

AMIKON TECHNICAL DOCUMENTATION

# Installation Instructions

Siemens 6ES7138-4CF02-0AB0

Fail-Safe Power and Output Module

| TYPE      | SUPPLY  | OUTPUTS        | COMMUNICATION |
|-----------|---------|----------------|---------------|
| PM-E F pm | 24 V DC | 2 DO + 1 relay | PROFIsafe     |

For qualified personnel only. Isolate the equipment and follow the complete manufacturer and site safety procedures. This reference does not replace the approved project design or the full installation manual.

01

## PREPARATION AND WIRING CHECKS

- For qualified personnel: use the complete ET 200S and safety-program documentation. This excerpt covers hardware identification and wiring, not full commissioning or troubleshooting.
- Switch off the PM-E F pm load voltage before insertion or removal. Match the PROFIsafe address switch to the configured address and the original uniqueness rules.
- Use the documented terminal module, safe extra-low-voltage supply and actuator conditions. Standard-DO arrangements provide safety-related shutdown, not safety-related activation.
- Keep the external 10 A B-characteristic relay protection and the DO2 parallel-terminal caution with the wiring diagrams. Observe load-grounding and cross-circuit restrictions.
- Read the historical ratings with the appended 10/2015 safety update. Configure readback, fault response and recommissioning using the full manual; mission time is not a service-life extension.

02

## ORIGINAL WIRING REFERENCE

Original source PDF pages: manual pp. 2-3,5,29-37,61-74,80-83; safety-update pp. 9,13,15. The following pages retain the original Siemens drawings and printed page numbers.

Siemens original documentation and product reference  
Siemens 10/2015, A5E03310062-AE; safety-update source pp. 9,13,15

## Safety Guidelines

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.



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### Danger

indicates that death or severe personal injury **will** result if proper precautions are not taken.

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### Warning

indicates that death or severe personal injury **may** result if proper precautions are not taken.

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### Caution

with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

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### Caution

without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

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### Notice

indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

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If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

## Qualified Personnel

The device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by **qualified personnel**. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

## Prescribed Usage

Note the following:



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### Warning

This device may only be used for the applications described in the catalog or the technical description and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens. Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.

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## Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

# Preface

## Purpose of this Manual

The information in this manual is a reference source for operations, function descriptions, and technical specifications of the fail-safe modules of the ET 200S distributed I/O system.

## Basic Knowledge Requirements

This manual is a supplement to the ET 200S Distributed I/O System manual. Working with this manual requires general knowledge of automation engineering. You also require experience of using the *STEP 7* basic software and the ET 200S distributed I/O system.

## Scope of this Manual

| Module                                              | Order Number        | Release Number and Higher |
|-----------------------------------------------------|---------------------|---------------------------|
| PM-E F pm DC24V PROFIsafe Power Module              | 6ES7 138-4CF02-0AB0 | 01                        |
| PM-E F pp DC24V PROFIsafe power module              | 6ES7 138-4CF41-0AB0 | 01                        |
| PM-D F DC24V PROFIsafe power module                 | 3RK1 903-3BA01      | 01                        |
| 4/8 F-DI DC24 V PROFIsafe Digital Electronic Module | 6ES7 138-4FA02-0AB0 | 01                        |
| 4 F-DO DC24V/2A PROFIsafe digital electronic module | 6ES7 138-4FB02-0AB0 | 01                        |

## What's New

Compared with the previous version, this manual includes the following major changes/additions:

- Ability to connect ET 200S to PROFINET I/O (with modules as of order numbers above)
- New parameter "Behavior after channel faults"

## Position in the Information Landscape

When working with ET 200S fail-safe modules and depending on your particular application, you will need to consult the additional documentation listed below.

References to additional documentation are included in this manual where appropriate.

| Documentation                                              | Brief Description of Relevant Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>ET 200S Distributed I/O system</i> manual               | Describes all generally applicable topics related to the ET 200S hardware (including configuration, installing, and wiring of the ET 200S) and the IM 151 interface module.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <i>Safety Engineering in SIMATIC S7</i> system description | <ul style="list-style-type: none"> <li>Provides an overview of the implementation, configuration, and method of operation of S7 Distributed Safety and S7 F/FH fail-safe automation systems</li> <li>Contains a summary of detailed technical information concerning fail-safe engineering in S7-300 and S7-400</li> <li>Includes monitoring and response time calculations for S7 Distributed Safety and S7 F/FH F-systems</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| For integration in the S7 F/FH F-systems                   | <p>The <i>S7 F/FH Automation Systems</i> manual describes the tasks that must be performed to commission an S7 F/FH F-system.</p> <ul style="list-style-type: none"> <li>The <i>S7-400, M7-400 Programmable Controllers Hardware and Installation</i> manual describes the installation and assembly of S7-400 systems.</li> <li>The <i>S7-400H Programmable Controllers, Fault-Tolerant Systems</i> manual describes the CPU 41x-H central modules and the tasks involved in setting up and commissioning an S7-400H fault-tolerant system.</li> <li>The <i>CFC for S7 Continuous Function Chart</i> manual/online help provides a description of programming with CFC.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| For integration in the S7 Distributed Safety F-system      | <p>The following elements are described in the <i>S7 Distributed Safety, Configuring and Programming</i> manual and online help:</p> <ul style="list-style-type: none"> <li>Configuration of the fail-safe CPU and the fail-safe I/O</li> <li>Programming of the fail-safe CPU in fail-safe FBD or LAD</li> </ul> <p>Depending on which F-CPU you use, you will need the following documentation:</p> <ul style="list-style-type: none"> <li>The operating manual <i>S7-300, CPU 31xC and CPU 31x: Configuration</i> describes the configuration, installation, addressing and commissioning of S7-300 systems.</li> <li>The <i>CPU 31xC and CPU 31x, Technical Data</i> product manual describes the standard functions of the CPU 315F-2 DP and PN/DP and the CPU 317F-2 DP and PN/DP.</li> <li>The <i>Automation System S7-400 CPU Specifications</i> manual describes the standard functions of the CPU 416F-2.</li> <li>The <i>ET 200S IM 151-7 CPU Interface Module</i> manual describes the standard IM 151-7 CPU.</li> <li>A separate product information bulletin is available for each applicable F-CPU. The product information bulletins describe only the deviations from the corresponding standard CPUs.</li> </ul> |
| <i>STEP 7</i> manuals                                      | <ul style="list-style-type: none"> <li>The <i>Configuring Hardware and Communication Connections with STEP 7 V5.x</i> manual describes the operation of the standard tools of STEP 7.</li> <li>The <i>System Software for S7-300/400 System and Standard Functions</i> reference manual describes functions for distributed I/O access and diagnostics.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <i>STEP 7</i> online help                                  | <ul style="list-style-type: none"> <li>Describes the operation of <i>STEP 7</i> standard tools</li> <li>Contains information about how to configure and assign parameters for modules and intelligent slaves with <i>HW Config</i></li> <li>Contains a description of the programming languages FBD and LAD</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <i>PCS 7</i> manuals                                       | <ul style="list-style-type: none"> <li>Describe how to operate the <i>PCS 7</i> process control system (required when ET 200S with fail-safe modules is integrated in a higher-level control system).</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

The entire SIMATIC S7 documentation is available on CD-ROM.

## 3.2 Assignment of the PROFIsafe address

### PROFIsafe Address

Each fail-safe module has its own PROFIsafe address in addition to the PROFIBUS address. Before installing fail-safe modules, you must set the PROFIsafe address on each F-module.

### PROFIsafe Address Assignment

The PROFIsafe addresses (F\_source\_address, F\_destination\_address) are automatically assigned when the fail-safe modules are configured in *STEP 7*.

You can view the F\_destination\_address in binary format in *HW Config* in the Object properties of the fail-safe modules in the "DIP switch setting" parameter. You read the PROFIsafe address from the parameter assignment dialog box and set it on the fail-safe module using an address switch.

You can change the configured F\_destination\_address in *HW Config*. To prevent addressing errors, however, we recommend using the automatically assigned F\_destination\_address.

### Address Switch for Setting PROFIsafe Addresses

An address switch (10-pin DIP switch) is located on the left-hand side of every fail-safe module. With this address switch, you enter the PROFIsafe address (F\_destination\_address) of the F-module.

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#### Note

Fail-safe modules in ET 200S can only be used in safety mode.

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### Setting the Address Switch

**Before installing** the F-module, ensure that the address switch is set correctly.

PROFIsafe addresses 1 through 1022 are permitted. In the following figure, you can see an example of the switch setting for addressing.

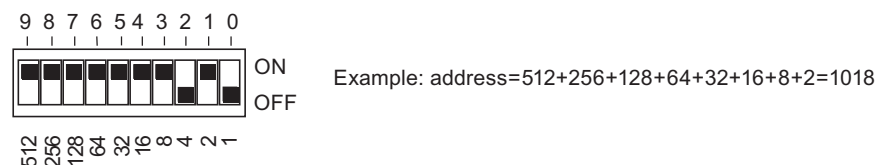


Figure 3-1 Example for Setting the Address Switch (DIP Switch)

## Rules for Address Assignment



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### Warning

Observe the following rules when assigning the address:

- Make sure that the address switch setting on the module matches the PROFIsafe address in *STEP 7 HW Config*.
- The switch setting on the address switch of the F-I/O, in other words, its PROFIsafe destination address must be unique within the network\* and station\*\* (throughout the system). A maximum of 1,022 PROFIsafe destination addresses can be assigned in one system. That is, a maximum of 1,022 F-modules can be addressed using PROFIsafe.

**Exception:** In different I-slaves, F-I/O can have the same PROFIsafe target addresses since they are only addresses within the station, in other words by the F-CPU in the I-slave.

- The following restriction applies only to ET 200S F-submodules whose default PROFIsafe addresses **cannot** be modified in *HW Config*.

If you use ET 200S F-modules whose PROFIsafe addresses cannot be modified in *HW Config* in a PROFIBUS network, you can only operate **one** DP master/IO controller with F-CPU in this network; otherwise, the system-wide uniqueness of the PROFIsafe addresses cannot be guaranteed.

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\*: A network consists of one or more subnets. "Network-wide" means across subnet boundaries.

\*\*: "Station-wide" means a station in *HW Config* (for example an S7-300 station or an I-slave)

## 3.3 Installing

### Installing Fail-Safe Modules

Fail-safe power modules, electronic modules, and terminal modules are part of the ET 200S range of modules. They are installed using the same procedure as for all standard modules in an ET 200S.

For more information about module installation, consult the *ET 200S Distributed I/O System* manual.

### Mounting Dimensions

Note that fail-safe modules are 30 mm wide (twice as wide as standard ET 200S modules). Otherwise, information provided in the *ET 200S Distributed I/O System* manual is applicable.

## Wiring and Fitting Modules

### 4.1 Introduction



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**Warning**

In order to prevent hazardous threats to persons or the environment, you must not under any circumstances override safety functions or implement measures that cause safety functions to be bypassed or that result in the bypassing of safety functions. The manufacturer is not liable for the consequences of such manipulations or for damages that result from failure to heed this warning.

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#### Overview

This chapter presents special features involved in wiring and fitting fail-safe modules. Information on this subject that applies to both ET 200S with fail-safe modules and ET 200S with standard modules can be found in the *ET 200S Distributed I/O System* manual.

## 4.2 Safe Functional Extra Low Voltage for Fail-Safe Modules

### Safe functional extra low voltage



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#### Warning

Fail-safe modules must be operated with safe functional extra low voltage. This means that these modules, even in the event of a fault, can only have a maximum voltage of  $U_m$ . The following applies for all fail-safe modules:

$$U_m < 60.0 \text{ V}$$

You can find additional information about safe functional extra low voltage, for example, in the data sheets of the applicable power supplies.

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All components of the system that are capable of supplying electrical energy in any form must satisfy this requirement.

Each additional circuit (24 VDC) implemented must have a safe functional extra low voltage. Refer to the relevant data specification sheets or contact the manufacturer for information.

Note, too, that sensors and actuators having an external power supply can be connected to F-modules. Here, pay attention to the supply voltage from safe functional extra-low voltage. The process signal of a 24 VDC digital module must not exceed a fault voltage of  $U_m$  in the event of a fault.



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#### Warning

All power sources, for example internal 24 V DC load voltage power supplies, external 24 V DC load voltage power supplies, 5 V DC bus voltage must be electrically connected externally. This prevents voltage additions in the individual voltage sources that would cause the fault voltage  $U_m$  to be exceeded even if there are voltage differences.

Ensure that there is sufficient line cross section for the electrical connection, in accordance with the ET 200S configuration guidelines (see *ET 200S Distributed I/O System* manual).

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## Power Supply Requirements in Compliance with NAMUR Recommendations

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### Note

You must use only power packs or power supplies (230 VAC --> 24 VDC) with a power failure ride-through of at least **20 ms** to comply with NAMUR recommendation NE 21, IEC 61131-2, and EN 298. The latest up-to-date information on power supply components are available on the Internet at:

<https://mall.ad.siemens.com>

These requirements are also applicable for network devices and power supplies that are not manufactured to ET 200S or S7-300/-400 configuration standards.

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## 4.3 Wiring fail-safe modules

### Same Wiring Procedure as for ET 200S

Fail-safe power modules, electronic modules, and terminal modules are part of the ET 200S range of modules. They are wired using the same procedure as for all standard modules in an ET 200S.

Refer to the *ET 200S Distributed I/O System* manual for detailed information on wiring and configuration of modules and the IM151.



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### Warning

When assigning signals of the F-DI module, remember that signals should only be routed within a cable or a nonmetallic sheathed cable if:

- A short circuit in the signals does not conceal a serious safety risk
  - Signals are supplied by different sensor supplies of this F-DI module
- 

### Mounting Rails

Only **35 x 15 mm** zinc-plated mounting rails in accordance with EN 50022 can be used for installing ET 200S with fail-safe modules. Mounting rails with the following order numbers, for example, comply with this requirement:

- 6ES5 710-8MA11
- 6ES5 710-8MA21
- 6ES5 710-8MA31
- 6ES5 710-8MA41

### Assignment of Terminal Modules

The terminal assignment of the terminal modules depends on the installed power or electronic module.

### See also

Wiring of the PM-E F pm DC24V PROFIsafe (Page 7-11)

Wiring of the PM-E F pp DC24V PROFIsafe (Page 7-29)

Wiring of the PM-D F DC24V PROFIsafe (Page 7-41)

Wiring of the EM 4/8 F-DI 24 VDC PROFIsafe (Page 7-50)

Wiring diagram of the EM 4 F-DO DC24V/2A PROFIsafe (Page 7-84)

## 4.4 Insertion and removal of fail-safe modules

### Inserting and Removing Electronic Modules

In ET 200S, the same procedure is used to insert and remove both fail-safe modules and standard modules on terminal modules (see ET 200S Distributed I/O System manual).

### Inserting and Removing Electronic Modules during Operation

F-modules can be inserted and removed during operation in exactly the same way as standard modules in ET 200S.

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#### Note

Note that replacing fail-safe modules in ET 200S during operation causes a communication error on the F-CPU.

You must acknowledge the communication error in your safety program (for the response of the F-system after communication errors, output of a fail-safe value and user acknowledgment, refer to the *S7 Distributed Safety, Configuration and Programming or Programmable Controllers S7 F/FH* manual). *S7 F/FH Automation Systems*).

If the communication error is not acknowledged, the useful data of the F-DO modules remain passivated (outputs at "0").

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## Requirements for Insertion and Removal during Operation

The following table lists the F-modules that can be inserted and removed during operation, and the conditions under which this is possible:

Table 4-1 Conditions for Inserting and Removing Fail-Safe Modules During Operation

| Module                             | Insertion and Removal | Conditions                        |
|------------------------------------|-----------------------|-----------------------------------|
| Interface module                   | No                    | –                                 |
| Fail-safe power module (PM E-F pm) | Yes                   | Load voltage must be switched off |
| Fail-safe power module (PM E-F pp) | Yes                   |                                   |
| Fail-safe power module (PM D-F)    | Yes                   |                                   |
| Fail-safe electronic module (F-DI) | Yes                   | –                                 |
| Fail-safe electronic module (F-DO) | Yes                   | –                                 |

## Remember to Set the PROFIsafe Address

When exchanging F-modules, ensure that the address switch (DIP switch) settings of the modules match.

## See also

Assignment of the PROFIsafe address (Page 3-3)

## 4.5 Requirements for Sensors and Actuators

### General Requirements for Sensors and Actuators

Note the following important information for safety-related use of sensors and actuators:



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#### Warning

The use of sensors and actuators is outside of our sphere of influence. We have equipped our electronics with such safety engineering features as to leave 85% of the maximum permissible probability of hazardous faults for sensors and actuators up to you (This corresponds to the recommended load division in safety engineering between sensing devices, actuating devices, and electronic switching for input, processing, and output).

Note, therefore, that instrumentation with sensors and actuators bears a considerable **safety responsibility**. Consider, too, that sensors and actuators do not generally withstand proof-test intervals of 10 years (the interval for an external function test according to IEC 61508) without considerable loss of safety.

The probability of hazardous faults and the rate of occurrence of hazardous faults of a safety function must comply with an upper limit determined by a safety integrity level (SIL). You will find a listing of values achieved by F-modules under "Fail-Safe Performance Characteristics" in the technical specifications for F-modules in Chapter 9.

To achieve SIL3 (AK6/Category 4), suitably qualified sensors are necessary.

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## Requirements for the Duration of Sensor Signals



### Warning

Observe the following requirements for sensor signals:

- In order to guarantee accurate detection of the sensor signal by the F-DI module, you must ensure that the sensor signals have a particular minimum duration.
- In order for pulses to be detected with certainty, the time between two signal changes (pulse duration) must be greater than the PROFIsafe monitoring time.

### Reliable acquisition by the F-DI module

The following table lists the minimum duration of the sensor signals for the F-DI module. This depends on the parameter settings for the short-circuit test and the input delay in *STEP 7*.

Table 4-2 Minimum Duration of the Sensor Signals to Allow Correct Acquisition by the F-DI Module

| Short-Circuit Test Parameter | Assigned Input Delay |       |       |
|------------------------------|----------------------|-------|-------|
|                              | 0.5 ms               | 3 ms  | 15 ms |
| Deactivated                  | 7 ms                 | 9 ms  | 23 ms |
| Activated                    | 7 ms                 | 12 ms | 37 ms |

### Reliable acquisition by the safety program on the F-CPU

You will find information on the times necessary for correct acquisition of the sensor signals in the safety program in *"Fail-Safe Modules"* in the system description *Safety Engineering in SIMATIC S7*.

## Additional Requirements for Actuators

Fail-safe modules test the outputs in regular intervals. To do so, the F-module briefly switches off activated outputs. The test pulses have the following duration:

- Dark period < 1 ms

Rapid response actuators can drop out briefly during the test. If your process does not tolerate this, you must use actuators with a sufficient lag (> 1 ms).



### Warning

If the actuators are operated at voltages higher than 24 VDC (for example, 230 VDC) or if the actuators clear higher voltages, safe isolation must be ensured between the outputs of a fail-safe output module and the components carrying a higher voltage (in accordance with EN 50178).

This is generally the case for relays and contactors. Particular attention must be paid to this aspect for semiconductor switching devices.

# Fail-Safe Modules

## 7.1 Introduction

### Overview

Fail-safe power modules and fail-safe digital modules are available for connecting digital sensors or encoders and actuators or loads to ET 200S. This chapter provides the following information for each fail-safe module:

- Properties and special features
- Front view, terminal assignment for terminal modules, and block diagram
- Wiring diagram and programmable parameters
- Diagnostic functions, including corrective measures
- Technical specifications



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#### Warning

The safety characteristics in the Technical Specifications apply for a proof-test interval of 10 years and a repair time of 100 hours.

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### Description of Usable Standard Power Modules and Terminal Modules

The applicable standard power modules and terminal modules are described in the *ET 200S Distributed I/O System* manual.

## 7.2 PM-E F pm DC24V PROFIsafe Power Module

### 7.2.1 Properties of the PM-E F pm DC24V PROFIsafe Power Module

#### Order Number

6ES7 138-4CF02-0AB0

#### Properties

The PM-E F pm DC24V PROFIsafe power module has the following properties:

- Two relays for switching voltage buses P1 and P2, 10 A output current
- 2 fail-safe digital outputs, P/M-switching, output current 2 A
- 24 VDC rated load voltage
- Suitable for solenoid valves, DC contactors, and indicator lights
- Group fault display (SF; red LED)
- Status display for each output (green LED)
- Status display for load current power supply (PWR; green LED)
- Assignable diagnostics
- For achievable safety classes (safety integrity level), see following table

Table 7-1 Overview of Achievable Safety Classes (Safety Integrity Levels) with PM-E F pm DC24V PROFIsafe

| PM-E F pm DC24V PROFIsafe        |                                          |                                      | Maximum Safety Level That Can Be Achieved |
|----------------------------------|------------------------------------------|--------------------------------------|-------------------------------------------|
| Relay outputs P1 and P2          | Without standard DO modules              | Signal switches daily or more often  | AK6/ SIL3/Category 4                      |
|                                  |                                          | Signal switches less than once a day | AK4/ SIL2/ Category 3                     |
|                                  | with standard DO modules                 |                                      | AK4/ SIL2/ Category 3                     |
| DO 0 and DO 1 electronic outputs | without standard DO modules on P1 and P2 |                                      | AK6/ SIL3/Category 4                      |
|                                  | with standard DO modules on P1 and P2    |                                      | AK4/ SIL2/ Category 3                     |

#### Switching of Voltage Buses P1 and P2

The power module can be used for fail-safe connection of voltage buses P1 and P2 by means of relay contacts in accordance with AK4/SIL2/Category 3.

## Two fail-safe digital outputs

In addition to the P1 and P2 voltage buses the power module has two fail-safe digital outputs, DO 0 and DO 1. AK6/SIL3/Category 4 can be achieved with these outputs if standard DO modules are not connected to P1 and P2.

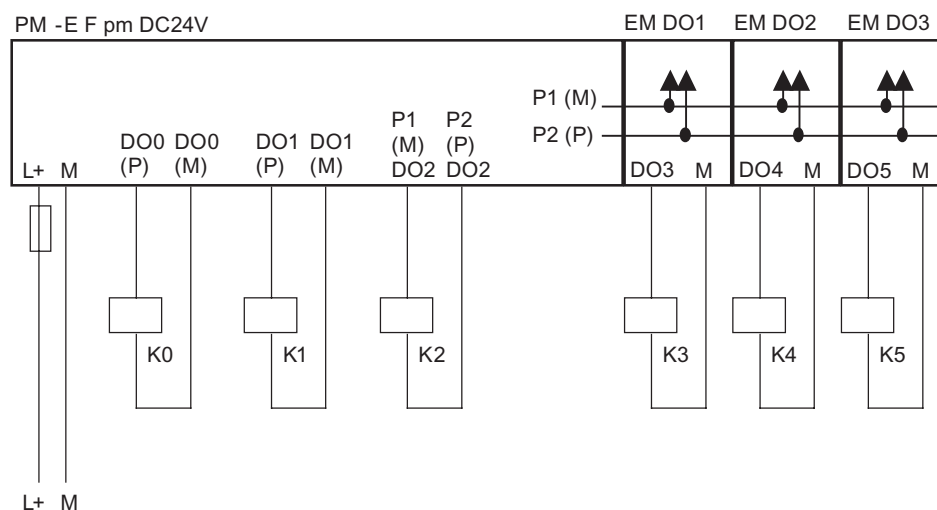


Figure 7-1 Wiring diagram of the PM-E F pm DC24V PROFIsafe

## Conditions for Achieving Safety Class

The conditions for achieving the respective safety classes are summarized in the following table.

Table 7-2 PM-E F pm DC24V PROFIsafe: Conditions for AK/SIL/Category

| Condition                                                      | Achievable AK/SIL/Category                            |
|----------------------------------------------------------------|-------------------------------------------------------|
| ET 200S standard modules supplied by means of P1 and P2        | AK4/SIL2/Category 3 on P1 and P2 and at DO 0 and DO 1 |
| DO 0 and DO 1 used, modules not supplied by means of P1 and P2 | AK6/SIL3/Category 4 on DO 0 and DO 1                  |

## Power Module Supplies for Standard ET 200S Modules



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### Warning

Always connect the 24 VDC supply for the standard ET 200S modules on the PM-E F pm DC24V PROFIsafe. Otherwise, the outputs of DO modules may exhibit safety critical behavior.

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### Warning

When supplying standard DO modules, always use the terminal modules to supply the sensors or actuators (actuator feedback on the DO module). Otherwise, the power module signals a short circuit and the load voltage of this voltage group is interrupted.

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## Safety-Related Shutdown of Standard DO Modules



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### Warning

The following ET 200S standard modules are approved for safety-related shutdown in accordance with SIL2:

- 2DO DC24V/0.5A (order number 6ES7 132-4BB01-0AA0 or higher)
  - 2DO DC24V/2A (order number 6ES7 132-4BB31-0AA0 or higher)
  - 2DO DC24V/0.5A HIGH FEATURE (order number 6ES7 132-4BB01-0AB0 or higher)
  - 2DO DC24V/2A HIGH FEATURE (order number 6ES7 132-4BB31-0AB0 or higher)
  - 4DO DC24V/0.5A (order number 6ES7 132-4BD00-0AA0 or higher)
  - 4DO DC24V/2A (order number 6ES7 132-4BD31-0AA0 or higher)
-



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**Warning**

Safety-related activation of outputs of standard DO modules is not possible; rather, only safety-related **shutdown** is possible. You must therefore take the following effects into account:

In the worst case you must consider all possible faults of the standard DO modules and the programs controlling them for which the faults cannot be found directly. For example, the PM-E F pm DC24V PROFIsafe does not detect external short-circuits as per L+ at the standard DO module outputs. All faults of the standard DO modules influence the process via final controlling elements. The process must be made known to the F-CPU via sensors and a suitable safety program.

The safety program must react in a safety-related and logically suitable fashion to unwanted or potentially dangerous states in the process via the PM-E F pm DC24V PROFIsafe and fail-safe output modules.

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If you want to avoid the problems described above completely, we recommend that you use P/M switching fail-safe electronic modules 4 F-DO DC24V/2A PROFIsafe with standard ET 200S power modules (see *"4 F-DO DC24V/2A PROFIsafe Digital Electronic Module"* and *Table "Assignment of Power Modules to Electronic Modules/Motor Starters and Safety Class"*) instead of standard DO modules.

**Property of the safety-related shutdown of standard DO modules by the PM-E F pm DC24V PROFIsafe:**

With this cost-effective solution, when a fault is discovered in the process or on the PM-E F pm DC24V PROFIsafe, there is a comprehensive and simultaneous shutdown of all outputs involved.

**Property of individual shutdown of F-modules with fail-safe outputs:**

If a fault is discovered, the extent of the shutdown is kept to a minimum. It is also possible to react to critical process states staggered over time or to perform safety-related shutdown of individual outputs. This solution is expensive compared with the safety-related shutdown by the PM-E F pm DC24V PROFIsafe.

### Switching grounded loads

If the PM-E F pm DC24V PROFIsafe switches loads that have a connection between chassis and ground (for example to improve the EMC properties) **and** if chassis and ground are connected in the power supply being used, a "short circuit" will be detected.

From the perspective of the F-module, the M switch is bridged by the chassis-ground connection (refer to the following figure as an example of a PM-E F pm DC24V PROFIsafe).

#### Remedy:

- Use the PM-E F pp DC24V PROFIsafe
- The value of the resistance between chassis and ground at the load end must be greater than 100 k $\Omega$

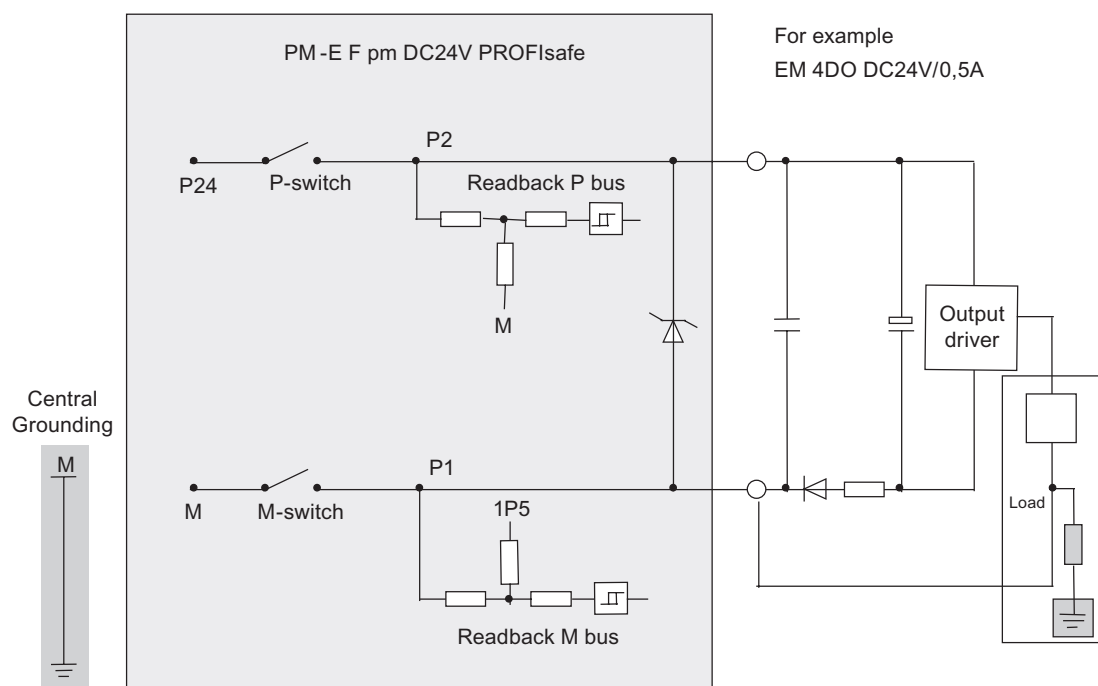


Figure 7-2 Connecting Grounded Loads (resistance exists between chassis and ground)

## Capacitive Crosstalk of Digital Input/Output Signals

When fail-safe digital output signals and fail-safe digital input signals are routed through one cable, readback errors can occur on the PM E-F pm DC24V PROFIsafe power module or the F-DO modules. The module then signals a short-circuit.

### Cause

During the sensor supply tests of the 4/8 F-DI DC24V PROFIsafe module, the steep switching edge of the output driver can cause crosstalk with other inactive output channels due to the coupling capacitance of the wire, for example on the PM E F pm DC24V PROFIsafe power module. In these channels, this can lead to a response in the readback circuit. A short is detected leading to a safety-related shutdown.

### Remedy

- Use separate cables for F-DI modules and F-DO modules or standard DO modules driven by a PM-E F pm DC24V PROFIsafe
- Coupling relay or diodes in the outputs
- Turn off the sensor supply test if this is permitted by the required safety class (safety integrity level).

## See also

Assigning Modules of an ET 200S (Page 2-4)

Properties of the 4 F-DO DC24V/2A PROFIsafe digital electronic module (Page 7-80)

## 7.2.2 Terminal assignment of the PM-E F pm DC24V PROFIsafe

### Incoming Supply of the 24 VDC Supply for Electronic Modules with Process-Related Functions

Depending on whether the electronic and load current supplies are electrically isolated in the electronic modules with process-related functions (positioning, counting), you must adhere to the following wiring instructions:

- If electrically isolated, provide an external 24 VDC feed for the electronic module.
- If electrical isolation is not implemented, you must supply the electronic module from the voltage bus P1 of the PM-E F pm 24 VDC PROFIsafe power module.

AK4/SIL2/Category 3 is attainable in both cases.

### Front View

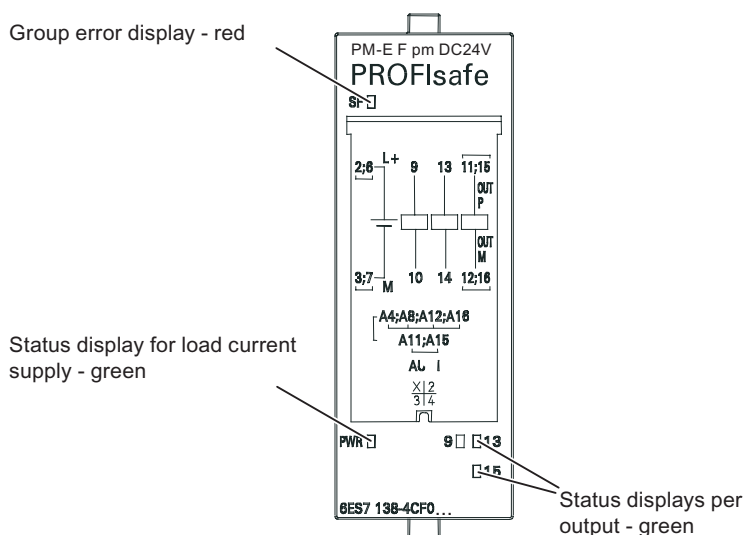


Figure 7-3 Front view of the PM-E F pm DC24V PROFIsafe



### Warning

The SF LED and the status displays of the outputs must not be evaluated for safety-related activities.

## Terminal assignment

The terminal assignment of the PM-E F pm DC 24 V PROFIsafe power module for the usable terminal modules TM-P30S44-A0 and TM-P30C44-A0 is shown in the following figure and table.

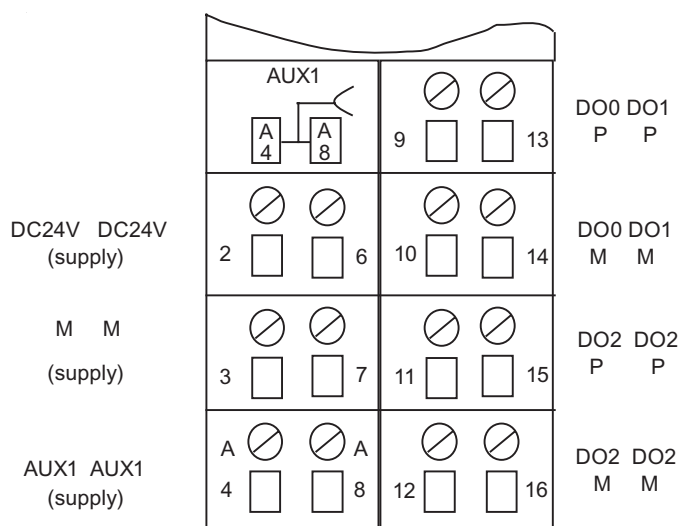


Figure 7-4 Terminal Assignment of the TM-P30S44-A0 or TM-P30C44-A0 for PM-E F pm DC 24V PROFIsafe

Table 7-3 Table-Terminal Assignment of the TM-P30S44-A0 or TM-P30C44-A0

| Terminal |        | Designation                                                                                                                                                                                                       |
|----------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2        | 24 VDC | 24 VDC rated load voltage for: <ul style="list-style-type: none"> <li>• Inserted power module,</li> <li>• Corresponding voltage group,</li> <li>• DO 0 and DO 1 and</li> <li>• Voltage buses P1 and P2</li> </ul> |
| 3        | M      | Ground                                                                                                                                                                                                            |
| A<br>4   | AUX 1  | Any terminal for PE or voltage bus up to the maximum rated load voltage of the module                                                                                                                             |
| 6        | 24 VDC | 24 VDC rated load voltage for: <ul style="list-style-type: none"> <li>• Inserted power module,</li> <li>• Corresponding voltage group,</li> <li>• DO 0 and DO 1</li> <li>• and voltage buses P1 and P2</li> </ul> |
| 7        | M      | Ground                                                                                                                                                                                                            |
| A<br>8   | AUX 1  | Any terminal for PE or voltage bus up to the maximum rated load voltage of the module                                                                                                                             |
| 9        | DO 0 P | Terminals for fail-safe digital output 0 (P/M switching)                                                                                                                                                          |
| 10       | DO 0 M |                                                                                                                                                                                                                   |
| 11       | DO 2 P | Terminals (relay contacts) for fail-safe switching of voltage buses P1 and P2<br>P1 and P2 can also be used as DO 2 M and DO 2 P                                                                                  |
| 12       | DO 2 M |                                                                                                                                                                                                                   |
| 13       | DO 1 P | Terminals for fail-safe digital output 1 (P/M switching)                                                                                                                                                          |
| 14       | DO 1 M |                                                                                                                                                                                                                   |
| 15       | DO 2 P | Terminals (relay contacts) for fail-safe switching of voltage buses P1 and P2<br>P1 and P2 can also be used as DO 2 M and DO 2 P                                                                                  |
| 16       | DO 2 M |                                                                                                                                                                                                                   |

**Caution**

If strong currents can occur on DO 2 P and DO 2 M, both terminals 11 and 15 (DO 2 P) and terminals 12 and 16 (DO 2 M) must be wired in parallel.

Otherwise, the current loading could cause the terminals to heat up.

### 7.2.3 Wiring of the PM-E F pm DC24V PROFIsafe

#### Block Diagram

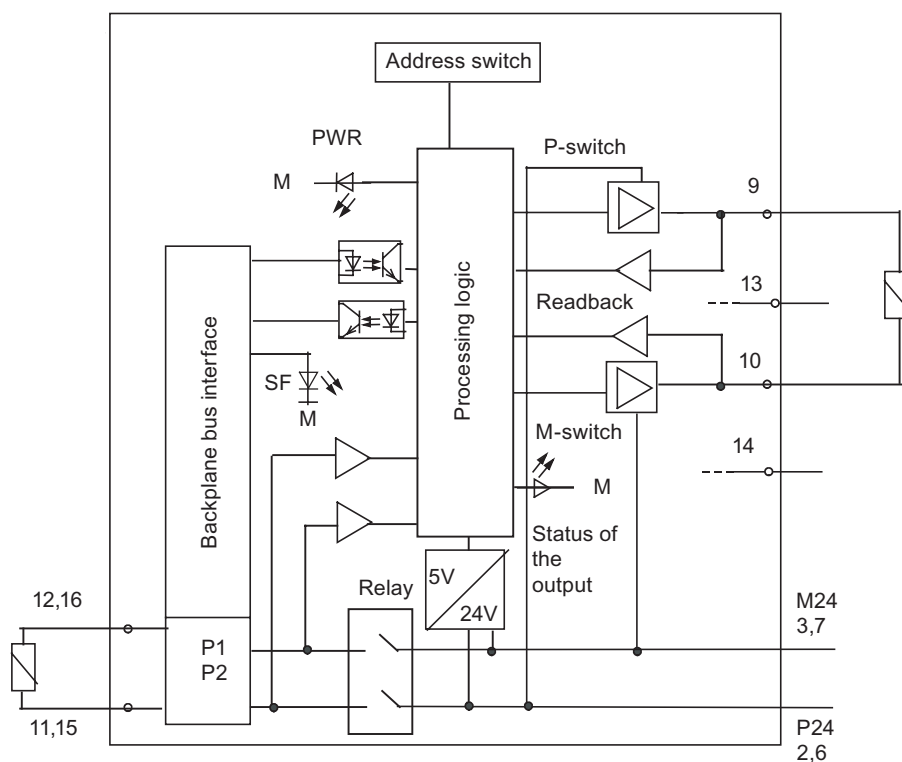


Figure 7-5 Block Diagram of the PM-E F pm DC24V PROFIsafe

## Wiring Diagram

Each of the three digital outputs consists of a DOx P P-switch and a DOx M M-switch. They connect the load between P and M-switches. The two switches are always controlled so that voltage is applied to the load.

The wiring for the power module is carried out on the special terminal module.

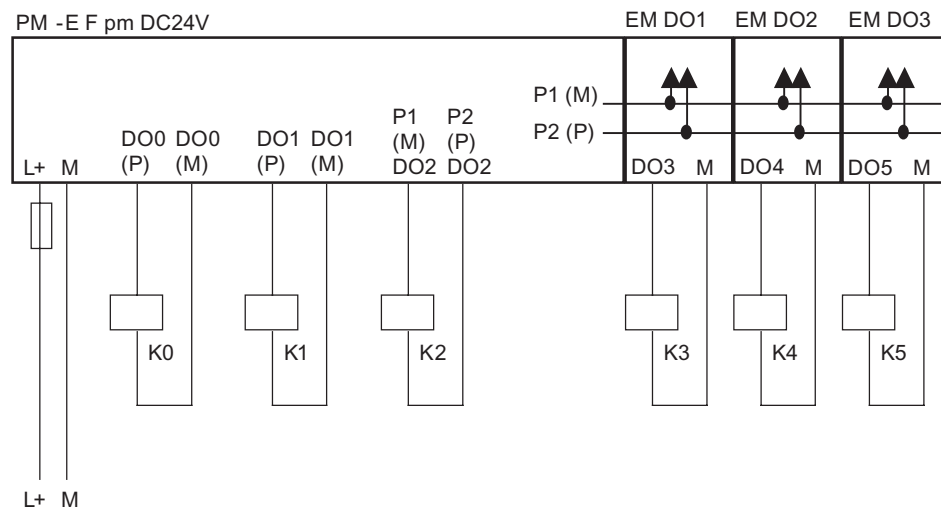


Figure 7-6 Wiring diagram of the PM-E F pm DC24V PROFIsafe



### Warning

Please use an external fuse for L+ at the PM-E F pm with the following properties to protect the relay contact from overload: circuit-breaker of B characteristic as per IEC 947-5-1, 10 A.

## Relay Output DO 2

The relay output DO 2 connects the voltage L+ and M using one relay contact for each. The voltage is fed outwards to the terminal module and to the internal voltage buses P1 and P2. This results in two connection options that can be used at the same time:

- A load can be connected directly to the terminal module (K2 in the figure above).
- Electronic modules can be supplied by means of the internal voltage buses P1 and P2. Loads can be connected to these modules in turn (K3, K4, K5 in the figure above).

## Connection of Two Relays on One Digital Output

You can connect two relays using one fail-safe digital output. The following conditions should be kept in mind:

- L+ and M of the relays must be connected with L+ and M of the PM-E F pm (the same reference potential is necessary).
- The normally open contacts of the two relays must be connected in series.

This connection can only be made on digital outputs DO 0 and DO 1 (not DO 2). With this circuit, you achieve:

- AK6/SIL3/Category 4 without standard DO modules on P1 and P2
- AK4/SIL2/Category 3 with standard DO modules on P1 and P2

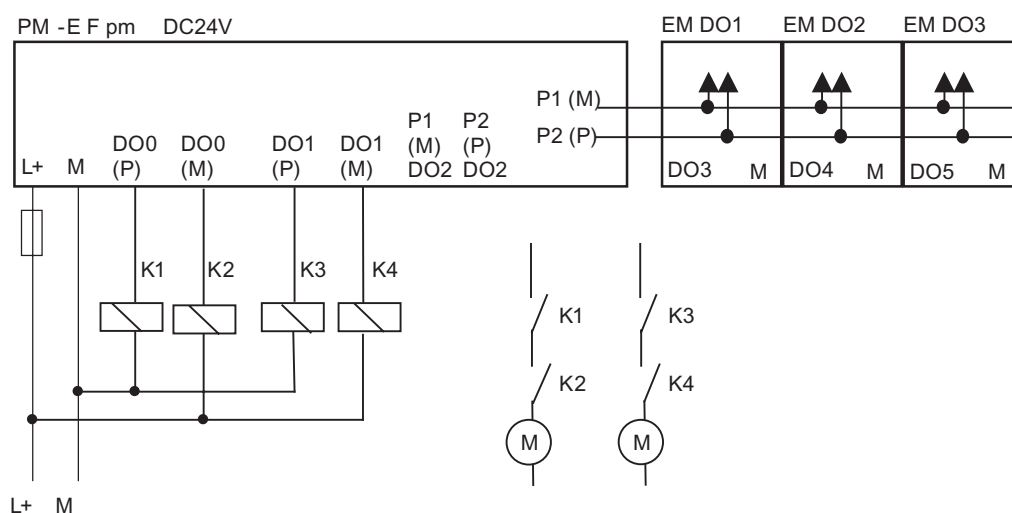


Figure 7-7 Wiring Diagram for Each of Two Relays on DO 0 and DO 1 of the PM-E F pm DC24V PROFIsafe



### Warning

When connecting two relays to one digital output (as shown above), the "wire break" and "overload" faults are only detected at the output P-switch (not at the M-switch).



### Warning

In the event of a cross circuit between the output P and M-switch the controlled actuator is no longer switched off. To avoid cross circuits between P and M-switches of a fail-safe digital output, you should connect the relay on the between P and M-switches to protect against cross circuits (for example with cables separately sheathed or in a separate cable duct).

**Note**

The PM-E F pm DC24V PROFIsafe performs a bit pattern test approximately every 15 minutes. The module generates a max. 4 ms pulse for this. This test is performed time staggered between the P and M switch, so that the actuator is not activated. However, the pulse may be picked up by respective relay, which can result in a reduced service life for the relay.

We therefore recommend the wiring scheme described in the following.

**Avoiding/Dealing with Cross Circuits**

To protect against cross circuits between P and M-switches of a fail-safe digital output, we recommend the following wiring schemes:

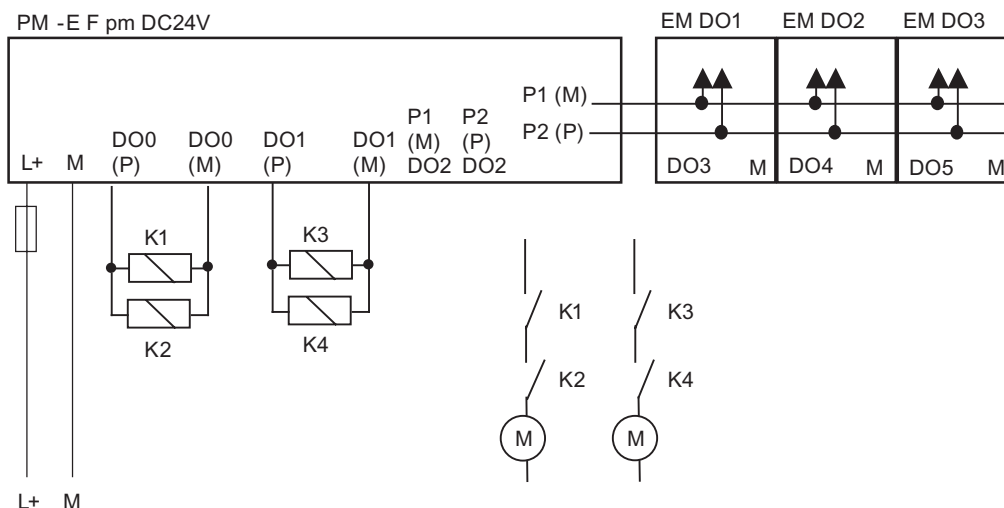


Figure 7-8 Wiring Diagram for Each of Two Relays on DO 0 and DO 1 of the PM-E F pm DC24V PROFIsafe

**Note**

With parallel connection of two relays to one digital output (as shown above), the "wire break" fault is only detect if the wire break disconnects both relays from P or M. This diagnosis is not safety-relevant.

## 7.2.6 Technical Specifications for PM-E F pm 24 VDC PROFIsafe

### Overview

| Technical Specifications                                                    |                                                                                          |
|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| <b>Dimensions and Weight</b>                                                |                                                                                          |
| Dimensions W x H x D (mm)                                                   | 30 x 81 x 52                                                                             |
| Weight                                                                      | Approx. 88 g                                                                             |
| <b>Data for Specific Module</b>                                             |                                                                                          |
| Number of outputs                                                           |                                                                                          |
| • Semiconductor outputs (P-M switching)                                     | 2                                                                                        |
| • Relay outputs (P-M switching)                                             | 1                                                                                        |
| Assigned address area                                                       |                                                                                          |
| • In the I/O area for inputs                                                | 5 Byte                                                                                   |
| • In the I/O area for outputs                                               | 5 Byte                                                                                   |
| Length of cable*                                                            |                                                                                          |
| • Unshielded                                                                | 200 m, maximum                                                                           |
| • Shielded                                                                  | 200 m, maximum                                                                           |
| Maximum achievable safety class                                             |                                                                                          |
| • In accordance with IEC 61508, DIN VDE 0801, and EN 954                    | Max. SIL3, AK6, Category 4 (for conditions see "PM-E F pm DC24V PROFIsafe Power Module") |
| Fail-safe performance characteristics                                       | SIL3                                                                                     |
| • Low demand mode (average probability of failure on demand)                | < 1,00E-05                                                                               |
| • High demand/continuous mode (probability of a dangerous failure per hour) | < 1,00E-05                                                                               |
| <b>Voltages, Currents, Potentials</b>                                       |                                                                                          |
| Rated supply voltage L+                                                     | 24 VDC                                                                                   |
| • Permissible range                                                         | 20.4 V to 28.8 V                                                                         |
| • Power loss ride-through of L+                                             | None                                                                                     |
| • Power loss ride-through of internal P5                                    | 5 ms                                                                                     |
| • Reverse polarity protection                                               | No                                                                                       |
| Aggregate current                                                           |                                                                                          |
| • Horizontal installation                                                   |                                                                                          |
| – Up to 40 °C                                                               | 10 A                                                                                     |
| – Up to 55 °C                                                               | 7 A                                                                                      |
| – Up to 60 °C                                                               | 6 A                                                                                      |
| • Vertical installation                                                     |                                                                                          |
| – Up to 40 °C                                                               | 6 A                                                                                      |
| Electrical isolation                                                        |                                                                                          |
| • Between channels and backplane bus                                        | Yes                                                                                      |
| • Between channels and power supply                                         | No                                                                                       |
| • Between channels                                                          | No                                                                                       |
| • Between channels/power supply and shield                                  | Yes                                                                                      |

| Technical Specifications                                                         |                                                                                                                                                            |
|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Permissible potential difference between                                         |                                                                                                                                                            |
| • Shield and ET 200S bus connection                                              | 75 VDC/60 VAC                                                                                                                                              |
| • Shield and I/O (DOs, P1/P2 buses)                                              | 75 VDC/60 VAC                                                                                                                                              |
| • ET 200S bus connection and I/O (DOs, P1/P2 buses)                              | 250 VAC                                                                                                                                                    |
| Isolation in the series tested with                                              |                                                                                                                                                            |
| • Shield and ET 200S bus connection                                              | 500 VDC/1 min or 600 VDC/1 s                                                                                                                               |
| • Shield and I/O (DOs, P1/P2 buses)                                              | 500 VDC/1 min or 600 VDC/1 s                                                                                                                               |
| • ET 200S bus connection and I/O (DOs, P1/P2 buses)                              | 1500 VAC/1 min or 2545 VDC/1 s                                                                                                                             |
| Isolation in the type test tested with                                           |                                                                                                                                                            |
| • Shield and ET 200S bus connection                                              | 350 VAC/1 min                                                                                                                                              |
| • Shield and I/O (DOs, P1/P2 buses)                                              | 350 VAC/1 min                                                                                                                                              |
| • ET 200S bus connection and I/O (DOs, P1/P2 buses)                              | 2830 VAC/1 min                                                                                                                                             |
| • Impulse current test between ET 200S bus connection and I/O (DOs, P1/P2 buses) | 6000 VDC/5 positive and 5 negative pulses                                                                                                                  |
| Current consumption                                                              |                                                                                                                                                            |
| • From backplane bus                                                             | 28 mA, maximum                                                                                                                                             |
| • From load voltage L+ (without load)                                            | 100 mA, typical                                                                                                                                            |
| Power dissipation of the module                                                  | 4 W, typical                                                                                                                                               |
| <b>Status, Interrupts, Diagnostics</b>                                           |                                                                                                                                                            |
| Status display                                                                   | <ul style="list-style-type: none"> <li>• Green LED per channel</li> <li>• Green LED for the load voltage</li> </ul>                                        |
| Diagnostic functions                                                             |                                                                                                                                                            |
| • Group fault display                                                            | Red LED (SF)                                                                                                                                               |
| • Diagnostic information can be displayed                                        | Possible                                                                                                                                                   |
| <b>Data for Selecting an Actuator for the Semiconductor Outputs**</b>            |                                                                                                                                                            |
| Output voltage                                                                   |                                                                                                                                                            |
| • For "1" signal                                                                 | <ul style="list-style-type: none"> <li>• Minimum L+ (-2.0 V)</li> <li>• P-switch: minimum L+ (-1.5 V), voltage drop in M-switch: 0.5 V, maximum</li> </ul> |
| Output current for "1" signal                                                    |                                                                                                                                                            |
| • Rated value                                                                    | 2 A                                                                                                                                                        |
| • Permissible range                                                              | 20 mA to 2.4 A                                                                                                                                             |
| For "0" signal (residual current)                                                | 0.5 mA, maximum                                                                                                                                            |
| Indirect control of load by means of interface relay:                            |                                                                                                                                                            |
| Residual current for "0" signal                                                  |                                                                                                                                                            |
| • P-Switch                                                                       | 0.5 mA, maximum                                                                                                                                            |
| • M-Switch                                                                       | 4 mA, maximum                                                                                                                                              |
| Load resistance range                                                            | 12 $\Omega$ to 1 k $\Omega$                                                                                                                                |
| Lamp load                                                                        | 10 W, maximum                                                                                                                                              |

| Technical Specifications                                            |                                                                      |                                   |
|---------------------------------------------------------------------|----------------------------------------------------------------------|-----------------------------------|
| Wire break monitoring (open load detection) and overload monitoring |                                                                      |                                   |
| • Response threshold                                                | I < 4 to 19 mA                                                       |                                   |
| • Fault detection time                                              | Depending on the selected readback time (see <i>Response Times</i> ) |                                   |
| Parallel connection of 2 outputs                                    |                                                                      | Not possible                      |
| Control of a digital input                                          |                                                                      | Not possible                      |
| Switching frequency                                                 |                                                                      |                                   |
| • With resistive load                                               | 30 Hz symmetrical, maximum                                           |                                   |
| • With inductive load in accordance with IEC 947-5-1, DC13          | 0.1 Hz symmetrical, maximum                                          |                                   |
| • With lamp load                                                    | 10 Hz symmetrical, maximum                                           |                                   |
| Voltage induced on current interruption limited to                  |                                                                      |                                   |
| • Semiconductor outputs                                             | L+ (-2x 47 V)                                                        |                                   |
| • Relay outputs                                                     | P1/P2 (1 V)                                                          |                                   |
| Short-circuit protection of semiconductor outputs                   |                                                                      | Yes, electronic                   |
| • Response threshold of short circuit                               | 5 A to 12 A                                                          |                                   |
| • Response threshold (external M-short circuit)                     | 5 A to 12 A                                                          |                                   |
| • Response threshold (external P-short circuit)                     | 25 A to 45 A                                                         |                                   |
| Overload protection of semiconductor outputs                        |                                                                      | Yes                               |
| • Response threshold                                                | I >2.6 A to 2.8 A                                                    |                                   |
| Data for Selecting an Actuator for the Relay Outputs**              |                                                                      |                                   |
| Switching capacity and service life of contacts (voltage 24 VDC)    |                                                                      |                                   |
| • Mechanical endurance (without load)                               | Current                                                              | Number of switching cycles (typ.) |
|                                                                     | 0 A                                                                  | 10 million                        |
| • For resistive load                                                | Current                                                              | Number of switching cycles (typ.) |
|                                                                     | 10 A                                                                 | 0.23 million                      |
|                                                                     | 8 A                                                                  | 0.3 million                       |
|                                                                     | 6 A                                                                  | 0.38 million                      |
|                                                                     | 4 A                                                                  | 0.5 million                       |
|                                                                     | 2 A                                                                  | 1.0 million                       |
|                                                                     | 1 A                                                                  | 2.0 million                       |
| • For inductive load in accordance with IEC 947-5-1, DC13           | Current                                                              | Number of switching cycles (typ.) |
|                                                                     | 10 A                                                                 | 0.1 million                       |
|                                                                     | 8 A                                                                  | 0.15 million                      |
|                                                                     | 6 A                                                                  | 0.2 million                       |
|                                                                     | 4 A                                                                  | 0.3 million                       |
|                                                                     | 2 A                                                                  | 0.5 million                       |
|                                                                     | 1 A                                                                  | 1.0 million                       |
| • For lamp load                                                     | Power                                                                | Number of switching cycles (typ.) |
|                                                                     | 100 W                                                                | 0.12 million                      |

| Technical Specifications                                                                                                                 |                                                                                                            |
|------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Contact protection (internal)                                                                                                            | Internal readback circuit                                                                                  |
| • Between P and M relay output                                                                                                           | 39 V suppressor diode                                                                                      |
| Wire break monitoring                                                                                                                    | No                                                                                                         |
| Parallel connection of 2 outputs                                                                                                         | Not possible                                                                                               |
| Control of a digital input                                                                                                               | Not possible                                                                                               |
| Switching frequency                                                                                                                      |                                                                                                            |
| • With resistive load                                                                                                                    | 2 Hz, maximum                                                                                              |
| • With inductive load in accordance with IEC 947-5-1, DC13                                                                               | 0.1 Hz, maximum                                                                                            |
| • With lamp load                                                                                                                         | 2 Hz, maximum                                                                                              |
| Short-circuit protection of output                                                                                                       | No, external miniature circuit breaker, "B" characteristic (in accordance with IEC 947-5-1), 10 A required |
| <b>Time, Frequency</b>                                                                                                                   |                                                                                                            |
| Internal preparation times                                                                                                               | See <i>Response Times</i>                                                                                  |
| Acknowledgment time in safety mode                                                                                                       | 4 ms minimum/8 ms maximum                                                                                  |
| <b>Protection against Overvoltage</b>                                                                                                    |                                                                                                            |
| Protection of supply voltage L+ from surge in accordance with IEC 61000-4-5 with external protection elements only                       |                                                                                                            |
| • Symmetrical (L+ to M)                                                                                                                  | + 1 kV; 1,2/50 µs                                                                                          |
| • Asymmetrical (L+ to PE, M to PE)                                                                                                       | +2 kV; 1,2/50 µs                                                                                           |
| Protection of outputs from surge in accordance with IEC 61000-4-5 with external protection elements only                                 |                                                                                                            |
| Symmetrical (DO to M)                                                                                                                    | + 1 kV; 1,2/50 µs                                                                                          |
| Asymmetrical (DO to PE, M to PE)                                                                                                         | + 1 kV; 1,2/50 µs                                                                                          |
| *: In order to achieve the specified cable length, you must route the P- and M-signal lines in a cable or a non-metallic sheathed cable. |                                                                                                            |
| **: For more information on the requirements for sensors and actuators see <i>Wiring and Installing Modules</i> .                        |                                                                                                            |

## Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, solutions, machines, equipment and/or networks. They are important components in a holistic industrial security concept. With this in mind, Siemens' products and solutions undergo continuous development. Siemens recommends strongly that you regularly check for product updates.

For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action (e.g. cell protection concept) and integrate each component into a holistic, state-of-the-art industrial security concept. Third-party products that may be in use should also be considered. You can find more information about industrial security on the Internet (<http://www.siemens.com/industrialsecurity>).

To stay informed about product updates as they occur, sign up for a product-specific newsletter. You can find more information on the Internet (<http://support.automation.siemens.com>).

## PFDavg and PFH values for components with use in SIMATIC Safety, Distributed Safety and F/FH Systems

This product information contains **important information on the F-systems SIMATIC Safety, Distributed Safety and F/FH Systems**. The Product Information is part of the product supplied.

### PFDavg and PFH values

The following tables contain the PFDavg and PFH values for individual components with use in SIMATIC Safety (S), Distributed Safety (D) and F/FH Systems (F) with a repair time of 100 hours:

| F-CPU S7-1200/1500 | Operation in low demand mode<br>low demand mode<br>According to IEC 61508:2010:<br>PFDavg = Average probability of a dangerous failure on demand | Operation in high demand or continuous mode<br>high demand/continuous mode<br>According to IEC 61508:2010:<br>PFH = Average frequency of a dangerous failure [h <sup>-1</sup> ] | With a mission time of | S | D | F |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---|---|---|
| For all F-CPU S    | < 2E-05                                                                                                                                          | < 1E-09                                                                                                                                                                         | 20 years               | x | - | - |

| <b>F-I/O ET 200SP</b>       | <b>Article number</b> | <b>Operation in low demand mode</b><br>low demand mode<br><b>According to IEC 61508:2010:</b><br><b>PFD<sub>avg</sub> = Average probability of a dangerous failure on demand</b> | <b>Operation in high demand or continuous mode</b><br>high demand/continuous mode<br><b>According to IEC 61508:2010:</b><br><b>PFH = Average frequency of a dangerous failure [h<sup>-1</sup>]</b> | <b>With a mission time of</b> | <b>S</b> | <b>D</b> | <b>F</b> |
|-----------------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------|----------|----------|
| F-DI 8x24VDC HF             | 6ES7136-6BA00-0CA0    | SIL 3: < 2E-05                                                                                                                                                                   | SIL 3: < 1E-09                                                                                                                                                                                     | 20 years                      | x        | x        | -        |
| F-DQ 4x24VDC/2A PM HF       | 6ES7136-6DB00-0CA0    | SIL 3: < 2E-05                                                                                                                                                                   | SIL 3: < 1E-09                                                                                                                                                                                     | 20 years                      | x        | x        | -        |
| F-PM-E 24VDC/8A PPM ST      | 6ES7136-6PA00-0BC0    | SIL 3: < 2E-05                                                                                                                                                                   | SIL 3: < 1E-09                                                                                                                                                                                     | 20 years                      | x        | x        | -        |
| F-RQ 1x24VDC/24..230V AC/5A | 6ES7136-6RA00-0BF0    | SIL 2: < 1E-04, with function test 1x per year                                                                                                                                   | SIL 2: < 1E-08, with function test 1x per year                                                                                                                                                     | 20 years                      | x        | x        | -        |
|                             |                       | SIL 3: < 1E-05, with function test 1x per month                                                                                                                                  | SIL 3: < 6E-09, with function test 1x per month                                                                                                                                                    | 20 years                      | x        | x        | -        |

| <b>F-I/O ET 200S</b>          | <b>Article number</b> | <b>Operation in low demand mode</b><br>low demand mode (PFD = average probability of failure on demand) | <b>Operation in high demand or continuous mode</b><br>high demand/continuous mode (PFH = probability of a dangerous failure per hour) | <b>With a mission time of</b> | <b>S</b> | <b>D</b> | <b>F</b> |
|-------------------------------|-----------------------|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------|----------|----------|
| 4/8 F-DI DC24V PROFIsafe      | 6ES7138-4FA03-0AB0    | SIL 2: < 1E-03<br>SIL 3: < 1E-05                                                                        | SIL 2: < 1E-08<br>SIL 3: < 1E-10                                                                                                      | 20 years                      | x        | x        | x        |
|                               | 6ES7138-4FA04-0AB0    | SIL 2: < 1E-03<br>SIL 3: < 1E-05                                                                        | SIL 2: < 1E-08<br>SIL 3: < 1E-10                                                                                                      | 20 years                      | x        | x        | x        |
|                               | 6ES7138-4FA05-0AB0    | SIL 2: < 1E-03<br>SIL 3: < 1E-05                                                                        | SIL 2: < 1E-08<br>SIL 3: < 1E-10                                                                                                      | 20 years                      | x        | x        | x        |
| 4 F-DO DC24V/2A PROFIsafe     | 6ES7138-4FB02-0AB0    | SIL 3: < 1E-05                                                                                          | SIL 3: < 1E-10                                                                                                                        | 20 years                      | x        | x        | x        |
|                               | 6ES7138-4FB03-0AB0    | SIL 3: < 1E-05                                                                                          | SIL 3: < 1E-10                                                                                                                        | 20 years                      | x        | x        | x        |
|                               | 6ES7138-4FB04-0AB0    | SIL 3: < 1E-05                                                                                          | SIL 3: < 1E-10                                                                                                                        | 20 years                      | x        | x        | x        |
| 4 F-DI/3 F-DO DC24V PROFIsafe | 6ES7138-4FC00-0AB0    | SIL 2: < 1E-04                                                                                          | SIL 2: < 1E-08                                                                                                                        | 20 years                      | x        | x        | x        |
|                               | 6ES7138-4FC01-0AB0    | SIL 2: < 1E-04                                                                                          | SIL 2: < 1E-08                                                                                                                        | 20 years                      | x        | x        | x        |
| PM-E F pm DC24V PROFIsafe     | 6ES7138-4CF02-0AB0    | SIL 3: < 1E-05                                                                                          | SIL 3: < 1E-10                                                                                                                        | 20 years                      | x        | x        | x        |
|                               | 6ES7138-4CF03-0AB0    | SIL 3: < 1E-05                                                                                          | SIL 3: < 1E-10                                                                                                                        | 20 years                      | x        | x        | x        |
| PM-E F pp DC24V PROFIsafe     | 6ES7138-4CF41-0AB0    | SIL 3: < 1E-05                                                                                          | SIL 3: < 1E-10                                                                                                                        | 20 years                      | x        | x        | x        |
|                               | 6ES7138-4CF42-0AB0    | SIL 3: < 1E-05                                                                                          | SIL 3: < 1E-10                                                                                                                        | 20 years                      | x        | x        | x        |
| 1 F-RO DC24V/AC24..230V /5A   | 6ES7138-4FR00-0AA0    | SIL 3: < 1E-05                                                                                          | SIL 3: < 1E-09                                                                                                                        | 20 years                      | x        | x        | x        |

|                                                                                                                                                    |                                                                                                                                                                                  |                                                                                                                                                                                                    |                               |          |          |          |
|----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------|----------|----------|
| <b>Fail-safe GSD based DP slaves</b><br><b>Fail-safe GSD based IO devices</b><br><b>Fail-safe PA field devices</b><br><b>Fail-safe HMI devices</b> | <b>Operation in low demand mode</b><br>low demand mode<br><b>According to IEC 61508:2010:</b><br><b>PFD<sub>avg</sub> = Average probability of a dangerous failure on demand</b> | <b>Operation in high demand or continuous mode</b><br>high demand/continuous mode<br><b>According to IEC 61508:2010:</b><br><b>PFH = Average frequency of a dangerous failure [h<sup>-1</sup>]</b> | <b>With a mission time of</b> | <b>S</b> | <b>D</b> | <b>F</b> |
| <b>Fail-safe GSD based DP slaves:</b> See Technical Data for fail-safe GSD based DP slave                                                          |                                                                                                                                                                                  |                                                                                                                                                                                                    |                               |          |          |          |
| <b>Fail-safe GSD based IO devices:</b> See Technical Data for fail-safe GSD based IO device                                                        |                                                                                                                                                                                  |                                                                                                                                                                                                    |                               |          |          |          |
| <b>Fail-safe PA field devices:</b> See Technical Data for fail-safe PA field device                                                                |                                                                                                                                                                                  |                                                                                                                                                                                                    |                               |          |          |          |
| <b>Fail-safe HMI devices:</b> See technical specifications on the fail-safe HMI device                                                             |                                                                                                                                                                                  |                                                                                                                                                                                                    |                               |          |          |          |
| <b>Other fail-safe devices:</b> See technical specifications on the fail-safe device                                                               |                                                                                                                                                                                  |                                                                                                                                                                                                    |                               |          |          |          |

#### Determine the contribution of the F-system to the PFD<sub>avg</sub> and PFH values

The contribution of the fail-safe system to the PFD<sub>avg</sub> and PFH values of a safety function is determined by adding the PFD<sub>avg</sub>- and PFH values of the F-CPU and F-I/Os involved.

The contribution of the safety-related communication is added to this. Please note that several F-systems can be involved in a safety function.

You determine the PFD<sub>avg</sub> and PFH values of a safety function by adding the contribution of the fail-safe system to the contribution of the encoders and actuators involved in the safety function.

#### Calculation example

A safety function is implemented with a SIMATIC Safety F-system. The F-CPU and F-I/O listed in the following table are involved in the safety function.

20 years was selected as the mission time. The fail-safe signal modules operate in safety mode for SIL3/Kat.4/PL<sub>e</sub>. Operation is in high demand mode:

| <b>F-CPU, F-SMs and safety-related communication involved in the safety function</b> | <b>Quantity</b> | <b>Probability of a dangerous failure per hour</b> |
|--------------------------------------------------------------------------------------|-----------------|----------------------------------------------------|
| CPU 319F-3 PN/DP<br>6ES7318-3FL01-0AB0                                               | 1               | 3E-09                                              |
| SM 326; DO 10 × DC 24V/2A<br>6ES7326-2BF01-0AB0                                      | 1               | 1E-09                                              |
| SM 326; DI 24 × DC 24V<br>6ES7326-1BK02-0AB0                                         | 2               | 2E-09                                              |
| Safety-related communication                                                         |                 | 1E-09                                              |
| <b>Total</b>                                                                         |                 | <b>7E-09</b>                                       |

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A5E03310062-AE, 10/2015