SIEMENS

SIMATIC

ET 200eco Distributed I/O Station - Fail-Safe I/O Module

Operating Instructions

Legal information

Warning notice system

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.

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

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

> ⚠ **CAUTION**
>
> indicates that minor personal injury can result if proper precautions are not taken.

> **NOTICE**
>
> indicates that property damage can result if proper precautions are not taken.

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 product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

> ⚠ **WARNING**
>
> Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

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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 ET 200eco fail-safe I/O module.

Basic knowledge requirements

This manual is a supplement to the *ET 200eco Distributed I/O Device* 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 200eco distributed I/O device.

Scope of this manual

Module	Order number	Release number and higher
Digital I/O module 4/8 F-DI DC24V PROFIsafe	6ES7 148-3FA00-0XB0	01

Approvals

You will find the approvals in the chapter on standards and approvals.

The fail-safe ET 200eco I/O module also certified for use in safety mode up to:

- Safety Integrity Level SIL3 according to IEC 61508:2000
- Performance level (PL) e and category 4 according to ISO 13849-1:2006 or EN ISO 13849-1:2008

CE approval

You will find the CE approval in the chapter on standards and approvals.

Certification Mark for Australia (C-Tick Mark)

You will find the mark for Australia in the chapter on standards and approvals.

Standards

You will find the standards in the chapter on standards and approvals.

Position in the information landscape

When working with the ET 200eco fail-safe I/O module, you will need to consult the supplementary documentation listed below depending on your particular application.

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

Documentation	Brief description of relevant contents
ET 200eco Distributed I/O Device manual	• Describes all general aspects of the ET 200eco hardware (including assembly, installation and wiring of the ET 200eco)
Safety Engineering in SIMATIC S7 system description	• Provides an overview of the use, configuration, and principle of operation of S7 Distributed Safety and S7 F/FH fail-safe automation systems • Contains a summary of detailed technical information concerning fail-safe engineering in S7-300 and S7-400 • Includes monitoring and response time calculations for S7 Distributed Safety and S7 F/FH fail-safe systems
For integration in the S7 F/FH fail-safe system	• The *S7 F/FH Automation Systems* manual describes the tasks that must be performed to create and commission an S7 F/FH fail-safe system. • The *S7-400, M7-400 Programmable Controllers Hardware and Installation* manual describes the installation and assembly of S7-400 systems. • The *S7-400H Programmable Controllers*, Fault-Tolerant Systems manual describes the CPU 41x-H central modules and the tasks required to set up and commission an S7-400H fault-tolerant system. • The *CFC for SIMATIC S7* manual/online help provides a description of programming with CFC.

Documentation	Brief description of relevant contents
For integration in the S7 Distributed Safety fail-safe system	The following elements are described in the *S7 Distributed Safety, Configuring and Programming* manual and online help: • Configuration of the F-CPU and the F-I/O • Programming of the fail-safe CPU in fail-safe FBD or LAD. Depending on which F-CPU you are using, you will need the following documentation: • The *CPU data reference manual: CPU 31xC and CPU 31x* describes the standard functions of the CPU 315F-2 DP and the CPU 317F-2 DP. • The product information for CPU 315F-2 DP describes only the deviations from the standard CPU 315-2 DP. • The product information for CPU 317F-2 DP describes only the deviations from the standard CPU 317-2 DP. • The *S7-400, CPU Data* reference manual describes the standard functions of the CPU 416F-2. • The product information for CPU 416F-2 describes only the deviations from the standard CPU 416-2. • The *ET 200S, Interface Module IM 151-7 CPU* manual describes the standard IM 151-7 CPU. • The product information for the IM 151-7 F-CPU describes only the deviations from the standard IM 151-7 CPU. • The *S7-300/M7-300, Module Data* manual describes how to install and wire S7-300 systems. • The *CPU 31xC and CPU 31x, Technical Specifications* manual describes the standard functions of the CPU 315F-2 DP.
STEP 7 manuals	• The *Configuring Hardware and Communication Connections with STEP 7 V5.x* manual describes the operation of the standard tools of STEP 7. • The *System and Standard Functions* reference manual describes functions for distributed I/O access and diagnostics.
STEP 7 online help	• Describes how to operate the standard tools in STEP 7 • Contains information about how to configure and assign parameters to modules and intelligent slaves with *HW Config* • Contains a description of the FBD and LAD programming languages
PCS 7 manuals	• Describe the handling of the PCS 7 control system (required when the fail-safe ET 200eco I/O is integrated in a higher-level control system)

The complete collection of SIMATIC S7 documentation is available on CD-ROM.

Guide

This manual describes the fail-safe 4/8 F-DI I/O module of the ET 200eco distributed I/O device. It consists of instructive sections and reference sections (technical specifications and appendices).

This manual covers the following basic aspects of the fail-safe I/O module:

- Design and use
- Configuration and parameter assignment
- Addressing, assembly, and wiring
- Diagnostic assessment
- Technical specifications
- Order numbers

Conventions

In this manual, the terms "safety engineering" and "fail-safe engineering" are used synonymously. The same applies to the terms "fail-safe" and "F-" and to the terms "fail-safe I/O module" and "ET 200eco 4/8 F-DI".

"*S7 Distributed Safety*" and "*S7 F Systems*" in italics refer to the optional packages for the two F-systems: "S7 Distributed Safety" and "S7 F/FH Systems".

Recycling and disposal

Due to the low levels of pollutants it contains, the fail-safe ET 200eco I/O module can be recycled. For proper recycling and disposal of your old module (device), consult a certified disposal facility for electronic scrap.

Additional support

If you have any additional questions about the use of products presented in this manual, contact your local Siemens representative:

http://www.siemens.com/automation/partner

Training Center

We offer courses to help you get started with the S7 automation system. Contact your regional training center or the central training center in 90327 Nuremberg, Federal Republic of Germany.

Phone: +49 (911) 895–3200

Internet: http://www.sitrain.com

H/F Competence Center:

The H/F Competence Center in Nuremberg offers special workshops on SIMATIC S7 fail-safe and fault-tolerant (high-availability) automation systems. The H/F Competence Center can also provide assistance with onsite configuration, commissioning, and troubleshooting.
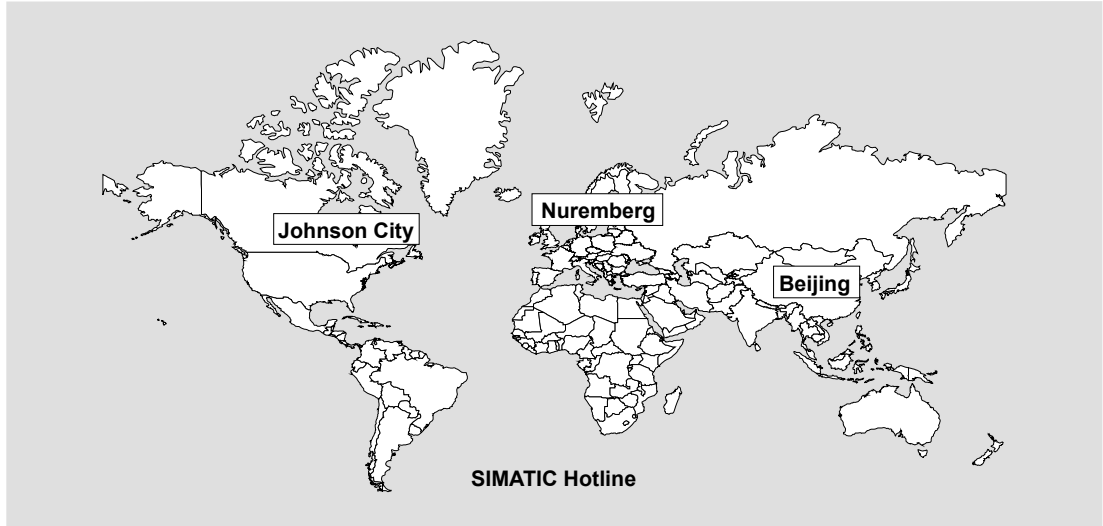
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Fax: +49 (911) 895-5193

For questions about workshops, etc., contact: hf-cc@nbgm.siemens.de

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In general, English and German are spoken by Technical Support and Authorization staff.		

Service & Support on the Internet

In addition to our documentation, we offer our complete knowledge base on the Internet at:

http://www.siemens.com/automation/service&support

There, you will find the following information:

- Newsletters providing the latest information on your products
- The right documentation for you.
- Worldwide forum in which users and experts exchange ideas
- Our contacts database where you can find your local Automation & Drives representative
- Information on local service, repairs, and replacement parts and much more can be found under "Services."

See also

Standards and Approvals (Page 37)

Table of contents

Product Overview

<div style="text-align: right">1</div>

1.1 Maintaining Operational Safety

Important Note for Maintaining Operational Safety of Your System

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Note

The operators of systems with safety-related characteristics must adhere to operational safety requirements. The supplier is also obliged to comply with special product monitoring measures. To keep you informed, a special newsletter is therefore available containing information on product developments and properties that are important (or potentially important) for operating systems where safety is an issue.

By subscribing to the appropriate newsletter, you will ensure that you are always up-to-date and able to make changes to your system, when necessary. Please connect to the following Internet address http://my.ad.siemens.de/myAnD/guiThemes2Select.asp?subjectID=2&lang=en and register for the following Newsletter:

– SIMATIC S7-300

– SIMATIC S7-400

– Distributed I/O

– SIMATIC Industrial Software

To receive these newsletters, select the "Updates" check box.

1.2 Using the Fail-Safe ET 200eco I/O Module

What is a fail-safe automation system?

Fail-safe automation systems (F-systems) are used in systems with higher-level safety requirements. F-systems are used to control systems having a safe state immediately after shutdown. In other words, F-systems control processes in which an immediate shutdown does not endanger humans or the environment.

What is the ET 200eco distributed I/O device?

The ET 200eco distributed I/O device is a compact DP slave in PROFIBUS DP and can consist of one fail-safe I/O module.

You can use copper cables to configure PROFIBUS-DP chains.

What is a fail-safe I/O module?

The essential difference between the fail-safe I/O module and standard ET 200eco I/O modules is that it has an internal two-channel design. The two integrated processors monitor each other, automatically test the input and output circuits, and switch the F-I/O module to a safe state in the event of a fault. The F-CPU communicates with the F-I/O module using the PROFIsafe safety-oriented bus profile.

Possible Uses of the Fail-Safe ET 200eco I/O Module

The use of ET 200eco fail-safe I/O modules allows conventional configurations in safety engineering to be replaced with PROFIBUS-DP components. This includes replacement of switching devices for emergency stop, protective door monitors, two-hand operation, etc.

Use in F-systems

Fail-safe ET 200eco I/O modules can be used as follows:

- In the S7 Distributed Safety F-system with the *S7 Distributed Safety* optional package as of version V 5.2
- In S7 F/FH systems with the *S7 F Systems* optional package as of version V 5.2

The *F Configuration Pack* V 5.3 Service Pack 2 or higher must be installed.

When using fail-safe ET 200eco I/O modules in F-systems, the information in the following manuals applies:

- *ET 200eco Distributed I/O device*
- *Safety Engineering in SIMATIC S7*
- *S7 Distributed Safety, Configuration and Programming or Programmable Controllers S7 F/FH Systems*

Example: Fail-Safe System with the Fail-Safe ET 200eco I/O Module

The following figure represents an example of a configuration for an S7 Distributed Safety F-system with ET 200eco on PROFIBUS DP.

The fail-safe DP master exchanges safety-related and non-safety-related data with the fail-safe and standard I/O.
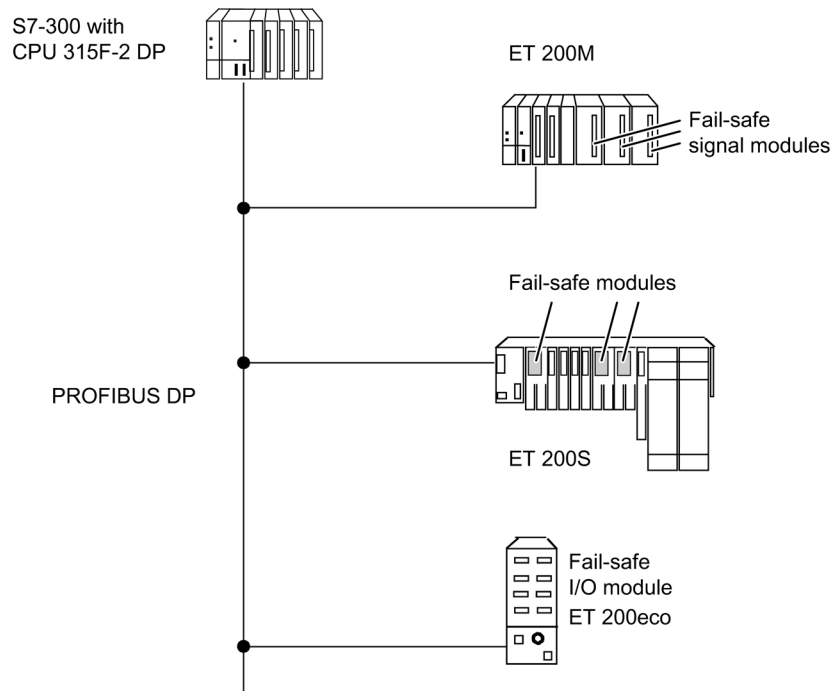

Figure 1-1   S7 Distributed Safety Fail-Safe System

Which fail-safe I/O modules are available?

The following fail-safe ET 200eco I/O module is available:

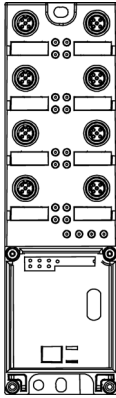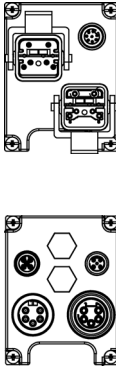- 4/8 F-DI DC24V PROFIsafe digital I/O module

See also

Configuration and Parameter Assignment (Page 19)

1.3 Components of the Fail-Safe ET 200eco

List of components

The following table provides you with an overview of the most important components of the fail-safe ET 200eco:

Table 1- 1   Components of the fail-safe ET 200eco

Component	Function	Schematic
Fail-safe I/O module ET 200eco 4/8 F-DI DC24V PROFIsafe	You connect the sensors to the fail-safe I/O module and set the PROFIsafe address on it.	
Terminal block	You connect the power supply for the fail-safe I/O module and PROFIBUS DP to the terminal block. The following variants of the terminal block are available: • ECOFAST • M12, 7/8"	

Use in safety mode

The fail-safe I/O module can only be used in safety mode. It cannot be used in standard mode.

Achievable safety classes

The fail-safe I/O module is equipped for safety mode with integrated safety functions.

The following safety classes can be achieved by making suitable parameter settings for the user safety functions in *STEP 7* with the *S7 Distributed Safety* or *S7 F Systems* optional package and by arranging and wiring the sensors accordingly:

Table 1- 2   Achievable safety classes in safety mode

Safety class in safety mode	
According to IEC 61508:2000	According to ISO 13849-1:2006 or EN ISO 13849-1:2008
SIL2	Cat. 3/PLd
SIL3	Cat. 4/PLe

1.4 Guide to Commissioning the Fail-Safe ET 200eco I/O Module on PROFIBUS DP

Introduction

The following table lists all the important steps you need to take to commission the fail-safe ET 200eco distributed I/O module as a DP slave on PROFIBUS DP.

Steps in Commissioning the Fail-Safe ET 200eco I/O Module

Commissioning the fail-safe ET 200eco I/O module involves the following steps:

1. Configuring and assigning parameters to the ET 200eco 4/8 F-DI in *STEP 7*

2. Setting the PROFIsafe address on the ET 200eco 4/8 F-DI

3. Installing the ET 200eco 4/8 F-DI

4. Wiring the ET 200eco 4/8 F-DI

5. Commissioning the ET 200eco 4/8 F-DI on PROFIBUS DP

   For more information, read the *ET 200eco Distributed I/O Station* manual.

6. If commissioning was not successful, run diagnostics on the ET 200eco 4/8 F-DI

   For more information, refer to the *ET 200eco Distributed I/O Station* manual.

   ### Note

   You must configure and assign parameters to the fail-safe I/O module in *STEP 7* before commissioning it.

   This is required because The PROFIsafe address of the fail-safe I/O module is assigned automatically by *STEP 7*. You must set the switches of the failsafe I/O module to this PROFIsafe address **before** installing the module.

See also

Configuration and Parameter Assignment (Page 19)

Installing (Page 23)

Wiring the Fail-Safe I/O Module (Page 27)

Diagnostic Functions of the ET 200eco 4/8 F-DI (Page 76)

Configuration and Parameter Assignment

<div style="text-align:right"># 2</div>

Requirements

One of the following optional packages must be installed in *STEP 7* before you can configure and assign parameters for the fail-safe I/O module.

- *S7 Distributed Safety*, Version V5.2 Service Pack 2 or higher
- *S7 F Systems*, Version V5.2 Service Pack 1 or higher

The following requirements also apply to the ET 200eco 4/8 F-DI:

- *STEP 7* V 5.2 and higher
- *F Configuration Pack* V 5.3 Service Pack 2 and higher

  You can download the *F Configuration Pack* from the Internet at . This ships with the optional packages *S7 Distributed Safety* V 5.2 Service Pack 2 or higher and *S7 F Systems* V 5.2 Service Pack 1 or higher.

Configuring the Fail-Safe I/O Module

Follow the usual procedure with *STEP 7 HW Config* to configure the fail-safe I/O module (in the same way as standard ET 200eco I/O modules).

Setting I/O Module Properties

To set the properties of fail-safe I/O modules:

1. Select the I/O module in *STEP 7 HW Config*.

2. Double-click on the "Slot 1" row of the I/O module or select the "Edit > Object Properties" menu command.

   Parameters are downloaded from the programming device to the F-CPU of the DP master, where they are stored and then transferred to the fail-safe I/O module.

Setting Bus Parameters for PROFIBUS DP

To comply with the values for electromagnetic compatibility, if you are using **transmission rates lower than 6 Mbps**, you must increase the bus parameter "Retry Limit" to at least "3" in your project engineering software (for example, COM PROFIBUS or *STEP 7*). Leave all other bus parameter default settings for the bus profile you are using.

Follow the steps outlined below in *HW Config*:

1. Open the "Network Settings" tab ("General > Properties") in the DP master system.

2. Set "User-defined" in the **Profile**.

3. Select **Bus parameters** and increase the "Retry Limit" from "1" to "3".

4. Exit the **Bus Parameters** dialog with "OK".

5. Open the **Bus Parameters** dialog again.

6. Click the **Recalculate** button.

7. Exit the **Bus Parameters** dialog with "OK".

Note

Remember that following any change to the DP master system (for example: inserting a new DP slave), you must click the **Recalculate** button again in the **Bus Parameters** dialog.

If you change to a transmission rate higher than 6 Mbps, you should set the "DP" bus profile again.

See also

Address assignment in the F-CPU (Page 21)

Assignment of the PROFIsafe address (Page 22)

Address Assignment and Installation

<div align="right">3</div>

3.1   Address assignment in the F-CPU

Address Assignment

The fail-safe I/O module occupies the following address areas on the F-CPU:

- S7 Distributed Safety: in the area of the process image
- S7 F/FH Systems: in the entire I/O range (inside and outside the process image).

Table 3- 1   Addresses assigned to the F-I/O module

F-I/O module	Occupied Bytes in the F-CPU:	
	In Input Range	In Output Range
ET 200eco 4/8 F-DI	x + 0 through x + 5	x + 0 through x + 3
x = Module start address		

Addresses Occupied by Useful Data

Of the addresses assigned to the fail-safe I/O module, the user data occupies the following addresses in the F-CPU:

Table 3- 2   Addresses Assigned for User Data

Byte in the F-CPU	Bits Assigned on the F-CPU:							
	7	6	5	4	3	2	1	0
ET 200eco 4/8 F-DI:								
x+0	Channel 7	Channel 6	Channel 5	Channel 4	Channel 3	Channel 2	Channel 1	Channel 0
x = Module start address								

⚠ WARNING

You must only access the addresses assigned for user data. The other address ranges occupied by the fail-safe I/O module are for other functions including safety-related communication between the fail-safe I/O module and F-CPU in compliance with PROFIsafe.

In 2v2 evaluation of sensors, only the less significant channel of the channels that are grouped as a result of the 2v2 sensor evaluation can be accessed in the safety program.

Additional Information

Detailed information on F-I/O access can be found in the *S7 Distributed Safety, Configuring and Programming* manual or the *Programmable Controllers S7 F/FH Systems* manual.

3.2 Assignment of the PROFIsafe address

PROFIsafe Address

Each fail-safe I/O module has its own PROFIsafe address in addition to the PROFIBUS address. Before installing the fail-safe ET 200eco I/O module, you must first set the PROFIsafe address of the fail-safe I/O module on every fail-safe I/O module.

PROFIsafe Address Assignment

The PROFIsafe addresses (F_source_address, F_destination_address) are assigned automatically during configuration of the fail-safe I/O module in *STEP 7*. The F_destination_address is displayed in binary format in the "DIP switch setting" parameter in the object properties of the fail-safe I/O module in *HW Config*.

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

On the terminal block of the fail-safe I/O module, there is an address switch (10-pin DIP switch). With this address switch, you enter the PROFIsafe address (F_destination_address) of the fail-safe I/O module.

Note

Fail-safe ET 200eco I/O modules can only be used in safety mode.

Before installing the terminal block of the fail-safe I/O module, make sure that the address switch is set correctly. The PROFIsafe addresses 1 through 1022.

Rules for Address Assignment

> ⚠️ **WARNING**
>
> make sure that the address switch setting on the fail-safe I/O 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.
>
> A network consists of one or more subnets. "Network-wide" means across PROFIBUS network boundaries.
>
> "Station-wide" means a station in HW Config (for example an S7-300 station or an I-slave)

Example: Setting the Address Switch

The following figure shows an example of a switch setting. The address 1018 is set in this example.
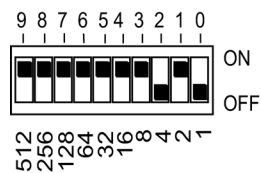

Figure 3-1   Example for Setting the Address Switch (DIP Switch)

3.3   Installing

Installing the Fail-Safe I/O Module

The fail-safe I/O module belongs to the I/O module spectrum of ET 200eco. It is installed in the same way as all standard ET 200eco I/O modules.

For more information about module installation, refer to the *ET 200eco Distributed I/O Station* manual.

Wiring

4

4.1 Introduction

⚠ 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.

Additional Information

For more detailed information on this topic that applies equally to the fail-safe I/O module and the standard ET 200eco I/O module, refer to the *Distributed I/O Station ET 200eco* manual.

4.2 Safe Functional Extra-Low Voltage for the Fail-Safe I/O Module

Safe functional extra low voltage

⚠ WARNING
The fail-safe I/O module must be operated with safe functional extra low voltage. This means that this module, even in the event of a fault, can only have a maximum voltage of U_m applied to it. The following applies to all fail-safe I/O modules: U_m < 60.0 V   All components of the system that are capable of supplying electrical energy in any form must satisfy this requirement.

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

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, also, that sensors having an external power supply can be connected to the fail-safe I/O module. Here, pay attention to the supply voltage from safe functional extra-low voltage. The process signal of a 24 VDC digital I/O module must not exceed a fault voltage of U_m in the event of a fault.

> ⚠ **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. Make sure that there is sufficient line cross section for the electrical connection, in accordance with the ET 200eco configuration guidelines (see *ET 200eco Distributed I/O Station* manual).

Power Supply Requirements in Compliance with NAMUR Recommendations

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 following power supply board components are available, for example:

S7-400:

6ES7 407-0K**A**01-0AA0 for 10 A

6ES7 407-0K**R**00-0AA0 for 10 A

S7-300:

6ES7 307-1**B**A00-0AA0 for 2 A

6ES7 307-1**E**A00-0AA0 for 5 A

6ES7 307-1**K**A00-0AA0 for 10 A

These requirements also apply, of course, to power packs and power supplies that do not have an S7-300 or S7-400 configuration.

4.3 Wiring the Fail-Safe I/O Module

Same Wiring Procedure as for ET 200eco

The ET 200eco fail-safe I/O module belongs to the I/O module range of ET 200eco. It is wired in the same way as all standard ET 200eco I/O modules.

For more information about wiring I/O modules, refer to the *ET 200eco Distributed I/O Station* manual.

⚠ **WARNING**

When assigning signals of the fail-safe I/O 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 constitute a serious safety risk

– Signals are supplied by different sensor supplies of this fail-safe I/O module

---

4.4 Replacing the Fail-Safe I/O Module

Replacing a Fail-Safe I/O module During Operation

A fail-safe I/O module can be replaced in exactly the same way as a standard ET 200eco I/O module (turn off the power to the I/O module, remove the module, connect up the new I/O module).

Note

Note that replacing a fail-safe ET 200eco I/O module 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 manual *S7 Distributed Safety, Configuration and Programming* or *Programmable Controllers S7 F/FH Systems*).

⚠ **CAUTION**

Turn off the load power supply (2L+) before dismantling the terminal block. When the terminal block is dismantled, degree of protection IP 65, IP 66 or IP 67 no longer applies.

Remember to Set the PROFIsafe Address

When replacing a fail-safe I/O module, make sure that the address switch (DIP switch) settings on the modules match (refer to the PROFIsafe address setting).

Note

Please refer to the information on dismantling and replacing the I/O module and the terminal block in the *ET 200eco Distributed I/O Station* manual.

See also

4.5 Sensor Requirements

General requirements for sensors

Note the following warning regarding safety-related use of sensors:

> ⚠️ **WARNING**
>
> The use of sensors 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 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 involves a considerable safety responsibility. You should also bear in mind that sensors do not generally stand up to proof-test intervals of 10 years according to the IEC 61508:2000 standard 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 the fail-safe I/O module under "Fail-Safe Performance Characteristics" in the technical specifications.
>
> To achieve SIL3 (Category 4), suitably qualified sensors are necessary.

Requirements for the duration of sensor signals

> ⚠ **WARNING**
>
> To guarantee accurate detection of the sensor signals by the fail-safe I/O module, make sure that the sensor signals have a certain 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 fail-safe I/O module

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

Table 4- 1   Minimum duration of the sensor signals to allow correct acquisition by the fail-safe I/O module

Short-circuit test parameter	Assigned input delay	
	3 ms	15 ms
Deactivated	9 ms	23 ms
Activated	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 *Chapter 9* of the system description *Safety Engineering in SIMATIC S7*.

Technical specifications of the sensors

Please check up on the technical specifications relating to the choice of sensors.

See also

Fail-Safe ET 200eco I/O Module 4/8 F-DI DC 24V PROFIsafe (Page 49)

Diagnostics

<div style="text-align:right">5</div>

5.1 Reactions to Faults

Safe State (Safety Concept)

The basic principle behind the safety concept is the existence of a safe state for all process variables. For digital fail-safe I/O modules, the safe state is, for example, the value "0".

Reactions to Faults and Startup of F-System

The safety function requires that the fail-safe values (safe state) are used instead of the process values for a fail-safe I/O module in the following situations (**passivation of the fail-safe I/O module**):

- When the F-system starts up
- In the case of faults during safety-related communication between the F-CPU and fail-safe I/O module using the PROFIsafe safety protocol (communication fault).
- In the case of F-I/O or channel faults (for example, wire break, short circuit, discrepancy error)

> ⚠️ **WARNING**
>
> For channels that you set to "deactivated" in *STEP 7*, there is no diagnostic reaction or error handling if a channel error occurs, not even when such a channel is affected indirectly by a channel group error (see "Channel activated/deactivated" parameter).

Fail-safe Value Output for the Fail-Safe I/O Module

For fail-safe input modules, if passivation occurs, the F-system provides fail-safe values for the safety program instead of the process values pending at the fail-safe inputs:

- For fail-safe digital input modules, this is always the fail-safe value 0.

Depending on which F-system is used and the type of fault that occurred (F-I/O, channel, or communication fault), fail-safe values are used either for the affected channel only or for all channels of the fail-safe I/O module involved.

Reintegration of a Fail-Safe I/O Module

Switchover from fail-safe values to process values (reintegration of a fail-safe I/O module) occurs either automatically or only after user acknowledgement in the safety program. For a fail-safe input module, the process values pending at the fail-safe inputs are provided again for the safety program after reintegration.

Additional Information on Passivation and Reintegration

For more detailed information on passivation and reintegration of F-I/O, refer to the *S7 Distributed Safety, Configuring and Programming* manual or *Programmable Controllers S7 F/FH Systems* manual.

See also

Fail-Safe ET 200eco I/O Module 4/8 F-DI DC 24V PROFIsafe (Page 49)

5.2 Fault Diagnostics

Definition

Diagnostics can be used to determine whether faults occurred during signal acquisition by the fail-safe I/O module. Diagnostic information is assigned either to one channel or to the entire fail-safe I/O module.

Diagnostic functions are not critical to safety

Diagnostic functions (displays and messages) are not critical to safety and therefore are not designed to be safety-oriented functions. That is, they are not tested internally.

Diagnostic options for the fail-safe I/O module

The following diagnostic options are available for the fail-safe I/O module:

- LED display on front panel of the I/O module
- Diagnostic functions of the fail-safe I/O module (slave diagnostics complying with the PROFIBUS standard IEC 61784-1 Ed3 CP 3/1)

Diagnostic functions that cannot be activated by the user

The fail-safe I/O module provides diagnostic functions that cannot be deselected or influenced. This means that diagnostics are always activated and are automatically made available by the fail-safe I/O module in **STEP 7** and passed on to the F-CPU in the event of a fault.

Diagnostic functions that can be assigned as parameters

You can activate certain diagnostic functions using parameter settings in *STEP 7*:

- The short-circuit monitoring (see short-circuit test parameter).

⚠ WARNING
Diagnostic functions should be activated or deactivated in accordance with the application.

Diagnostics by LED display

- The fail-safe I/O module indicates faults with its SF LED (group fault LED), for example faults in the internal sensor power supplies.

    - The SF-LED lights up as soon as a diagnostic function is triggered by the fail-safe I/O module.

    - The SF LED flashes when a fault is cleared but has not yet been acknowledged. It goes out when all faults have been eliminated and acknowledged.

- The fail-safe I/O module also has an ON LED that displays the load voltage power supply of the voltage group.

    - The ON LED is lit when the sensor power supply is present.

    - The ON LED flashes when there is a fault in the sensor power supply.

- The fail-safe I/O module also has a BF LED to indicate bus problems.

    - The BF LED is lit/flashes as soon as there is a bus problem.

    - The BF LED goes off, when all bus problems have been cleared.

Slave diagnostics

Slave diagnostics complies with the IEC 61784-1 Ed3 CP 3/1 standard. The fail-safe I/O module supports slave diagnostics in exactly the same way as the standard ET 200eco I/O modules.

You will find a description of the general configuration of slave diagnostics for ET 200eco and the fail-safe I/O module in the *ET 200eco Distributed I/O Device* manual. Below, you will find the difference relating to bytes 0, 4 and 5 as well as the channel-related diagnostics for the fail-safe I/O module.
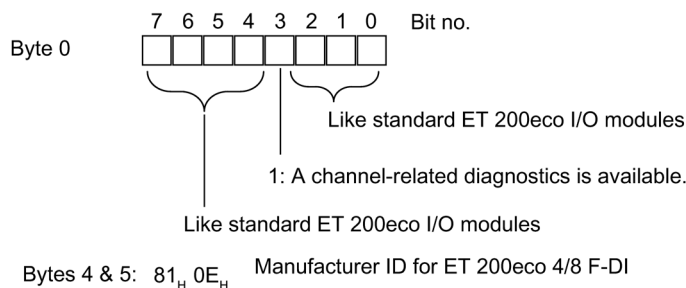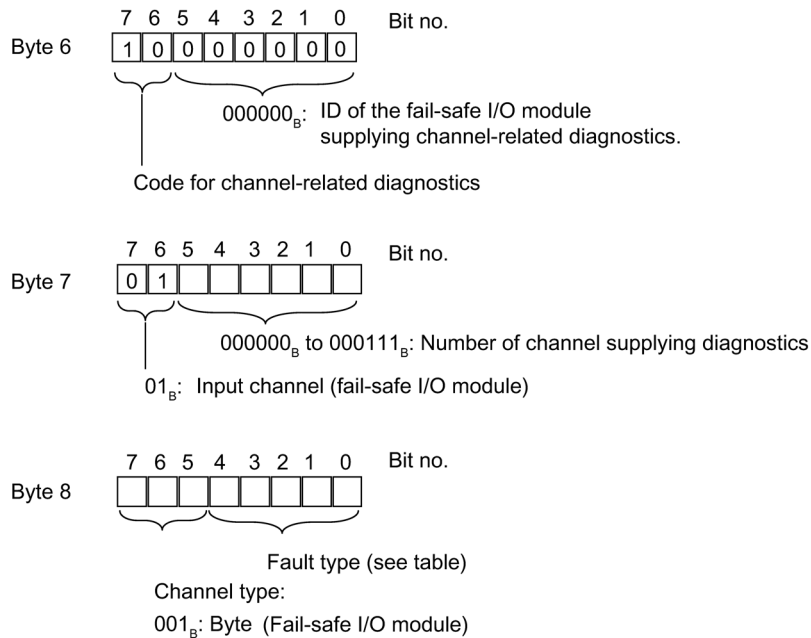

Figure 5-1   Byte sturcture 0, 4 and 5 for slave diagnostics

Channel-related diagnostics

As with ET 200eco, three bytes of channel-related diagnostics are available per fault starting with byte 6. Channel-related diagnostics for the fail-safe I/O module is configured as follows:

Byte 6

7 6 5 4 3 2 1 0   Bit no.

| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

000000_B: ID of the fail-safe I/O module supplying channel-related diagnostics.

Code for channel-related diagnostics

Byte 7

7 6 5 4 3 2 1 0   Bit no.

| 0 | 1 | | | | | | |

000000_B to 000111_B: Number of channel supplying diagnostics

01_B: Input channel (fail-safe I/O module)

Byte 8

7 6 5 4 3 2 1 0   Bit no.

| | | | | | | | |

Fault type (see table)

Channel type:

001_B: Byte (Fail-safe I/O module)

Byte 9 to 11   Next channel-related diagnostics (assignment same as bytes 6 to 8)

. . .

Max.   Byte 63 (64 bytes)

Figure 5-2   Configuration of channel-related diagnostics

Note

Channel-related diagnostics are always updated to the current diagnostic function in the diagnostic message frame. Subsequent, older diagnostic functions are not deleted.

Solution: Evaluate the valid current length of the diagnostic message frame in *STEP 7* using the RET_VAL parameter of SFC13.

Possible errors/faults of the fail-safe I/O module

Table 5- 1   Channel-related diagnostics: Fault types of the fail-safe I/O module

Fault number	Diagnostic function in *STEP 7* (fault type)	Special significance for fail-safe I/O modules
1$_H$	Short circuit	Short-circuit
5$_H$	Overtemperature	Overtemperature
9$_H$	Fault	Internal error
10$_H$	Parameter assignment error	Parameter assignment error
11$_H$	Sensor voltage or load voltage is missing	Missing external auxiliary supply
13$_H$	Communication error	Communication error
19$_H$	Safety-related shutdown	Discrepancy error

Behavior of the fail-safe I/O module in the event of module failure

The following events occur following a serious internal fault in the fail-safe I/O module causing fail-safe I/O module failure:

- The connection to PROFIBUS DP is interrupted and the fail-safe inputs are passivated
- Diagnostic information is not sent by the fail-safe I/O module and the standard diagnostic message "module fault" is signaled.
- The SF LED of the fail-safe I/O module lights up.

Specific Information about Diagnostic Functions

All module-specific diagnostic functions, possible causes and remedies are described in the section on the digital fail-safe I/O module. This section also describes which status and diagnostic functions can be displayed by LEDs on the front panel of the fail-safe I/O module.

Reading diagnostic functions

You can display the cause of a fault in the module diagnostics of *STEP 7* (see *STEP 7 Online Help*).

You can read out diagnostic functions (slave diagnostics) by means of SFC 13 in the standard user program (see *System and Standard Functions* reference manual).

General technical specifications

<div style="text-align:right; font-size:3em;">6</div>

6.1 Standards and Approvals

What are general technical specifications?

The general technical specifications include standards and test values adhered to and met by the fail-safe ET 200eco I/O module and the criteria used for testing.

CE approval

$\mathsf{C}\mathsf{E}$

The fail-safe ET 200eco I/O module satisfies the requirements and safety objectives of the following European Community directives and complies with the harmonized European standards (EN) for programmable logic controllers published in the Gazette of the European Community:

- 2006/42/EC "Machinery Directive"
- 73/23/EEC "Electrical Equipment Designed for Use within Certain Voltage Limits" (low voltage directive)
- 89/336/EWG "Electromagnetic Compatibility" (EMC Guideline)
- 94/9/EC " Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres" (Explosion Protection Guideline)

The EC declarations of conformity are kept available for the relevant authorities at:

Siemens Aktiengesellschaft
Bereich Automatisierungstechnik
A&D AS RD ST
Postfach 1963
D-92209 Amberg, Germany

UL approval

(UL)

Underwriters Laboratories Inc., in accordance with

- UL 508 (Industrial Control Equipment)

CSA Approval

Canadian Standard Association (CSA) in accordance with

- C22.2 No. 142 (Process Control Equipment)

or

Underwriters Laboratories Inc., in accordance with

- UL 508 (Industrial Control Equipment)
- CSA C22.2 No. 142 (Process Control Equipment)

or

HAZ. LOC.

Underwriters Laboratories Inc., in accordance with

- UL 508 (Industrial Control Equipment)
- CSA C22.2 No. 142 (Process Control Equipment)
- UL 1604 (Hazardous Location)
- CSA-213 (Hazardous Location)

APPROVED for use in
Class I, Division 2, Group A, B, C, D Tx;
Class I, Zone 2, Group IIC Tx

Note

The nameplate of the specific I/O module indicates the currently valid approvals.

Marking for Australia

The fail-safe ET 200eco I/O module satisfies the AS/NZS 2064 standard (class A).

IEC 61131

The fail-safe ET 200eco I/O module satisfies the requirements and criteria of the IEC 61131-2 standard (Programmable Controllers, Part 2: Equipment Requirements and Tests).

PROFIBUS standard

The ET 200eco distributed I/O device is based on the IEC 61784-1 Ed3 CP 3/1 standard.

Shipbuilding approval

Submitted to the following classification bodies:

- ABS (American Bureau of Shipping)
- BV (Bureau Veritas)
- DNV (Det Norske Veritas)
- GL (Germanischer Lloyd)
- LRS (Lloyds Register of Shipping)
- Class NK (Nippon Kaiji Kyokai)

Use in Industry

SIMATIC products are designed for use in industrial environments.

Area of application	Requirement relating to	
	Emitted Interference	Immunity to Interference
Industry	EN 50081-2 : 1993	EN 50082-2 : 1995

Use in Residential Areas

If you use the ET 200eco in residential areas, you must ensure limit class B (EN 55011) for emission of radio interferences.

Suitable measures for achieving limit class B for emission of radio interference are:

- Installing the ET 200eco in grounded switching cubicles/switch boxes
- Use of filters in power supply lines

TÜV Certificate and Standards

The fail-safe ET 200eco I/O module is certified for the following standards. Refer to the report accompanying the TÜV certificate for the current version/edition of the standard.

Standards/Directives Functional Safety	Standards/Directives Machine Safety	Additional Standards/Guidelines
DIN V 19250	98/37/EC	DIN VDE 0110-1
DIN V VDE 0801	EN 60204-1	DIN VDE 0160
DIN V VDE 0801/A1	Standards/Directives for Fuel Engineering	93/68/EEC
IEC 61508:2000	DIN VDE 0116, Clause 8.7	92/31/EEC and 93/68/EEC
prEN 50159-1 and 2	prEN 50156-1	DIN EN 55011
Standards/Directives for Process Engineering	EN 230, Clause 7.3	EN 50081-2
DIN V 19251	EN 298, Clauses 7.3, 8, 9, and 10	EN 61000-6-2
VDI/VDE 2180-1 to 5	DIN V ENV 1954	DIN EN 61131-2
NE 31		
ISA S 84.01		

Requesting TÜV Certificate

You can request copies of the TÜV certificate and the accompanying report at the following address:

Siemens Aktiengesellschaft
Bereich Automatisierungstechnik
A&D AS RD ST
Postfach 1963
D-92209 Amberg, Germany

6.2 Electromagnetic Compatibility

Introduction

This section contains information on the interference immunity of the fail-safe I/O module and information on radio interference suppression.

Definition of EMC

Electromagnetic compatibility is the ability of an electrical device to function in its electromagnetic environment in a satisfactory manner without affecting this environment.

The fail-safe ET 200eco I/O module also satisfies the requirements of the EMC directive of the European Economic Area. This is possible only when the ET 200S distributed I/O station complies with the specifications and guidelines for electrical assembly.

Pulse-shaped interference

The following table shows the electromagnetic compatibility of the fail-safe I/O module with regard to pulse-shaped interference.

Pulse-Shaped Interference	Tested With	Degree of Severity
Electrostatic discharge in accordance with IEC 61000-4-2 (DIN VDE 0843 Part 2)	8 kV	3 (air discharge)
	6 kV (cabinet installation mandatory)	3 (contact discharge)
	4 kV (no cabinet installation)	
Burst pulse (rapid transient interference) in accordance with IEC 61000-4-4 (DIN VDE 0843 Part 4)	2 kV (supply line)	3
	2 kV (signal line)	4
Surge in accordance with IEC 61000-4-5 (DIN VDE 0839 Part 10) Degrees of severity 2 and 3 require an external protective circuit (see paragraph following table)		
Asymmetrical connection	1 kV (supply line)	2
	1 kV (signal lead/data lead)	
	2 kV (supply line)	3
Symmetrical connection	0,5 kV (supply line)	2
	0,5 kV (signal lead/data lead)	
	1 kV (supply line)	3
	1 kV (signal lead/data lead)	

Bus Parameter Settings for PROFIBUS DP

To comply with the values for electromagnetic compatibility, if you are using **transmission rates lower than 6 Mbps**, you must increase the bus parameter "Retry Limit" to at least "3" in your project engineering software (for example, COM PROFIBUS or *STEP 7*). Leave all other bus parameter default settings for the bus profile you are using.

Protecting the Fail-Safe ET 200eco I/O Module from Overvoltages

If your equipment makes protection from overvoltage necessary, you must use an external protective circuit (surge filter) between the load voltage power supply and the load voltage input of the I/O module to ensure surge immunity for the fail-safe ET 200eco I/O module.

Note

Lightning protection measures always require a case-by-case examination of the entire system. Nearly complete protection from overvoltages, however, can only be achieved if the entire building surroundings have been designed for overvoltage protection. In particular, this involves structural measures in the building design phase.

Therefore, for detailed information regarding overvoltage protection, we recommend that you contact your Siemens representative or a company specializing in lightning protection.

The following figure shows an example of an external surge filter for the fail-safe ET 200eco I/O module.

For additional information about surge protection for standard I/O modules, refer to the *ET 200eco Distributed I/O Station* manual.
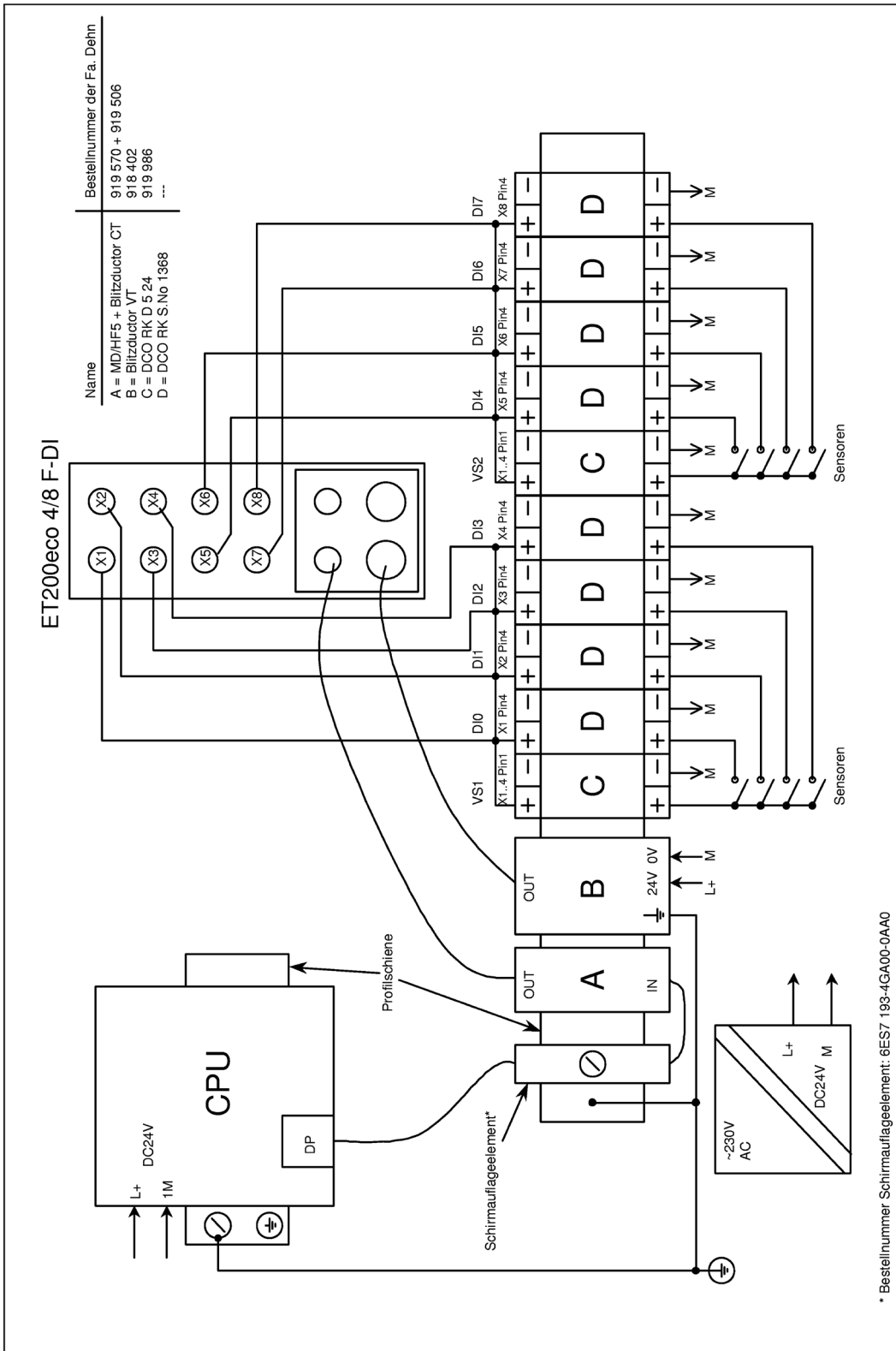
Figure 6-1   External Surge Filter for the Fail-Safe ET 200eco I/O Module

Sinusoidal interference

RFI immunity according to IEC 61000-4-3:

- Electromagnetic HF field, amplitude modulated:
  from 80 through 2000 MHz; 10 V/m; 80 % AM (1 kHz)

- Electromagnetic HF field, pulse-modulated:
  900 ± 5 MHz; 10 V/m; 50 % ESD; 200 Hz repetition rate

- GSM/ISM field interferences of different frequencies (EN 298: 1998):

System	Frequency	Test Level	Modulation
GSM	890-915 MHz	20 V/m	Pulse modulation 200 Hz
GSM	1710-1785 MHz	20 V/m	Pulse modulation 200 Hz
GSM	1890 MHz	20 V/m	Pulse modulation 200 Hz
ISM	433.05-434.79 MHz	20 V/m	AM, 80% 1 kHz
ISM	83,996-84,004 MHz	20 V/m	AM, 80% 1 kHz
ISM	167.992-168.008 MHz	20 V/m	AM, 80% 1 kHz
ISM	886.000-906.000 MHz	20 V/m	AM, 80% 1 kHz

- HF coupling with signal lines and data lines, etc. complying with IEC 61000-4-6, high frequency, asymmetric, amplitude-modulated:
  from 0.15 through 80 MHz; 10 V R. M. S value, unmodulated; 80 % AM (1 kHz); 150 Ω source impedance

- ISM interferences of different frequencies (EN 298: 1998):

System	Frequency	Test Level	Modulation
ISM	6,765-6,795 MHz	20 V	AM, 80% 1 kHz
ISM	13,553-13,567 MHz	20 V	AM, 80% 1 kHz
ISM	26,957-27,283 MHz	20 V	AM, 80% 1 kHz
ISM	40.66-40.70 MHz	20 V	AM, 80% 1 kHz
ISM	3.370-3.410 MHz	20 V	AM, 80% 1 kHz
ISM	13.533-13.533 MHz	20 V	AM, 80% 1 kHz
ISM	13.567-13.587 MHz	20 V	AM, 80% 1 kHz

Radio Interference Emission

Emitted interference of electromagnetic fields according to EN 55011: Limit value class A, group 1 (measured at a distance of 10 m).

Frequency	Emitted Interference
Between 30 MHz and 230 MHz	< 40 dB (µV/m)Q
Between 230 MHz and 1000 MHz	< 47 dB (µV/m)Q

Emitted interference over network AC power supply in accordance with EN 55011: Limit class A, group 1.

Frequency	Emitted Interference
Between 0,15 MHz and 0,5 MHz	< 79 dB (µV)Q, < 66 dB (µV)M
Between 0,5 MHz and 5 MHz	< 73 dB (µV)Q, < 60 dB (µV)M
Between 5 MHz and 30 MHz	< 73 dB (µV)Q, < 60 dB (µV)M

See also

Configuration and Parameter Assignment (Page 19)

6.3 Transport and storage conditions

Conditions for the Fail-Safe I/O Module

In terms of transport and storage conditions, the ET 200eco fail-safe I/O module surpasses the requirements according to IEC 61131-2.

The following information applies to fail-safe I/O modules that are transported and/or stored in their original packaging.

Type of Condition	Permissible range
Free fall	≤ 1 m
Temperature	from -40 °C through +70 °C
Temperature change	20 K/h
Air pressure	1080 hPa to 660 hPa (corresponds to an altitude of -1000 m to 3500 m)
Relative humidity	5% to 95%, without condensation

6.4   Mechanical and Climatic Environmental Conditions

Mechanical Environmental Conditions

The mechanical environmental conditions for the fail-safe I/O module are listed in the following table as sinusoidal oscillations.

Frequency Range (Hz)	Continuous	Intermittent
10 ≤ f ≤ 58	0,35 mm amplitude	0.75 mm amplitude
58 ≤ f ≤ 150	5 g constant acceleration	10 g constant acceleration

Reduction of Vibration

If the fail-safe I/O module is subjected to greater shock pulses or oscillation, you must take appropriate measures to reduce acceleration and amplitude.

We recommend that you mount the ET 200eco on cushioning material (for example, on a rubber-metal vibration damper).

Testing for Mechanical Environmental Conditions

The following table provides information about the type and scope of testing for mechanical environmental conditions.

Condition	Test Standard	Comments
Oscillation	Osclillation test complying with IEC 60068-2-8	Type of vibration: frequency sweeps with a rate of change velocity of 1 octave per minute. 10 Hz ≤ f ≤ 58 Hz, constant amplitude 0,75 mm 58 Hz ≤ f ≤ 150 Hz, constant acceleration 10 g Duration of vibration: 10 frequency sweeps per axis in each of three perpendicular axes
Shock	Shock, tested to IEC 60068-2-27	Shock method: half sine Strength of shock: 30 g peak value, 18 ms duration Direction of shock: 3 shocks each in +/- direction in each of three perpendicular axes
Permanent shock	Shock, tested to IEC 60068-29	Shock method: half sine Strength of shock: 25 g peak value, 6 ms duration Direction of shock: 1000 shocks each in +/- direction in each of three perpendicular axes

Climatic Environmental Conditions

The fail-safe ET 200eco I/O module can be used under the following climatic environmental conditions:

Environment-Related requirements	Range of Application	Comments
Temperature	from 0 through 55 °C	All installations
Temperature change	10 K/h	
Relative humidity	from 15 through max. 95 %	no condensation
Air pressure	1080 hPa to 795	Corresponds to an altitude of -1000 m to 2000 m
Contaminant concentration	SO_2: < 0.5 ppm; relative humidity < 60%, no condensation	Test: 10 ppm; 4 days
	H_2S: < 0.1 ppm; relative humidity < 60%, no condensation	1 ppm; 4 days

6.5 Specifications for Nominal Line Voltages, Isolation Tests, Protection Class, and Type of Protection

Nominal Line Voltages for Operation

The fail-safe ET 200eco I/O module operates with a nominal voltage of 24 V DC. The tolerance range is 20.4 V DC to 28.8 V DC.

Protection class

Protection class I in compliance with IEC 60536 (VDE 0106-1); in other words, ground terminal required on grounding screw!

Pollution degree/overvoltage category according to IEC 61131

- Pollution degree 2
- Overvoltage category
    - at U_N = 24 V DC: II

Degree of protection IP 65

Degree of protection to IEC 529

- Protection against ingress of dust and full protection against touch

- Protection against a stream of water from a nozzle onto the enclosure from all directions. (The water must not have any detrimental effects.)

Degree of protection IP 66 and 67

Degree of protection to IEC 529

- Protection against ingress of dust and full protection against touch

- IP 66: Protection against heavy seas or strong water stream. (Water must not enter the enclosure in harmful quantities.)

- IP 67: Protection against water when the enclosure is immersed in water under specified pressure and time conditions. (Water must not enter the enclosure in harmful quantities.)

Digital F I/O Module

7

7.1 Fail-Safe ET 200eco I/O Module 4/8 F-DI DC 24V PROFIsafe

Order number

6ES7 148-3FA00-0XB0

Properties

The 4/8 F-DI DC24V PROFIsafe fail-safe I/O module has the following properties:

- 8 inputs (SIL2/Category 3) or 4 inputs (SIL3/Category 3 or Category 4)
- 24 V DC nominal input voltage
- Suitable for switches and 3 or 4-wire proximity switches (BEROs)
- Two short-circuit-proof sensor supplies each for four inputs
- External sensor supply possible
- Group fault display (SF; red LED)
- Status display for each input (green LED)
- Bus fault display (BF; red LED)
- A common fault display for both sensor power supplies (green ON LED flashes)
- Configurable diagnostics

Note

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

Front View
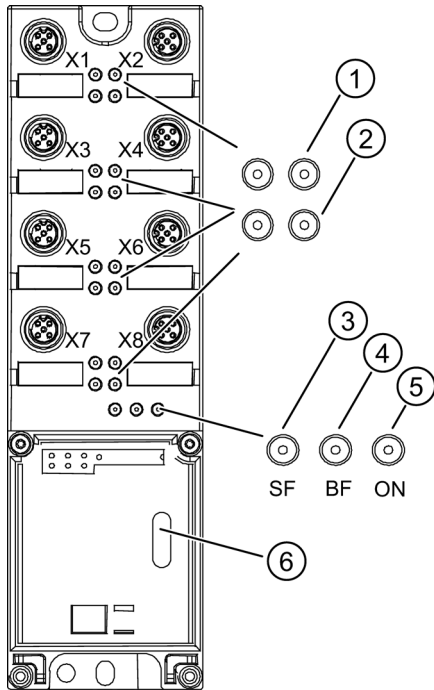
(1)	Status display per channel (green)
(2)	Not used
(3)	Group fault (red)
(4)	Bus fault (red)
(5)	Electronics/sensor supply 1L+ (green)
(6)	PROFIsafe address switch

Figure 7-1   Front View of the ET 200eco 4/8 F-DI

Terminal assignment

The following table shows the assignment of the 8 female connectors of the fail-safe ET 200eco I/O module for connecting the digital inputs.

Table 7- 1   Pin Assignment of the Sockets X1 through X8 for Digital Inputs

Pin	Assignment of Socket X1	Assignment of Socket X2	Assignment of Socket X3	Assignment of Socket X4	View of the Socket (from front)
1	24 V sensor supply 1				
2*	Input signal channel 4	Input signal channel 5	Input signal channel 6	Input signal channel 7	
3	Ground sensor power supply (1M)				
4	Input signal channel 0	Input signal channel 1	Input signal channel 2	Input signal channel 3	
5	24 V sensor supply 2				
Pin	Assignment of Socket X5	Assignment of Socket X6	Assignment of Socket X7	Assignment of Socket X8	
1	24 V sensor supply 2				
2	Not used				
3	Ground sensor power supply (1M)				
4	Input signal channel 4	Input signal channel 5	Input signal channel 6	Input signal channel 7	
5	Not used				
* Pin 2: The contact of the second channel (X5-X8) is looped through (1oo2 evaluation 1-channel sensor, see use case 2.1 – one sensor connected over one channel to two inputs)					

Block Diagram
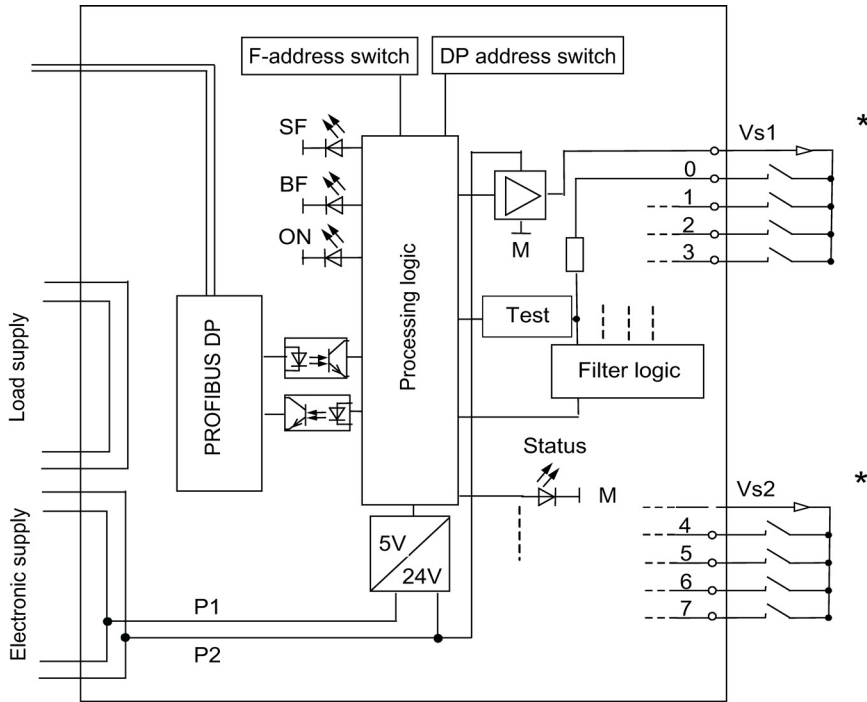
* The representation of NO contacts matches the module labeling.
Usually, the sensors must be equipped with NC contacts in order to ensure the safe state of process variables.

Figure 7-2   Block Diagram of the ET 200eco 4/8 F-DI

Parameters in STEP 7

The following table shows the parameters that can be set for the ET 200eco 4/8 F-DI:

Table 7- 2   Parameters of the ET 200eco 4/8 F-DI

Parameter	Range	Default	Type of Parameter	Effective range
F Parameter:				
F_destination_address	1 to 1022	Assigned automatically	Static	Module
F_monitoring_time	10 ms to 10000 ms	150 ms	Static	Module
F-Module Parameter:				
Input delay	3 ms/15 ms	3 ms	Static	Module
Short-circuit test	Cyclic/blocked	Cyclic	Static	Module
Channel n, n+4	Activated/deactivated	Activated	Static	Channel group
Evaluation of the sensors	1oo2 evaluation/ 1oo1 evaluation/	1oo2 evaluation	Static	Channel group
Type of sensor interconnection	2-channel equivalent/ 1-channel/ 2-channel non-equivalent	2-channel equivalent (or 1-channel for "1oo1 evaluation")	Static	Channel group
Discrepancy behavior	Provide value 0/ Provide last valid value	"Provide 0 value"	Static	Channel group
Discrepancy time	10 ms to 30000 ms	500 ms (for "Provide value 0") or 10 ms (for "1-channel" or "Provide last valid value")	Static	Channel group

Parameter input delay

Note

If there is a risk of overvoltage on the lines, to avoid a safety shutdown for the fail-safe digital inputs and the sensor power supply, you must set an input delay of 15 ms.

Short-circuit test parameter

The cyclic short-circuit test is activated or deactivated using the short-circuit test parameter. The short-circuit test is only useful for simple switches that do not have their own power supply. If the short-circuit test has been activated, the internal sensor power supplies must be used (see also "Use Cases of the ET 200eco 4/8 F-DI").

Behavior of discrepancy parameter

As the "response to discrepancy", you set the value that is made available to the safety program in the F-CPU while there is a discrepancy between the two input channels involved; in other words, during the discrepancy time. You set the response to a discrepancy as follows:

- "provide last valid value" or

- "Provide value 0"

Requirements

You have set the following:

- Evaluation of the sensors: "1oo2 evaluation" and

- Type of sensor interconnection: "2-channel equivalent" or "2-channel non-equivalent"

"Provide Last Valid Value"

The last valid value (old value) before discrepancy occurs is made available in the safety program in the fail-safe CPU as soon as a discrepancy is detected between the signals of the affected input channels. This value remains available until the discrepancy disappears or until the discrepancy time expires and a discrepancy error is detected. The sensor-actuator response time is extended according to the this time.

As a result, the discrepancy time of sensors connected over two channels must be set for fast responses to short response times. It makes no sense, for example, if sensors connected over two channels with a discrepancy time of 500 ms trigger a time-critical shutdown. In the worst case, the sensor-actuator response time is extended by an amount approximately equal to the discrepancy time:

- For this reason, position the sensor in the process in such a way as to minimize discrepancy.

- You should then select the shortest possible discrepancy time that nevertheless also provides adequate reserves to prevent incorrect triggering of discrepancy errors.

"Provide value 0"

The value "0" is made available to the safety program in the F-CPU as soon as a discrepancy is detected between the signals of the two affected input channels.

If you assigned the parameter "Provide value 0", the sensor-actuator response time will not be affected by the discrepancy time.

Discrepancy time parameter

Here, you can specify the discrepancy time for each pair of channels. The value entered is rounded to whole multiples of 10 ms.

Requirements

You have set the following:

● Evaluation of the sensors: "1oo2 evaluation" and

● Type of sensor interconnection: "2-channel equivalent" or "2-channel non-equivalent"

Discrepancy Analysis and Discrepancy Time

If you use a 2-channel, one non-equivalent, or two 1-channel sensors, that measure the same physical process variable, the sensors will respond with a slight time delay among each other due to the limited accuracy of the arrangement.

Discrepancy analysis for equivalence or non-equivalence is used for fail-safe inputs in order to determine faults based on the time characteristic of two signals with the same functionality. The discrepancy analysis starts when different levels (when checking for non-equivalence: the same level) are detected for two related input signals. The signals are checked to establish whether the difference (when checking for non-equivalence: conformity) has disappeared after expiration of a specified time known as the discrepancy time. If not, this means that a discrepancy error exists.

The most cases, the discrepancy time is started but is not elapse fully since the signal differences disappear after a short time.

Select the discrepancy time large enough so that in case of no error the difference of the two signals (when checking for non-equivalence: signals matching) has disappeared in every case before the discrepancy time is elapsed.

Response While the Discrepancy Time Is Running

While the discrepancy time is running internally on the module, either the last valid value or "0" is provided for the safety program on the F-CPU by the input channels involved depending on the parameter settings for the response to discrepancy.

Response after the Discrepancy Time Elapses

If the input signals do not match after the specified discrepancy time has elapsed (when checking for non-equivalence: inequality), for example due to a break in the sensor wire, a discrepancy error is detected and the "discrepancy" diagnostic message is generated in the diagnostic buffer of the fail-safe I/O module indicating the faulty channels.

See also

7.2 Use Cases of the ET 200eco 4/8 F-DI

Selecting the Application

The following figure provides information to help you select the use case that corresponds to your fail-safe requirements. In each use case, you will learn about wiring the fail-safe I/O module and see the requirements for specific parameter settings in *STEP 7*.
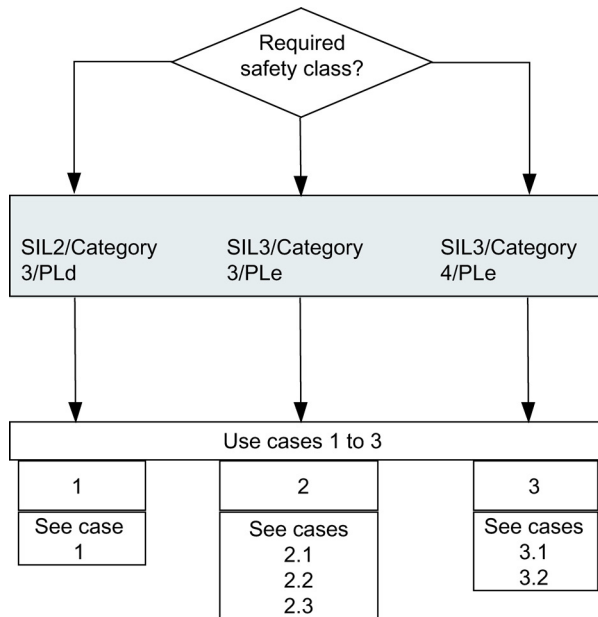
Figure 7-3   Selecting use case – ET 200eco 4/8 F-DI

⚠️ **WARNING**

The achievable safety class depends on the quality of the sensor and the length of the proof-test interval according to IEC 61508:2000 (interval for external function test). If the quality of the sensor is lower than the quality stipulated in the required safety class, the sensor must be used redundantly and connected over two channels.

Conditions for achieving SIL/category

The conditions for achieving the respective safety requirements are presented in the following table.

Table 7- 3   ET 200eco 4/8 F-DI: Conditions for achieving SIL/category

Application	Sensor	Evaluation of the sensors	Sensor supply	Achievable SIL/category
1	One-channel	1oo1	Internal, with short-circuit test	2 / 3
			Internal, without short-circuit test	
			External	
2.1	One-channel	1oo2	Internal, with short-circuit test	3 / 3
			Internal, without short-circuit test	
			External	
2.2	2-channel equivalent	1oo2	Internal, without short-circuit test	
			External	
2.3	2-channel, non-equivalent	1oo2	Internal, without short-circuit test	
			External	
3.1	2-channel equivalent	1oo2	Internal, with short-circuit test	3 / 4
3.2	2-channel, non-equivalent			

Note

You can operate the various inputs of an fail-safe I/O module simultaneously in SIL2/Category 3 **and** SIL3/Category 3 or 4. You only need to interconnect and assign parameters for the inputs as shown in the individual use cases.

Sensor Requirements

Please note the requirements for the safety-oriented use of sensors.

7.3 Use Case 1: Safety mode SIL2/Category 3

Sensor Supply

The ET 200eco 4/8 F-DI provides sensor supply Vs1 for inputs 0 to 3 and sensor supply Vs2 for inputs 4 to 7. The sensor supply can be provided internally or externally.

Wiring Diagram (Use Case 1 - Connecting One Sensor over One Channel)

One sensor is connected over 1 channel (1oo1 evaluation) for each process signal.
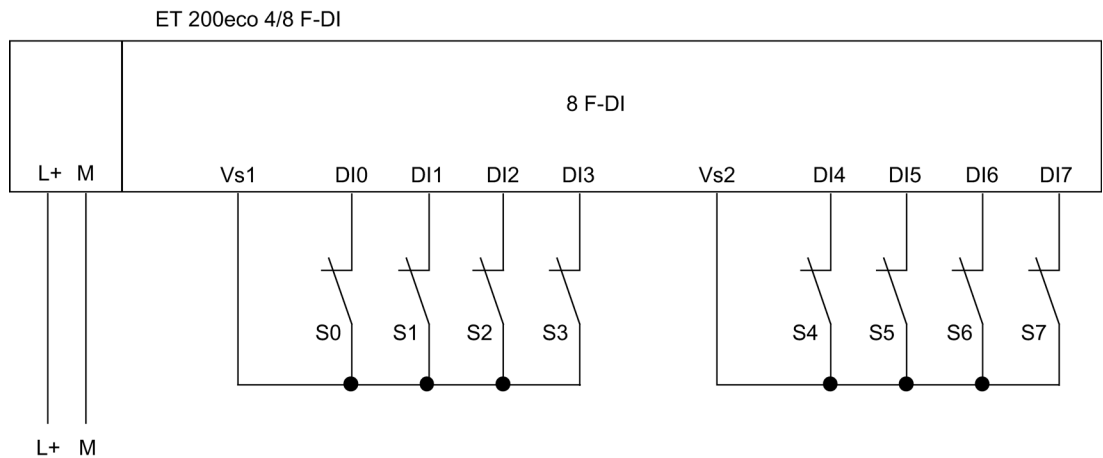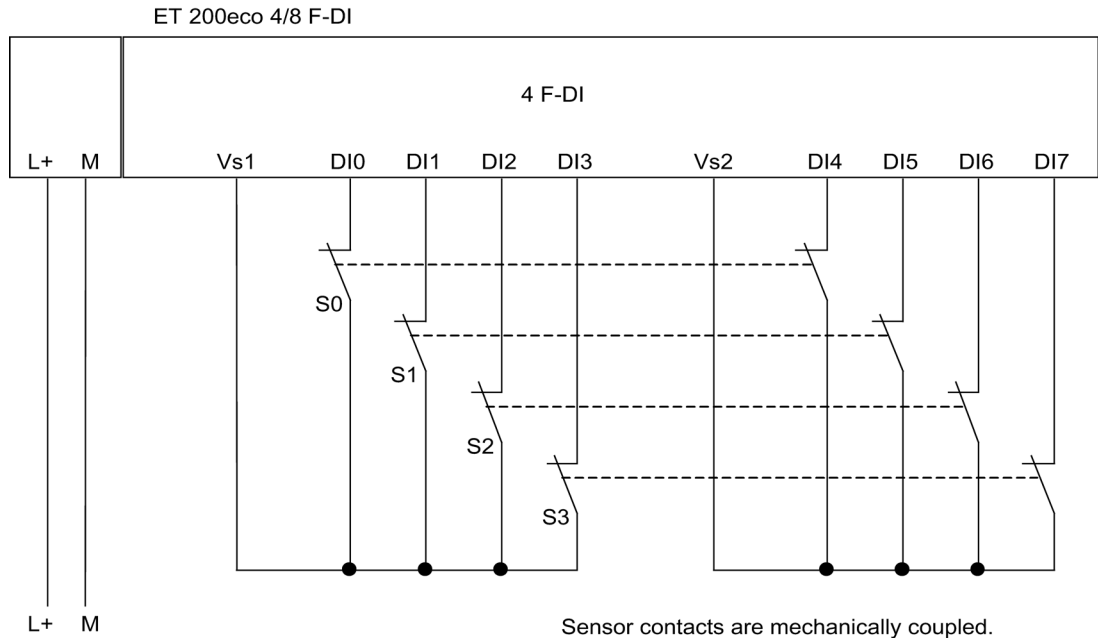

Figure 7-4   Wiring Diagram ET 200eco 4/8 F-DI - One Sensor Connected over One Channel, Internal Sensor Supply
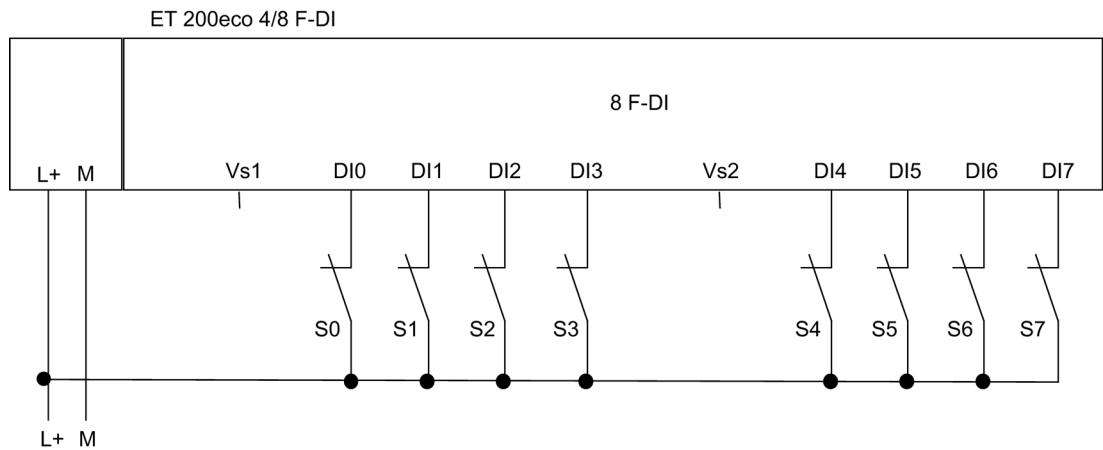
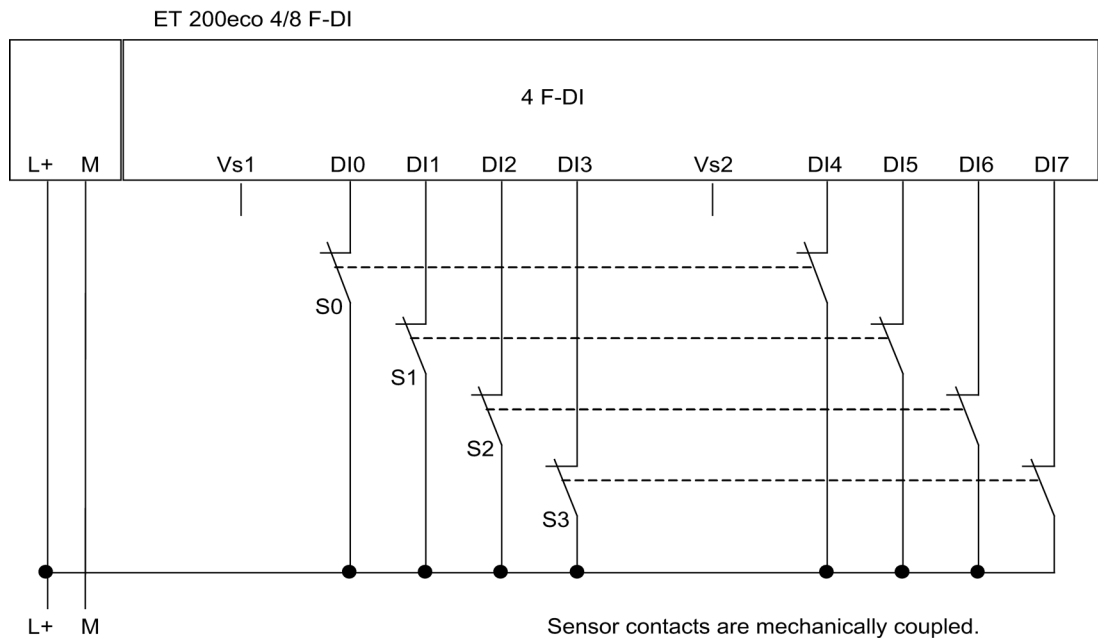Figure 7-5   Wiring Diagram ET 200eco 4/8 F-DI - One Sensor Connected over One Channel, External Sensor Supply

Assignable Parameters (Use Case 1)

Set the parameter "Evaluation of sensor" to "1oo1 evaluation" for the respective input.

You can activate or deactivate the "short-circuit test" parameter. However, you must deactivate the short-circuit test as soon as one or more fail-safe digital inputs are **externally** supplied. Otherwise the "short circuit" diagnosis may be reported.

Special Features of Fault Detection (Application 1)

The following table shows fault detection according to the sensor supply and the parameter assignment for the short-circuit test:

Table 7- 4   ET 200eco 4/8 F-DI: Fault Detection (Use Case 1)

Example of Error	Fault detection when ...		
	Internal sensor power supply and activated short-circuit test	Internal Sensor Supply and Deactivated Short-Circuit Test	External Sensor Supply
Short circuit in DI 0 with DI 1	No	No	No
Short circuit in DI 0 with DI 4	Yes*	No	No
P-short circuit in DI 0	Yes	No	No
M-short circuit in DI 0	Yes*	Yes*	No
Discrepancy error	–	–	–
P short-circuit in sensor supply 1	Yes	No	No
M-short circuit in sensor supply 1 or sensor supply defective	Yes	Yes	Yes
Short circuit in sensor supply 1 with sensor supply 2	Yes	No	No
Error in read/test circuit	Yes	Yes	Yes
Supply voltage fault	Yes	Yes	Yes
* Fault is detected only in case of signal corruption. In other words, the signal read differs from the sensor signal. If there is no signal corruption with respect to the sensor signal, error detection is not possible and is not required from a safety standpoint.			

7.4   Use Case 2: Safety mode SIL3/Category 3

Assigning inputs to each other

The ET 200eco 4/8 F-DI has 8 fail-safe inputs DI 0 to DI 7 (SIL2). Two inputs each can be used as one input (SIL3). The following assignment applies:

- DI 0 with DI 4
- DI 1 with DI 5
- DI 2 with DI 6
- DI 3 with DI 7

Sensor supply

The ET 200eco 4/8 F-DI provides sensor supply Vs1 for inputs 0 to 3 and sensor supply Vs2 for inputs 4 to 7. The sensor power supply can be provided internally or externally.

Wiring diagram (use case 2.1 – connection of one sensor over one channel to two inputs)

A sensor is connected over one channel to two inputs of the fail-safe I/O module for each process signal (1oo2 evaluation).

Note

If the voltage is supplied to the sensor by the fail-safe I/O module, you must use the internal sensor supply Vs1. Connection to Vs2 is not possible.
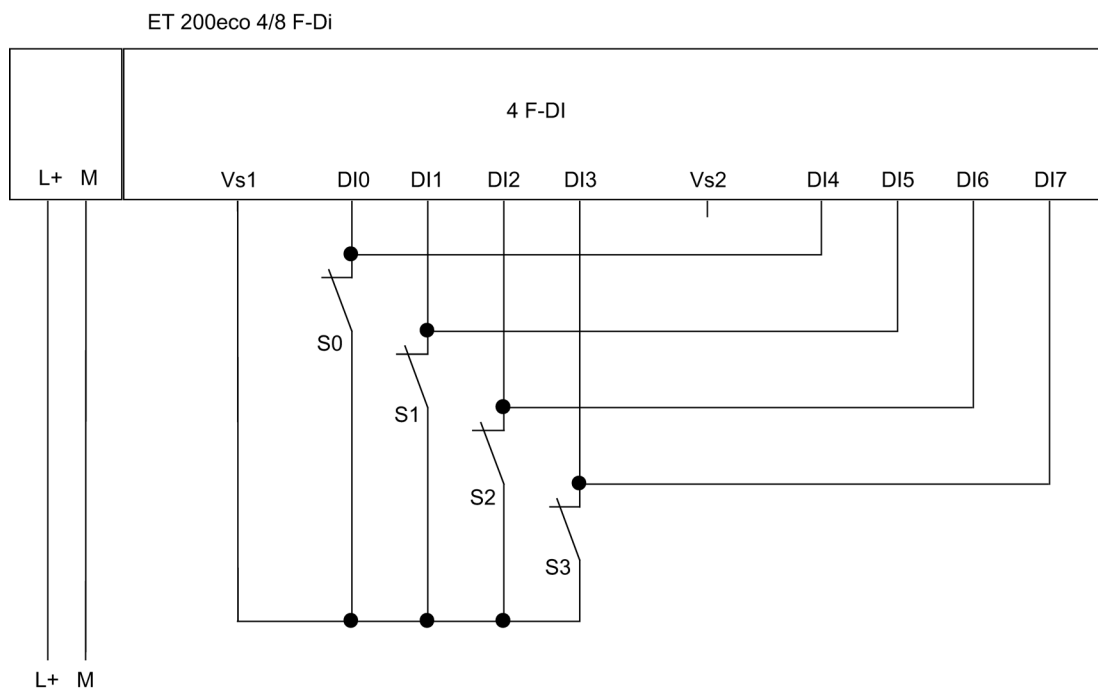
Figure 7-6   Wiring diagram ET 200eco 4/8 F-DI – one sensor connected over one channel to two inputs, internal power supply
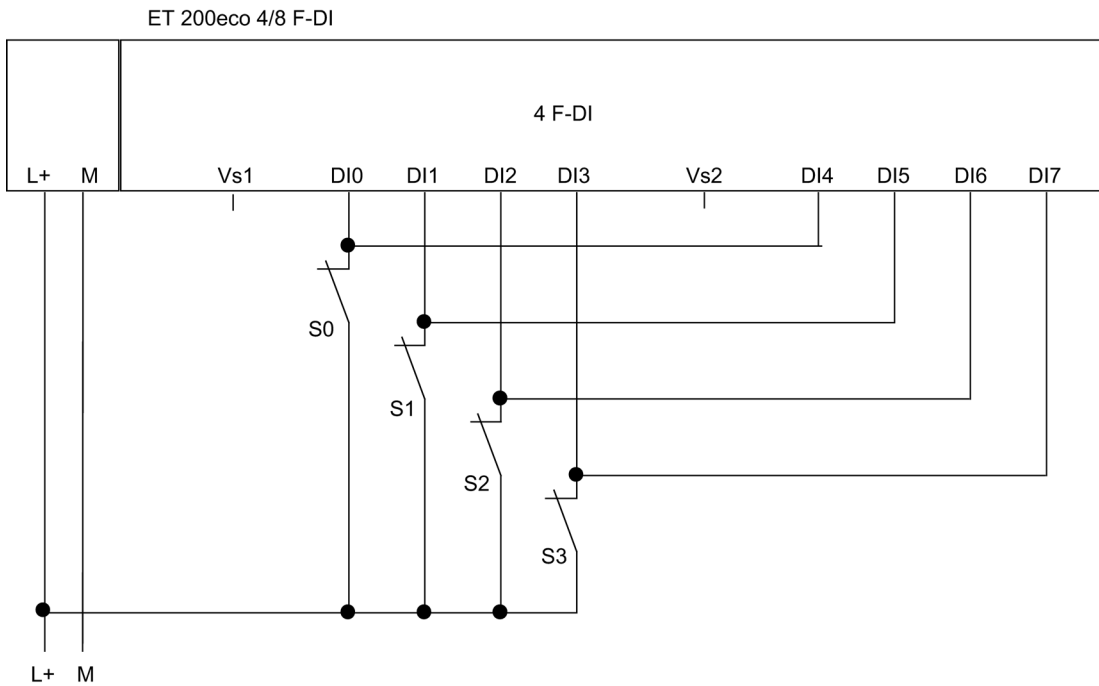
Figure 7-7   Wiring diagram ET 200eco 4/8 F-DI – one sensor connected over one channel to two inputs, external power supply

> ⚠ **WARNING**
>
> To achieve SIL3/Category 3 using this wiring, you must use a suitably qualified sensor.

Configurable parameters (use case 2.1)

Set the parameter "Evaluation of the sensors" to "1oo2 evaluation" and the parameter "Type of sensor interconnection" to "1-channel" for the relevant input. The discrepancy time is preset to 10 ms and cannot be changed.

You can activate or deactivate the "short-circuit test" parameter. However, you must deactivate the short-circuit test as soon as one or more fail-safe digital inputs are **externally** supplied. Otherwise the "short circuit" diagnosis may be reported.

Special features of fault detection (use case 2.1)

The following table shows fault detection according to the sensor supply and the parameter assignment for the short-circuit test:

Table 7- 5   ET 200eco 4/8 F-DI: Fault detection (use case 2.1)

Example of fault	Fault detection when ...		
	Internal sensor power supply and activated short-circuit test	Internal sensor supply and deactivated short-circuit test	External sensor supply
Short circuit in DI 0 with DI 1	No	No	No
Short circuit in DI 0 with DI 4	–	–	–
P-short circuit in DI 0	Yes	No	No
M-short circuit in DI 0	Yes*	Yes*	No
Discrepancy error	Yes	Yes	Yes
P-short circuit in sensor supply 1	Yes	No	No
M-short circuit in sensor supply 1, or sensor supply 1 defective	Yes	Yes	Yes
Short circuit in sensor supply 1 with sensor supply 2	Yes	No	No
Error in read/test circuit	Yes	Yes	Yes
Supply voltage fault	Yes	Yes	Yes
* Fault detection only in the case of signal corruption. In other words, the signal read differs from the sensor signal (discrepancy error). If there is no signal corruption with respect to the sensor signal, fault detection is not possible and is not required from a safety standpoint.			

Wiring diagram (use case 2.2 – connection of a two-channel sensor over two channels)

A 2-channel sensor is connected over two channels to two inputs of the fail-safe I/O module for each process signal (1oo2 evaluation).

Figure 7-8   Wiring diagram ET 200eco 4/8 F-DI – one two-channel sensor connected over two channels, internal sensor supply
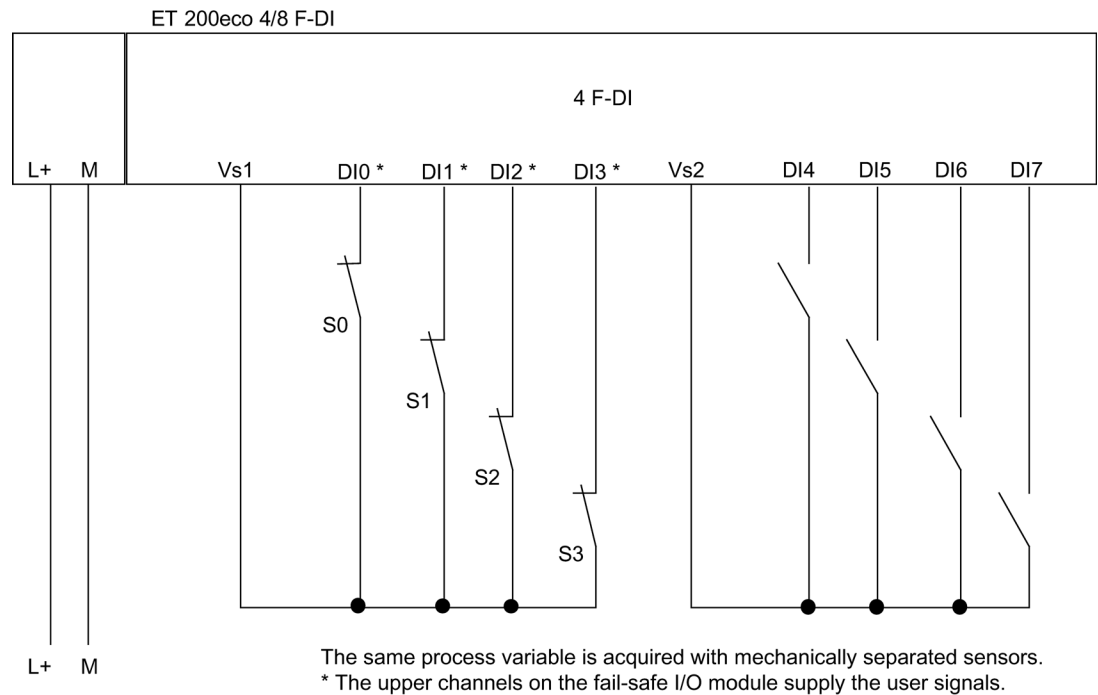

Figure 7-9   Wiring diagram ET 200eco 4/8 F-DI – one two-channel sensor connected over two channels, external sensor supply

Wiring diagram (use case 2.2 – connection of two one-channel sensors over two channels)

Two 1-channel sensors are connected over two channels to two inputs of the fail-safe I/O module for each process signal (1oo2 evaluation). The sensors can also be supplied via an external sensor supply.
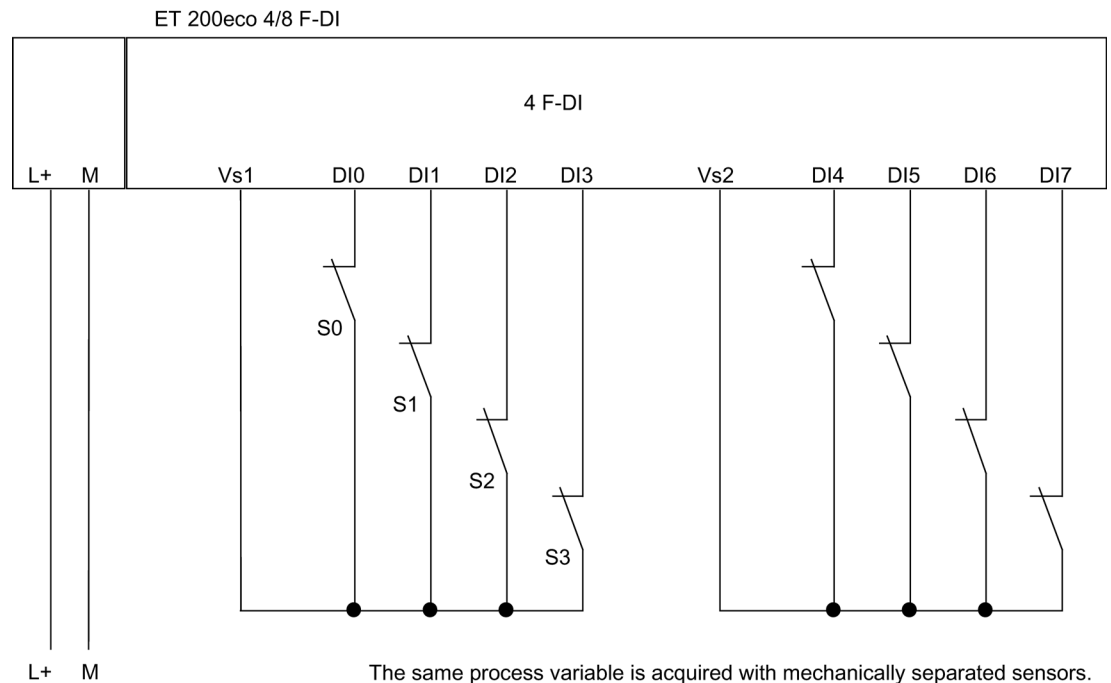
Figure 7-10   Wiring diagram ET 200eco 4/8 F-DI – two 1-channel sensors connected over two channels, internal sensor supply

---

⚠ **WARNING**

To achieve SIL3/Category 3 using this wiring, you must use a suitably qualified sensor.

Configurable parameters (use case 2.2)

Set the parameter "Evaluation of the sensors" to "1oo2 evaluation" and the parameter "Type of sensor interconnection" to "2-channel equivalent" for the relevant input. Deactivate the parameter "short-circuit test."

Special features of fault detection (use case 2.2)

The following table shows fault detection according to the sensor supply and the parameter assignment for the short-circuit test:

Table 7- 6   ET 200eco 4/8 F-DI: Fault detection (use case 2.2)

Example of fault	Fault detection when ...	
	Internal sensor supply and deactivated short-circuit test	External sensor supply
Short circuit in DI 0 with DI 1	No	No
Short circuit in DI 0 with DI 4	No	No
P-short circuit in DI 0	No	No
M-short circuit in DI 0	Yes*	No
Discrepancy error	Yes	Yes
P-short circuit in sensor supply 1	No	No
M-short circuit in sensor supply 1, or sensor supply 1 defective	Yes	Yes
Short circuit in sensor supply 1 with sensor supply 2	No	No
Error in read/test circuit	Yes	Yes
Supply voltage fault	Yes	Yes
* Fault detection only in the case of signal corruption. In other words, the signal read differs from the sensor signal (discrepancy error). If there is no signal corruption with respect to the sensor signal, fault detection is not possible and is not required from a safety standpoint.		

Wiring diagram (use case 2.3 – two-channel,
non-equivalent connection of a non-equivalent sensor)

A non-equivalent sensor is connected over two channels for non-equivalence to two inputs of the fail-safe I/O module for each process signal (1oo2 evaluation).
The upper channels on the fail-safe I/O module (DI0 through DI3) supply the user signals. If no faults are detected, these signals will be available in the I/O area for inputs on the F-CPU.

Note

If the voltage is supplied to the sensor by the fail-safe I/O module, you must use the internal sensor supply Vs1. Connection to Vs2 is not possible.
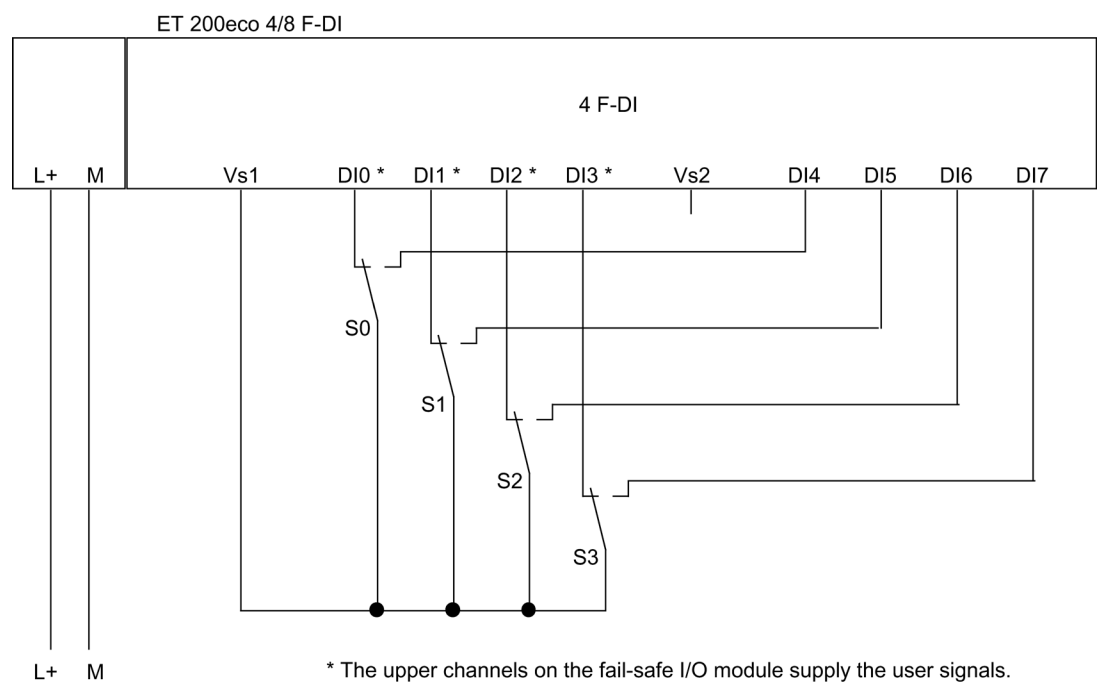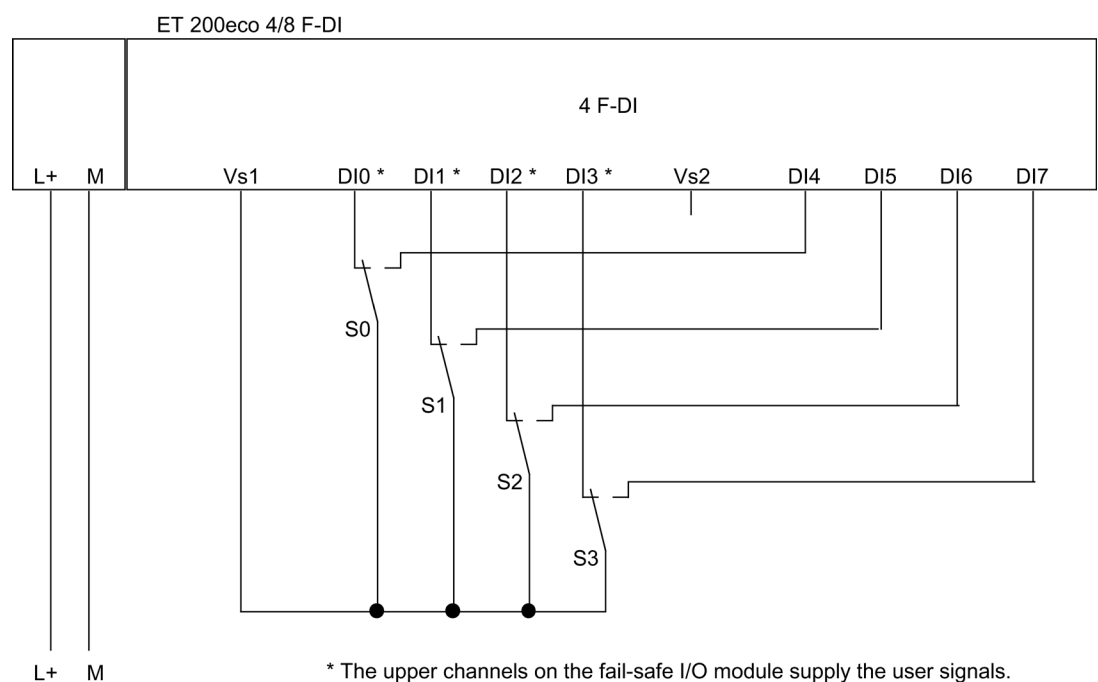

Figure 7-11   Wiring diagram ET 200eco 4/8 F-DI – one non-equivalent sensor connected over two channels (for non-equivalence), internal sensor supply
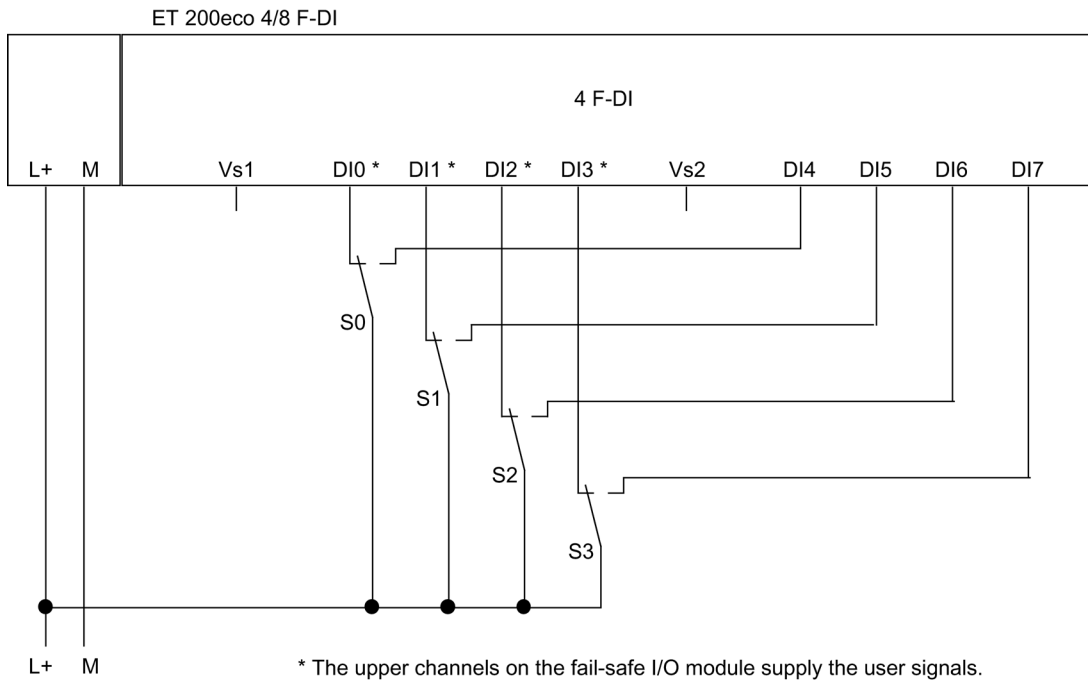
Figure 7-12   Wiring diagram ET 200eco 4/8 F-DI – one non-equivalent sensor connected over two channels (for non-equivalence), external sensor supply

Wiring diagram (use case 2.3 – connection of two one-channel sensors over two channels for non-equivalence)

Two 1-channel sensors are connected for non-equivalence over two channels to two inputs of the fail-safe I/O module for each process signal (1oo2 evaluation). The sensors can also be supplied via an external sensor supply.

Figure 7-13   Wiring diagram ET 200eco 4/8 F-DI – two one-channel sensors connected over two channels for non-equivalence, internal sensor supply

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⚠ **WARNING**

To achieve SIL3/Category 3 using this wiring, you must use a suitably qualified sensor.

Configurable parameters (use case 2.3)

Set the parameter "Evaluation of the sensors" to "1oo2 evaluation" and the parameter "Type of sensor interconnection" to "2-channel non-equivalent" for the relevant input. Deactivate the parameter "short-circuit test."

Special features of fault detection (use case 2.3)

The following table shows fault detection depending on the sensor power supply and the parameter assignment for the short-circuit test.

Table 7- 7   ET 200eco 4/8 F-DI: Fault detection (use case 2.3)

Example of fault	Fault detection when ...	
	Internal sensor supply and deactivated short-circuit test	External sensor supply
Short circuit in DI 0 with DI 1	No	No
Short circuit in DI 0 with DI 4	Yes	Yes
P-short circuit in DI 0	No	No
M-short circuit in DI 0	No	No
Discrepancy error	Yes	Yes
P-short circuit in sensor supply 1	No	No
M-short circuit in sensor supply 1, or sensor supply 1 defective	Yes	Yes
Short circuit in sensor supply 1 with sensor supply 2	No	No
Error in read/test circuit	Yes	Yes
Supply voltage fault	Yes	Yes
* Fault detection only in the case of signal corruption. In other words, the signal read differs from the sensor signal (discrepancy error). If there is no signal corruption with respect to the sensor signal, fault detection is not possible and is not required from a safety standpoint.		

7.5   Use case 3: Safety mode SIL3/Category 4

Assigning inputs to each other

The ET 200eco 4/8 F-DI has 8 fail-safe inputs DI 0 to DI 7 (SIL2). Two inputs each can be used as one input (SIL3). The following assignment applies:

- DI 0 with DI 4
- DI 1 with DI 5
- DI 2 with DI 6
- DI 3 with DI 7

Sensor supply

The ET 200eco 4/8 F-DI provides sensor supply Vs1 for inputs 0 to 3 and sensor supply Vs2 for inputs 4 to 7. The sensor **must** be supplied internally.

Wiring diagram (use case 3.1 – connection of a two-channel sensor over two channels)

A 2-channel sensor is connected over two channels to two inputs of the fail-safe I/O module for each process signal (1oo2 evaluation).
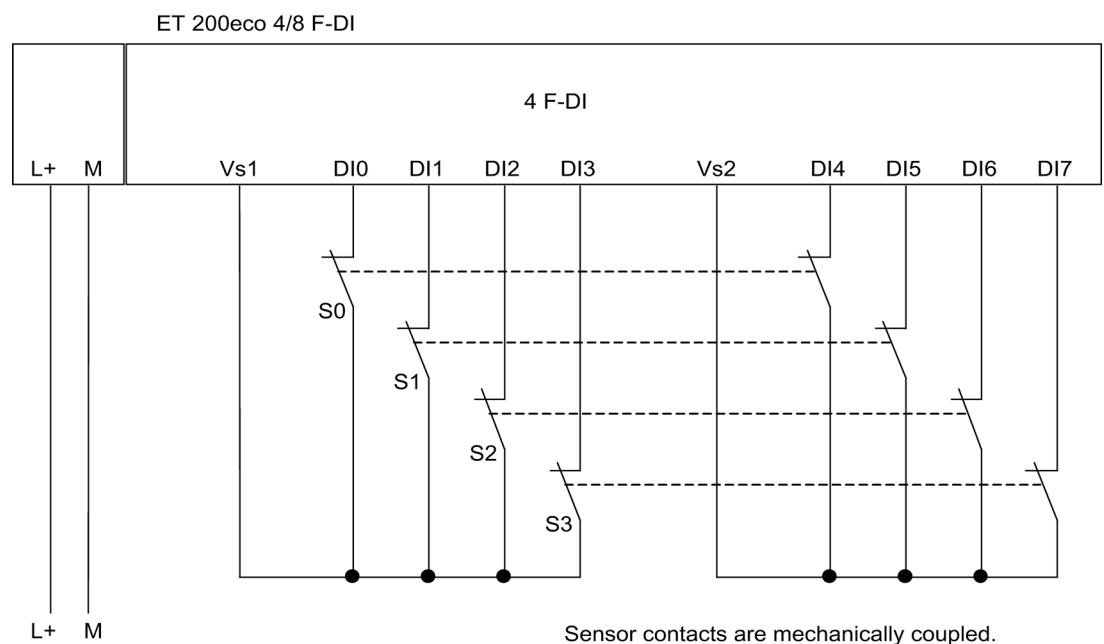
Figure 7-14   Wiring diagram ET 200eco 4/8 F-DI – one two-channel sensor connected over two channels, internal sensor supply

As an alternative, you can connect two 1-channel sensors over two channels (see wiring diagram for use case 2.2 - connecting two 1-channel sensors over two channels). In this case, the same process variable is acquired with two mechanically separate sensors.

⚠ WARNING
To achieve SIL3/Category 4 using this wiring, you must use a suitably qualified sensor.

Configurable parameters (use case 3.1)

Set the parameter "Evaluation of the sensors" to "1oo2 evaluation" and the parameter "Type of sensor interconnection" to "2-channel equivalent" for the relevant input. Activate the "short circuit test" parameter.

Wiring diagram (use case 3.2 – two-channel, non-equivalent connection of a non-equivalent sensor)

A non-equivalent sensor is connected over two channels to two inputs of the fail-safe I/O module for each process signal (1oo2 evaluation).

The upper channels on the fail-safe I/O module (DI0 through DI3) supply the user signals. If no faults are detected, these signals will be available in the I/O area for inputs on the F-CPU.

Note

You must use the internal sensor supply Vs1 to supply voltage to the sensor. Connection to Vs2 is not possible.

Figure 7-15   Wiring diagram ET 200eco 4/8 F-DI – one non-equivalent sensor connected over two channels (for non-equivalence), internal sensor supply

As an alternative, you can connect two one-channel sensors over two channels for non-equivalence (see wiring diagram for use case 2.3 - connecting two one-channel sensors over two channels for non-equivalence). In this case, the same process variable is acquired with two mechanically separate sensors.

⚠ **WARNING**

To achieve SIL3/Category 4 using this wiring, you must use a suitably qualified sensor.

Configurable parameters (use case 3.2)

Set the parameter "Evaluation of the sensors" to "1oo2 evaluation" and the parameter "Type of sensor interconnection" to "2-channel non-equivalent" for the relevant input. Activate the "short circuit test" parameter.

Special features of fault detection (use cases 3.1 and 3.2)

The following table shows fault detection according to the sensor supply and the parameter assignment for the short-circuit test:

Table 7- 8   ET 200eco 4/8 F-DI: Fault detection (use cases 3.1 and 3.2)

Example of fault	Fault detection with internal sensor power supply and activated short-circuit test for...	
	Sensor two-channel equivalent	Sensor two-channel non-equivalent
Short circuit in DI 0 with DI 1	No	No
Short circuit in DI 0 with DI 4	Yes*	Yes
P-short circuit in DI 0	Yes	Yes
M-short circuit in DI 0	Yes*	Yes*
Discrepancy error	Yes	Yes
P-short circuit in sensor supply 1	Yes	Yes
M-short circuit in sensor supply 1, or sensor supply 1 defective	Yes	Yes
Short circuit in sensor supply 1 with sensor supply 2	Yes	Yes
Error in read/test circuit	Yes	Yes
Supply voltage fault	Yes	Yes
* Fault detection only in the case of signal corruption. In other words, the signal read differs from the sensor signal (discrepancy error). If there is no signal corruption with respect to the sensor signal, fault detection is not possible and is not required from a safety standpoint.		

Requirements for machine protection applications with category 4

The following requirements apply for applications in machine protection with category 4:

- Wiring between sensors and the automation system and between the automation system and the actuators must be state-of-the-art and must comply with standards for preventing short circuits.

- that all short circuits listed in the above table are covered.
  It is sufficient to locate a short circuit, because two faults are required for it to occur (both shorted signal lines have an isolation fault). A multiple short circuit analysis is not required.

Procedures for locating all short circuits are therefore permissible if single short circuits are not located,

- cause corruption of read signals compared to the sensor signals or

- cause corruption of read signals compared to sensor signals in the direction that ensures safety.

7.6 Diagnostic Functions of the ET 200eco 4/8 F-DI

Reaction to Sensor Power Supply Faults

Faults in the sensor power supplies Vs1 and Vs2 of the ET 200eco 4/8 F-DI are indicated by the ON LED flashing on the fail-safe I/O module. This information is also provided in the I/O module (diagnostic entry).

- Fail-safe system S7 Distributed Safety: The entire fail-safe I/O module is passivated.
- Fail-safe system S7 F/FH Systems: The channels of the sensor power supply affected are passivated.

The SF LED is lit. When the fault is cleared, the LED flashes. After acknowledging the fault in the safety program, the SF LED goes off again.

Diagnostic Functions

The following table provides you with an overview of the diagnostic functions of the ET 200eco 4/8 F-DI. Diagnostic functions are assigned either to one channel or to the entire fail-safe I/O module.

Table 7- 9   Diagnostic Functions of the ET 200eco 4/8 F-DI

Diagnostic Function*	Fault number	LED	Signaled in Application	Effective Range of Diagnostics	Can be Set?
Short circuit	1_H	SF	1, 2, 3	Channel	Yes
Overtemperature	5_H	SF	1, 2, 3	Module	No
Internal error	9_H	SF	1, 2, 3	Module	No
Parameter assignment error	10_H	SF	1, 2, 3	Module	No
Sensor or load voltage fault	11_H	SF	1, 2, 3	Module	No
Communication error	13_H	SF	1, 2, 3	Module	No
Discrepancy error (1oo2 evaluation)	19_H	SF	2,3	Channel	No
* Specifically for fail-safe I/O modules; display in *STEP 7*, see table of channel-related diagnostics.					

Note

If you have activated the **short-circuit test** for the fail-safe I/O module in *STEP 7* and are using only one of the two internal sensor supplies of the module (Vs1 or Vs2), a channel P-short circuit is then detected for each of the four channels with a sensor supply that is not used. Four "short-circuit" diagnostic functions are generated in the diagnostic buffer of the fail-safe I/O module.

Special Features for Error Detection

Detection of some errors (such as short circuits or discrepancy errors) is dependent on the application, wiring, and parameter assignment of the short-circuit test. For this reason, you will find tables on error detection in the use cases.

Causes of Errors and Corrective Measures

The following table presents the possible causes of errors and corrective measures for the individual diagnostic messages of the ET 200eco 4/8 F-DI.

Table 7- 10   Diagnostic Messages of the ET 200eco 4/8 F-DI, Causes of Errors and Corrective Measures

Diagnostic Message	Possible Causes	Remedies
Short circuit	Short circuit in the sensor	Eliminate short circuit/cross circuit
	Cross circuit in the sensor	
	Internal error	Replace module
Overtemperature	Temperature limit in the module housing is exceeded causing module to be deactivated	Check ambient temperature, and check whether permissible output current of the sensor supply is exceeded for the ambient temperature
		After clearing the problem, you must turn the power off and on again
Internal error	Internal module error has occurred	Replace module
Parameter assignment error	Inserted module does not match configuration Faulty parameter assignment	Correct the configuration (compare actual and preset configuration), and check communication paths Correct the parameter assignment
	PROFIsafe address set incorrectly in the fail-safe I/O module	Check whether the PROFIsafe address on the module matches the configuration in *STEP 7 HW Config*
External auxiliary power supply missing	No supply voltage or supply voltage is too low	Check module for correct contact After clearing the problem, you must turn the power off and on again
Communication error	Problem in communication between F-CPU and module due, for example, to defective PROFIBUS connection or higher than permissible EMI	Check the PROFIBUS connection Eliminate the interference.
	PROFIsafe monitoring time set too low	Set a higher value for the "F-monitoring time" parameter for the module in *STEP 7 HW Config*
	Configuration of the fail-safe I/O module does not match safety program	Recompile the safety program; then download the configuration and safety program to the F-CPU again

Diagnostic Message	Possible Causes	Remedies
Discrepancy error (1oo2 evaluation)	Faulty process signal Defective sensor	Check process signal, replace sensor if necessary
	Short circuit between unconnected sensor cable and the sensor supply cable	Eliminate short circuit
	Wire break in connected sensor cable or the sensor supply cable	Eliminate broken wire
	Assigned discrepancy time too short	Check the assigned discrepancy time
		After eliminating the problem, the fail-safe I/O module must be re-integrated in the safety program.

For more detailed information on passivation and reintegration of F-I/O, refer to the section on diagnostics and to the *S7 Distributed Safety, Configuring and Programming* manual or *S7 F/FH Automation Systems* manual.

See also

Reactions to Faults (Page 31)

Use case 3: Safety mode SIL3/Category 4 (Page 71)

7.7 Technical Specifications of the ET 200eco 4/8 F-DI

Overview

> ⚠ **WARNING**
>
> The safety-related characteristics in the technical specifications apply for a proof-test interval of 10 years and a repair time of 100 hours.

Technical specifications		
Dimensions and Weight		
Dimensions W x H x D (mm)	60 x 210 x 28	
Weight	Approx. 220 g	
Module-specific specifications		
Number of inputs	Can be selected per input	
• Channels	8, maximum	
• Channels	4, maximum	
Assigned address area		
• In the I/O area for inputs	6 Byte	
• In the I/O area for outputs	4 Byte	
Length of cable		
Unshielded	30m, maximum	
Maximum achievable safety class	One-channel	Two-channel
• According to IEC 61508:2000	SIL2	SIL3
• According to ISO 13849-1:2006 or EN ISO 13849-1:2008	Category 3	Category 4
Fail-safe performance characteristics	SIL2	SIL3
• Low demand mode (average probability of failure on demand)	<< 1,00E-03	<< 1,00E-05
• High demand/continuous mode (probability of a dangerous failure per hour)	<< 1,00E-08	<< 1,00E-10
Voltages, currents, potentials		
Rated supply voltage L+	24 V DC	
• 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	

Technical specifications	
• Reverse polarity protection	No
Number of simultaneously controllable inputs	8
• All installations – Up to 55°C	8
Electrical isolation	
• Between channels and backplane bus	Yes
• Between channels and power supply	No
• Between channels	No
• Between channels/power supply and shield	Yes
Permissible potential difference between	
• Shield and ET 200eco bus connection	75 V DC/60 V AC
• Shield and I/O	75 V DC/60 V AC
• ET 200eco bus connection and I/O	75 V DC/60 V AC
Isolation in the type test tested with	
• Shield and ET 200eco bus connection	350 V AC/1 min
• Shield and I/O	350 V AC/1 min
• ET 200eco bus connection and I/O	350 V AC/1 min
Current consumption	
• From load voltage L+ (without load)	100 mA, typical
Power loss of the fail-safe I/O module	3 W, typical
Status, interrupts, diagnostics	
Status display	
Inputs	Green LED per channel
Sensor supply	Green LED for both channels
Interrupts	
Diagnostic interrupt	"ON"
Diagnostic functions	
• Group fault display	Red LED (SF)
• Bus fault display	Red LED (BF)
• Diagnostic information can be displayed	Possible
Sensor supply outputs	
Number of outputs	2
Output voltage	
• Loaded	Minimum L+ (-1.5 V)
Output current	
• Rated value	300 mA
• Permissible range	0 mA to 300 mA

Technical specifications		
Permissible aggregate current of outputs	600 mA	
Short-circuit protection	Yes, electronic	
• Operating value	0.7 A to 1.8 A	
Data for selecting a sensor**		
Input voltage		
• Rated value	24 V DC	
• For "1" signal	15 V to 30 V	
• For "0" signal	-30 V to 5 V	
Input current		
• For "1" signal	3.7 mA, typical	
Input delay*****	Configurable (for all inputs together)	
• For "0" after "1"	Typically 3 ms	(2.6 ms to 3.4 ms)
	Typically 15 ms	(13 ms to 17 ms)
• For "1" after "0"	Typically 3 ms	(2.6 ms to 3.4 ms)
	Typically 15 ms	(13 ms to 17 ms)
Input characteristic	In accordance with IEC 1131, Type 1	
Connection of 2-wire proximity switch	Not possible	
• Permissible quiescent current	0.6 mA, maximum	
Time, frequency		
Internal preparation times	See Response times	
Acknowledgment time in safety mode		

• Short-circuit test activated
  at input delay of 3 ms:
  with input delay of 15 ms:
	min. 13 ms / max. 26 ms
	min. 13 ms / max. 22 ms	

• Short-circuit test deactivated	13 ms minimum/22 ms maximum	
Minimum sensor signal duration	See table with minimum durations of the sensor signals	
Protection against overvoltage		
Protection of power supply 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	

Technical specifications	
Protection of outputs from surge in accordance with IEC 61000-4-5 with external protection elements only	
• Symmetrical (Vs, DI to M)	+ 1 kV; 1.2/50 µs
• Asymmetrical (Vs, DI to PE, M to PE)	+ 1 kV; 1.2/50 µs
* If there is a risk of overvoltage on the lines, to avoid a safety shutdown for the fail-safe digital inputs and the sensor power supply, you must set an input delay of 15 ms. ** Remember the requirements for sensors	

Accessories and Order Numbers

A

Accessories and Order Numbers

Below, you will find the order numbers of the ET 200eco components you require to use the fail-safe ET 200eco I/O module.

The standard accessories for I/O modules, terminal block ECOFAST and terminal block M12, 7/8" can also be used with the fail-safe ET 200eco I/O module (see *ET 200eco Distributed I/O Station*) manual.

Components of the Fail-Safe ET 200eco I/O Module

Component	Order number
4/8 F-DI DC24V PROFIsafe digital I/O module	6ES7 148-3FA00-0XB0
Terminal block M12, 7/8"	6ES7 194-3AA00-0BA0
Terminal block ECOFAST	6ES7 194-3AA00-0AA0

Response Times B

Introduction

The response times of ET 200eco fail-safe I/O module are listed below. The response times of the fail-safe I/O module are included in the calculation of F-system response time.

You will find information about the calculation of F-system response times in the *Safety Engineering in SIMATIC S7* system description.

Response Time for Fail-Safe Digital Inputs

The response time is the time between a signal change at the digital input and reliable generation of the safety message frame on PROFIBUS DP.

Maximum Response Time of the ET 200eco 4/8 F-DI

Table B- 1   Formula for calculating the maximum response time if there is no fault:

Maximum response time without fault   = T_{max} + input delay + short-circuit test time*

* Short-circuit test time = 2 x input delay

Parameters for the input delay and the short-circuit test are assigned in *STEP 7*.

Table B- 2   ET 200eco 4/8 F-DI: Internal Conditioning Times

Evaluation of the Sensors	Minimum internal processing time T_{min}	Maximum internal processing time T_{max}
1v1 and 2v2	13 ms	20 ms

Maximum response time if a fault occurs:

The following table shows the maximum response times of the fail-safe ET 200eco I/O module when an error/fault is present, depending on the parameter assignment in *STEP 7* and the evaluation of the sensors.

Table B- 3   ET 200eco 4/8 F-DI: Maximum Response Time if a Fault Occurs:

	1oo1 evaluation		1v2 evaluation**	
Input delay	3 ms	15 ms	3 ms	15 ms
Short-circuit test deactivated	35 ms	47 ms	23 ms	35 ms
Short-circuit test activated	55 ms	106 ms	29 ms	65 ms
** With **2v2 evaluation** the response times also depend on the configured discrepancy response: **Provide 0 value**: The times in the table above apply. **Provide last valid value**: The times in the above table extend to the configured discrepancy time.				

Note

Please note that the Excel files for calculation of the maximum response times (*s7fcotia.xls* and *s7fttimea.xls*) provided with the *S7 Distributed Safety* and *S7 F/FH Systems* option packages already supports calculation of the extension of the "Maximum responses time in the event of a fault" by the configured discrepancy time.

See also

Fail-Safe ET 200eco I/O Module 4/8 F-DI DC 24V PROFIsafe (Page 49)

Glossary

Fail-safe I/O module

ET 200eco I/O module that can be used for safety-related operation (in -> safety mode) in the S7 Distributed Safety or S7 F/FH fail-safe systems. This I/O module is equipped with integrated -> safety functions.

F-systems

-> Fail-safe systems

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