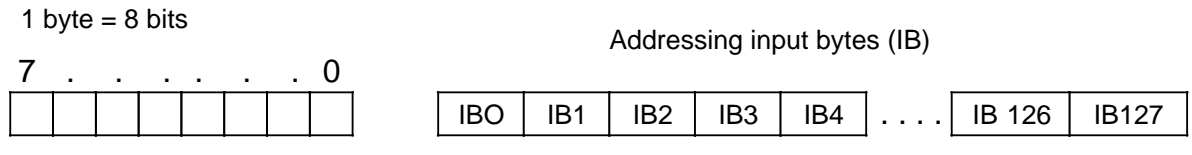


Figure 10-35. Byte-Oriented Addressing (Inputs, Outputs)

* FW 0 is reserved for the logical program counter.
 FW 2 to FW 198 (F 2.0 to F 199.7) are permissible in the user program.
 FW 200 to FW 254 (F 200.0 to F 255.7) can only be used if you are not using any standard FBs.

The word is the next largest unit after the byte. It is 16 bits long. Two bytes constitute one word. Inputs (I), outputs (Q) and flags (F).

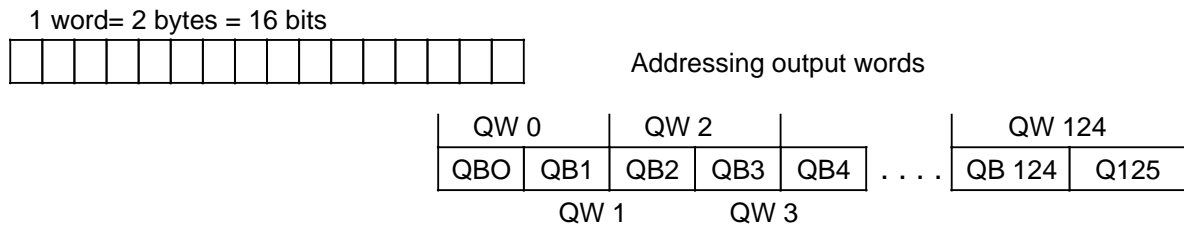


Figure 10-36. Word-Oriented Addressing (Inputs, Outputs, Flags)

Note

Use only even numbers in word-oriented addressing. This avoids overlaps (e.g. QW 2 and QW 3 both contain QB 3).

10.16.2 Address Grid

I/O module addressing is geared to word addresses. The odd byte address corresponds to the right half of the word (low-order byte). The even byte address corresponds to the left half of the word (high-order byte).

Fixed Slot Addressing

If you operate the central controller without expansion racks, you can do without the IM 306 interface for variable slot addressing. You must then use the termination connector supplied instead of the IM 306. This assigns fixed addresses to slots 0 to 5.

Slot	Initial module address	
	Digital module	Analog module
0	0	128
1	4	160
2	8	192
3	12	224
4	16	-
5	20	-

Note

If you are using single-channel I/Os, the assigned address must *not* be used in the second subunit.

Variable Addressing

The S5-115F allows you to assign an address to every slot. This is possible if an IM 306 interface module is plugged into the central controller and each expansion unit. Whether the module is plugged into the CC or an EU is irrelevant as far as addressing is concerned. There is a flap covering the address field on the right-hand side of the interface module. On the address field, there is a DIP switch for each slot for setting the lowest byte number of a given slot.

Note

Input modules and output modules can be assigned the same address.

Address setting on the IM 306

Use switch (Figure 10-38) to set the number of inputs and outputs of the module plugged into this slot. ¹

Switch in OFF position: 32-bit digital or 16-channel analog module.

Switch in ON position: 16-bit digital or 8-channel analog module.

Use the seven address switches to set the lowest address (the address for channel "0") on a particular module. This sets the addresses of the other channels of this module in ascending order.

Please note the following when setting the initial addresses:

- 32-bit digital modules can only be assigned initial addresses whose byte number can be divided by 4 (e.g. 0, 4, 8, etc.).
- 16-bit digital modules may only be assigned initial addresses whose byte number can be divided by 2 (e.g. 0, 2, 4, etc.).
- 8-bit DI/DQs are addressed with the even byte address.
- 16-channel analog modules may only be assigned the initial addresses 128, 160, 192 and 224.
- 8-channel analog modules may only be assigned the initial addresses 128, 144, 160 to 240.

Example

A 16-bit digital input module is plugged into slot 2. To assign it the initial address 46.0, proceed as follows:

- Check whether the byte number of the desired initial address can be divided exactly by 2, since you are dealing with a 16-channel digital module.
 $46 : 2 = 23 \text{ Remainder } 0$
- Set the number of input channels (switch at ON).
- Take the address switch setting from Figure 10.38 and set it on the DIP switch with slot number 2.

¹ The digital input/output module (6ES5 482-7LA11) is handled like the 16-channel modules.

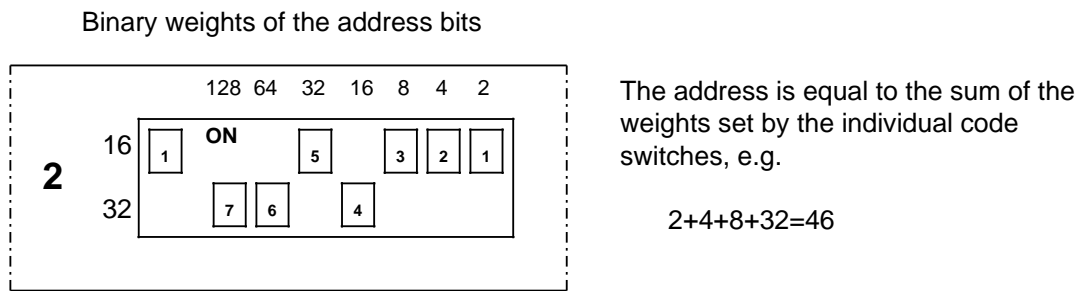


Figure 10-37. Setting a DIP Switch

The module is then addressed as follows:

Channel No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Address	46.0	46.1	46.2	46.3	46.4	46.5	46.6	46.7	47.0	47.1	47.2	47.3	47.4	47.5	47.6	47.7

Note

COM 115F CONFIGURE checks the inputs for duplication of addresses, but it does not check for module address overlap or initial addresses. It can therefore happen that the address named in the user program does not agree with the address actually accessed.

The user must therefore make sure that the address grid and the initial addresses are set correctly for all modules.

For this reason, check the settings on the IM 306, AI 463 and CP 523 modules.

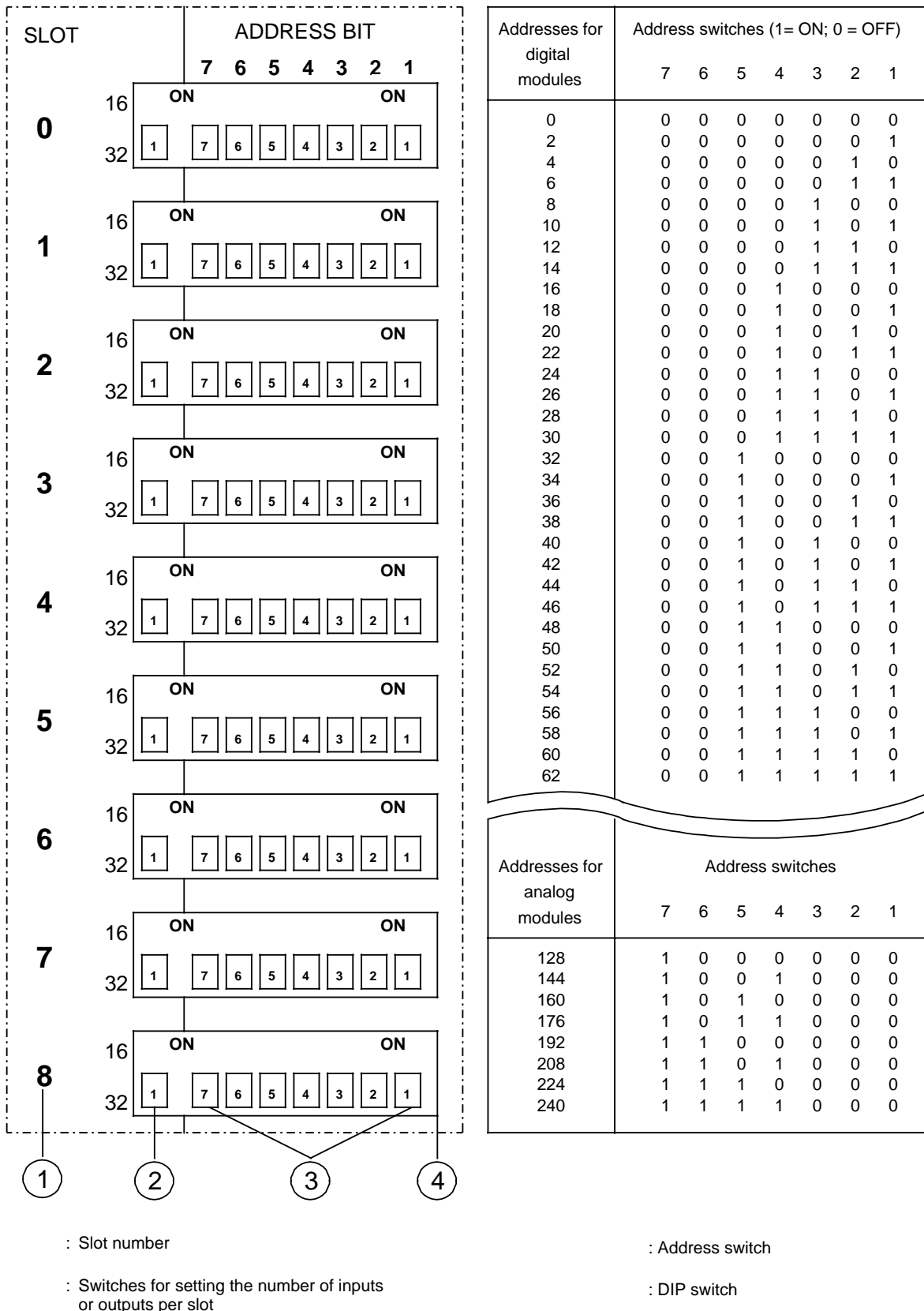


Figure 10-38. Setting the Addresses in the Address Field of the IM 306 Interface Module

10.17 Responding to I/O Module Errors

To increase the availability of the S5-115F, the operating system does not necessarily respond to I/O module errors with PLC STOP. The user can define system response to I/O errors himself. There are four I/O error tolerance variants (I/O ETVs) available for this purpose:

- I/O ETV 1 All I/O module errors result in PLC STOP
- I/O ETV 2 Possibility of shutting down technologically-related modules via the operating system
- I/O ETV 3 and I/O ETV 4 Possibility of initiating responses to I/O errors via the user program.

Signal group numbers are used to further differentiate between I/O errors. You can assign technologically-related modules to a signal group with a programmable signal group number.

You adapt the system response of the S5-115F to your process as follows:

- Define an I/O error tolerance variant for the overall system and
- Assign different signal groups when configuring the safety-related I/O modules. The signal numbers must lie within the range 0 to 28.

Table 10-9. Meaning of the Signal Group Numbers in the Case of Error Tolerance Variants 1 to 4

I/O Error Tolerance Variant	Signal Group Number	Response to I/O Error	
1	Not required	PLC STOP	
2	0	PLC STOP	
	1	Individual passivation	
		8-bit, 16-bit DI /DQ	Passivation of the module
		32-bit DI	Passivation of a word (16 bit)
		AI/AQ	Passivation of a channel
	2 to 28	(Group) passivation	
All modules of a given signal group are passivated.			
3	0	PLC STOP	
	1	Individual passivation (see I/O ETV 2 signal group 1)	
	2 to 27	(Group) passivation (see I/O ETV 2 signal group 2 to 28)	
	28	Error message from the operating system and safety response from the user program and organizational measures (e.g. supervised operation) Standard values in the case of discrepant two-channel digital signals are generated by ORing the two signals. In the case of a discrepancy of two analog input modules, the passivation value specified in FB 250 is taken.	

Table 10-9. Meaning of the Signal Group Numbers in the Case of Error Tolerance Variants 1 to 4 (Continued)

I/O Error Tolerance Variant	Signal Group Number	Response to I/O Error
4	0	PLC STOP
	1	Individual passivation
	2 to 26	(Group) passivation
	27	Error message from the operating system and safety response from the user program and organizational measures (e.g. supervised operation) Standard values in the case of discrepant two-channel digital signals are generated by ANDing the two signals. In the case of a discrepancy of two analog input modules, the passivation value specified in FB 250 is taken.
	28	Error message from the operating system and safety response from the user program and organizational measures (e.g. supervised operation) Standard values in the case of discrepant two-channel digital signals are generated by ORing the two signals. In the case of a discrepancy of two analog input modules, the passivation value specified in FB 250 is taken.

You adapt the S5-115F system response to your process by taking the following measures

- Define an I/O error tolerance variant for the whole system
- Assign different signal groups when configuring safety-related I/O modules.

Note

The operating system does **not** monitor the intervals between I/O errors and the second error occurrence time.

- Please note the following in the case of I/O ETV 2 with signal group no. 2 to 28, I/O ETV 3 with signal group no. 2 to 27 and I/O ETV 4 with signal group no. 2 to 26:
All I/O modules of the relevant signal group are passivated in the relevant signal group when an I/O error is detected. The first erroneous bit of the I/O word is entered in the error stack of the error DB.
- Please note the following in the case of I/O ETV 3 with signal group no. 28 and I/O ETV 4 with signal group no. 27 and 28:
The I/O modules are **not passivated** when an I/O error is detected. The first erroneous bit of the I/O word is simply entered in the error stack of the error DB.
The error response must be initiated by the user control program.
- If more than sixteen I/O errors with different addresses are entered in the error stack when using I/O ETV 3 and 4, the system responds with a PLC STOP due to accumulated errors.

10.17.1 Passivation of I/O Modules

The system response to an I/O error must not necessarily result in PLC STOP.

If your automated process consists of several independent subprocesses, the following is possible over the operating system:

- Passivation of the relevant I/O word (individual passivation via signal group 1)
- Passivation of the I/O modules belonging to one signal group (group passivation)

Passivation of I/O modules means software shutdown and power shutdown of I/O modules. Only I/O modules in autonomous and in self-contained subprocesses can be passivated.

Every signal group passivated by the operating system is entered in block 0 of the error DB. You can evaluate this entry in your control program and respond accordingly.

Passivation results in the following:

- In the case of DI modules without interrupt capability: Deletion of the PII section of the relevant DI module
- In the case of DI modules with interrupt capability: Deletion of the status and interrupt registers. OB 2 ceases to be processed.
- In the case of DQ modules: Deletion of the DQ and the PIQ section of the relevant DQ.
- In the case of AI modules: When 250 ANEI is called, the programmed passivation value is output as a result (Vol. 2, 6.1 of the Manual)

When an I/O module is passivated, the relevant R (readback) or CH (check) module is simultaneously passivated. You must note this in the case of an I/O mix on an I/O module.

Analog output modules are not passivated since they are not safety-related.

Table 10-10. Passivating I/O Modules

Passivated module	DI	DQ	AI
Relevant passivated module	CH DQ	R DI	CH AQ



Important

The following are not permissible:

- Analog input modules of different signal groups on one CH AQ channel.
- Several analog input modules with signal group 1 (individual passivation) on one CH AQ channel.

Please note in the case of individual passivation

- Individual passivation without loss of module bit capacity is only possible with 8-bit and 16-bit digital I/O modules.
- You can use only one channel in the case of a CH AQ module.

10.17.2 Revoking Passivation of I/O Modules

Sensors and actuators are frequently the cause of passivation of I/O modules. If you can remove the fault in PLC RUN, FB 255 allows you to revoke passivation; the depassivated I/O module is then referenced anew by the CPU.

You may call the FB 255 only in the cyclic program part (OB1). Calling the FB 255 in time-driven or interrupt-controlled program parts is prohibited.

You must specify the following when initializing FB 255:

- A bit which initiates depassivation in the case of an edge change from 0 to 1.
- Data in KF format with the signal group for the I/O module to be depassivated
- A byte for FB 255 messages

Depassivation should always be initiated for one signal group only. For this reason, assign a separate depassivation bit to each signal group.

Note

Before you reactivate the I/O modules of a signal group with FB 255, your control program must branch to a routine in which you can check, evaluate and, if necessary, update all the variables required for switching, or re-initialize the process variables.

Calling and initializing

Parameter	Meaning			Assignment	STL
SIGR	Signal group	D	KF	2 to 28	: JU FB 255 Name : AGF:DEPA
DEPA	Depassivation bit (positive edge)	I	BI	I0.0 to I27.7 F2.0 to F99.7 Q0.0 to Q25.7	: SIGR : DEPA : PAFE
PAFE	Signal byte	Q	BI	00 _H = Depassivation successful 11 _H = Signal group has not been configured or passivated 21 _H = Signal group can no longer be passivated (error no longer in error DB) 31 _H = Depassivation has not been tested 41 _H = Erroneous passivation of FB 255 51 _H = No signal group has been passivated D0 _H = Depassivation currently being executed	

If you call FB 255 conditionally (e.g. JC FB 255), the enable for the conditional jump must **not** be the bit that you want to assign to the DEPA parameter.

Increases in PLC scan time

If you call FB 255 DEPA, the PLC scan time increases as follows:

- 110 ms, if a digital input of I/O type 3 was the cause of passivation,
- 140 ms, if a digital input of I/O type 10 was the cause of passivation
- 30 ms, if an analog input of I/O type 14 or 15 was the cause of passivation.

Interrupt processing

If you have configured an interrupt response time of less than 30 ms when initializing the operating system with COM 115F, the interrupt response will increase to 30 ms during processing of FB 255 DEPA.

For safety reasons, you must switch off the load voltage of the I/O modules before expiry of the second error occurrence time. You can avoid having to switch off here if you depassivate the I/O modules before expiry of the second error occurrence time.

Example: Depassivation of I/O modules

A boiler is heated by four burners. The burners work independently of each other so that each burner control constitutes an autonomous subprocess. Signal groups 11 to 14 are assigned for the I/O modules of these subprocesses.

The entire control is monitored by a pre-interlock. Since the pre-interlock applies to all four burners and is of primary safety significance, signal group 0 is assigned to the I/O modules.

<p>Pre-Interlock of Burner Control I/O modules for pre-interlock with signal group 0</p>			
<p>Burner 1 I/O modules with signal group 11</p>	<p>Burner 2 I/O modules with signal group 12</p>	<p>Burner 3 I/O modules with signal group 13</p>	<p>Burner 4 I/O modules with signal group 14</p>

Figure 10-39. Dividing the I/O Modules into Signal Groups

Example:

Structure of the control program

The control program is structured so that when a signal group is passivated, the relevant program section is no longer processed (Figure 10-40).

Please note that the I/O modules of one signal group can only be de-passivated after safe switch on of the control program has been confirmed.

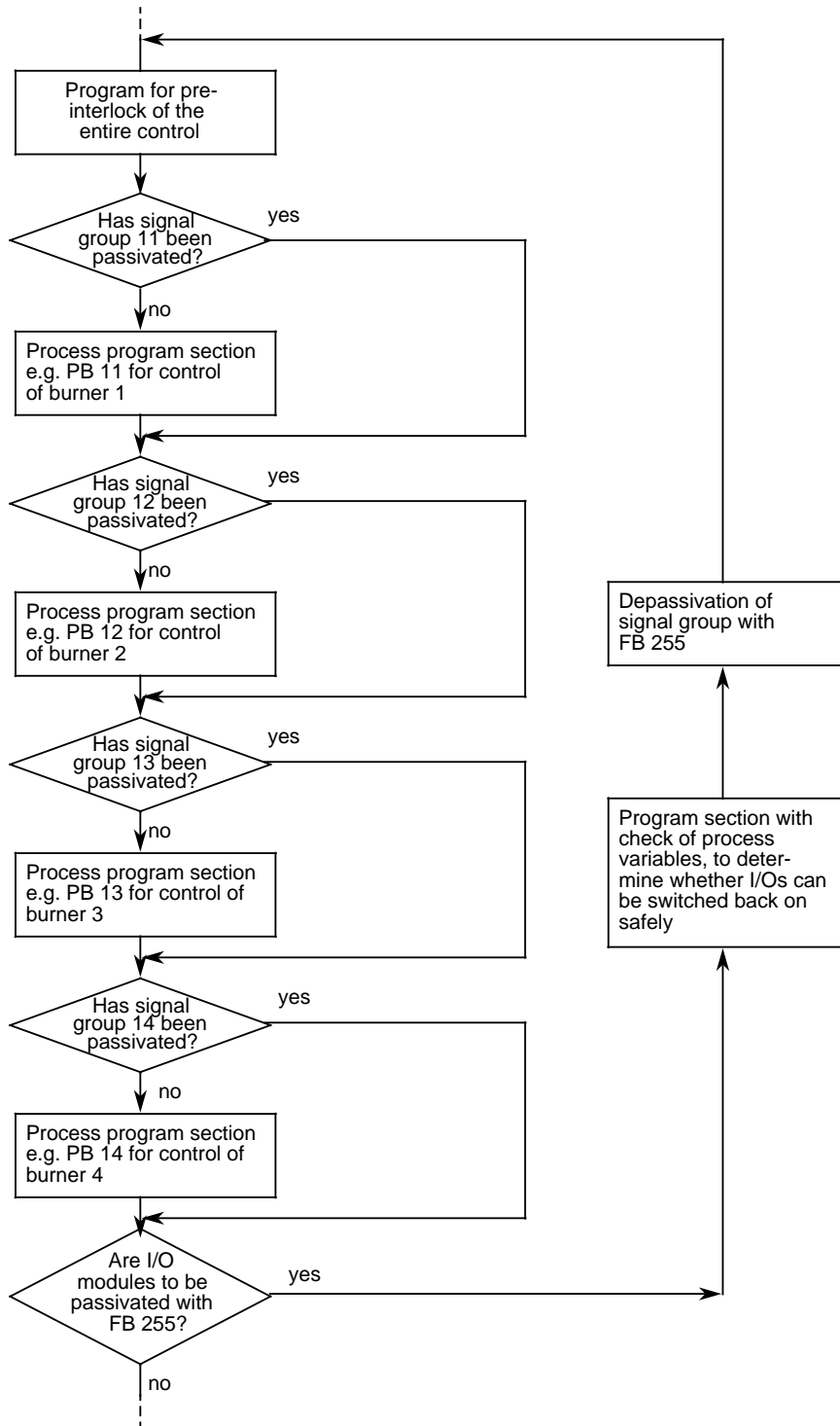


Figure 10-40. Schematic of a Structured Program Sequence

10.17.3 Operating System and User Program Response in the Case of I/O ETV*3 and 4

While I/O ETVs 1 and 2 end the error response with PLC STOP or passivation of I/Os, you receive only the relevant error message when you select

- I/O ETV 3 with signal group 28 and
- I/O ETV 4 with signal group 27 or 28.

The error response is left to the user program. It evaluates the error messages and initiates all safety responses, such as safe shutdown.

- **Error analysis**

Error analysis is carried out in the same way as for I/O ETVs 1 and 2. Analysis is continued after an I/O error is discovered until the error is corrected. This results in the PLC cycle being loaded with the discrepancy time because of cyclic comparison.

- **Error message**

Every error detected with a different address is entered in the error stack of the error DB. If a SINEC L1 LAN is available, the error DB body is transferred to the SINEC L1 master. The error is sent to the CP 523, provided one has been configured as a message module for printing COM 115F error messages.

Up to 16 errors are entered in the error stack. The 17th error message results in PLC STOP due to the central safety significance in the case of I/O ETV 3 and 4.

- **Standard value generation**

The standard value is generated

- After error detection in cyclic image comparison
 - In the case of I/O ETV 4 with signal group 27, the standard value is generated by
- ANDing the nonmatching DI or R DI signals
 - In the case of I/O ETV 3 or 4 with signal group 28 the standard value is generated by
- ORing the nonmatching DI or RB DI signals
- In the case of discrepancy when accessing a non-interrupt DI direct, it can be the case that the value cannot be read since a test is taking place. In such a case, the nonmatching DI bits are read from the DI byte stored before the test.
- No standard value is generated in the case of an AI comparison error. The passivation value configured in FB 250 is used here (as in the case of I/O ETV 2).

* I/O ETV = I/O Error Tolerance Variant

- Safety requirements to be met by the user program

If you want to prevent processes being shut down immediately after the occurrence of the first I/O error, always use

- I/O ETV 3 with signal group 28
- I/O ETV 4 with signal group 27 or 28

The responses to these I/O errors are usually individual in nature and must be adapted to the process. For this reason, error response cannot be implemented from the operating system. Error response must be initiated and monitored from the user program.

Note

When using I/O ETV 3 with signal group 28 or I/O ETV 4 with signal group 27 or 28, responsibility for the response rests solely with the operator.

The user program can make two different safety responses to I/O errors:

The process is switched off for a short time when the first I/O error occurs. Operating personnel are informed (e.g. by a bleeper) and the system waits for acknowledgement.

After acknowledgement, the process is resumed by qualified personnel in the "Supervised operation" mode.

Proof is required here that the process can be resumed by qualified personnel under these conditions until it reaches a point at which it can be meaningfully shut down.

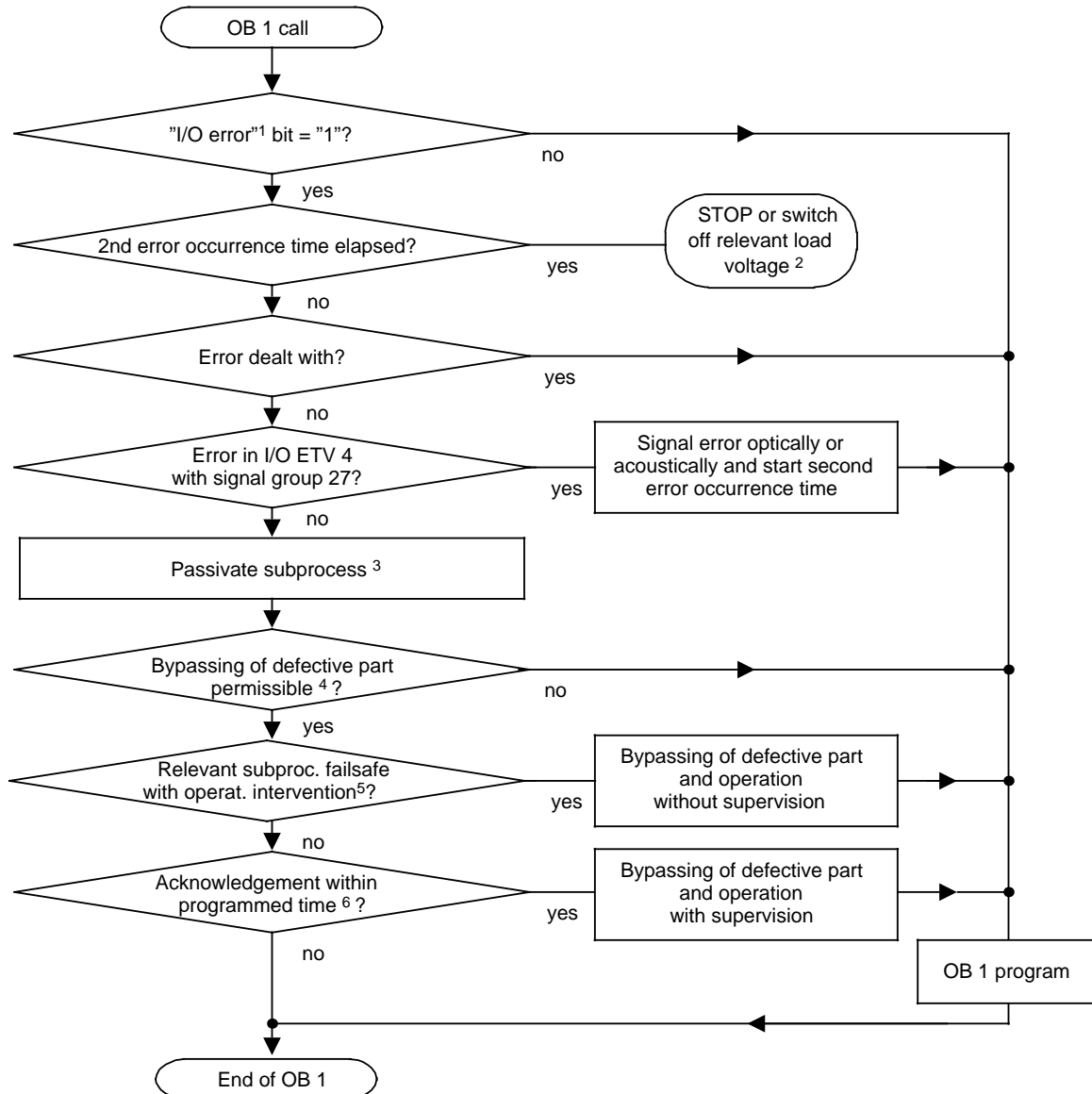
The user program is responsible for switching off the process no later than the end of the second error occurrence time.

The process is not yet switched off on occurrence of the first I/O error. The user program ensures that the process is shut down in a safe state (failsafe), i.e. a second I/O error must not be allowed to give rise to a dangerous situation.

The following flowchart for the control program is an additional aid when using

- I/O ETV 3 with signal group 28
- I/O ETV 4 with signal group 27 or 28.

The term "subprocess" is used in the flowchart. Subprocess is here taken to mean part of the automated system distinguished by its function and including the relevant S5-115F hardware and software.



1 "I/O error" bit = bit 4 of the error detection byte (1st byte in the error DB)

2 The S5-115F stops or the user makes sure that the relevant part of signal group 27 or 28 is shut down.

3 Set all outputs and inputs of the subprocess to 0 and start the monitoring time with the second error occurrence time.

4 Error in an I/O word which can also be operated in single-channel configuration as a safety-related word (requires permit)

Examples:

Safety-related, single-channel operation permissible in the case of DQ for cable car main motor in the "Slow" position and under "Operation with supervision"

Safety-related, single-channel operation not permissible in the case of DI for emergency STOP

5 Failsafe with operator intervention means: safe operator response is guaranteed even if the 2nd channel becomes defective (proof required)

6 Time less than second error occurrence time (if no STOP response)

Figure 10-41. Flowchart for I/O Error Tolerance Variant 3 (I/O ETV 3) and 4 (I/O ETV 4) with Signal Group Nos. 27 and 28

10.17.4 Repair Procedure

All passivated output modules must be switched off within the second error occurrence time. The I/O errors can then be corrected in the off state. You can switch the repaired modules on again at any time. To do so, you must delete the passivation information:

- Test mode: POWER OFF - POWER ON
- Safety mode: OVERALL PLC RESET



Important

Overall Reset is a safety-related action because it also deletes the error information in the error DBs.

For this reason, an Overall Reset may only be executed after all defective components have been repaired and is the sole responsibility of the operator!

10.18 Handling the Programmer

The S5-115F has special requirements regarding the connection and operation of the programmer.

10.18.1 Connecting the Programmer

How to connect the programmer depends on whether you are operating a SINEC L1 LAN. The programmer must be connected to subunit A.

If you implement a two-channel SINEC L1 LAN, the SINEC L1 LAN A must be used as the programmer bus. In this case, the programmer must be connected to the CP 530. LAN channel redundancy does not apply as long as channel A is used as the programmer bus. This has no negative effect on the system as long as channel B is intact.

Table 10-11. Connecting the Programmer and SINEC L1

SINEC L1 Operation	PG Connection	SINEC L1 Connection
No	Subunit A	-
Single-channel	Subunit A	CP 530 for subunit B
Two-channel	CP 530 which supplies subunit A	Subunit A and CP 530 for subunit B

10.18.2 Operator Entry in the Programmer in Safety Mode

The table below gives an overview of the programmer functions for the CPU 942-7UF15.

Note that it is not possible to key data into the programmer in safety mode when the PLC is set to RUN. When the PLC is set to STOP, data can be keyed in using the Parameter Entry DB.

If you need to key in data on the programmer in safety mode when the PLC is set to STOP, to change a recipe, for example, you must:

- Configure the parameter entry DB for receiving input data from the programmer with COM 115F
- Write a filter program
The filter program must be capable of checking the validity of the data entered. For example, binary data is not acceptable.
The filter program must be processed by the S5-115F in OB 21 and/or OB 22.

Table 10-12. Overview of the Programmer Operator Functions

PG --- PLC Operator functions Bold type: Operator entry function in the S5-115F	Test mode			Safety mode		
	Large STOP loop	Lesser STOP loop	RUN	Large STOP loop	Lesser STOP loop	RUN
1. Input DB, FB, PB, OB, SB	X	-	-	Only Param. entry DB	-	-
2. Display (with correction) DB, FB, PB, OB, SB	X	-	Without correction	Without correction	-	Without correction
3. Compare DB, FB, PB, OB, SB	X	-	X	X	-	X
4. Transfer to PLC DB, FB, PB, OB, SB	X	-	-	Only Param. entry DB	-	-
5. Transfer from PLC DB, FB, PB, OB, SB	X	-	X	X	-	X
6. Removal of blocks	X	-	-	-	-	-
7. Start PLC	X	-	-	-	-	-
8. Stop PLC	-	-	X	-	-	-
9. Directory Display	X	-	X	X	-	X
10. Memory Configuration Display	X	X	X	X	X	X
11. Display ISTACK/BSTACK	X	-	-	X	-	-
12. Display SYSPAR	X	X	X	X	X	-
13. Display ADR (memory location) with input¹	X	Without correction	X ²	Without correction	Without correction	-
14. FORCE (outputs only)	X	-	-	-	-	-
15. FORCE VAR (I,Q, F, T, C, D)	X	-	X	Without correction ²	-	Without correction
16. STATUS (FY,PB,OB,SB) with correction	X	-	Without correction	-	-	Without correction
17. STATUS VAR (I, Q, F, T, C, D)	X	-	X	-	-	X

1 The entry under address EA0C_H with a length of two bytes only affects bit 2⁷ of byte EA0C_H.

2 The display "ADR" can last up to 200 ms. This can result in OB 13 not being able to properly service time interrupts of less than 200 ms.

Note

If the validity of your input data cannot be checked, you cannot make operator entries with the programmer.

Filter program for parameter entry DB**Note**

The filter program for the parameter entry DB must be approved by the inspector.

10.19 SINEC L1 LAN

Note the following points when operating a SINEC L1 LAN:

- The SINEC L1 master may be any PLC of the U range.
- The SINEC L1 master must have no interrupt list.
- The SINEC L1 master may not initiate safety-related actions (e.g. START/STOP of a slave).
- A description of the data flow via the SINEC L1 LAN must be provided for the individual acceptance test. The test is made easier if I/O signals, for example, are not transmitted along several consecutive SINEC paths.
- When transmitting analog values, the accompanying "Error" and "Overrange" bits must also be transmitted.
- The BT 777 transceiver must be supplied via separate power supply units.
- If you want to generate a mailbox in a data block, you must create the data block either
 - in the restart OBs (OB 21 and OB 22) or
 - using the programmer.
- COM 530 may not be used in safety mode.
The keylock switch on the relevant programmer must be locked.
- You can find additional information in section 7.2.3.
- If an S5-115F slave is to be shut down in a SINEC L1 network, the power supply of the relevant transceiver must be switched off.
- Program the SINEC L1 master (CP 530 in the higher-level S5-115U, S5-135U, S5-150U or S5-155U) in such a way that the length of messages to a slave S5-115F matches the configured length of the Receive mailbox.
You must extend shorter messages to the length of the Receive mailbox.
- High-level protection of the destination slave number is always necessary if you configure more than two slaves with the same mailbox length. The S5-115F enters the information for error detection and correction in the first byte of the mailbox. You must not alter the error detection and correction information.
- High-level protection of the destination slave number and a message change byte are always necessary if you want to send broadcast messages. The S5-115F enters the information for error detection and correction in the first two bytes of the mailbox. You must not alter the error detection and correction information.

10.19.1 Polling List

The polling list must be such that every connection (source - destination) can be implemented at least once.

Hinweis

You should make the appropriate number of entries in the polling list for source PLCs transmitting to several nodes. You can increase the priority of the relevant data transfers with multiple entries of the source PLC in the polling list. You must not, however, enter the same source PLC in the polling list several times in immediate succession.

10.19.2 SINEC L1 Safety Time

The SINEC L1 safety time depends on your automated process and on the control programs of the communications partners involved. At the individual acceptance test, you must agree with the inspector on a **uniform** SINEC L1 safety time for all configured data paths.

The SINEC L1 safety time is configured by you when assigning communication parameters with COM 115F. At the same time, COM 115F specifies the automatically calculated SINEC L1 polling time. Ensure that the calculated SINEC L1 polling time is less than the agreed SINEC L1 safety time. You can decrease the SINEC L1 safety time by reducing the volume of data to be transferred or by reducing the number of configured data paths.

At least one valid message must be received over each configured data path within the SINEC L1 safety time. If any data path does not receive a valid message within the SINEC L1 safety time, the operating system interprets this as a permanent error on the data transmission circuit and deletes the relevant receive mailbox. The operating system also sets the source slave bit in block 1 of the error DB.

If messages are received with errors as a result of brief fault causes (e.g. RF noise), repetition of the messages is permissible before expiry of the SINEC L1 safety time. Message received with errors are detected by the operating system and do **not** change the contents of the receive mailbox compared to the old status.

Repetition of messages is possible thanks to:

- Multiple entry of the source PLC in the polling list
- Reduction of the SINEC L1 polling time

Under error-free conditions, the response time is determined to a great extent by the SINEC L1 polling time. In the case of permanent faults, the safety response (deletion of the receive mailbox) only takes place after an interval determined essentially by the SINEC L1 safety time.

10.19.3 FB 254 Synchronization for SINEC L1 LAN

Data traffic on the SINEC L1 LAN is also monitored for a configurable safety time. Within this safety time, a data transfer must have taken place with all the communications partners configured (except the master PLC), otherwise the Receive mailbox will be erased for security reasons. If you use the SINEC L1 LAN, we recommend that you call FB 254 every 30 to 40 ms, if possible.

10.19.4 Two-Channel SINEC L1 LAN

You must note the following if you operate the SINEC L1 LAN with two channels:

Before you access the Receive mailbox of the SINEC L1 channel B, you must call MBXT FB 253. This FB checks whether the relevant data path is defective (Vol. 2, 6.1.5 of the Manual). If the data path is defective, the FB 253 transfers the Receive mailbox of the intact SINEC L1 channel A to the defective SINEC L1 channel B.

10.20 Individual Acceptance Test of the Safety-Related System

The S5-115F is a component of your safety-related system and is inspected during the acceptance test of the overall system.

A significant aspect for the test of the S5-115F is failsafe interaction with all safety-related components, such as sensors and actuators.

This section contains information which will help you in preparing for the acceptance test of the safety-related system.

It has been found useful in practice to divide the licensing procedure into three sections.

We therefore recommend division as follows:

- Planning phase
- Pre-inspection
- System acceptance test

10.20.1 Planning Phase

You should clarify the following points with the licensing authority while you are planning your system:

Definition of safety requirements

Specify the standard (e.g. DIN VDE 0116) which describes the safety requirements for your system, and determine the quality level to DIN V 19250.

Perform risk analysis

In the risk analysis, you define which subprocesses of your system are safety-related. If safety-related and non-safety-related subprocesses are juxtaposed you must also perform a risk analysis for the non-safety-related subprocesses.

Define protection targets

Define the protection targets for your process and the criteria for transfer of the system to a safe state.

Answer the following questions on this subject:

- Under what circumstances must the entire system be shut down?
- Under what circumstances would it suffice to shut down only subprocesses?
- Is passivation of I/O modules permitted?
- Under what conditions can subprocesses of the system remain switched on under supervision?

Define safety-related counters and timers

Define all safety-related timers and counters together with the inspector. This includes variables which you need to specify when setting the operating system parameters with COM 115F, such as:

- Maximum test scan time
- Maximum discrepancy times
- Second error occurrence time

Also define system-specific variables such as

- Maximum total response time of the system (response time of the PLC + response time of the sensors and actuators)
- Maximum number of permissible firing attempts (in the case of burners)

Hardware requirements

All modules and module racks suitable for the S5-115F have been prototype-tested by the Bavarian Technical Inspectorate and require no further testing.

However, please ensure adherence to the required ambient conditions such as temperature and humidity as specified in the Technical Specifications. Check the characteristics and requirements of your sensors and actuators.

Communications with further devices

Please ensure that no safety-related functions or subprocesses are impaired as a result of data interchange with communications partners. For this reason, check the connection of the S5-115F to the following:

- Local area networks (e.g. SINEC L1 LAN)
- Point-to-point connection partners (e.g. connection over the CP 523)
- Data terminal devices (e.g. printer, modem or terminal)

If you want to further process safety-related data in a safety-related manner, you require a failsafe connection, e.g. a point-to-point connection over CP 523 with failsafe standard FBs.

At least one reaction-free connection is required for transferring non-safety-related data.

Answer the following questions if you are planning communications with other devices:

- Who are the communications partners?
- Is the data to be transferred unidirectionally or bidirectionally?
- Is safety-related data to be transferred?
- Could the data transfer lead to falsification of safety-related data in the S5-115F?

Documentation for the pre-inspection

Discuss with the inspector what documentation is required for the pre-inspection.

10.20.2 Pre-Inspection

The following documents specifying system, version and date are usually required for the pre-inspection:

- Component mounting diagrams of the hardware
- Configuration printout with COM 115F DOCUMENT on a data medium and as a listing
- Logic and signal flow diagrams
- Control program, program sequence diagrams, program overview with data blocks on data media and as listings
- Cross-reference list for inputs, outputs, flags, timers, counters, blocks and I/O modules
- Certification conditions

As well as confirming that the conditions of inspection have been met, the pre-inspection also deals with the following points:

Checking of operating system parameters

Use a printout with COM 115F to demonstrate that all safety-related parameters are set in such a way as to meet the safety requirements.

Which parameters are taken into account here will depend on the special requirements of the system.

The monitored maximum scan time must meet the requirements of the process.

Checking of the configured hardware

The inspector uses the component mounting diagrams and the configuration printout to check that all safety-related inputs and outputs have been switched in a failsafe manner. This affects both input modules and output modules as well as sensors and actuators.

Checking the control program

The inspector checks the control program using the program listing, the sequence diagrams and the logic plans.

Among the points checked are the following:

- Correct conversion of logic diagrams
- Initialization of the integral blocks
- Initialization of standard function blocks
- Failsafe feature of outputs, timers and counters

Outputs, timers and counters are regarded as failsafe if the input parameters used are failsafe or if a fault prognosis has been performed. The purpose of a fault prognosis is to establish that the failure of a non-failsafe input parameter could under no circumstances result in a hazardous state.

Checklist for system check

Generate a checklist for the system check. The following are among the points to be included:

- Function tests for safety-related functions
- The conditions of inspection to be observed
- Protection targets
- The verifiable regulations for the automated process

10.20.3 System Test

Before you perform the system test with the inspector, you should have tested your failsafe system at least once in safety mode with the EPROM submodule.

You require the following equipment for the onsite test:

- Programmer
- Printer
- At least three EPROM submodules passed for safety mode
- UV eraser
- Labels for the EPROMs

Comparison of pre-inspected hardware and implemented hardware

For comparison of the hardware the inspector requires the configuration list and a printout of the configuration data generated with COM 115F DOCUMENT.

Among the points the inspector takes into account when checking the hardware are:

- Suitability of the modules for use in the S5-115F
- Use of failsafe modules for safety-related signals
- Wiring of the I/O modules
- Connections from further devices

Should changes manifest themselves during the comparison of hardware, it is possible that the inspector might demand a new pre-inspection.

Comparison of pre-inspected and implemented software

For comparison of the software the inspector requires the current control program as a listing on a data medium.

The inspector compares the software handed over by you at the pre-inspection with the installed software. To check this, comparison with the STEP 5 basic package "QL, VGL, UVM" is recommended.

Should changes manifest themselves during the comparison of software, it is possible that the inspector might demand a new pre-inspection.

Error simulations

Error simulations are to be performed onsite on the implemented system using the checklist generated at the pre-inspection.

Confirmation of adherence to the conditions of inspection

At this point a check is made to confirm that all conditions of inspection and all safety regulations listed in the manual are adhered to.

This applies, for example, to the requirement that the quiescent current principle is adhered to in the case of all safety circuits connected externally to the system. Other points are power supply electrical configuration and the memory media used in safety operation.

A check must also be made here that the ambient conditions specified in the Technical Specifications are adhered to.

Documentation

The current software in the form of a listing and additionally on diskette or EPROM is to be retained as documentation. The EPROM labels should specify the following:

- System
- Date
- Subunit ID
- Signature of the EPROM submodule



Warning

After the acceptance test, any modification to the hardware or software must be agreed with the inspector. An unauthorized change can lead to critical system states and to immediate loss of permit.

Appendices

- Appendix A . . Evaluation of Error DBs DB2 and DB3 without COM 115F
- Appendix B . . . Slot Assignments
- Appendix C . . . Prototype Test Certification
- Appendix D . . SIEMENS Addresses Worldwide

A Evaluation of Error DBs DB2 and DB3 without COM 115F

A Evaluation of Error DBs DB2 and DB3 without COM 115F

You will normally use COM 115F to display user-friendly error messages on your programmer screen.

You can evaluate the error DBs

- if you have no CRT-based programmer
- if you want to write your own error messages

These DBs contain all the information you require.

You will find notes on the structure of the error DBs in Vol. 2, 5.4.2 of the Manual.

Consult the following pages for the precise meaning of the eight bytes of an error message.

Meaning of the eight bytes of an error message

Byte		
0	=	Gr = Error group (Vol. 2, 5.5.2 of the Manual)
1	=	Error No. = (Progr. No.; Consec. No. Vol. 2, 5.4.1)
2	=	
3 to 7	=	Additional information

The following assignments apply in the case of error messages with "I/O identifier" in byte 3	
Byte 3 =	I/O identifier:
Byte 4 =	Word No. (0 to 63) of DI module, DQ module or AI module;
Byte 5 =	Word No. (0 to 63) of CH DQ, R DI or CH AQ module but not the CH relay DQ module for connecting sensors or the CH AQ module in the case of AI modules;
Byte 6 =	Bit No.;
Byte 7 =	Word No. (0 to 62) of the CH relay DQ in AI modules

I/O identifier in DI error messages:	
Bit 3 to 0 =	0001
Bit 4 =	0 DI without CH DQ
	= 1 DI with CH DQ
Bit 5 =	0 not used
Bit 6 =	0 CH DQ not in subunit A
	= 1 CH DQ in subunit A
Bit 7 =	0 CH DQ not in subunit B
	= 1 CH DQ in subunit B

I/O identifier in DI error messages:	
Bit 3 to 0 =	0010
Bit 4 =	0 DQ without RB DI
	= 1 DA with RB DI
Bit 5 =	0 not used
Bit 6 =	0 RB DI not in subunit A
	= 1 RB DI in subunit A
Bit 7 =	0 RB DI not in subunit B
	= 1 RB DI in subunit B

I/O identifier in DI error messages:	
Bit 3 to 0 =	0100
Bit 4 =	0 AI without CH AQ and CH Rel DQ
	= 1 AI with CH AQ and CH Rel DQ
Bit 5 =	0 AI with 1 sensor, CH Rel DQ in the same subunit as CH AQ
	1 AI with 2 sensors CH Rel DQs in both subunits
Bit 6 =	0 CH AQ not in subunit A
	= 1 CH AQ in subunit A
Bit 7 =	0 CH AQ not in subunit B
	= 1 CH AQ in subunit B

Error No.	Gr.	Byte No.	Additional information	Remarks	Byte No.	Additional information	Remarks
2.1	20	3, 4	User time decr. in A /10 msec.		5, 6	User time decr. in B /10msec.	
2.2	14	3, 4	Unit time difference /10 msec.		5, 6 7	Configured limit val. /10 msec. FB 254 location parameter	
2.3	20	3, 4	Quartz monitor counter A		5, 6	Quartz monitor counter B	
2.4	20	3, 4	Sum in A /10 msec.		5, 6	Sum in B /10 msec.	
4.1	1	3, 4	OB 13 timer val. A /10 msec.		5, 6	B 13 timer value B /10 msec.	
4.2	14	3	Actual time interval /10 msec.		4 5	Config. max. time int. /10 msec. FB 254 location parameter	
4.3	20	3	Time difference in A /10 msec.		4	Time difference in B /10 msec.	
14.1	13	3	Desired mode A and B				
16.1	8*	3	I/O identifier =01 _H DI without CH DQ =51 _H DI with CH DQ in subunit A =91 _H DI with CH DQ in subunit B =D1 _H DI with CH DQ in both subunits =D2 _H Input is RB DI		4	DI word No. or Q word No.	0, 1 to 63 ** 0, 1 to 62 **
16.1	9				5	Word No. of CH DQ (if present) or RB DI word No.	0, 1 to 62 0, 1 to 63 **
					6	Bit No.	0, 1 to 15
16.4	13	3	DI byte No.	0, 1 to 127	4	DI bit No.	0, 1 to 7
16.5	19	3	DI word No.	0, 2 to 126			
17.1	19	3	AI word No.	128, 130 to 254			
17.2	8*	3	I/O identifier =04 _H AI without CH AQ and CH Rel DQ, with one sensor =24 _H AI without CH AQ and CH Rel DQ, with two sensors =54 _H AI with CH AQ and CH Rel DQ in subunit A, with one sensor =74 _H AI with CH AQ in subunit A, with CH Rel DQ in both subunits, with two sensors =94 _H AI with CH AQ and CH Rel DQ in subunit B, with one sensor =B4 _H AI with CH AQ in subunit B, with CH Rel DQ in both subunits, with two sensors		4	AI word No.	0, 1 to 63 **
17.2	9				5	CH AQ word No., if CH AQ present	0, 1 to 63 **
17.4	8*				6	---	
17.4	9				7	CH Rel DQ word No if CH Rel DQ present	0, 1 to 62 ** (CH Rel DQ for connecting sensors or CH DQ)
17.6	8*						
17.6	9						
18.1	20	3	DQ word No.	0, 2 to 124	4, 5	DQ word in A	
		6, 7	DQ word in B				
18.2	20	3	Counter No.	0, 2 to 127	4, 5	Counter word in A	
		6, 7	Counter word in B				

Error No.	Gr.	Byte No.	Additional information	Remarks	Byte No.	Additional information	Remarks
23.1	1	3	Message source No.	0, 1 to 30			
23.2	1	3	Message destination No.	0, 1 to 30			
23.3	1						
25.1	13	3, 4	SD 36				
25.2	16	3	No. of DB serviced		4, 5	DB address	
25.3	16	3	DB No.		4, 5	DB address	
26.1	15	3, 4	RAM address		5	RAM byte in A	
		6	Ram byte in B				
26.2	13	3, 4	Initial address test area				
26.3	7	3, 4	RAM addr. inverse location		5	Contents of original location	
		6	Contents of inverse location				
26.4	13						
27.1	4	3	Page No.	0, 1	4, 5	Memory address	
		6	Current test background				
27.2	4	3, 4	Page No.	0, 1	4, 5	Memory address	
		6	Current test background		7	Current check pattern	
27.3	13	3, 4	Initial address				
28.1	16	3	I/O type	DI, DQ, AI, AQ			
28.2	8*	3	I/O identifier:		4	DI word No.	0, 1 to 63 **
28.2	10		=51 _H DI with CH DQ in subunit A		5	CH DQ word No.	0, 1 to 62 **
28.3	8*		=91 _H DI with CH DQ in subunit B		6	Bit No.	0, 1 to 15
28.3	10		=D1 _H DI with CH DQ in both subunits				
28.4	8*						
28.4	10						
28.5	8*	3	I/O identifier:		4	DQ word No.	0, 1 to 62 **
28.5	10		=D2 _H DQ with RB DI in both subunits		5	RB DI word No.	0, 1 to 63 **
28.6	8*				6	Bit No.	0, 1 to 15
28.6	10						
28.7	8*						
28.7	10						

Error No.	Gr.	Byte No.	Additional information	Remarks	Byte No.	Additional information	Remarks
28.8	19	3	DI word No.	0, 2 to126			
28.9	19	3	DQ word No.	0, 2 to124			
28.10	8*	3	I/O identifier: =51 _H DI with CH DQ in subunit A =91 _H DI with CH DQ in subunit B =D1 _H DI with CH DQ in both subunits		4	DI word No.	0, 1 to 63 **
28.10	10				5	CH DQ word No.	0, 1 to 62 **
28.11	8*				6	Bit No.	0, 1 to 15
28.11	10						
28.12	8*						
28.12	10						
28.13	8*						
28.13	10						
28.14	8*						
28.14	10						
28.15	8*						
28.15	10						
28.16	8*						
28.16	10						
28.17	8*						
28.17	10						
28.18	8*						
28.18	10						
29.1	12	3, 4	Block type	FB, OB, PB, SB	5	Block No.	
		6, 7	User memory initial address				
29.2	3	3, 4	Block type	FB, OB, PB, SB	5	Block No.	
		6, 7	User memory initial address				
30.1	13	3	FXTEKO in A		4	FXTEKO in B	
30.2	13	3	FXTE_ZEI0_Hin A		4	FXTE_ZEI0_Hin B	
30.3	13	3	FXTE_ZEI0_L in A		4	FXTE_ZEI0_L in B	
30.4	13	3	FXTE_ZEI1_Hin A		4	FXTE_ZEI1_Hin B	
30.5	13	3	FXTE_ZEI1_L in A		4	FXTE_ZEI1_L in B	

Error No.	Gr	Byte No.	Additional information	Remarks	Byte No.	Additional information	Remarks
30.6	13	3	FXTE_ZEI2_Hin A		4	FXTE_ZEI2_Hin B	
30.7	13	3	FXTE_ZEI2_L in A		4	FXTE_ZEI2_L in B	
30.8	13	3	FXTEKO_OK in A		4	FXTEKO_OK in B	
30.9	13	3	FXEA_BLOCK_ADR_H in A		4	FXEA_BLOCK_ADR_H in B	
30.10	13	3	FXEA_BLOCK_ADR_L in A		4	FXEA_BLOCK_ADR_L in B	
30.11	13	3	FXEA_DB_END_ADR_H in A		4	FXEA_DB_END_ADR_H in B	
30.12	13	3	FXEA_DB_END_ADR_L in A		4	FXEA_DB_END_ADR_L in B	
30.13	13	3	FXEA_TEST_ANZ in A		4	FXEA_TEST_ANZ in B	
31.1	23	3	Subunit of original message	A, B			
31.2	29	3 5	Contents of err. DB byte in A Byte No. in err. DB incl. header		4	Contents of err. DB byte in B	
31.3	29	3	Signal group No.	0, 1 to 128			
31.4	29						
31.5		3	Current stack	> 230	4	Maximum permissible stack	230
32.1	19	3	CH DQ word No.	0, 2 to 124			
32.2	19	3	DI word No.	0, 2 to 126			
32.3	13	3	DI word No.	0, 2 to 126			
32.4	8*	3	I/O identifier: =51 _H DI with CH DQ in subunit A =91 _H DI with CH DQ in subunit B =D1 _H DI with CH DQ in both subunits		4	DI word No.	0, 1 to 63 **
32.4	10				5	CH DQ word No.	0, 1 to 62 **
32.5	8*				6	Bit No.	0, 1 to 15
32.5	10						
32.6	8*						
32.6	10						
33.1	19	3	AI word No.	128, 130 to 254			
33.2	19	3	CH relay DQ word No.	0, 2 to 124			
33.3	19	3	CH AQ word No.	128, 130 to 254			
33.4	8*	3	I/O identifier: =54 _H AI with CH AQ and CH DQ in subunit A , with one sensor for both subunits =74 _H AI with CH AQ in subunit A, with CH DQ in both subunits, with two sensors =94 _H AI with CH AQ and CH DQ in subunit B, with one sensor for both subunits =B4 _H AI with CH AQ in subunit B, with CH DQ in both subunits, with two sensors		4	AI word No.	0, 1 to 63 **
33.4	10				5	CH AQ word No.	0, 1 to 63 **
					6	-	
					7	CH relay DQ word No.	0, 1 to 62 (CH relay DQ for connecting sensors or CH AQ)

Error No.	Gr.	Byte No.	Additional information	Remarks	Byte No.	Additional information	Remarks
44.1	14	3	Configured safety time	10 to 16383 *10 msec.	4	Calculated SINEC polling time	/10 msec.
45.1	7	3, 4	RAM address		5	Desired test background	
		6	Actual test background				
45.2	7	3, 4	RAM address		5	Test background	
		6	Desired check pattern		7	Actual check pattern	
46.1	2	3	Operation group No.				
47.1	2	3	Check byte address		4	Desired contents check byte	
		5	Actual contents check byte				
47.2	2	3	Adjacent byte address		4	Check byte address	
		5	Desired contents adjac. byte		6	Actual contents adjac. byte	
		7	Contents check byte				
48.1	3	3	Operation group No.				
48.2	3						
49.1	5	3, 4	Actual signature		5, 6	Desired signature	
50.1	6	3, 4	Actual signature		5, 6	Desired signature	
51.1	13	3	Page No.	0, 1	4	Page access mode (from R 7) Bit 1=1 Read access requested Bit 2=1 Write access requested Bit 6=1 Reserve own page Bit 7=1 Reserve other page Bits 0, 3 to 5 are irrelevant	
			Byte 4=42 _H Read own page =44 _H Write to own page				
51.2	23	3	Page No.	0, 1	4	No. of program causing error	
51.3	1	3	Page No.	0, 1	4	Semaphore register	
		5	No. of program causing error				
51.4	13	3	Page No.	0, 1	4	Page access mode	
		5	No. of program causing error				
51.5	23	3	Page No.	0, 1	4	Page access mode	
		5	Semaphore register		6	No. of program causing error	

Error No.	Gr.	Byte No.	Additional information	Remarks	Byte No.	Additional information	Remarks
53.1	1	3	Job No.		4	Call localization parameter	
53.2	13	3, 4	Log. OS progr. counter A		5	Call localization parameter	
		6	Job No.				
53.3	23	3, 4	Log. user progr. counter A		5, 6	Log. user progr. counter B	
53.4	23	3, 4	Log. OS progr. counter A		5, 6	Log. OS progr. counter B	
53.5	23	3	Job No. of A		4	Job No. of B	
		5	Localization parameter of A		6	Localization parameter of B	
54.1	29	3	(FXFE_URS+0)		4	(FXFE_URS+1)	
		5	(FXFE_URS+2)		6	(FXFE_URS+3)	
54.2	29	3	(FXFE_URS+0)		4	(FXFE_URS+1)	
		5	(FXFE_URS+2)		6	(FXFE_URS+3)	
		7	(FXFE_URS+4)				
54.3	29	3	(FXFE_URS+0)		4	(FXFE_URS+1)	
		5	(FXFE_URS+2)		6	(FXFE_URS+3)	
		7	(FXFE_URS+4)				
54.4	29	3	(FXFE_URS+0)		4	(FXFE_URS+1)	
		5	(FXFE_URS+2)		6	(FXFE_URS+3)	
		7	(FXFE_URS+4)				
54.5	29	3	(FXFE_URS+0)		4	(FXFE_URS+1)	
		5	(FXFE_URS+2)		6	(FXFE_URS+3)	
		7	(FXFE_URS+4)				
54.6	29	3	(FXFE_URS+0)		4	(FXFE_URS+1)	
		5	(FXFE_URS+2)		6	(FXFE_URS+3)	
		7	(FXFE_URS+4)				
54.7	29	3	(FXFE_URS+0)		4	(FXFE_URS+1)	
		5	(FXFE_URS+2)		6	(FXFE_URS+3)	
		7	(FXFE_URS+4)				

Error No.	Gr.	Byte No.	Additional information	Remarks	Byte No.	Additional information	Remarks
54.8	29	3	(FXFE_URS+0)		4	(FXFE_URS+1)	
		5	(FXFE_URS+2)		6	(FXFE_URS+3)	
		7	(FXFE_URS+4)				
55.1	19	3	I/O word No.	0, 2 to 254			
55.2	1	3	Subunit	A, B	4	Source slave No.	
56.1	19	3	I/O word No.	0, 2 to 254			
58.1	1	3	No. of prev. processed progr.		4, 5	Data pointer	
59.1	1	3	No. of prev. processed progr.		4, 5	Data pointer	
60.1	1	3	No. of prev. processed progr.		4, 5	Data pointer	
61.1	1	3	No. of prev. processed progr.		4, 5	Data pointer	
62.1	1	3	No. of prev. processed progr.		4, 5	Data pointer	
63.1	1	3	No. of prev. processed progr.		4, 5	Data pointer	
74.1	16	3	Subunit	A, B		I/O type	DI, DQ, AI, AQ
		5	Smallest I/O word No.	0, 2 to 254			
74.2	16	3	Subunit	A, B	4	I/O type	DI, DQ, AI, AQ
		5	Smallest I/O word No.	0, 2 to 254			
74.3	16						
74.4	16	3	I/O type	1, 2 to 18, gaps	4	DB No.	4 to 255
		5, 6	DB address				
90.1	12	3	Module address				
90.2	16						
99.1	1						
99.2	1						
99.3	1						
99.4	1						
100.1	30	3	EPROM identifier				
100.2	1						
100.3	31	3	Subunit identifier found				
100.4	30	3	Subunit identifier found				
100.5	17	3, 4	Address 1st undefined char.				

Error No.	Gr.	Byte No.	Additional information	Remarks	Byte No.	Additional information	Remarks
100.6	13	3	Code No.				
101.1	24	3	EPROM identifier in A		4	EPROM identifier in B	
101.2	5	3, 4	User EPROM signature in A		5, 6	User EPROM signature in B	
102.1	30	3	EPROM identifier				
102.2	24	3	EPROM identifier in A		4	EPROM identifier in B	
102.3	24	3, 4	User EPROM signature in A		5, 6	User EPROM signature in B	
102.4	25						
102.5	18						
102.6	18						
102.7	19						
102.8	19						
102.9	17	3, 4	Address 1st undefined char.				
102.10	19						
102.11	6	3	Block type: =DE _H Function block =DC _H Organization block =E0 _H Program block =E2 _H Sequence block		4	Block No.	
					5, 6	Initial address	
102.12	16	3	Block type: =DE _H Function block =DC _H Organization block =E0 _H Program block =E2 _H Sequence block		4	Block No.	
					5, 6	Actual signature	
103.1	1	3, 4	Interrupt condition code word				
103.2	25						
103.3	13						
103.4	19	3, 4	Interrupt condition code word				
103.5	19						
103.6	1						
103.7	19						
104.1	3						
104.2	13						

Error No.	Gr.	Byte No.	Additional information	Remarks	Byte No.	Additional information	Remarks
105.1	21	3, 4	Configured scan time /10 msec.		5, 6	Actual scan time	/10 msec.
105.2	1						
105.3	1						
106.1	16	3	DB No.		4, 5	DB length	
106.2	16	3	DB No.		4, 5	DB length	
106.3	1	3	R2 (register bank 3)		4	R3 (register bank 3)	
		5	R4 (register bank 3)		6	R6 (register bank 3)	
		7	R6 (register bank 3)				
106.4	12	3	DB No.	4, 5 to 255	4, 5	DB length	
107.1	11						
108.1	1						
108.2	18						
108.3	21	3, 4	Configured scan time /10 msec.	10 to 16383 *10 msec.	5, 6	Actual scan time /10 msec.	
108.4	16	3	Current stack pointer	80 _H to FF _H	4	Highest stack pointer	
109.1	12	3	Input byte/word No.	0, (1) to 254, (255)			
109.2	14	3	Input byte/word No.	0, (1) to 254, (255)			
109.4	8*	3	I/O identifier: =01 _H DI without CH DQ =51 _H DI with CH DQ in subunit A =91 _H DI with CH DQ in subunit B =D1 _H DI with CH DQ in both subunits		4	DI word No.	0, 1 to 63 **
109.4	9				5	CH DQ word No. if CH DQ present	0, 1 to 62**
					6	Bit No.	0, 1 to 15
109.5	19	3	Input byte No. or input word No.	0, 1 to 255 0, 1 to 254			
109.6	12	3	Source address or destination address	with LIR oper. with TIR oper.			
109.7	12	3	DQ byte No. or DQ word No.	with TPY oper. with TPW oper.			
109.8	12	3, 4	Current source address	Decrementing	5, 6	Current destination address	
		7	Current residual length	Init. value 0			
109.9	12						

Error No.	Gr.	Byte No.	Additional information	Remarks	Byte No.	Additional information	Remarks
109.10	12						
109.11	12						
109.12	26						
109.13	12						
109.14	8*	3	I/O identifier:		4	Interrupt DI word No.	0, 1 to 63 **
109.14	9		=51 _H Interrupt DI with CH DQ in subunit A		5	CH DQ word No. (CH DQ with interrupt DI always present in this version)	0, 1 to 62 **
			=91 _H Interrupt DI with CH DQ in subunit B		6	Bit No.	0, 1 to 15
			=D1 _H Interrupt DI with CH DQ in both subunits				
109.15	1						
109.16	12						
109.17	12	3	Word No.	1, 3 to 255			
109.18	12	3	Word No.	1, 3 to 253			
109.21	12	3	Address within the block address list The high byte indicates the block type: DC _H Organization block DD _H Organization block DE _H Function block DF _H Function block E0 _H Program block E1 _H Program block E2 _H Sequence block E3 _H Sequence block		4	Address within the block address list The low byte indicates the block No. The following applies: Block No. = $\frac{\text{Value of the low byte}}{2}$ if the high byte DC _H , DE _H , E0 _H , E2 _H Block No. = $\frac{\text{Value of the low byte}}{2} + 127$ if the high byte DD _H , DF _H , E1 _H , E3 _H	
250.1	12	3	AI word No.	128, 130 to 254			
250.2	12	3	Module address ("BG")	128, 130 to 248	4	Channel No. ("KN")	0, 1 to 7
250.3	12	3	Module address ("BG")	128, 130 to 248	4	Channel No. ("KN")	0, 1 to 7
250.4	14	3	Module address ("BG")	128, 130 to 248	4	Channel No. ("KN")	0, 1 to 7
		5	Channel type from config. DB	3, 4, 5, 6			
250.5	12	3	Module address ("BG")	128, 130 to 248	4	Channel No. ("KN")	0, 1 to 7
250.6	19	3	Module address ("BG")	128, 130 to 248	4	Channel No. ("KN")	0, 1 to 7

Error No.	Gr.	Byte No.	Additional information	Remarks	Byte No.	Additional information	Remarks
250.7	8*	3	I/O identifier: =04 _H AI without CH AQ and CH Rel DQ, with one sensor =24 _H AI without CH AQ and CH Rel DQ, with two sensors =54 _H AI with CH AQ and CH Rel DQ in subunit A, with one sensor =74 _H AI with CH AQ in subunit A, with CH Rel DQ in both subunits, with two sensors =94 _H AI with CH AQ and CH Rel DQ in subunit B, with one sensor =B4 _H AI with CH AQ in subunit B, with CH Rel DQ in both subunits, with two sensors		4	AI word No.	0, 1 to 63 **
250.7	9				5	CH AQ word No. if CH AQ present	0, 1 to 63 **
250.9	8*				6	---	
250.9	9				7	CH Rel DQ word No. if CH Rel DQ present	0, 1 to 62 ** CH Rel DQ for connecting sensors or CH DQ)
250.11	8*						
250.11	9						
250.12	12	3, 4	Lower wire-break limit		5, 6	Upper wire-break limit	
250.13	19	3	CH relay DQ word No.	0, 2 to 124			
250.14	19	3	CH AQ word No.	128, 130 to 254			
250.15	12						
250.16	12	3, 4	Lower wire-break limit		5, 6	Upper wire-break limit	
250.17	12	3	AI address				
251.1	20	3	AQ word No.		4, 5	AQ value in A	
		6, 7	AQ value in B				
251.2	12						
252.1	12						
252.2	12	3	Module address				
252.3	12						
252.4	12	3	Wrong character				
252.5	12		DB No.				
252.6	12		Wrong character				
252.7	12						
252.8	12	3	DB No.				
252.9	12						

Error No.	Gr.	Byte No.	Additional information	Remarks	Byte No.	Additional information	Remarks
252.10	12						
252.11	19	3	Modules address				
253.1	12						
253.2	12	3	Source slave No.				
253.3	12	3	Source slave No.				
253.4	12	3	Source slave No.				
253.5	12	3	Source slave No.				
253.6	19						
254.1	12	3	Parameter				
254.2	12						
255.1	13	1	Signal group		2	I/O type	
			Current error block No. 9				
255.2	12						

* Only in the case of I/O ETV 3 and 4

** Internal word count; multiply the specified value by the factor 2 to get the STEP 5 I/O address.

B Slot Assignments

B.1	Power Supply Connector Pin Assignment	B - 1
B.2	Connector Pin Assignments of the CPU	B - 2
B.3	Connector Pin Assignments of Analog Input/Output Modules	B - 3
B.4	Connector Pin Assignments of the Interface Modules	B - 4
B.4.1	Connector Pin Assignments of the Symmetrical and Serial EU Interface Modules	B - 4
B.4.2	Connector Pin Assignments of the Symmetrical and Serial CC Interface Modules	B - 5
B.4.3	Connector Pin Assignments of the Asymmetrical IM 305 / IM 306 Interface Modules	B - 6
B.5	Connector Pin Assignments of the ER 701-3 Subrack	B - 7
B.6	Legend for Connector Pin Assignment	B - 10

B Slot Assignments

B.1 Power Supply Connector Pin Assignment

Top connector

Bottom connector
(only for CC 2F and
EU 2/3)

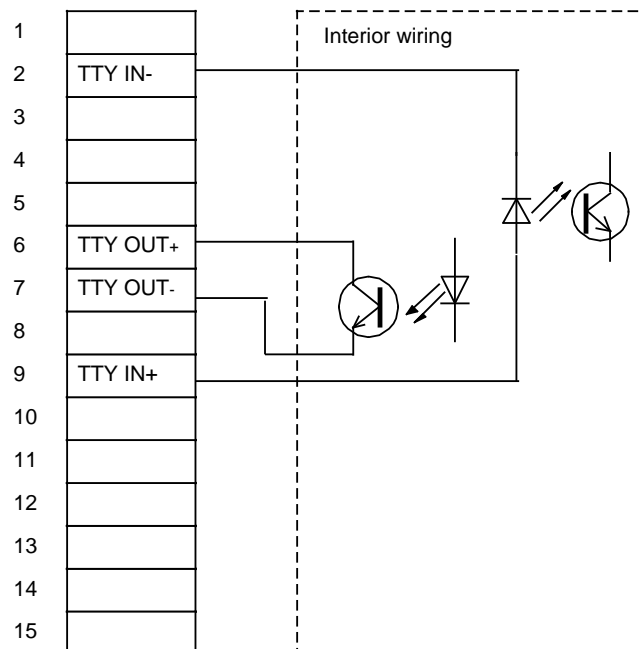
	a	b		a	b
1	M		1	M	
2	+5V		2	+5V	
3	+5V		3	+5V	
4	+5V		4	+5V	
5	+5V		5	+5V	
6	+5V		6	M	
7	+5V		7	M	
8			8	M	
9	M		9	M	
10	M		10	NAU	
11	UBATT		11	M	
12	M		12	BAU	
13	HOLD		13	M	
14	M		14	RESETA	
15	RESETA		15	M	
16	M		16	PEU	
17	RESET		17	M	
18	M		18	HOLDA3	
19	BAU		19	HOLDA2	
20	M		20	HOLDA1	
21			21	HOLD	
22	HOLDA1		22		
23	NAU		23		
24	HOLDA2		24		
25	PEU		25		
26	HOLDA3		26		
27	DS1		27		
28	M		28		
29			29		
30			30		
31			31		
32	M		32	M	

B.2 Connector Pin Assignments of the CPU

CPU slot
Top connector

	z	b	d	f
2	+5V	M		+5V
4	TAKT	PESP	UBATT	$\overline{F0}$
6	RESET	ADB0	ADB12	$\overline{F1}$
8	\overline{MRD}	ADB1	ADB13	$\overline{F2}$
10	\overline{MWR}	ADB2	ADB14	$\overline{F3}$
12	\overline{RDY}	ADB3	ADB15	$\overline{F4}$
14	DB0	ADB4	\overline{IRA}	$\overline{F5}$
16	DB1	ADB5	\overline{IRB}	$\overline{F6}$
18	DB2	ADB6		\overline{ASF}
20	DB3	ADB7		\overline{HOLD}
22	DB4	ADB8	\overline{BAU}	$\overline{HOLDA1}$
24	DB5	ADB9	\overline{NAU}	$\overline{HOLDA2}$
26	DB6	ADB10	\overline{PEU}	$\overline{HOLDA3}$
28	DB7	ADB11		\overline{PRAL}
30		BASP		
32		M	\overline{BASPA}	\overline{ASG}

Interface assignment of the serial interface



B.3 Connector Pin Assignments of Analog Input/Output Modules

Slots 0 to 8 (right)*

	a	b
1	M	
2	+5V	
3	PESP	
4	ADB0	
5	RESET	
6	ADB1	
7	$\overline{\text{MRD}}$	
8	ADB2	
9	$\overline{\text{MWR}}$	
10	ADB3	
11	$\overline{\text{RDY}}$	
12	ADB4	
13	DB0	
14	ADB5	
15	DB1	
16	ADB6	
17	DB2	
18	ADB7	
19	DB3	
20	ADB8	
21	DB4	
22	ADB9	
23	DB5	
24	ADB10	
25	DB6	
26	ADB11	
27	DB7	
28	BASP	
29	$\overline{\text{PRAL}}$	
30	M	
31	$\overline{\text{ASG}}$	
32	$\overline{\text{FX}}^{**}$	

* In CC2F slots 0a to 6a
 In EU1 slots 0 to 8
 In EU2 slots 0b to 7b
 In EU3 slots 0b to 7b

** Enable lines of the individual slots (X=0 to 8)

B.4 Connector Pin Assignments of the Interface Modules

B.4.1 Connector Pin Assignments of the Symmetrical and Serial EU Interface Modules

Slots 5 and 6 (left) in CC2F

Top connector

	z	b	d
2	+5V	M	
4	TAKT	PESP	+5V
6	RESET	ADB0	ADB12
8	$\overline{\text{MRD}}$	ADB1	ADB13
10	$\overline{\text{MWR}}$	ADB2	ADB14
12	$\overline{\text{RDY}}$	ADB3	ADB15
14	DB0	ADB4	+5V
16	DB1	ADB5	+5V
18	DB2	ADB6	M
20	DB3	ADB7	M
22	DB4	ADB8	M
24	DB5	ADB9	M
26	DB6	ADB10	M
28	DB7	ADB11	M
30		BASP	M
32	M	M	$\overline{\text{BASPA}}$

Bottom connector

	z	b	d
2	+5V	M	
4			
6			
8			
10			
12	+5V	+5V	
14	+5V	+5V	
16	+5V	+5V	
18	$\overline{\text{RESETA}}$	$\overline{\text{PEU}}$	
20			
22	M	M	
24	M	M	
26	M	M	
28	M	M	
30	M	M	
32	M	M	

B.4.2 Connector Pin Assignments of the Symmetrical and Serial CC Interface Modules

Slot 7 (left) in EU2/3

Top connector

	z	b	d
2	+5V	M	
4		PESP	+5V
6	RESET	ADB0	
8	$\overline{\text{MRD}}$	ADB1	
10	$\overline{\text{MWR}}$	ADB2	
12	$\overline{\text{RDY}}$	ADB3	
14	DB0	ADB4	+5V
16	DB1	ADB5	+5V
18	DB2	ADB6	M
20	DB3	ADB7	M
22	DB4	ADB8	M
24	DB5	ADB9	M
26	DB6	ADB10	M
28	DB7	ADB11	M
30		BASP	M
32		M	$\overline{\text{BASPA}}$

Bottom connector

	z	b	d
2	+5V	M	M
4			
6			
8			
10			
12	+5V	+5V	
14	+5V	+5V	
16	+5V	+5V	
18	$\overline{\text{RESETA}}$	$\overline{\text{NAU}}$	
20			
22	M	M	
24	M	M	
26	M	M	
28	M	M	
30	M	M	
32	M	M	

B.4.3 Connector Pin Assignments of the Asymmetrical IM 305 / IM 306 Interface Modules

Top connector

	z	b	d
2	+5V	M	+5V
4		PESP	+5V
6	RESET	ADB0	$\overline{\text{RESETA}}$
8	$\overline{\text{MRD}}$	ADB1	$\overline{\text{F0}}$
10	$\overline{\text{MWR}}$	ADB2	$\overline{\text{F1}}$
12	$\overline{\text{RDY}}$	ADB3	$\overline{\text{F2}}$
14	DB0	ADB4	$\overline{\text{F3}}$
16	DB1	ADB5	$\overline{\text{F4}}$
18	DB2	ADB6	$\overline{\text{F5}}$
20	DB3	ADB7	$\overline{\text{F6}}$
22	DB4	ADB8	$\overline{\text{F7}}$ *
24	DB5	ADB9	$\overline{\text{F8}}$ **
26	DB6	ADB10	
28	DB7	ADB11	$\overline{\text{PEU}}$
30	M	BASP	$\overline{\text{ASF}}$
32	M	M	$\overline{\text{ASG}}$

* Only in EU1, EU2 and EU3

** Only in EU1

B.5 Connector Pin Assignments of the ER 701-3 Subrack

Power supply

Top connector

	a	b
1	M	
2	+5V	
3	+5V	
4	+5V	
5	+5V	
6	+5V	
7	+5V	
8		
9	M	
10	M	
11	UBATT	
12	M	
13		
14	M	
15	$\overline{\text{RESETA}}$	
16	M	
17	RESET	
18	M	
19	$\overline{\text{BAU}}$	
20	M	
21		
22		
23	$\overline{\text{NAU}}$	
24		
25	$\overline{\text{PEU}}$	
26	M	
27	$\overline{\text{DSI}}$	
28		
29		
30		
31		
32	M	

Bottom connector

	a	b
1	M	
2	+5V	
3	+5V	
4	+5V	
5	+5V	
6	M	
7	M	
8	M	
9	M	
10	NAU	
11	M	
12	BAU	
13	M	
14	$\overline{\text{RESETA}}$	
15	M	
16		
17	M	
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32	M	

Slots 0a to 6a

Top connector

	z	b	d
2	+5V	M	
4	TAKT	PESP	UBATT
6	RESET	ADB0	ADB12
8	$\overline{\text{MRD}}$	ADB1	ADB13
10	$\overline{\text{MWR}}$	ADB2	ADB14
12	$\overline{\text{RDY}}$	ADB3	ADB15
14	DB0	ADB4	$\overline{\text{IRA}}$
16	DB1	ADB5	$\overline{\text{IRB}}$
18	DB2	ADB6	$\overline{\text{IRC}}$
20	DB3	ADB7	$\overline{\text{IRD}}$
22	DB4	ADB8	$\overline{\text{BAU}}$
24	DB5	ADB9	$\overline{\text{NAU}}$
26	DB6	ADB10	$\overline{\text{PEU}}$
28	DB7	ADB11	$\overline{\text{DSI}}$
30		BASP	
32		M	$\overline{\text{BASPA}}$

Bottom connector

	z	b	d
2	+5V	M	
4			
6			
8			
10			
12			
14	$\overline{\text{NAU}}$		
16	$\overline{\text{BAU}}$		
18			
20			
22			
24			
26			
28			
30			
32		M	

Slot 7a

Top connector

	z	b	d
2	+5V	M	
4		PESP	+5V
6	RESET	ADB0	ADB12
8	$\overline{\text{MRD}}$	ADB1	ADB13
10	$\overline{\text{MWR}}$	ADB2	ADB14
12	$\overline{\text{RDY}}$	ADB3	ADB15
14	DB0	ADB4	+5V
16	DB1	ADB5	+5V
18	DB2	ADB6	M
20	DB3	ADB7	M
22	DB4	ADB8	M
24	DB5	ADB9	M
26	DB6	ADB10	M
28	DB7	ADB11	M
30		BASP	M
32		M	$\overline{\text{BASPA}}$

Bottom connector

	z	b	d
2	+5V	M	
4			M
6			
8			
10			
12	+5V	+5V	
14	+5V	+5V	
16	+5V	+5V	
18	$\overline{\text{RESETA}}$	$\overline{\text{NAU}}$	
20			
22	M	M	
24	M	M	
26	M	M	
28	M	M	
30	M	M	
32	M	M	

Slots 0b to 7b

Top connector

a b

1	M
2	+5V
3	PESP
4	ADB0
5	RESET
6	ADB1
7	$\overline{\text{MRD}}$
8	ADB2
9	$\overline{\text{MWR}}$
10	ADB3
11	$\overline{\text{RDY}}$
12	ADB4
13	DB0
14	ADB5
15	DB1
16	ADB6
17	DB2
18	ADB7
19	DB3
20	ADB8
21	DB4
22	ADB9
23	DB5
24	ADB10
25	DB6
26	ADB11
27	DB7
28	BASP
29	
30	M
31	$\overline{\text{ASG}}$
32	$\overline{\text{F}}_0 \dots \overline{\text{F}}_7$

B.6 Legend for Connector Pin Assignment

+5V	Supply voltage for all modules
M	GND (0 V reference potential) for +5 V
U _{BATT}	3.4 V battery voltage for RAM backup
RESET	Reset pulse for all modules
<u>RESE</u> T A	Reset pulse request (triggers a reset pulse or extends it)
BAU	Battery failure; the signal is generated if the battery is not plugged in or if it is flat.
<u>NAU</u>	Power failure; the signal is generated shortly before the supply voltage fails.
<u>PEU</u>	I/Os not ready; the signal is generated if the power supply in the expansion unit fails.
DSI	Data security; the signal is generated with a delay after <u>NAU</u> and, in the case of some modules, switches the battery-backed RAM to standby hardware.
BASP	Command output disable; the signal is generated when the CPU stops. The signal disables digital outputs.
<u>MRD</u>	Memory Read; the signal is generated at every Read access.
<u>MWR</u>	Memory Write; the signal is generated at every Write access.
<u>RDY</u>	Ready; acknowledgement signal for <u>MRD</u> or <u>MWR</u> access
<u>PESP</u>	Memory I/O select; the signal is generated at every I/O access.
<u>ASF</u>	Interface free; the central controller is operated without an interface module; a terminating resistor must be plugged into the IM slot.
<u>ASG</u>	Interface module plugged in
<u>IRA</u> , <u>IRB</u>	Interrupt A, B; hardware interrupt signals from intelligent I/O modules
<u>PRAL</u>	Process interrupt; hardware interrupt signal from a digital I/O module
<u>HOLDA</u> 1, 2, 3	S5 bus enable for the intelligent closed-loop control module
<u>HOLD</u>	S5 bus access by the intelligent closed-loop control module
F0 to 8	Enabling lines for the I/O modules
ADB0 to 15	Address bus
DB0 to 7	Data bus

C Prototype Test Certification

C Prototype Test Certification

All the modules of the S5-115F have been subjected to prototype tests by the Technical Inspectorate of Bavaria (TÜV Bayern).

All the certificates issued in connection with the prototype tests are in German, and can be obtained from us on request. Please direct inquiries to:

Siemens AG
Abt. AUT 125
c/o Mrs. Bleicher
Postfach 1963

D-92209 Amberg
Fed. Rep. of Germany

Fax: 09621/803146

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Abbreviations

Abbreviations

Abbreviation	Term
AI	Analog input module
AQ	Analog output module
BASP	Command output disable
BAU	Battery failure
BCD	Binary coded decimal
BE	Block end
BEC	Conditional block end
BSTACK	Block stack
CC	Central controller
CH AQ	Check analog output module
CH DQ	Check digital output module
CP	Communications processor
CPU	Central processing unit
CSF	Control system flowchart
DB	Data block
DI	Digital input module
DL	Lefthand byte of a data word
DQ	Digital output module
DR	Righthand byte of a data word
DW	Data word
EEPROM	Electrically erasable and programmable read-only memory
EPROM	Erasable (with UV light) programmable read-only memory
ET	Electronic terminator
EU	Expansion unit
FB	Function block
FW	Flag word
FY	Flag byte
IB	Input byte
IM	Interface module
I/O	Input/output (module)

Abbreviation	Term
I/O ETV	Input/output error tolerance variant
IP	Intelligent input/output module
ISR	Interrupt service routine
ISTACK	Interrupt stack
IW	Input word
JC	Conditional jump
JU	Unconditional jump
KS	Character
KF	Fixed-point number
KG	Floating-point number
KH	Hexadecimal number
KM	Bit pattern
KN/KT	Channel number/channel type
KT	Time
KY	Byte; 2 binary absolute numbers 0 to 255
KC	Count
LAD	Ladder diagram
LPLZ	Logical program counter
NOP	No operation
OB	Organization block
OR	Overall reset
OS	Operating system
PB	Program block
PLC	Programmable logic controller
PEU	I/Os not ready
PII	Process output image
PIQ	Process output image
PL	Parallel link
PROM	Programmable read-only memory
PS	Power supply
PT	Printer

Abbreviation	Term
PW	Peripheral word
PY	Peripheral byte
QB	Output byte
QVZ	Timeout
QW	Output word
RB DI	Readback digital input module
RAM	Read/write memory
RLO	Result of logic operation
RN	RUN
ROM	Read-only memory
SAC	Step address counter (memory address)
SB	Sequence block
SINEC	Siemens Network Communication
ST	STOP
STL	Statement list
TRAF	Transfer error
UAW	Interrupt condition code word
ZYK	Scan (cycle) time exceeded

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Siemens AG
AUT 125 Doku
Postfach 1963

D-92209 Amberg
Federal Republic of Germany

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