SIEMENS

SIMATIC

Distributed I/O
ET 200eco PN
F-DI 8x24VDC, 4xM12 /
F-DQ 3x24VDC/2.0A, 3xM12

Equipment Manual

V1.1, 01/2020

A5E39389453-AB

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.

Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

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.

Siemens AG
Division Digital Factory
Postfach 48 48
90026 NÜRNBERG
GERMANY

℗ 12/2019 Subject to change

Preface

Preface

Purpose of the manual

The S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), and ET 200S/ET 200SP series are families of Siemens programmable logic controllers (PLCs) that can control a variety of automation applications. The S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), and ET 200S/ET 200SP models and Windows-based programming tools give you the flexibility you need to solve your automation problems.

This manual provides information about installing, wiring, configuring, commissioning, and maintaining the ET 200eco PN F-DI 8 / F-DQ 3 module to work with the S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), and ET 200S/ET 200SP fail-safe CPUs. The manual is designed for engineers, programmers, installers, and electricians who have a general knowledge of programmable logic controllers.

Note

"ET 200eco PN F-DI 8 x 24 VDC, 4xM12 / F-DQ 3 x 24 VDC/2.0A PM, 3xM12" is the official name of the product. For ease of use, the manual uses the shortened name "ET 200eco PN F-DI 8 / F-DQ 3" throughout the manual.

Required basic knowledge

To understand this manual, you require a general knowledge of automation and programmable logic controllers.

Scope of the manual

This manual describes or references the following products:

- *STEP 7 Professional V15* or later with *STEP 7 Safety Advanced V15* or later
- S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), and ET 200S/ET 200SP fail-safe CPUs
- ET 200eco PN F-DI 8 / F-DQ 3 module
- Hardware Support Packages (HSP) 204, required with *STEP 7 Professional V15* and *STEP 7 Safety Advanced V15*. With *STEP 7 Professional V15.1* or later and *STEP 7 Safety Advanced V15.1* or later, the HSP is no longer required.

For a complete list of the products described in this manual, refer to "Ordering information" (Page 212).

WARNING

The "SIMATIC Safety - Configuring and Programming, Programming and Operating Manual" in the current version is the authoritative source for Functional Safety-related information concerning configuring and programming.

Siemens identifies the "SIMATIC Safety - Configuring and Programming, Programming and Operating Manual" (http://support.automation.siemens.com/WW/view/en/54110126/0/en) as the authoritative and/or original source in the case of discrepancies between the manuals.

All warnings in the "SIMATIC Safety - Configuring and Programming, Programming and Operating Manual" have to be observed. (*S801*)

Note

Refer to the "Distributed I/O ET 200eco PN Operating Instructions" (https://support.industry.siemens.com/cs/document/29999018/simatic-distributed-i-o-et-200eco-pn?dti=0&lc=en-WW) for further information about the ET 200eco PN system.

Certification, CE label, C-Tick, and other approvals

Refer to the technical specifications (Page 191) for more information.

Glossary

The definitions in the glossary are provided to give the reader an easy first reference for understanding the terms used in this manual. Some terms have detailed formal definitions in IEC 61508, EN ISO 13849, EN 62061, IEC 61784-3-3, and associated standards, and must be understood in terms of broad safety concepts detailed in these standards.

Another reference for more exact definitions is the "SIMATIC Safety - Configuring and Programming, Programming and Operating Manual" (http://support.automation.siemens.com/WW/view/en/54110126/0/en).

Service and support

In addition to our documentation, Siemens offers our technical expertise on the Internet on the customer support web site (http://www.siemens.com/automation/).

Contact your Siemens distributor or sales office for assistance in answering any technical questions, for training, or for ordering S7 products. Because your sales representatives are technically trained and have specific knowledge about your operations, processes, and industry, as well as the individual Siemens products that you are using, they can provide the fastest and most efficient answers to any problems you might encounter.

Documentation and information

STEP 7; S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), and ET 200S/ET 200SP CPUs; and ET 200eco PN provide a variety of documentation and other resources for finding the technical information that you require:

- The *SIMATIC ET 200eco PN F-DI 8 / F-DQ 3 Manual* presents an overview of the Siemens Safety software, fail-safe CPUs and distributed I/O, and a Getting Started configuration and programming example. However, the focus of the manual is the ET 200eco PN F-DI 8 / F-DQ 3 module. Module installation, configuration, diagnostics, applications, and technical specifications are emphasized.

  The English version of the *SIMATIC ET 200eco PN F-DI 8 / F-DQ 3 Manual* is the authoritative (original) language for Functional Safety-related information. All translated manuals refer back to the English manual as the authoritative, original source. Siemens identifies the English manual as the authoritative, original source in the case of discrepancies between the translated manuals.
- The *SIMATIC Safety - Configuring and Programming, Programming and Operating Manual* provides information that enables you to configure and program SIMATIC Safety fail-safe systems. In addition, you will obtain information on acceptance testing of a SIMATIC Safety fail-safe system. Read and understand this entire manual before attempting to configure and program an actual live, fail-safe operation.
- The *SIMATIC Distributed I/O ET 200eco PN, Operating Instructions* provides information that enables you to operate the ET 200eco PN F distributed I/O device on PROFINET.
- The *SIMATIC S7-1200 Functional Safety Manual* presents an overview of the Siemens Safety software, fail-safe CPUs and SMs, and a Getting Started configuration and programming example. However, the focus of the manual is the S7-1200 fail-safe SMs. SM installation, configuration, diagnostics, applications, and technical specifications are emphasized.
- The *SIMATIC S7-1200 Programmable Controller System Manual* provides specific information about the operation, programming, and the specifications for the complete S7-1200 product family. In addition to the system manual, the *S7-1200 Easy Book* provides a more general overview to the capabilities of the S7-1200 family.
- The *SIMATIC S7-1200/S7-1500 F-CPUs Product Information* provides important information on the available S7-1200/1500 F-CPUs.
- The *SIMATIC S7-1500, ET 200MP Automation System Manual* provides you with important information on how to configure, install, wire, and commission the S7-1500 automation system/ET 200MP distributed I/O system.
- The *SIMATIC S7-300 CPU 31xC and CPU 31x: Technical specifications Manual* and *SIMATIC S7-300 Module Data Manual* is a reference to operating, to functions, and to the technical data of the signal modules, power supply modules, and interface modules of the S7-300.
- The *SIMATIC S7-400 Automation System, CPU Specifications Manual* and *SIMATIC S7-400 Module Data Manual* is a reference to operating, to functions, and to the technical data of the signal modules, power supply modules, and interface modules of the S7-400.
- The *SIMATIC ET 200SP Distributed I/O system, System Manual* provides important information on configuring, installing, wiring, and commissioning the ET 200SP distributed I/O system.

- The *SIMATIC ET 200pro Distributed I/O system, Operating Instructions* provide important information on configuring, installing, wiring, and commissioning the ET 200pro distributed I/O system.
- *SIMATIC ET 200pro CPU 1516PRO-2 PN, Operating Instructions:* The information provided in this manual and the operating instructions of the ET 200pro enables you to commission the ET 200pro CPU 1516PRO-2 PN and to run it as an IO controller on PROFINET.
- *SIMATIC ET 200pro IM 154-8 PN/DP CPU interface module, Operating Instructions:* The information provided in this manual and the operating instructions of the ET 200pro enables you to commission the ET 200pro IM 154-8 PN/DP CPU interface module and to run it as an IO controller on PROFINET.
- The *SIMATIC ET 200S Distributed I/O system, Operating Instructions* provide important information on configuring, installing, wiring, and commissioning the ET 200S distributed I/O system.
- *SIMATIC ET 200S Distributed I/O, IM 151-8 PN/DP CPU interface module, Operating Instructions*: The information provided in this manual and the operating instructions of the ET 200S enables you to commission ET 200S with the IM 151-8 PN/DP CPU interface module and to run it as an IO controller on PROFINET.
- The *SIMATIC ET 200AL Distributed I/O system, System Manual* provides you with important information on how to configure, install, wire, and commission the SIMATIC ET 200AL distributed I/O system.

- The following manuals/product information's are available as electronic (PDF) manuals. You can download or view the electronic manuals from the Siemens Industry Online Support Web site (http://support.industry.siemens.com).
  - *SIMATIC ET 200eco PN F-DI 8 / F-DQ 3 Manual*
  - *SIMATIC Safety - Configuring and Programming, Programming and Operating Manual*
  - *SIMATIC Distributed I/O ET 200eco PN, Operating Instructions*
  - *SIMATIC S7-1200 Functional Safety Manual*
  - *SIMATIC S7-1200 Programmable Controller System Manual*
  - *SIMATIC S7-1200 Easy Book*
  - *SIMATIC S7-1200/S7-1500 F-CPUs Product Information*
  - *SIMATIC S7-1500, ET 200MP Automation System Manual*
  - *SIMATIC S7-300 CPU 31xC and CPU 31x: Technical specifications Manual* and *SIMATIC S7-300 Module Data Manual*
  - *SIMATIC S7-400 Automation System, CPU Specifications Manual* and *SIMATIC S7-400 Module Data Manual*
  - *SIMATIC ET 200SP Distributed I/O system System Manual*
  - *SIMATIC ET 200pro Distributed I/O system, Operating Instructions*
  - *SIMATIC ET 200pro CPU 1516PRO-2 PN, Operating Instructions*
  - *SIMATIC ET 200pro IM 154-8 PN/DP CPU interface module, Operating Instructions*
  - *SIMATIC ET 200S Distributed I/O system, Operating Instructions*
  - *SIMATIC ET 200S Distributed I/O, IM 151-8 PN/DP CPU interface module*
  - *SIMATIC ET 200AL Distributed I/O system System Manual*
- The TIA portal STEP 7 online help information system provides immediate access to the conceptual information, specific instructions, and error code event IDs that describe the operation and functionality of the programming package and basic operation of SIMATIC CPUs.
- The Siemens Industry Online Support Web site (http://support.industry.siemens.com) provides access to the electronic (PDF) versions of the SIMATIC documentation set. Existing documents are available from the Product Support link. With this online documentation access, you can also drag and drop topics from various documents to create your own custom manual.

  You can access online documentation by clicking "mySupport" from the left side of the page and selecting "Documentation" from the navigation choices. To use the mySupport Documentation features, you must sign up as a registered user.

- Siemens also provides online comprehensive support for your use of safety technology. A Safety Evaluation Tool assists you in determining required safety levels, Functional Examples guide you in your safety applications, SITRAIN classes offer training in safety standards and products, and you can calculate your maximum system response time using the RT_calculator Excel file. Visit the following web sites to access these support activities:
  - Safety Evaluation Tool (http://www.siemens.com/safety-evaluation-tool)
  - Functional examples (http://www.siemens.com/safety-functional-examples)
  - SITRAIN (http://www.siemens.com/sitrain-safetyintegrated)
  - SIMATIC STEP 7 Safety Advanced: F-Execution Times, F-Runtimes, F-Monitoring and Reaction Times (http://support.automation.siemens.com/WW/view/en/49368678/133100).) Excel file (RT_calculator)
- The customer support web site also provides FAQs and other helpful documents for STEP 7. Visit the following web site to access the collection of podcasts: STEP 7 Professional (http://w3.siemens.com/mcms/simatic-controller-software/en/step7/step7-professional/Pages/Default.aspx)
- You can also follow or join product discussions on the Service & Support technical forum (https://support.industry.siemens.com/tf/ww/en/?Language=en&siteid=csius&treeLang=en&groupid=4000002&extranet=standard&viewreg=WW&nodeid0=34612486). These forums allow you to interact with various product experts.
  - Forum for ET 200eco (https://support.industry.siemens.com/tf/us/en/posts/et200-eco-pn/70418/?page=0&pageSize=10)
  - Forum for S7-1200 (https://support.industry.siemens.com/tf/ww/en/threads/237?title=simatic-s7-1200&skip=0&take=10&orderBy=LastPostDate+desc)
  - Forum for S7-1500 (https://support.industry.siemens.com/tf/ww/en/threads/277/?page=0&pageSize=10)
  - Forum for S7-300 (https://support.industry.siemens.com/tf/ww/en/threads/130/?page=0&pageSize=10)
  - Forum for S7-400 (https://support.industry.siemens.com/tf/ww/en/threads/131/?page=0&pageSize=10)
  - Forum for Decentral Peripherie (https://support.industry.siemens.com/tf/ww/en/threads/140/?page=0&pageSize=10)
  - Forum for STEP 7 Professional (https://support.industry.siemens.com/tf/ww/en/threads/243?title=step-7-tia-portal&skip=0&take=10&orderBy=LastPostDate+desc)
  - Safety Newsletter Product Information (https://support.industry.siemens.com/cs/ww/en/view/109477906)

Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit (https://www.siemens.com/industrialsecurity).

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customers' exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed visit (https://www.siemens.com/industrialsecurity).

Table of contents

Product overview

1

SIMATIC Safety fail-safe system

The objective of safety engineering is to minimize danger to humans and the environment as much as possible through use of safety-oriented technical installations without restricting industrial production and the use of machines and chemical products any more than necessary. The SIMATIC Safety Fail-Safe system is available to implement safety concepts in the area of machine and personnel protection (for example, for emergency STOP devices for machining and processing equipment).

What are fail-safe automation systems?

Fail-safe automation systems control processes that can achieve a safe state immediately as a result of an unexpected operation or failure. These are fail-safe control processes where an immediate shutdown to safe state does not endanger humans or the environment.

Fail-safe systems go beyond conventional safety engineering to enable far-reaching intelligent systems that extend all the way to the electrical drives and measuring systems. You use fail-safe systems in applications with specific safety requirements. You can resume production quickly following a safety-related interruption, using the improved fault detection and localization provided in fail-safe systems through detailed diagnostic information.

Achievable safety requirements

SIMATIC Safety fail-safe systems can satisfy the following safety requirements:

- Safety class (Safety Integrity Level) SIL 1 to SIL 3 in accordance with IEC 61508
- Category 2 to 4, Performance Level (PL) a to e in accordance with EN ISO 13849-1

Principles of safety functions in SIMATIC Safety

You implement functional safety using the hardware and firmware of the fail-safe CPUs and modules in conjunction with the safety program downloaded by the TIA Portal software Engineering System (ES). The SIMATIC Safety system executes the safety function to bring the system to a safe state or maintain a safe state in case of a dangerous event.

The fail-safe modules ensure the safe application of process information (for example, sensors such as pushbuttons and light curtains that initiate emergency OFF operations and actuators that move or control a mechanism). The fail-safe modules have the required hardware and software components for safe processing, in accordance with the required Safety Integrity Level (SIL).

You provide the safety function for the process through the application program that you create or by the reaction of the fail-safe system to a fault. In the event of an error, the fail-safe system executes the fault reaction function (for example, the fail-safe system shuts down the associated outputs).

Example of user safety function

If an object interrupts the beam of a light curtain, the fail-safe system stops the motion in the area protected by the light curtain (user safety function):

- The light curtain provides a "1" signal, perhaps redundantly, to say the light beam is not broken or "0" to say the light beam is broken.
- The fail-safe digital inputs acquire the signal from the light curtain and provide the state to the fail-safe CPU through a safe communication protocol. Redundant microcontrollers with mutual diagnostics in the fail-safe digital inputs provide a high assurance that a "1" or a "0" is provided only when correct.
- The fail-safe CPU executes your user program for normal control of the motion and includes your programmed safety logic that says a "1" from the light curtain is required to enable the motion. Your programmed safety logic is encoded by the Engineering System in redundant logic steps that gives a high assurance that any fault in CPU execution results in outputs of "0". If the CPU fails to receive verifiable communication from the fail-safe digital inputs in a required time, the fail-safe CPU replaces the signal from the fail-safe digital inputs with "0".
- The fail-safe CPU delivers the results of the safety logic to the fail-safe digital outputs through the safe communication protocol. A "1" signal from your safety logic enables motion by turning an output channel ON, or a "0" turns the output channel OFF. Redundant microcontrollers with mutual diagnostics in the fail-safe digital outputs provide a high assurance that redundant output switches (P/M 24 V DC solid state switches) are turned ON only when this condition is correct and at least one output switch turns OFF if a fault occurs. If the fail-safe digital outputs fail to receive verifiable communication from the fail-safe CPU in a required time, the fail-safe digital outputs replace the signal from the fail-safe CPU with "0" and turn outputs OFF.

1.1 Hardware and software components

Fail-Safe CPUs

You can use any of the following fail-safe CPUs with the ET 200eco PN F-DI 8 / F-DQ 3 module:

- S7-1200/1500
- S7-300/400
- ET 200pro (IP67 compliant)
- ET 200S/ET 200SP

A fail-safe system requires a fail-safe CPU with fail-safe central I/O and/or fail-safe distributed I/O.

Hardware components for PROFINET IO

You can use the following fail-safe PROFINET IO hardware components in a fail-safe system:

- Fail-Safe CPUs with built-in PROFINET interface
- Fail-Safe inputs and outputs (F-I/O), such as:
  - ET 200eco PN fail-safe modules (includes module described in this manual)
  - ET 200SP fail-safe modules
  - ET 200MP fail-safe modules
  - ET 200S fail-safe modules
  - ET 200M fail-safe modules
  - ET 200pro fail-safe modules
  - Fail-Safe GSDML-based, PROFIsafe-capable I/O devices (for example, a light curtain or laser scanner)

Hardware components for PROFIBUS DP

You can use the following fail-safe PROFIBUS DP components in a fail-safe PROFINET IO system:

- Fail-Safe CPUs with the CM 1243-5 (PROFIBUS DP master)
- Fail-Safe inputs and outputs (F-I/O), such as:
  - ET 200SP fail-safe modules
  - ET 200MP fail-safe modules
  - ET 200S fail-safe modules
  - ET 200M fail-safe modules
  - ET 200pro fail-safe modules
  - ET 200iSP fail-safe modules
  - Fail-Safe GSDML-based, PROFIsafe-capable DP slaves (for example, a light curtain or laser scanner)

Required software components

You require the *STEP 7 Professional V15* or later with *STEP 7 Safety Advanced V15* or later optional package software combination to configure and program the ET 200eco PN F-DI 8 / F-DQ 3 in a SIMATIC Safety Fail-Safe system.

In the *STEP 7 Safety Advanced V15* software package, you receive the following:

- Support for configuring the fail-safe CPUs with fail-safe central I/O and/or fail-safe distributed I/O in the hardware and network editor of the TIA portal
- Support for creating the safety program using LAD and FBD and integrating error detection functions into the safety program
- Instructions for programming your safety program in LAD and FBD, which you are familiar with from the standard user programs
- Instructions for programming your safety program in LAD and FBD with special safety functions

1.2 Fail-Safe CPUs

1.2.1 Overview

You can use any of the following fail-safe CPUs with the ET 200eco PN F-DI 8 / F-DQ 3 module:

- S7-1200/1500
- S7-300/400
- ET 200pro (IP67 compliant)
- ET 200S/ET 200SP

The fail-safe CPU can execute your safety program along with a standard applications program. Communication between the fail-safe CPU and the fail-safe module is verified using the PROFIsafe protocol.

 S7-300 F	 IM 154-8F PN/DP CPU for ET 200pro	 S7-400 F
 S7-1200 F	 S7-1500 F	 ET 200pro 1516PRO F-2 PN
 ET 200SP F	 ET 200S PN F	

Safety program

You can create a safety program using the program editor. You can program fail-safe function blocks (FB) and functions (FC) in the Function Block Diagram (FBD) or Ladder Logic (LAD) programming languages and create fail-safe data blocks (DB).

The fail-safe CPU performs a dual execution using coded processing. The fail-safe ES automatically performs safety checks and inserts additional fail-safe logic for error detection and error response when the safety program compilation occurs. These safety checks and additional fail-safe logic ensure the detection of failures and faults and appropriate execution of reactions to maintain the fail-safe system in the safe state or bring it to a safe state.

In addition to the safety program, you can run a standard user program on the fail-safe CPU. A standard program can coexist with a safety program in a fail-safe CPU. The fail-safe CPU protects the safety-related data of the safety program from the unintentional effects of the standard user program data.

WARNING

You cannot put an S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), or ET 200S/ET 200SP Fail-Safe system that provides safety-related functions into operation after installation or modification until after you successfully validate the safety-related functionality.

Death or serious personal injury and damage to machines and equipment may result if proper precautions are not taken.

An S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), or ET 200S/ET 200SP Fail-Safe system that provides both safety-related functions and standard (non safety-related) functions must not be put into operation in order to use the standard functions before you successfully validate the safety-related functions, even if all fail-safe signal modules go to the error state and thus remain safe. *(S802)*

You can exchange data between the safety program and the standard user program in the fail-safe CPU by means of bit memory or data of a standard DB.

1.2.2 Behavior differences between standard and fail-safe CPUs

1.2.2.1 Safety mode

Safety mode

In safety mode, the safety functions for fault detection and fault reaction are activated in the following:

- Safety program of the fail-safe CPU
- Fail-safe modules

Safety mode of safety program

The safety program runs in the fail-safe CPU in safety mode. The safety program activates safety mechanisms for fault detection and fault reaction. You cannot modify the safety program during operation in safety mode, while the fail-safe CPU is in RUN mode.

You can deactivate and reactivate the safety mode of the safety program. "Deactivated safety mode" enables the safety program for online tests and changes as needed while the fail-safe CPU is in RUN mode.

For SIMATIC Safety, you can switch back to safety mode only after an operating mode change of the fail-safe CPU from RUN to STOP to RUN.

Safety message frame

The fail-safe CPU and fail-safe modules consistently transmit data between each other in a safety message frame. The safety message frame in accordance with PROFIsafe standards consists of the following:

- Process data (user data)
- Status byte/control byte (coordination data for safety mode)
- Virtual Monitoring Number (encoded in CRC signature, provides keep-alive mechanism and detection of out-of-sequence messages)
- CRC signature

1.2.2.2 Fault reactions

Safe state

The fail-safe concept depends on the identification of a safe state for all process variables. The value "0" (de-energized) represents this safe state for digital fail-safe modules. The safe state value of "0" (de-energized) applies to both sensors and actuators.

Passivation

Passivation applies safe state values to the fail-safe channel(s) instead of process values when the fail-safe system detects faults. The safety function requires passivation of the fail-safe channel(s) in the following situations:

- When the fail-safe system starts up
- If the fail-safe system detects overall module faults, such as RAM or Processor failures
- If the fail-safe system detects errors during safety-related communication between the fail-safe CPU and the fail-safe module through the PROFIsafe safety protocol (communication error)
- If fail-safe channel faults occur (for example, short-circuit and discrepancy errors or internal faults of fail-safe input or output channels)

When passivation occurs in the digital inputs of the fail-safe module, SIMATIC Safety provides the safety program with safe state values (0) instead of the process data pending at the fail-safe inputs in the input process image.

When passivation occurs in the digital outputs of the fail-safe module, the module sets the passivated channel(s) to a value of (0).

Reintegration

Reintegration returns the process from passivation to a normal state after successful diagnostics determine that the fault has cleared. After reintegration of a fail-safe digital input, SIMATIC Safety again provides the process data pending at the inputs to the safety program. For a fail-safe digital output, SIMATIC Safety again transfers the output values provided by the safety program to the fail-safe outputs. Reintegration from safe state values to process data can be automatic or require acknowledgement by your safety program. See "Reactions to faults" (Page 167) for steps to reintegrate.

Detection and response to faults

SIMATIC Safety systems detect and respond to faults in several different conditions:

- Faults in the fail-safe CPU hardware and firmware
- Faults in the fail-safe user program
- PROFIsafe communication errors caused by conditions in either the fail-safe CPU or modules
- Fail-safe module-wide errors such as microprocessor errors or memory errors
- Fail-safe module channel errors such as discrepancy errors, wiring shorts, or internal channel faults

Fail-safe CPU faults and fail-safe user program faults often result in the CPU operating mode being set to STOP. You can reintegrate PROFIsafe communication faults once communication is successfully restored. In some cases, you can reintegrate module-wide faults. In other cases, you must power cycle the fail-safe module to recover from a module-wide fault. You can often reintegrate and return channel faults to proper operation by removing the fault and reintegrating the channel.

Virtual monitoring number, cyclic interrupt time, and F-monitoring time

The following parameters are integral to fault reactions:

- Virtual monitoring number: The PROFIsafe protocol provides time monitoring and detection of message sequence errors by means of a periodically-updated monitoring number.
- Cyclic interrupt time: The cyclic interrupt time is the interval by which the F-runtime group executes and determines how often the fail-safe CPU sends the PROFIsafe frame to the fail-safe modules. When you add a fail-safe CPU to your project, STEP 7 creates Functional Safety Organization Block 1 (FOB_1) (OB123 by default). FOB_1 contains the cyclic time interrupt time. You can configure the cyclic interrupt time (100 ms by default).
- F-monitoring time: The F-monitoring time is the amount of time a fail-safe module or CPU waits for an error-free communication including a new Virtual Monitoring Number before passivating channels. You can configure the F-monitoring time. The fail-safe CPU and modules must receive a valid, current safety message frame with a valid monitoring number within the configured F-monitoring time.

If the fail-safe system fails to detect a valid monitoring number within the F-monitoring time, the fail-safe system passivates the fail-safe module. Expiration of a module's F-monitoring time causes a transition to safe state for all F-inputs and F-outputs of the module.

CRC (Cyclic Redundancy Check) signature

A CRC signature contained in the safety message frame protects the validity of the process data in the safety message frame, the accuracy of the assigned address references, and the safety-relevant parameters.

If a CRC signature error occurs during communication between the fail-safe CPU and fail-safe modules, the fail-safe system passivates the fail-safe modules.

1.2.2.3 Restart of fail-safe system

The operating modes of the SIMATIC Safety system differ from those of the standard system only in terms of the restart characteristics.

Restart characteristics

When you switch a fail-safe CPU from STOP to RUN mode, the standard user program restarts in the usual way. When you restart the safety program, the fail-safe system initializes all data blocks with the F-Attribute with values from load memory. This action is comparable to a cold restart.

The fail-safe system attempts to reintegrate each fail-safe module at restart. In contrast to the standard user program, you cannot use startup OBs in the safety program.

1.3 ET 200eco PN F-DI 8 / F-DQ 3 module

1.3.1 Overview

Siemens intends for you to use the ET 200eco PN F-DI 8 / F-DQ 3 module to help achieve functional safety in machine applications.

Redundant two-microcontroller functional safety design

The major difference between the ET 200eco PN F-DI 8 / F-DQ 3 and standard modules is that this module uses redundancy to achieve functional safety, including two microcontrollers that control fail-safe operation. Both microcontrollers monitor each other and verify that they are executing the same code at the same time, automatically test the I/O circuits, and set the fail-safe module to safe state in the event of a fault. Each processor monitors internal and external power supplies and module internal temperature and can passivate the module if an abnormal condition is detected.

Safety-related input and output signals form the interface to the process. This interface enables direct connection of single-channel and two-channel input signals from devices such as emergency STOP buttons or light curtains. The fail-safe module redundantly combines the safety-related signals internally and passes the unified result on to the CPU in a fail-safe manner for further processing.

The fail-safe CPU sends the safety-related output states from the CPU to the fail-safe module for each individual output channel. Each output then sets two independent switches for each channel, a P and M solid-state switch. For each channel, the P switch is controlled by one processor, and the M switch is controlled by the other processor.

Use as a safety module

You can use the ET 200eco PN F-DI 8 / F-DQ 3 as a safety module, but not as a standard module.

1.3.2 Description

The ET 200eco PN F-DI 8 / F-DQ 3 module is a safety module with built-in distributed PROFINET device capability (in other words, the safety module does not require the presence of a separate interface module). The ET 200eco PN F-DI 8 / F-DQ 3 is IP67 compliant and is capable of being installed independently from typical IP20 control cabinetry.

You can connect to the module from a PROFIsafe compliant controller, V2.6.x (RIOforFA-Safety profile) or PROFIsafe V2.4. The module supports either version.

The ET 200eco PN F-DI 8 / F-DQ 3 contains twelve M12 connectors which support the following connections. Refer to the figure below:

- Two PROFINET communication connections (X01 P1 and X01 P2) which function as a single switch, useful for passing PROFINET to the next module
- One eCoding plug (X40) which contains the PROFIsafe address assignment unique to this module
- Four pairs of inputs (X1 through X4) which allow up to eight 1oo1 or up to four 1oo2 safety inputs
- Three PM outputs (X5 through X7)
- One power input (X03) which contains both logic and input power (1L+) and output power (2L+)
- One power output (X02) to send 1L+ and 2L+ to the next module

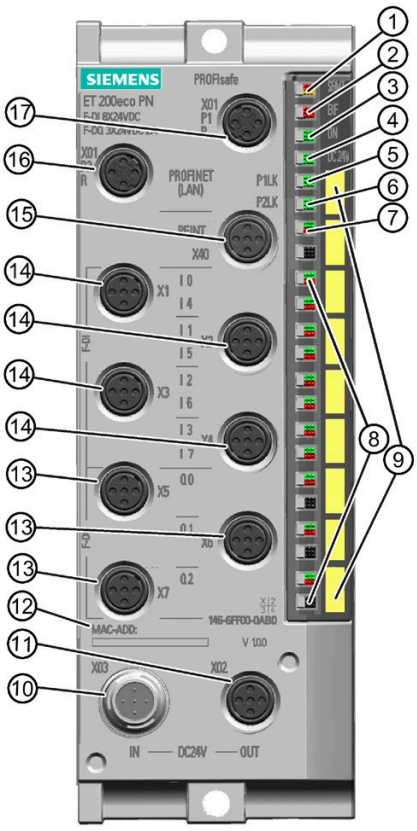
⚠ WARNING

If you insert an M12 I/O cable (X1 to X7 connectors) into the M12 X02 power connector, you can damage the ET 200eco PN F module or provide power to a safety load. On the ET 200eco PN F module, M12 I/O connectors and the M12 X02 power connector are the same physical connector.

Death or serious personal injury and damage to the ET 200eco PN F module and associated machines/equipment may result if proper precautions are not taken.

Only insert an M12 I/O cable into the X1 to X7 connectors. Always comply with the required standards and safety guidelines when configuring a system. *(S804)*

Table 1- 1 Components of the ET 200eco PN F-DI 8 / F-DQ 3

I/O device	Components	
	①	SF/MT LED (Red/Yellow)
	②	BF LED (Red)
	③	ON LED (Green)
	④	DC 24V LED (Green)
	⑤	P1 LK LED (Green)
	⑥	P2 LK LED (Green)
	⑦	REINT (Green/Red)
	⑧	Channel status (Green) / channel fault (Red)
	⑨	Plastic yellow connector labels
	⑩	X03: Voltage infeed
	⑪	X02: Loop through of the voltage
	⑫	MAC address
	⑬	Output signal
	⑭	Input signal
	⑮	X40 eCoding Plug connection
	⑯	X01 P2 LAN: PROFINET IO connection
	⑰	X01 P1 LAN: PROFINET IO connection

1.3.3 Properties

Article number

6ES7146-6FF00-0AB0

Properties

The ET 200eco PN F-DI 8 / F-DQ 3 module has the following features:

- PROFINET IO Device
- PROFIsafe communication
- Supports the "RIOforFA-Safety" profile on S71200/1500 fail-safe CPUs
- PROFIsafe address type 2
- Four pairs of inputs (X1 through X4) which allow up to eight 1oo1 (SIL 2/Category 3/PL d) or up to four 1oo2 (SIL 3/Category 3 or Category 4/PL e) safety inputs

- Three PM outputs (X5 through X7) (SIL 3/Category 3 or Category 4/PL e)
- One eCoding plug (X40) which contains the PROFIsafe address assignment unique to this module
- One power input (X03) which contains both logic and input power (1L+) and output power (2L+)
- One power output (X02) to send 1L+ and 2L+ to the next module
- Two PROFINET connections (X01 P1 and X01 P2) which function as a single switch (single MAC address), useful for passing PROFINET to the next module
- 24 V DC-rated input voltage
- Suitable for switches and 3/4-wire proximity switches (BEROs)
- Two short-circuit proof sensor supplies, each one for four inputs
- External sensor supply possible
- Module fault display (System Fault (SF) red LED)
- Status display for each input and each output (green LED)
- Fault display for each input and each output (red LED)
- Refer to "Fault diagnostics" (Page 171) for a description of LED and diagnostic message functions.

The module supports the following functions:

- Firmware update
- I&M identification data

1.3.4 User data space

The ET 200eco PN F-DI 8 / F-DQ 3 module's digital inputs user data space is one byte (8 bits) of Process value input, followed by one byte of Value status bits.

This is the bit structure for the module's digital inputs configured with the input start address of 8:

Table 1- 2 Input terminal F-DI start F-DI end

Input terminal	F-DI start	F-DI end
Process value bit	I8.0	I8.7
Value status bit	I9.0	I9.7

The ET 200eco PN F-DI 8 / F-DQ 3 module's digital outputs user data space is the first three bits of one byte (8 bits) of Process value output, followed by the first three bits of the third byte of Value status bits.

This is the bit structure for the module's digital outputs configured with the output start address of 8:

Output terminal	Process value bit	Value status bit
Process value bit	Q8.0	Q8.2
Value status bit	I10.0	I10.2

1.3.5 Fail-Safe digital inputs

The digital inputs of the ET 200eco PN F-DI 8 / F-DQ 3 are rated for connection to 24 V DC sensors/switches and 3/4-wire proximity switches (for example, BEROs: Siemens line of no-touch sensors) and have an EN61131-2 type 1 input rating.

The fail-safe module has two sensor supply outputs that can power external sensors (inputs). All 1oo1 and 1oo2 application modes, except the "1oo2, 2 channel 3-wire non-equivalent" application mode, use the Vs1 sensor supply to provide power for channels 0 to 3 and the Vs2 sensor supply to provide power for channels 4 to 7. The "1oo2, 2 channel 3-wire non-equivalent" application mode uses the Vs1 sensor supply to provide power for all eight inputs and does not use the Vs2 sensor supply.

Inputs and test circuit

The fail-safe digital inputs consist of eight input channels (F-DI x.0 to x.7). You can configure these inputs as eight one-out-of-one (1oo1) inputs (SIL 2/Category 3/PL d), four one-out-of-two (1oo2) inputs (SIL 3/Category 3 or Category 4/PL e), or combinations of 1oo1 and 1oo2 channels.

Connections	Input channel pairs
X1	0 and 4
X2	1 and 5
X3	2 and 6
X4	3 and 7

Note

A configuration of an input channel pair as one-out-of-one (1oo1) inputs requires the use of a Y cable. Refer to Appendix B.2: "Accessories for the ET 200eco PN F-DI 8 / F-DQ 3 module" (Page 212) for ordering information on the Siemens SIMATIC DP, Y cable.

One microcontroller monitors inputs 0 to 3, and the other microcontroller monitors inputs 4 to 7. The corresponding channels (0, 4), (1, 5), (2, 6), and (3, 7) form a 1oo2 channel group. The first of the two inputs, conveys the signal in a 1oo2 configuration. For example, if you wire I0.0 and I0.4 in a 1oo2 configuration and configure STEP 7 to use 1oo2 sensor evaluation, the signal appears at only the I0.0 input when you close or open the circuit for both.

When you configure a channel group as 1oo2, the two controllers must sense the same input change within a configured time. Otherwise, the two controllers detect a discrepancy error.

If you use a sensor supply output to provide power to a sensor, you can enable short-circuit testing. The short-circuit test checks for shorts to 24 V DC by periodically pulsing the sensor output off and verifying that the associated input is off.

This short-circuit test also checks for shorts to the other circuit in "1oo2, 2 channel equivalent" and "1oo2, 2 channel 4-wire non-equivalent" because the test pulses the two sensor outputs off at different times.

The microcontrollers cooperate in providing internal test pulses to each others process input circuits to verify that sensing electronics are responsive to "1" and "0" inputs.

1.3.6 Fail-Safe digital outputs

The digital outputs of the ET 200eco PN F-DI 8 / F-DQ 3 are for use in fail-safe applications and are suitable for various actuators including solenoid valves, DC contactors, and indicator LEDs. The three digital outputs have P- and M-switching that are rated for connection to 24 V DC actuators with up to a 2.0 A rating. The three digital outputs use the supply voltage 2L+, and the supply voltage 2L+ infeed current is a maximum of 4.0 A. This means that the total current usage by the three digital outputs cannot exceed 4.0 A.

Outputs

The fail-safe digital outputs consist of three output channels (F-DQ x.0 to x.2). You can use each output for SIL 3 applications.

Connections	Output channel
X5	0
X6	1
X7	2

Each output consists of two switches:

- A P-switch connects 24 V DC positive (L+) through the load.
- An M-switch connects the load to M or 24 V DC return.

Both switches must be turned ON for current to flow to the load.

The fail-safe digital outputs use two microcontrollers to implement the safety function. One microcontroller controls the P-switch while the other microcontroller controls the M-switch. There is feedback from the P-switch output to the other microcomputer that is controlling the M-switch. Likewise, there is feedback from the M-switch output to the other microcomputer that is controlling the P-switch. The feedback verifies that the output switches are operating properly and in the commanded state.

You must configure a "Maximum readback time" that specifies the allowed delay for the output voltage to respond to the switch change.

The fail-safe digital outputs regularly test each P- and M-switch to verify that each switch is still functional and under independent control. Your configured "Maximum readback time" also sets the duration of the "OFF" test pulse. You must configure a "Maximum readback time switch on test" which sets the duration of the "ON" test pulse. You should choose these durations short enough to not affect your load.

The module can detect a broken wire or missing load when the output PV is off and the load is wired as a PM mode.

Getting started

2

2.1 Introduction to example

2.1.1 Instructional videos

The "Getting Started" chapter contains twelve instructional videos. Nine instructional videos take you step-by-step through many of the configuring and programming tasks. These instructional videos show the completed task at the beginning of the video, with a fadeout to a step-by-step tutorial that demonstrates all of the required sub-tasks:

- "Operating the Getting Started example" (Page 35) (shows a wiring overview of the ET 200eco PN F-DI 8 / F-DQ 3 with an S7-1500 fail-safe CPU application example)
- "Step 1: Configuring the fail-safe CPU" (Page 40) (step-by-step tutorial)
- "Step 5: Assigning ET 200eco PN F-DI 8 / F-DQ 3 PROFIsafe addresses" (Page 52) (step-by-step tutorial)
- "Step 11: Creating an F-FB" (Page 70) (step-by-step tutorial)
- "Step 12: Programming the safety door function" (Page 71) (step-by-step tutorial)
- "Step 13: Programming the emergency stop function" (Page 73) (step-by-step tutorial)
- "Step 14: Programming the feedback monitoring" (Page 75) (step-by-step tutorial)
- "Step 15: Programming the user acknowledgment for reintegration of the fail-safe module" (Page 77) (step-by-step tutorial)
- "Step 16: Programming of the main safety block" (Page 78) (step-by-step tutorial)
- "Step 17: Compiling the safety program" (Page 79) (step-by-step tutorial)
- "Step 18: Downloading the complete safety program to the fail-safe CPU and activating safety mode" (Page 81) (step-by-step tutorial)
- "Step 18: Downloading the complete safety program to the fail-safe CPU and activating safety mode" (Page 81) (second video; shows the end result of the LAD programming steps)

2.1.2 Requirements for configuring and programming

These instructions will guide you step-by-step through a specific example for configuring and programming with *STEP 7 Safety Advanced V15* or later.

You will become acquainted with the basic functions and special features of *STEP 7 Safety Advanced V15* or later.

You can work through this example in one or two hours, depending on your level of experience.

Requirements for the example

The following requirements must be met:

- In order to understand these Getting Started instructions, you need general knowledge of automation technology. You also need to be familiar with *STEP 7 Professional V15* or later and *STEP 7 Safety Advanced V15* or later.
- You need a PLC station consisting of the following components:
  - Fail-Safe CPU (S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), or ET 200S/ET 200SP fail-safe CPUs)
  - ET 200eco PN 16DI module
  - ET 200eco PN F-DI 8 / F-DQ 3 module
- *STEP 7 Professional V15* or later and *STEP 7 Safety Advanced V15* or later must be correctly installed on your Windows-based programming device with an Ethernet interface.
- You must install an HSP in order to add the ET 200eco PN F-DI 8 / F-DQ 3 module to the Hardware catalog. TIA Portal V15 does not include the ET 200eco PN F module in its initial release. Hardware Support Packages (HSP) provide a way to configure modules that are not contained in the hardware catalog of your current STEP 7 installation. Refer to "Installing the Hardware Support Package (HSP)" (Page 44) for further information.
- You must connect a programming device to the fail-safe CPU through the PROFINET interface.
- The S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), or ET 200S/ET 200SP fail-safe CPUs must be fully installed and wired. Documentation on the installation and wiring of these fail-safe CPUs can be found in the Preface, "Documentation and information" (Page 5).
- You can find information on the installation and wiring of the ET 200eco PN 16DI in the "Distributed I/O ET 200eco PN, Operating Instructions" (https://support.industry.siemens.com/cs/document/29999018/simatic-distributed-i-o-et-200eco-pn?dti=0&lc=en-WW) and of the ET 200eco PN F-DI 8 / F-DQ 3 in the "Installation (Page 106)" and "Wiring" (Page 112) chapters of this manual.

WARNING

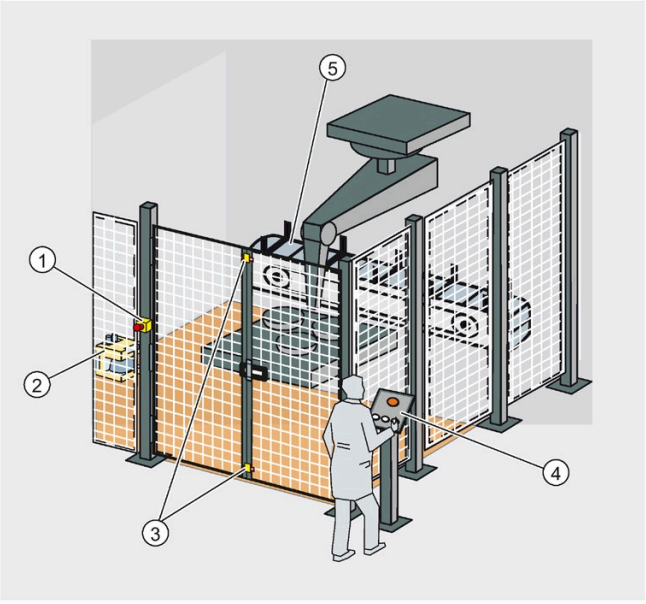
As components in plants and systems, the S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), or ET 200S/ET 200SP fail-safe CPUs and the ET 200eco PN F-DI 8 / F-DQ 3 module are subject to specific standards and regulations depending on the area of application. Please note the applicable safety and accident prevention regulations (for example, IEC 60204-1 (General Requirements for Safety of Machinery)).

The example in these Getting Started instructions serves as an introduction to configuring and programming of *STEP 7 Safety Advanced V15* or later. The example does not lead to actual live operation in every case. Before you work on the example, it is essential that you refer to the current version of the "SIMATIC Safety - Configuring and Programming, Programming and Operating Manual" (http://support.automation.siemens.com/WW/view/en/54110126/0/en). The warnings and other notes contained in that manual must be heeded at all times even if they are not repeated in this document.

Serious injury and damage to machines and equipment may result if these regulations are ignored. *(S805)*

2.1.3 Example structure and task definition

The Getting Started example consists of a production cell with access protection. Your task is to configure and program the field devices (shown in the image below) to provide that access protection.



① Emergency stop (E-Stop)
② Laser scanner
③ Safety door
④ Control panel with start and acknowledgement pushbuttons
⑤ Conveyor motor

A laser scanner monitors the entry to the production area. A safety door secures the service area.

Entering the production area or opening the safety door results in a stop or shutdown of the production cell similar to an emergency stop.

The system can only be restarted when the emergency stop is cancelled, the safety door is closed, and the laser scanner detects no one in the protected area. The user must acknowledge that conditions have returned to a safe state before production can be restarted.

2.1.4 Operating the Getting Started example

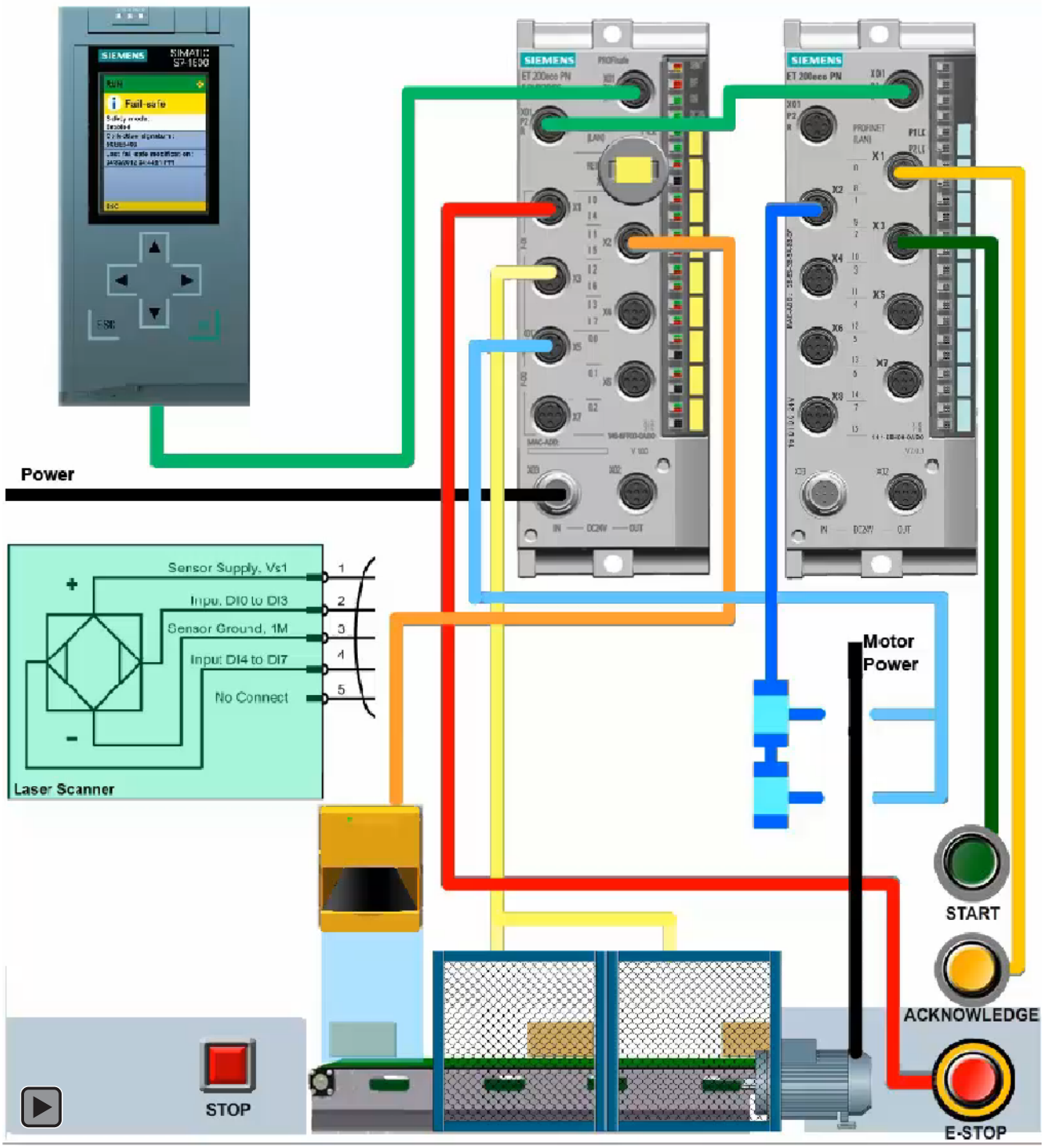
This interactive graphic gives you the opportunity to become familiar with how the example functions in this Getting Started.

Move your cursor over the image, and the video controls (Play, Stop, Go to the beginning, or Go to the end) appear at the bottom of the video screen.

Click the "Play" button to start the video. Move to another page to deactivate the video.

The video switches the Laser Scanner, E-Stop, and Safety Door on and off to simulate unsafe conditions. Each device operates independently of the other two devices. As the video portrays, if you do activate a device, you must deactivate that device before continuing.

The video shows that you must press the "Acknowledge" button to notify the system that you have returned to a safe state. Then, you can press the "Start" button to operate the system again.


Power
Sensor Supply, Vs1
Input, DI0 to DI3
Sensor Ground, 1M
Input DI4 to DI7
No Connect
Laser Scanner
Motor
Power
START
ACKNOWLEDGE
STOP
E-STOP

The table below describes the steps and their actions:

Step	Action	Description
1	Press the Stop button.	The motor stops.
2	Press the Start button.	The motor restarts.
3	Activate the E-Stop. [1, 2]	This action prevents resumption of the operation.
4	Deactivate the E-Stop. [3]	The E-Stop deactivates.
5	Press the Acknowledge button.	The safety program requires manual acknowledgement.
6	Press the Start button.	The motor restarts.
7	Open the Safety Door. [1, 2]	This action prevents resumption of the operation.
8	Close the Safety Door. [3]	The Safety Door closes.
9	Press the Acknowledge button.	The safety program requires manual acknowledgement.
10	Press the Start button.	The motor restarts.
11	Trigger the Laser Scanner. [1, 2]	This action prevents resumption of the operation.
12	Deactivate the Laser Scanner. [3]	The Laser Scanner deactivates.
13	Press the Acknowledge button.	The safety program requires manual acknowledgement.
14	Press the Start button.	The motor restarts.

[1] You can activate the E-STOP, trigger the Laser Scanner, or open the Safety Door individually or in any order to stop operations and bring the system to a safe state.

[2] To continue operations, you must do the following steps in this order: 1. Deactivate the fail-safe device, 2. Press the Acknowledge button, and 3. Press the Start button.

[3] This action allows reintegration from safe state values to process data and, if required, acknowledgement by your safety program. You can now restart the motor.

2.1.5 Procedure

In summary, the example in these Getting Started instructions consists of the following sections:

Configuring

1. Configure the following components:
   - S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), or ET 200S/ET 200SP fail-safe CPU
   - ET 200eco PN 16DI module
   - ET 200eco PN F-DI 8 / F-DQ 3 module.
2. Use the ET 200eco PN 16DI module standard digital inputs for a user acknowledgement, a feedback loop, and a start pushbutton.
3. Configure the ET 200eco PN F-DI 8 / F-DQ 3 module fail-safe inputs for connecting an emergency stop switch, the position switches for monitoring a safety door, and the laser scanner for monitoring the entry area.
4. Finally, configure an ET 200eco PN F-DI 8 / F-DQ 3 module fail-safe output for connecting a motor.

The "Configuring" (Page 39) section describes the configuration process.

Programming

Once you successfully complete the configuration, program your safety program.

In the example, you program a fail-safe block with the following instructions:

- Emergency stop
- Safety door function
- Feedback loop (as restart protection, when an incorrect load exists)
- User acknowledgement for reintegration

You then compile the block to form a safety program.

The "Programming" (Page 65) section describes the programming process.

2.2 Configuring

2.2.1 Introduction

You require a PLC station consisting of an S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), or ET 200S/ET 200SP fail-safe CPU, an ET 200eco PN 16DI module, and an ET 200eco PN F-DI 8 / F-DQ 3 module. Your programming device must be connected to the fail-safe CPU through a PROFINET interface.

WARNING

You may come into contact with live electrical wires connected to the main power supply.

Only wire the fail-safe CPU, ET 200eco PN 16DI, and ET 200eco PN F-DI 8 / F-DQ 3 control system when the input power is turned OFF.

Death or serious personal injury and damage to machines and equipment may result if proper precautions are not taken. *(S806)*

Documentation on the installation and wiring of the S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), or ET 200S/ET 200SP fail-safe CPUs can be found in the Preface, "Documentation and information" (Page 5). You can find information on the installation and wiring of the ET 200eco PN 16DI in the "Distributed I/O ET 200eco PN, Operating Instructions" (https://support.industry.siemens.com/cs/document/29999018/simatic-distributed-i-o-et-200eco-pn?dti=0&lc=en-WW) and of the ET 200eco PN F-DI 8 / F-DQ 3 in the "Installation (Page 106)" and "Wiring" (Page 112) chapters of this manual.

Configuring the Hardware

After installing and wiring your PLC station, in STEP 7 Safety, you configure the following components:

- Fail-Safe CPU
- ET 200eco PN 16DI standard digital inputs for user acknowledgement, feedback loop, and start pushbutton
- ET 200eco PN F-DI 8 / F-DQ 3 module fail-safe digital inputs for connecting an emergency stop switch and position switches for monitoring a safety door and the laser scanner
- ET 200eco PN F-DI 8 / F-DQ 3 module fail-safe digital output for connecting a motor

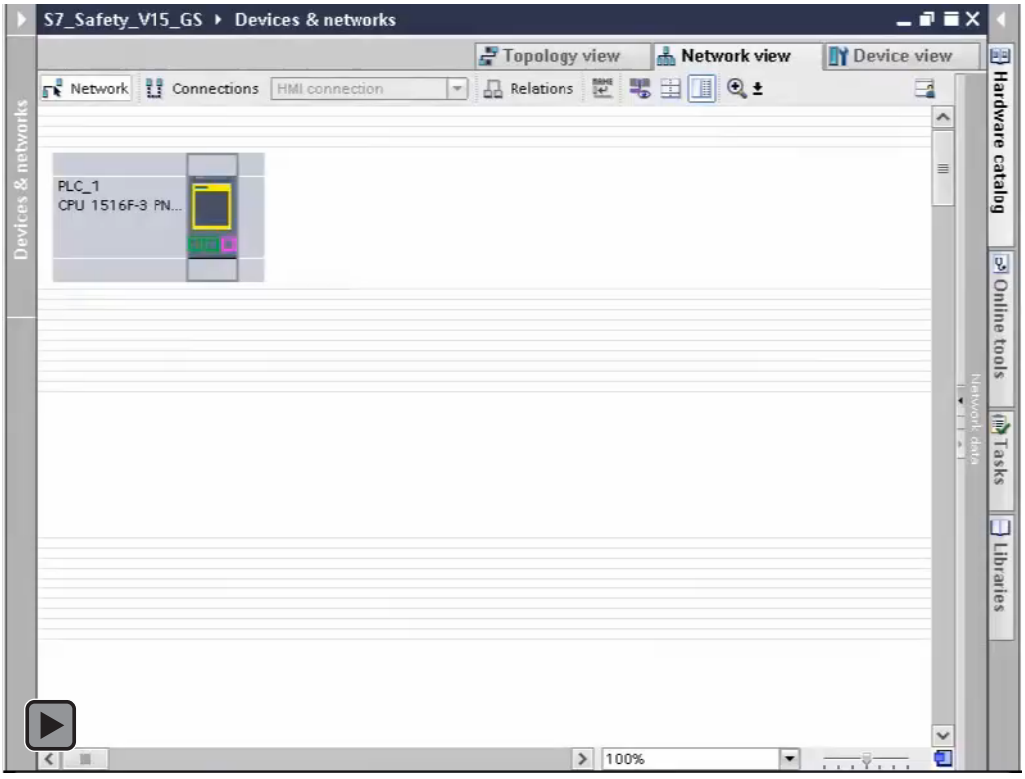
2.2.2 Step 1: Configuring the fail-safe CPU

In this step, you create a new project, add a fail-safe CPU, and assign parameters.

Move your cursor over the image, and the video controls (Play, Stop, Go to the beginning, or Go to the end) appear at the bottom of the video screen.

Click the "Play" button to start the video. Move to another page to deactivate the video.

Procedure



1. In the portal view of STEP 7 Safety, create a new project named "S7_Safety_V15_GS"
2. Use "Add new device" to add a CPU 1516F-3 PN/DP.

Note

You can use any of the following fail-safe CPUs in this example:

- S7-1200/1500
- S7-300/400
- ET 200pro (IP67 compliant)
- ET 200S/ET 200SP

Result: The Device View containing the CPU 1516F-3 PN/DP opens.

3. Locate the "Fail-safe: F-parameters" area.

   You can change the following parameters or accept the default setting:

   – "Low limit for F-destination addresses": Default value is suitable for a stand-alone S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), or ET 200S/ET 200SP fail-safe CPU.

   – "High limit for F-destination addresses": Default value is suitable for a stand-alone S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), or ET 200S/ET 200SP fail-safe CPU.

   – "Central F-source address": Default value is suitable for a stand-alone S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), or ET 200S/ET 200SP fail-safe CPU.

   Refer to "Configuring F-parameters" (Page 147) for further information.

   Leave the default values unchanged for this example.

4. Move to the "Protection & Security" area.

   Select the "Access level" property to select the access level and enter passwords. "Full access incl. fail-safe (no protection)" access level is the lowest level for a fail-safe CPU. Enter and confirm a password for the required protection. Passwords are case-sensitive.

   When you download the protection configuration, in the figure above, to the fail-safe CPU, you have HMI access and can access HMI functions without a password. To read data, you must enter the configured password for one of the following access levels:

   – "Read access"

   – "Full access (no protection)"

   – "Full access incl. fail-safe (no protection)".

   To write data, the user must enter the configured password for one of the following access levels:

   – "Full access (no protection)"

   – "Full access incl. fail-safe (no protection)"

Note

If you require a password for only the Read access security level, you must also enter a password for the "Full access incl. fail-safe (no protection)" access security level.

If you require a password for only the Full access (no protection) security level, you must also enter a password for "Full access incl. fail-safe (no protection)" access security level.

Access protection for the fail-safe CPU

The fail-safe CPU provides five levels of security for restricting access to specific functions. When you configure the security level and password for a fail-safe CPU, you limit the functions and memory areas that can be accessed without entering a password.

Each level allows certain functions to be accessible without a password. The default condition for the fail-safe CPU is to have no restriction and no password-protection. To restrict access to a fail-safe CPU, you configure the properties of the fail-safe CPU, and enter and confirm the password.

Table 2- 1 Access levels for the CPU

Access level	Access restrictions
Full access incl. fail-safe (no protection)	Allows full access without password. This is the lowest level of protection for a fail-safe CPU.
Full access (no protection)	Allows full access, except write access to fail-safe blocks, without password protection. Password is required for the following operations: • Modifying (writing to) fail-safe blocks • Changing the CPU mode (RUN/STOP)
Read access	Allows reading the data in the CPU, HMI access, and all forms of PLC-to-PLC communications without password protection. Password is required for following operations: • Modifying (writing to) fail-safe blocks • Modifying (writing to) the CPU • Changing the CPU mode (RUN/STOP)
HMI access	Allows HMI access and all forms of PLC-to-PLC communications without password protection. Password is required for the following operations: • Modifying (writing to) fail-safe blocks • Modifying (writing to) the CPU • Reading the data in the CPU • Changing the CPU mode (RUN/STOP)
No access (complete protection)	Allows no access without password protection. Password is required for the following operations: • Modifying (writing to) fail-safe blocks • Modifying (writing to) the CPU • Reading the data in the CPU • Changing the CPU mode (RUN/STOP) • Access to HMI

Result

The new project has been created and the configuration of the fail-safe CPU is complete.

2.2.3 Step 2: Configuring the ET 200eco PN 16DI

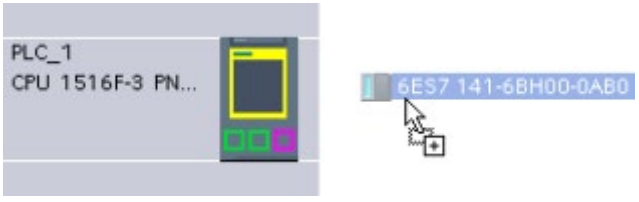
In the "Devices and networks" portal, use the hardware catalog to add PROFINET IO devices.

For example, expand the following containers in the hardware catalog to add an ET 200eco PN IO device:

- Distributed I/O
- ET 200eco PN
- Interface modules
- PROFINET
- DI
- 16DI x 24VDC 8xM12
- 6ES7141-6BH00-0AB0

You can then select from the list of ET 200eco PN devices (sorted by part number) and add the ET 200eco PN 16DI IO device.

Table 2- 2 Adding an ET 200eco PN 16DI IO device to the device configuration

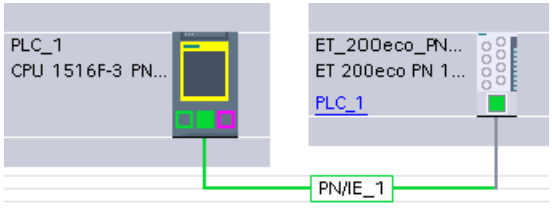
Insert the IO device	Result
	

You can now connect the PROFINET IO device to the CPU:

1. Right-click the "Not assigned" link on the device and select "Assign to new IO controller" from the context menu to display the "Select IO controller" dialog.
2. Select your S7-1516F-3 PN/DP CPU (in this example, "PLC_1") from the list of IO controllers in the project.
3. Click "OK" to create the network connection.

You can also go to the "Devices and networks" portal and use the "Network view" to create the network connections between the devices in your project:

1. To create a PROFINET connection, click the green (PROFINET) box on the first device, and drag a line to the PROFINET box on the second device.
2. Release the mouse button and your PROFINET connection is joined.
3. Save the configuration, or download it to the fail-safe CPU.



2.2.4 Step 3: Configuring the ET 200eco PN F-DI 8 / F-DQ 3

2.2.4.1 Installing the Hardware Support Package (HSP)

Hardware Support Packages (HSP) provide a way to configure modules that are not contained in the hardware catalog of your current STEP 7 installation. You can download the HSPs from the Siemens Industry Online Support Web site at "Support Packages for the hardware catalog in the TIA Portal (HSP)" (https://support.industry.siemens.com/cs/us/en/view/72341852). Use the following steps to install the ET 200eco PN F-DI 8 / F-DQ 3 HSP:

1. Create a project.
2. Select project view.
3. From the TIA Portal main menu, select the Options > Support Packages menu command.
4. In the dialog, ensure that you select "Installation of support packages" in the left pane (should already be selected).
5. Click the "Download from the Internet" link.
6. Navigate to the required HSP zip file (that contains HSP_V15_0204_001_ET200eco_FDI8_FDQ3_1.0.isp15) in the Siemens support site's "Support Packages for the hardware catalog in the TIA Portal (HSP)".
7. Click the required HSP zip file, download to a folder on your computer, and unzip the HSP.
8. Click the "Add from file system" button.
9. Navigate to the HSP (HSP_V15_0204_001_ET200eco_FDI8_FDQ3_1.0.isp15) on your local drive.
10. Click the "Open" button.
11. The HSP is inserted into the "Local support packages" list. Select the HSP by putting a check mark in the check box on the left.
12. Click the "Install" button on the bottom right of the dialog.

13. Click "Continue" on the pop up that appears
14. Click "Finish".
15. Click "Close".

2.2.4.2 Configuring the PROFINET IO device

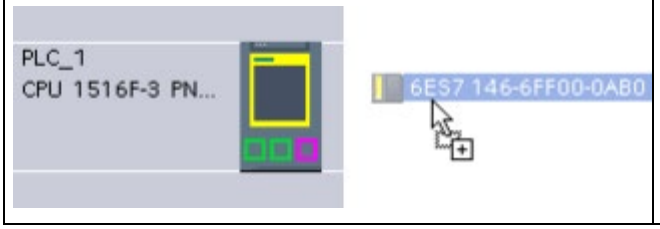
In the "Devices and networks" portal, use the hardware catalog to add PROFINET IO devices.

For example, expand the following containers in the hardware catalog to add an ET 200eco PN F IO device:

- Distributed I/O
- ET 200eco PN
- Interface modules
- PROFINET
- DI/DO
- F-DI 8 x 24 VDC, 4xM12 / F-DQ 3 x 24 VDC/2.0A, 3xM12
- 6ES7146-6FF00-0AB0

Add the ET 200eco PN F-DI 8 / F-DQ 3 IO device. You can double-click the part number or drag it to the "Devices and networks" view to insert the module.

Table 2- 3 Adding an ET 200eco PN F-DI 8 / F-DQ 3 IO device to the device configuration

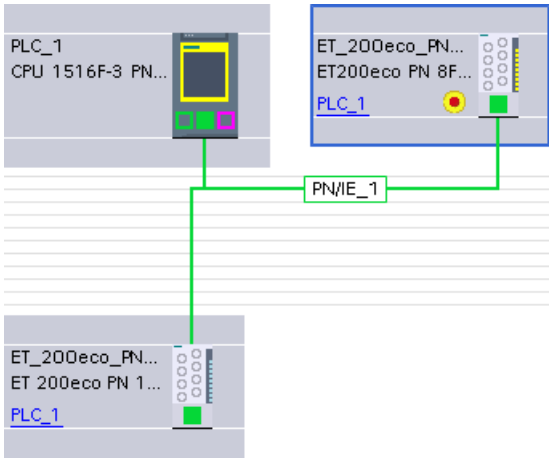
Insert the IO device	Result
	

You can now connect the PROFINET IO device to the CPU:

1. Right-click the "Not assigned" link on the device and select "Assign to new IO controller" from the context menu to display the "Select IO controller" dialog.
2. Select your S7-1516F-3 PN/DP CPU (in this example, "PLC_1") from the list of IO controllers in the project.
3. Click "OK" to create the network connection.

You can also go to the "Devices and networks" portal and use the "Network view" to create the network connections between the devices in your project:

1. To create a PROFINET connection, click the green (PROFINET) box on the first device, and drag a line to the PROFINET box on the second device.
2. Release the mouse button and your PROFINET connection is joined.
3. Save the configuration, or download it to the fail-safe CPU.



2.2.4.3 Configuring F-parameters

Procedure

1. Under the "Properties" tab, select the "General" tab, and then select the "F-parameters" area. Here, you can change the following parameters or apply the default settings:
   - "F-monitoring time": A valid current safety message frame must be received from the fail-safe CPU to the ET 200eco PN F-DI 8 / F-DQ 3 within the F-monitoring time. Otherwise, the fail-safe module goes to safe state. The F-monitoring time must be set high enough so that message frame delays are tolerated and, at the same time, low enough that the process can react as quickly as possible when a fault occurs.

     Note

     The "F-runtime group cycle time" is a closely-related parameter to the F-monitoring time. The cycle time is the interval by which the F-runtime group executes and determines how often the fail-safe CPU sends the PROFIsafe frame to the ET 200eco PN F-DI 8 / F-DQ 3.

     When you add a fail-safe CPU to your project, STEP 7 creates Functional Safety Organization Block 1 (FOB_RTG1) (OB123 by default). FOB_RTG1 is a cyclic-interrupt OB which executes using the "cycle time" interval specified in the Safety Administration editor for the corresponding F-runtime group.

   - "F-destination address": A unique PROFIsafe address is critical for every F-IO module used in a safety system (network and CPU-wide). Refer to the "SIMATIC Safety - Configuring and Programming, Programming and Operating Manual" (http://support.automation.siemens.com/WW/view/en/54110126/0/en) for procedures to set and verify unique PROFIsafe addresses in networked systems.

   Leave the settings unchanged for the F-parameters for this example.

Result

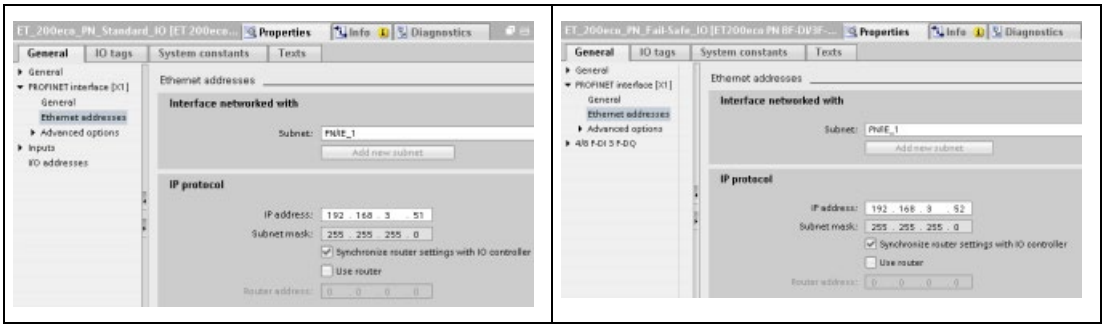
The configuration of the ET 200eco PN F-DI 8 / F-DQ 3 F-parameters is now complete.

2.2.5 Step 4: Assigning the IP addresses and PROFINET device names

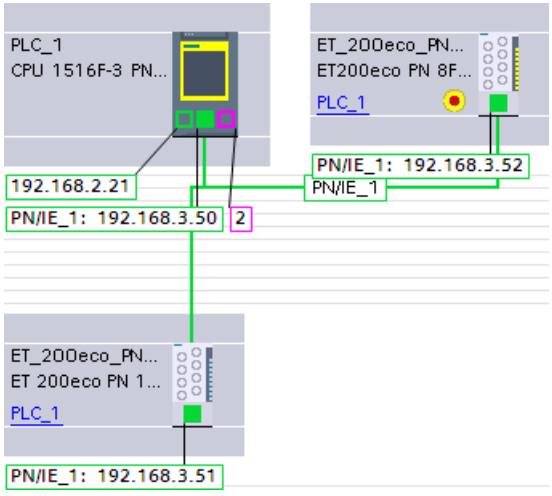
2.2.5.1 Assigning the IP addresses

An IO device is configured and an IP address assigned in the hardware configuration.

To assign an IP address to your ET 200eco PN 16 DI and ET 200eco PN F-DI 8 / F-DQ 3 modules, navigate to each module's Property page, and select **General > PROFINET interface [Xn] > Ethernet addresses**. Locate the "IP protocol" field, and enter the IP address for your ET 200eco PN 16 DI and ET 200eco PN F-DI 8 / F-DQ 3. as shown in the figure below:



The TIA portal, Network view displays your IP addresses as shown in the example below:



2.2.5.2 Assigning the PROFINET device names

Every PROFINET device is assigned a unique device ID (MAC address) before it leaves the factory.

Each ET 200eco PN 16 DI and ET 200eco PN F-DI 8 / F-DQ 3 IO device is addressed based on its device name during configuration.

Requirements

- An online PROFINET connection from the programming device to the IO device is required for assigning the device name to the IO device.
- The IO device is configured and an IP address assigned in hardware configuration.

Note

When you assign PROFINET device names to devices on the PROFINET network using an S7-1500 CPU, your programming device, S7-1500 CPU, and distributed IO devices must all be on the same subnet.

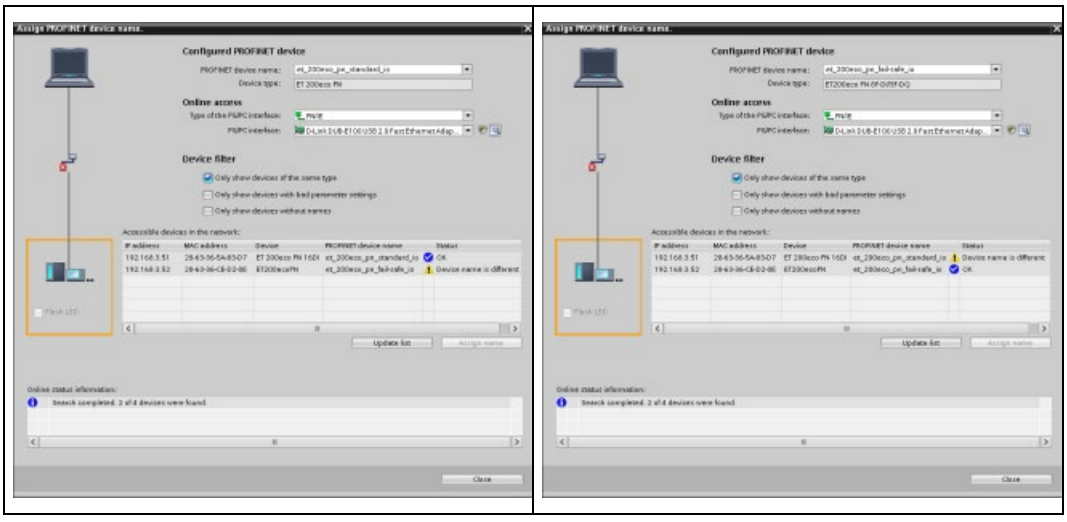
In this example, you communicate from your S7-1500 CPU to your programming device through the S7-1500 CPU's "X2" Ethernet port. You communicate from your S7-1500 CPU to your distributed IO devices through the S7-1500 CPU's "X1" Ethernet port. The "X1" Ethernet port has two physical Ethernet cable connections.

In order to have all of your PROFINET devices on the same subnet, you must communicate to all of your devices through the S7-1500 "X1" Ethernet port. Therefore, you must move the S7-1500 "X2" port Ethernet connection cable to the bottom "X1" Ethernet port. Then, you can communicate with the modules because then you are on the same Ethernet network.

Assigning device names

1. Switch on the supply voltages for the ET 200eco PN 16 DI and ET 200eco PN F-DI 8 / F-DQ 3 modules.
2. Open the ET 200eco PN 16 DI and ET 200eco PN F-DI 8 / F-DQ 3 Property pages.
3. Select **General > Project information > Name** and enter a device name.

4. Right-click on the module in the "Devices and networks" view, and select "Assign device name" to bring up the "Assign PROFINET device name" dialog.



5. Ensure that you select the "Only show devices of the same type" check box (should be selected by default).
6. Click the "Update list" button.
7. Select the MAC address for your IO device from the list.
8. Click the "Assign name" button.

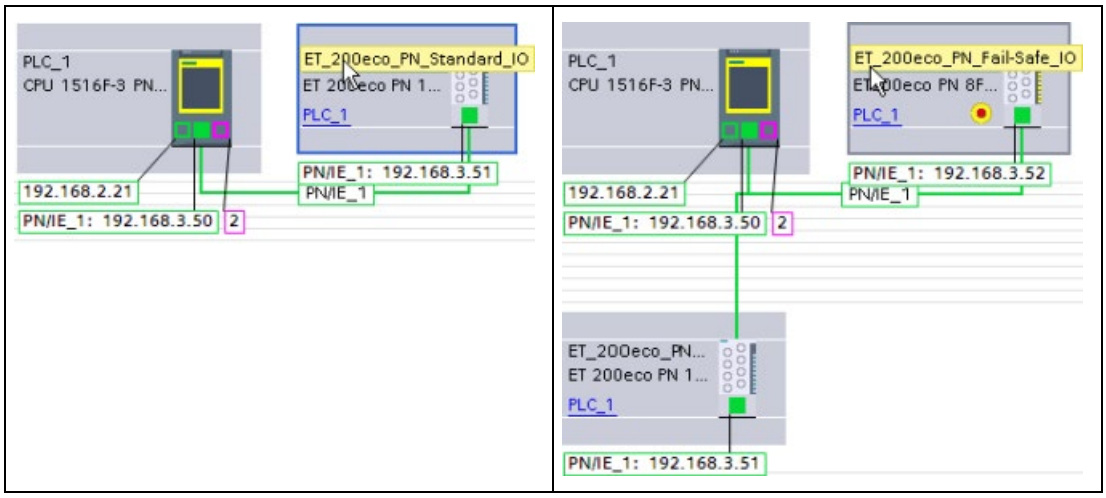
Note

If the module is not found, be sure the programming device is on the same network as the module (can connect Ethernet cable direct from the programming device to the module for this function).

Refer to the TIA Portal online help for further information on assigning PROFINET IO device names.

Result

The device name is saved internally in the ET 200eco PN 16 DI and ET 200eco PN F-DI 8 / F-DQ 3:



Node flash test

The "Assign PROFINET device name" dialog box displays all IO devices used. Compare the MAC address of the device with the MAC address displayed, and then select the correct IO device.

A node flash test facilitates the identification of IO devices in a plant. You activate the flash test as follows:

1. Select the required IO device from the "Accessible devices in the network" list.
2. Select the "Flash LED" check box.

The LINK LEDs flash on the selected IO device.

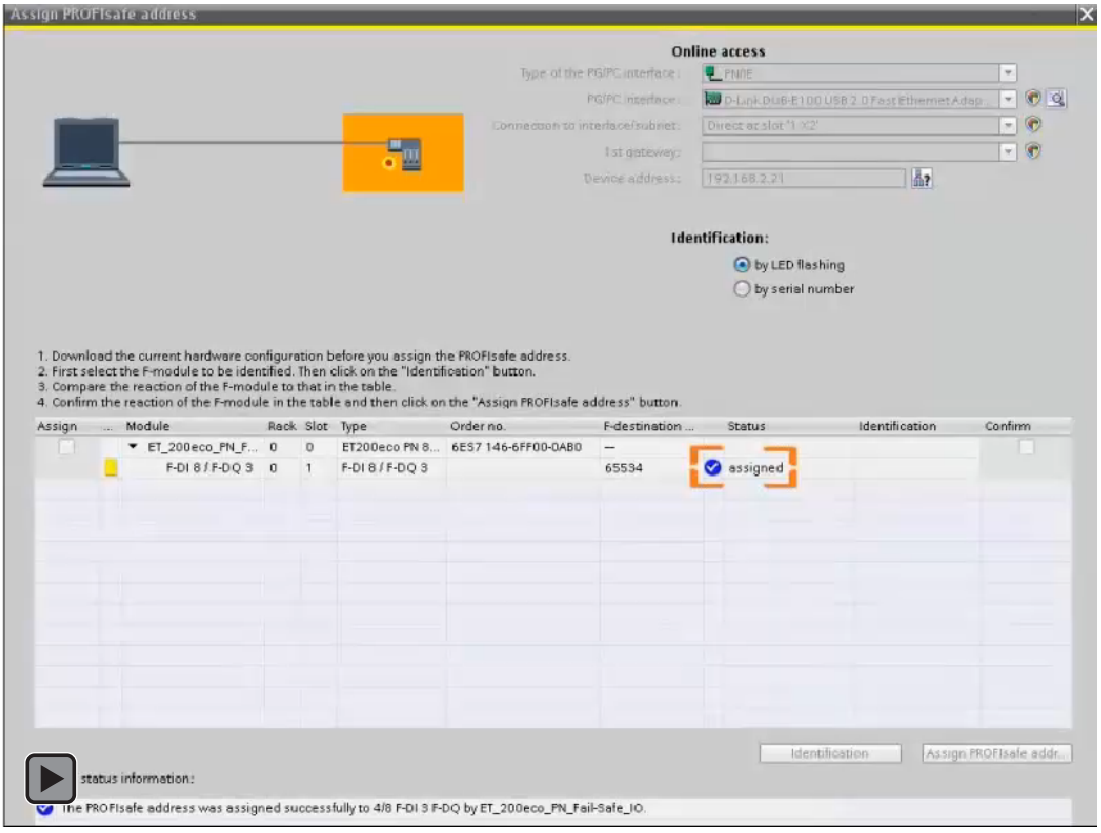
2.2.6 Step 5: Assigning PROFIsafe addresses

In this step, you identify the ET 200eco PN F-DI 8 / F-DQ 3 module for assignment and assign a PROFIsafe address to it.

Move your cursor over the image, and the video controls (Play, Stop, Go to the beginning, or Go to the end) appear at the bottom of the video screen.

Click the "Play" button to start the video. Move to another page to deactivate the video.

Procedure



Identifying the module

You identify the ET 200eco PN F-DI 8 / F-DQ 3 module using the following steps:

1. Download the current hardware configuration before you assign the PROFIsafe addresses.
2. In the network view, select the ET 200eco PN F module to which you want to assign the PROFIsafe address.
3. Right-click the ET 200eco PN F module, and select "Assign PROFIsafe address" from the context menu to display the "Assign PROFIsafe address" dialog.
4. In the "Identification" field, select the method to be used for identifying the ET 200eco PN F module:
   - "By LED flashing": This is the default setting. The System Fault, Channel Fault, and Channel Status LEDs of the ET 200eco PN F module that you want to identify flash upon identification.
   - "By serial number": If you cannot see the ET 200eco PN F module directly, you can identify the module by the serial number of the module.
5. In the "Assign" column, select the check box for the ET 200eco PN F module to which you want to assign PROFIsafe address.
6. Click the "Identification" button, and compare the reaction of the fail-safe module to that in the table:
   - Check whether the Channel Status LEDs of the ET 200eco PN F modules whose PROFIsafe addresses you want to assign are flashing green.
   - If you identify using the serial number, compare the displayed serial number to the serial number of the module.
7. In the "Confirm" column, select the check box for the ET 200eco PN F module for which you want to confirm the reaction of the fail-safe module in the table.

Assigning a PROFIsafe address to the module

To assign an F-destination address, proceed as follows:

1. Ensure that you install an eCoding plug on each ET 200eco PN F-DI 8 / F-DQ 3 module.
2. Use the "Assign PROFIsafe addr..." button to assign the PROFIsafe address to the ET 200eco PN F-DI 8 / F-DQ 3 module. You may have to enter the password of the fail-safe CPU.
3. You must answer "yes" to the "Confirm PROFIsafe address assignment" dialog within 60 seconds to assign the PROFIsafe address.

Note

Refer to the "Assigning PROFIsafe addresses" (Page 158) for further information about PROFIsafe address identification and assignment.

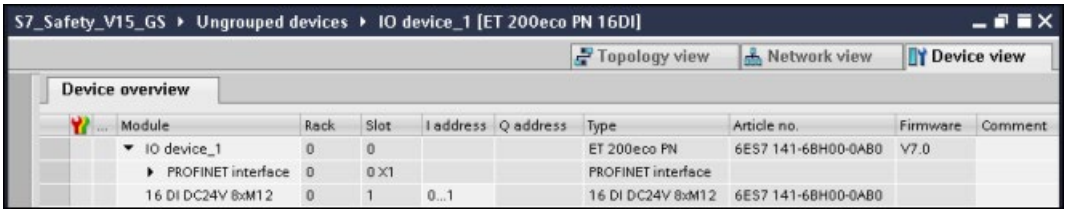
2.2.7 Step 6: Configuring the standard digital inputs for the user acknowledgement, feedback circuit, and start pushbutton

In this step, you connect ET 200eco PN 16DI standard digital inputs to the non-fail-safe signals (user acknowledgement, feedback loop, and start pushbutton) in your program.

Procedure

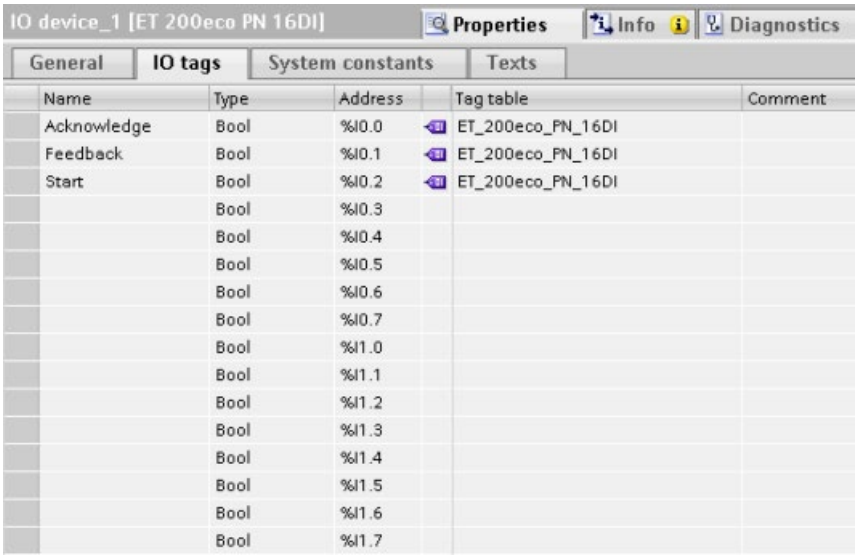
1. Assign the input address of the ET 200eco PN digital input module (16 DI DC 24 V DC 8xM12 (6ES7141-6BH00-0AB0)) to "0" for this example. You can assign these addresses in the ET 200eco PN digital input module's device configuration under "16 DI DC24V 8xM12", "I/O addresses".

   Refer to the "ET 200eco PN 16DI Device view" information from the TIA Portal shown below:



Module	Rack	Slot	I address	Q address	Type	Article no.	Firmware	Comment
IO device_1	0	0			ET 200eco PN	6ES7 141-6BH00-0AB0	V7.0	
PROFINET interface	0	0 X1			PROFINET interface			
16 DI DC24V 8xM12	0	1	0...1		16 DI DC24V 8xM12	6ES7 141-6BH00-0AB0		

2. Return to the "Device view" and select the ET 200eco PN 16DI. Under the "Properties" tab, select the "IO tags" tab. Here, you can define tags for each channel:



Name	Type	Address	Tag table	Comment
Acknowledge	Bool	%I0.0	ET_200eco_PN_16DI	
Feedback	Bool	%I0.1	ET_200eco_PN_16DI	
Start	Bool	%I0.2	ET_200eco_PN_16DI	
	Bool	%I0.3		
	Bool	%I0.4		
	Bool	%I0.5		
	Bool	%I0.6		
	Bool	%I0.7		
	Bool	%I1.0		
	Bool	%I1.1		
	Bool	%I1.2		
	Bool	%I1.3		
	Bool	%I1.4		
	Bool	%I1.5		
	Bool	%I1.6		
	Bool	%I1.7		

Result

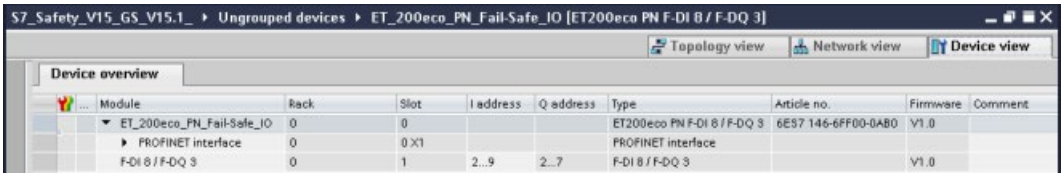
The configuration of the ET 200eco PN 16DI standard digital inputs is now complete.

2.2.8 Step 7: Configuring the Process value and Value status bits

In this step, you configure the Process value and Value status bits of the ET 200eco PN F-DI 8 / F-DQ 3.

Procedure

1. Select the "Device view" tab to display the "Device overview" area. Here, you can change the starting addresses for the inputs and outputs of your fail-safe module. Use the module default I/O addresses of "2" and "2" for this example (inputs begin at byte 2, and outputs begin at byte 2).



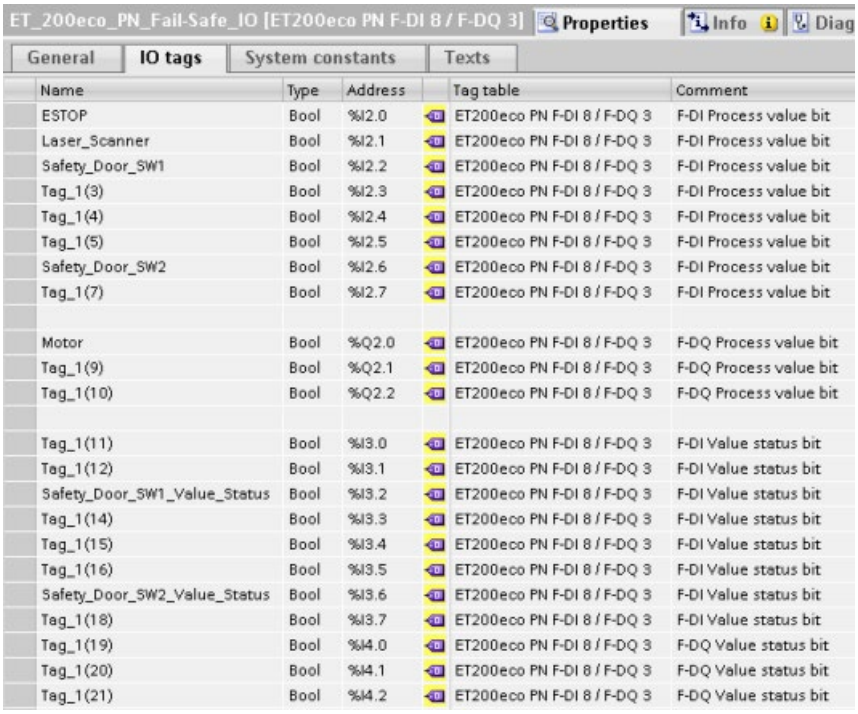
Note

The ET 200eco PN F-DI 8 / F-DQ 3 internally uses both Is and Qs to work with the physical input and output channels.

The ET 200eco PN F-DI 8 / F-DQ 3 digital inputs can have 4 - 8 input channels, and the digital outputs have 3 output channels.

The number of input (I) bytes and output (Q) bytes that the ET 200eco PN F-DI 8 / F-DQ 3 requires depends upon which PROFIsafe profile your fail-safe CPU uses. If using PROFIsafe profile V2.4 (with S7-300/S7-400), the module requires 7 input (I) bytes and 5 output (Q) bytes. If using PROFIsafe profile V2.6 (with S7-1200/S7-1500), the module requires 8 input (I) bytes and 6 output (Q) bytes.

2. Return to the "Device view" and select the ET 200eco PN F-DI 8 / F-DQ 3. Under the "Properties" tab, select the "IO tags" tab. This action displays the "Process value" and "Value status" bits for the fail-safe module. Here, you can define tags for each channel:



ET_200eco_PN_Fail-Safe_IO [ET200eco PN F-DI 8 / F-DQ 3] Properties | Info | Diag

General | IO tags | System constants | Texts

Name	Type	Address	Tag table	Comment
ESTOP	Bool	%I2.0	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Laser_Scanner	Bool	%I2.1	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Safety_Door_SW1	Bool	%I2.2	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Tag_1(3)	Bool	%I2.3	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Tag_1(4)	Bool	%I2.4	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Tag_1(5)	Bool	%I2.5	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Safety_Door_SW2	Bool	%I2.6	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Tag_1(7)	Bool	%I2.7	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Motor	Bool	%Q2.0	ET200eco PN F-DI 8 / F-DQ 3	F-DQ Process value bit
Tag_1(9)	Bool	%Q2.1	ET200eco PN F-DI 8 / F-DQ 3	F-DQ Process value bit
Tag_1(10)	Bool	%Q2.2	ET200eco PN F-DI 8 / F-DQ 3	F-DQ Process value bit
Tag_1(11)	Bool	%I3.0	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Tag_1(12)	Bool	%I3.1	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Safety_Door_SW1_Value_Status	Bool	%I3.2	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Tag_1(14)	Bool	%I3.3	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Tag_1(15)	Bool	%I3.4	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Tag_1(16)	Bool	%I3.5	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Safety_Door_SW2_Value_Status	Bool	%I3.6	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Tag_1(18)	Bool	%I3.7	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Tag_1(19)	Bool	%I4.0	ET200eco PN F-DI 8 / F-DQ 3	F-DQ Value status bit
Tag_1(20)	Bool	%I4.1	ET200eco PN F-DI 8 / F-DQ 3	F-DQ Value status bit
Tag_1(21)	Bool	%I4.2	ET200eco PN F-DI 8 / F-DQ 3	F-DQ Value status bit

Each Process value bit has an associated Value status bit that reports whether the corresponding process value is valid (ON) or associated with a passivated channel (OFF). If an entire module is passivated, then the Value status bits associated with all channels are all OFF.

Digital input Process value and Value status bits

To check the Process value bits and the Value status bits, you must know where these bits are mapped in the module. For an ET 200eco PN F-DI 8 / F-DQ 3, the first byte of the input (I) image register is the Process value bits for the digital inputs, and the next byte of the input (I) image register is the Value status bits for the digital inputs. For example, if the module starting address is I2.0 and Q2.0 for the ET 200eco PN F-DI 8 / F-DQ 3 and you have a 1oo1 configuration, then the Process value bits and corresponding Value status bits for the digital inputs are allocated as shown in the following table:

Digital input Process value bits - 1oo1 configuration	Digital input Value status bits - 1oo1 configuration
I2.0	I3.0
I2.1	I3.1
I2.2	I3.2
I2.3	I3.3
I2.4	I3.4
I2.5	I3.5
I2.6	I3.6
I2.7	I3.7

If you have all channel pairs configured to use 1oo2 evaluation, then the Process value bits and corresponding Value status bits for the digital inputs are allocated as shown in the following table:

Digital input Process value bits - 1oo2 configuration	Digital input Value status bits - 1oo2 configuration
I2.0	I3.0
I2.1	I3.1
I2.2	I3.2
I2.3	I3.3
-	-
-	-
-	-
-	-

Digital Output Process value and Value status bits

To check the Process value bits and the Value status bits, you must know where these bits are mapped in the module. For an ET 200eco PN F-DI 8 / F-DQ 3, the first three bits of the output (Q) image register are the Process value bits, and the first three bits of the third byte of the input (I) image register are the Value status bits for the digital outputs. For example, if the module starting address is I2.0 and Q2.0 for the ET 200eco PN F-DI 8 / F-DQ 3, then the Process value bits and corresponding Value status bits for the digital outputs are allocated as shown in the following table:

Digital output Process value bits	Digital output Value status bits
Q2.0	I4.0
Q2.1	I4.1
Q2.2	I4.2

Result

The configuration of the ET 200eco PN F-DI 8 / F-DQ 3 Process value and Value status bits is now complete.

2.2.9 Step 8: Connecting digital inputs to an emergency stop switch, position switches, and a laser scanner

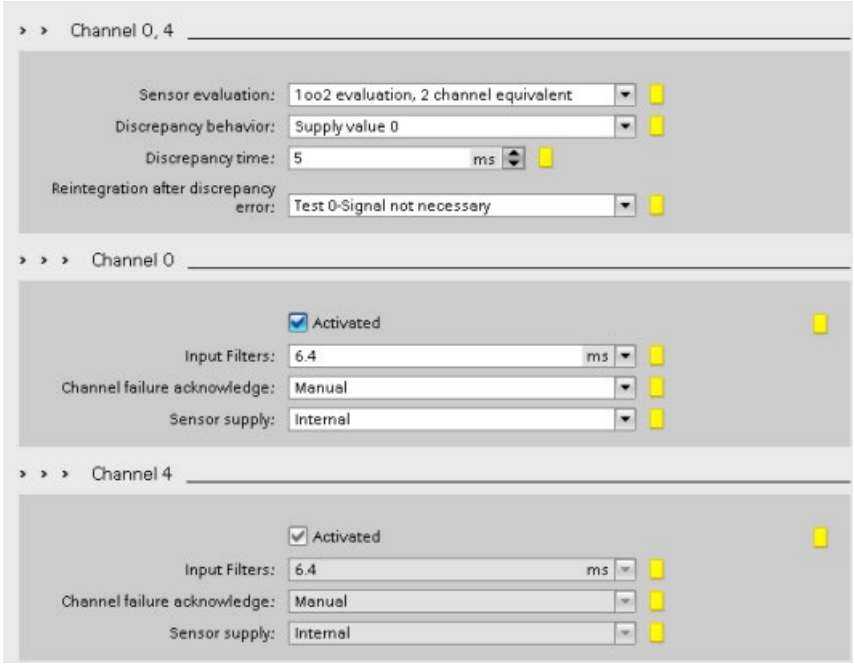
In this step, you connect ET 200eco PN F-DI 8 / F-DQ 3 digital inputs to an emergency stop switch, the position switches for monitoring a safety door, and a laser scanner for monitoring the entry area.

Procedure

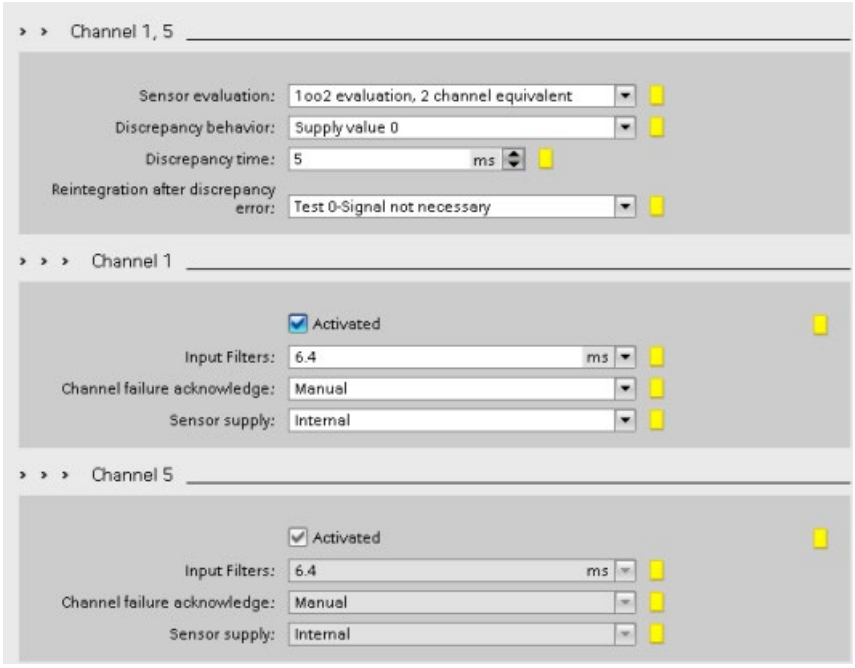
1. Select "4/8 F-DI 3 F-DQ", "DI parameters", and "Channel parameters".
2. Connect a two-channel emergency stop switch (emergency stop) to channels 0 and 4.

   Our example wires these channels to Process value bits I2.0 and I2.4. The first of the two inputs, I2.0, conveys the signal in this 1oo2 configuration. Expand "DI parameters" and "Channel parameters", and select "Channel 0, 4".

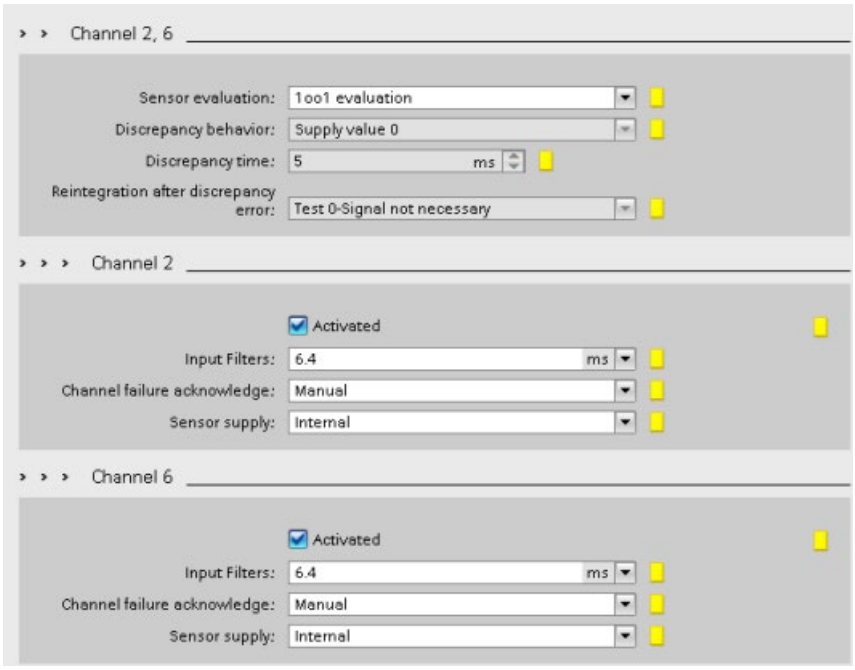
   Enter the settings as shown in the following figure:



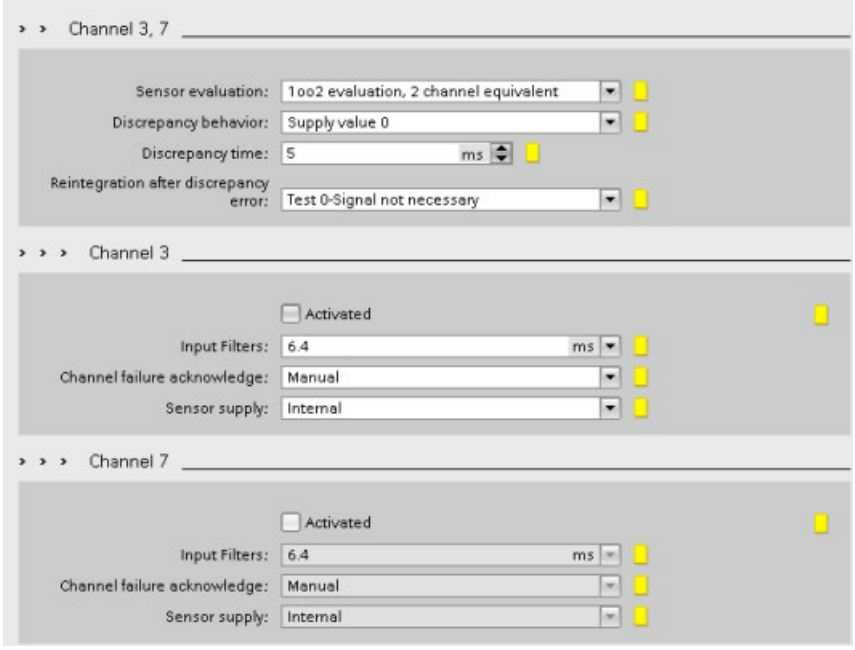
3. In this example, in a 1oo2 configuration, connect the laser scanner for monitoring the accessible entry area to channels 1 and 5. Make the settings as shown in the following figure:



4. In this example, in a 1oo1 configuration, connect the position switches for monitoring a two-switch safety door to channels 2 and 6. Make the settings as shown in the following figure:



5. Disable the unused DI channels 3 and 7 by clearing the "Activated" check box:



Result

The configuration of the ET 200eco PN F-DI 8 / F-DQ 3 digital inputs is now complete.

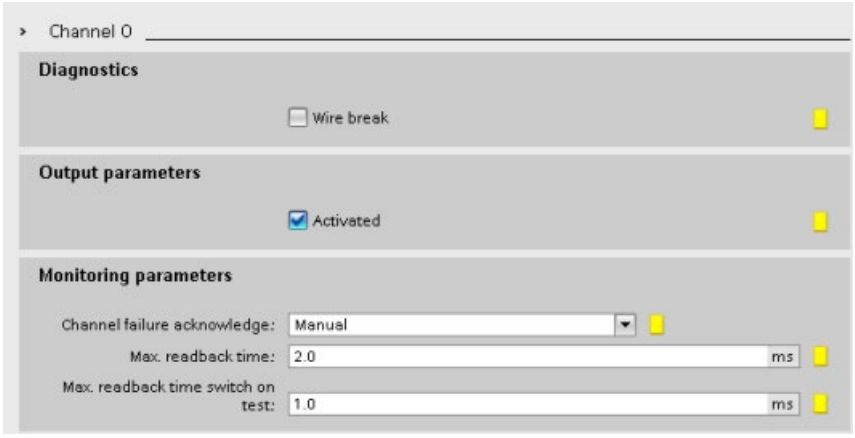
2.2.10 Step 9: Connecting a digital output to a motor

In this step, you configure an ET 200eco PN F-DI 8 / F-DQ 3 module's digital outputs for indirect connection of a motor to channel 0, using 2 contactors.

Procedure

1. Select the "DQ parameters" area. Here, you can change channel-specific parameters or apply the default settings.

   Enter the settings for the example as shown in the following figure:



2. Disable the unused DQ channels 1 and 2 by clearing the "Activated" check box.

Result

The configuration of the ET 200eco PN F-DI 8 / F-DQ 3 digital outputs is now complete.

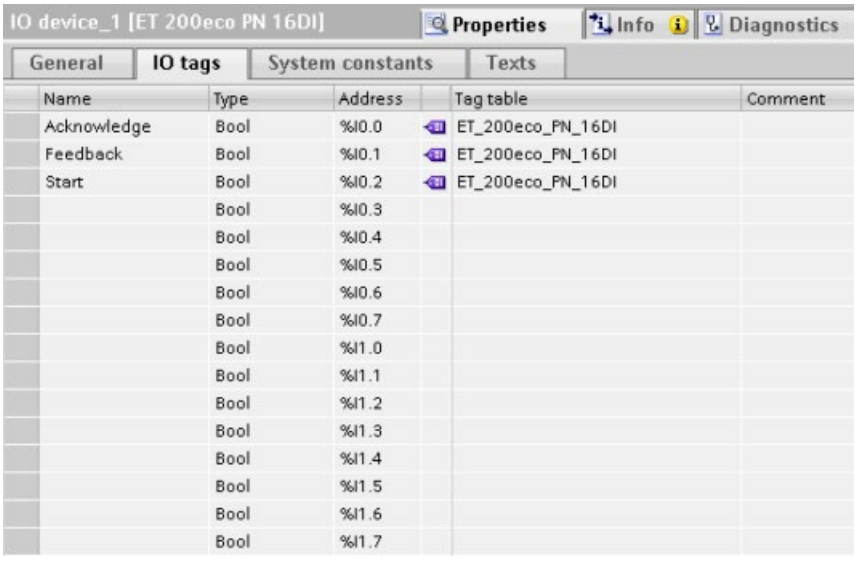
2.2.11 Summary: Configuring the Hardware

Summary

So far, you have configured the CPU 1516F-3 PN/DP and ET 200eco PN F-DI 8 / F-DQ 3 module according to the task definition for the example:

- CPU 1516F-3 PN/DP
- ET 200eco PN 16 DI standard digital inputs for user acknowledgment, feedback loop, and start pushbutton:

  - Starting byte addresses of the input and output data areas: IB0 and QB0
  - Input channel (bit) 0 for reintegration acknowledgement (I0.0)
  - Input channel (bit) 1 for feedback (I0.1)
  - Input channel (bit) 2 for start (I0.2)



Name	Type	Address	Tag table	Comment
Acknowledge	Bool	%I0.0	ET_200eco_PN_16DI	
Feedback	Bool	%I0.1	ET_200eco_PN_16DI	
Start	Bool	%I0.2	ET_200eco_PN_16DI	
	Bool	%I0.3		
	Bool	%I0.4		
	Bool	%I0.5		
	Bool	%I0.6		
	Bool	%I0.7		
	Bool	%I1.0		
	Bool	%I1.1		
	Bool	%I1.2		
	Bool	%I1.3		
	Bool	%I1.4		
	Bool	%I1.5		
	Bool	%I1.6		
	Bool	%I1.7		

- ET 200eco PN F-DI 8 / F-DQ 3 fail-safe digital inputs for connecting an emergency stop switch, position switches for monitoring a safety door, and the laser scanner for monitoring the accessible production area:

  - Starting byte addresses of the input and output data areas: IB2 and QB2
  - Input channel (bits) 0 and 4 for the emergency stop (I2.0)
  - Input channel (bits) 1 and 5 for the laser scanner (I2.1)
  - Input channel (bit) 2 for one safety door position switch (I2.2)
  - Input channel (bit) 6 for other safety door position switch (I2.6)

- ET 200eco PN F-DI 8 / F-DQ 3 fail-safe digital output for connecting a motor:

  - Starting byte addresses of the input and output data areas: IB2 and QB2
  - Output channel (bit) 0 for indirect switching of a motor using 2 contactors (Q2.0)

ET_200eco_PN_Fail-Safe_IO [ET200eco PN F-DI 8 / F-DQ 3] Properties Info Diag

General | IO tags | System constants | Texts

Name	Type	Address	Tag table	Comment
ESTOP	Bool	%I2.0	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Laser_Scanner	Bool	%I2.1	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Safety_Door_SW1	Bool	%I2.2	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Tag_1(3)	Bool	%I2.3	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Tag_1(4)	Bool	%I2.4	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Tag_1(5)	Bool	%I2.5	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Safety_Door_SW2	Bool	%I2.6	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Tag_1(7)	Bool	%I2.7	ET200eco PN F-DI 8 / F-DQ 3	F-DI Process value bit
Motor	Bool	%Q2.0	ET200eco PN F-DI 8 / F-DQ 3	F-DQ Process value bit
Tag_1(9)	Bool	%Q2.1	ET200eco PN F-DI 8 / F-DQ 3	F-DQ Process value bit
Tag_1(10)	Bool	%Q2.2	ET200eco PN F-DI 8 / F-DQ 3	F-DQ Process value bit
Tag_1(11)	Bool	%I3.0	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Tag_1(12)	Bool	%I3.1	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Safety_Door_SW1_Value_Status	Bool	%I3.2	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Tag_1(14)	Bool	%I3.3	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Tag_1(15)	Bool	%I3.4	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Tag_1(16)	Bool	%I3.5	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Safety_Door_SW2_Value_Status	Bool	%I3.6	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Tag_1(18)	Bool	%I3.7	ET200eco PN F-DI 8 / F-DQ 3	F-DI Value status bit
Tag_1(19)	Bool	%I4.0	ET200eco PN F-DI 8 / F-DQ 3	F-DQ Value status bit
Tag_1(20)	Bool	%I4.1	ET200eco PN F-DI 8 / F-DQ 3	F-DQ Value status bit
Tag_1(21)	Bool	%I4.2	ET200eco PN F-DI 8 / F-DQ 3	F-DQ Value status bit

You can now continue with programming the safety program.

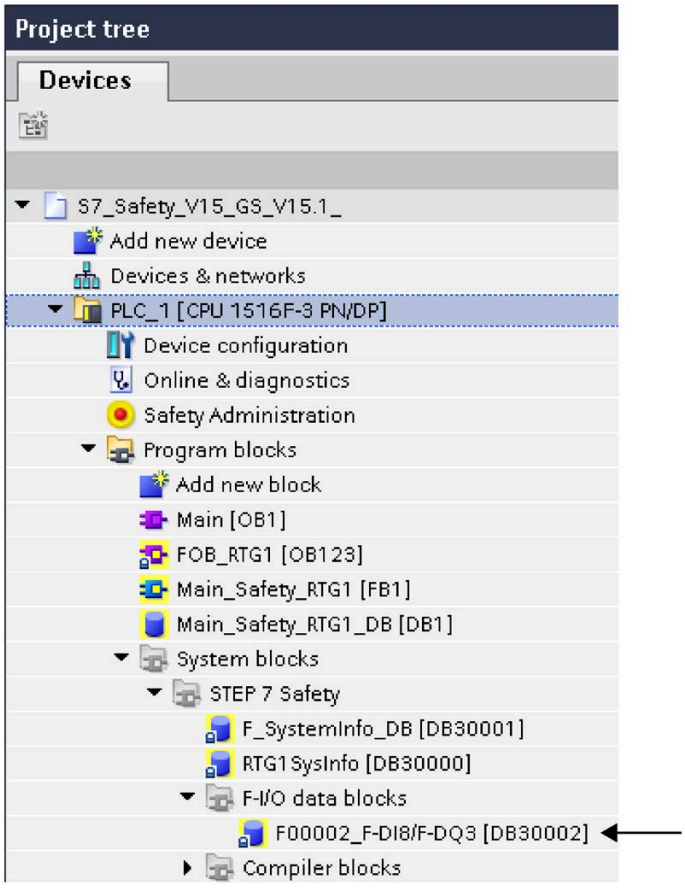
2.3 Programming

2.3.1 Introduction

In this example, a fail-safe function block (F-FB) will be programmed with a safety door function, an emergency stop function (safety circuit for switch-off in case of emergency stop, open safety door, or someone entering the protected area monitored by the laser scanner), a feedback circuit (as protection against reclosing in case of faulty load), a user acknowledgement for reintegration, and indirect switching of a motor using two contactors. The programmed F-FB will then be compiled to form a safety program and downloaded to the fail-safe CPU.

Fail-Safe module data blocks (F-IO DBs)

An F-IO DB is automatically generated when you add a fail-safe module to your configuration. The F-I/O DBs generated for the example I/O are located in the "Project tree" in the "Program blocks", "System blocks" folder:



The default name of the F-I/O DB is formed from the fixed prefix "F", the start input address of the fail-safe module, and the names entered in the properties for the fail-safe module in the hardware and network editor.

You can access the tags of the F-I/O DB with a fully qualified DB access (that is, by specifying the name of the F-I/O DB and the name of the tag).

Programming

You can program the safety program in LAD and FBD. In so doing, the instructions, data types, and operand areas you can use are subject to certain restrictions (see the "Programming" chapter, "Overview of programming" section of the "SIMATIC Safety - Configuring and Programming, Programming and Operating Manual" (http://support.automation.siemens.com/WW/view/en/54110126/0/en)).

The FBD programming language is used in this example.

Note

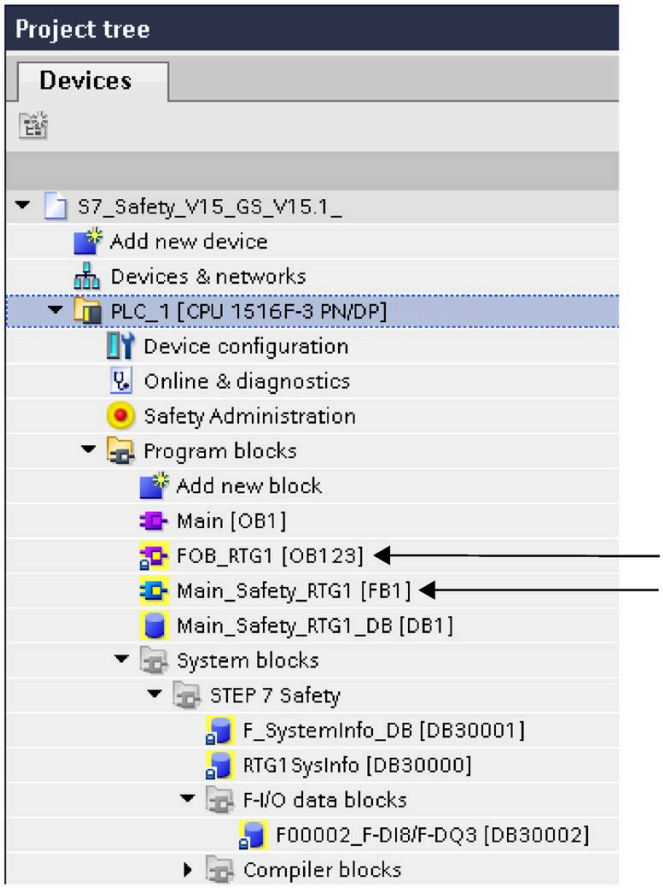
Fail-safe signals are shown in yellow in the "LAD/FBD Editor".

Note

Note the rules for the program structure in the "Programming" chapter, "Defining F-runtime groups" section of the "SIMATIC Safety - Configuring and Programming, Programming and Operating Manual" (http://support.automation.siemens.com/WW/view/en/54110126/0/en).

2.3.2 Step 10: Specifying the centralized settings for the safety program

When the fail-safe CPU is inserted, an F-runtime group and the associated main safety block are created by default and assigned to the CPU. An F-runtime group consists of an F-OB (cyclic interrupt OB) that calls a main safety block FB. Additional user-specific safety functions must then be called from this main safety block:



The first step in programming of the safety program is the main safety block. The program calls the main safety block (which is an F-FB (with instance DB)) from the "Fail-Safe Organization Block" (F-OB) (cyclic interrupt OB), assigned in each F-runtime group. By default, the F-OB has a higher priority than other standard OBs.

The program calls the F-blocks that you create from the main safety block. You can change the calling block and the called block at any time.

After the CPU executes the safety program, the standard user program will resume.

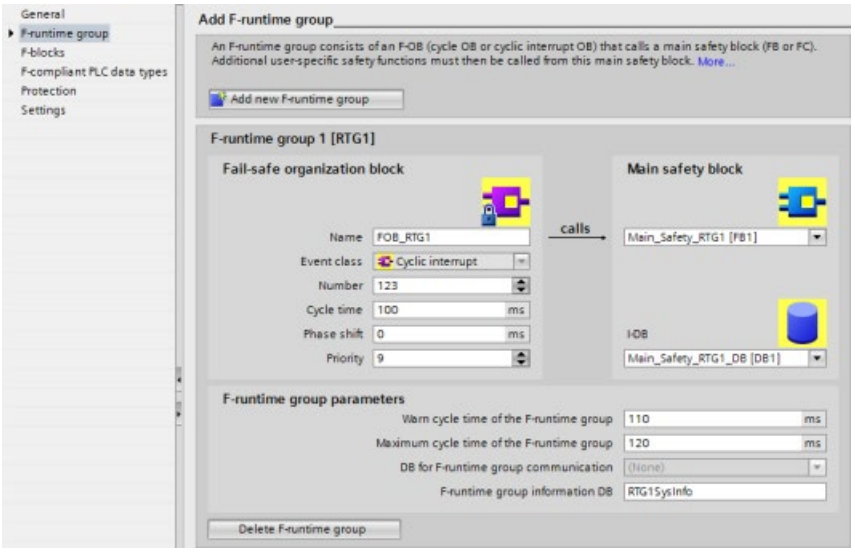
Opening the Safety Administration editor

1. In the "Project tree" of the fail-safe CPU, double-click on "Safety Administration".

   Result: The "Safety Administration" editor opens.

   You make central settings for the safety program in the Safety Administration editor.

2. In the area navigation of the Safety Administration editor, click "F-runtime group". The F-runtime group is created automatically when the fail-safe CPU is created and the associated main safety block is displayed:



The cyclic interrupt OB (FOB_RTG1 [OB123]) calls the main safety block (Main_Safety_RTG1 [FB1]) by default. The program calls the F-blocks that you create from the main safety block. You can change the calling block and the called block at any time.

Leave the preset blocks for this example.

For additional information on the Safety Administration editor, refer to the "SIMATIC Safety - Configuring and Programming, Programming and Operating Manual" (http://support.automation.siemens.com/WW/view/en/54110126/0/en).

Numbering ranges of fail-safe system blocks

When the safety program is compiled, F-blocks are automatically added in order to generate an executable safety program.

By default, the system automatically manages the numbering range, which is displayed in the Safety Administration editor under "Settings".

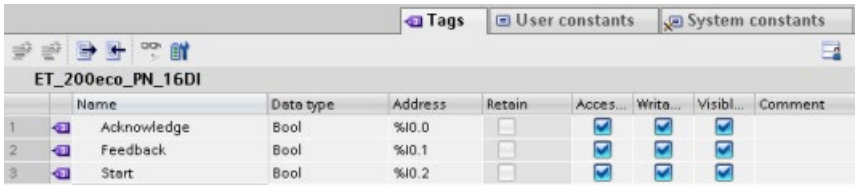
Keep the pre-assigned settings for this example.

Specifying inputs and outputs for the safety program

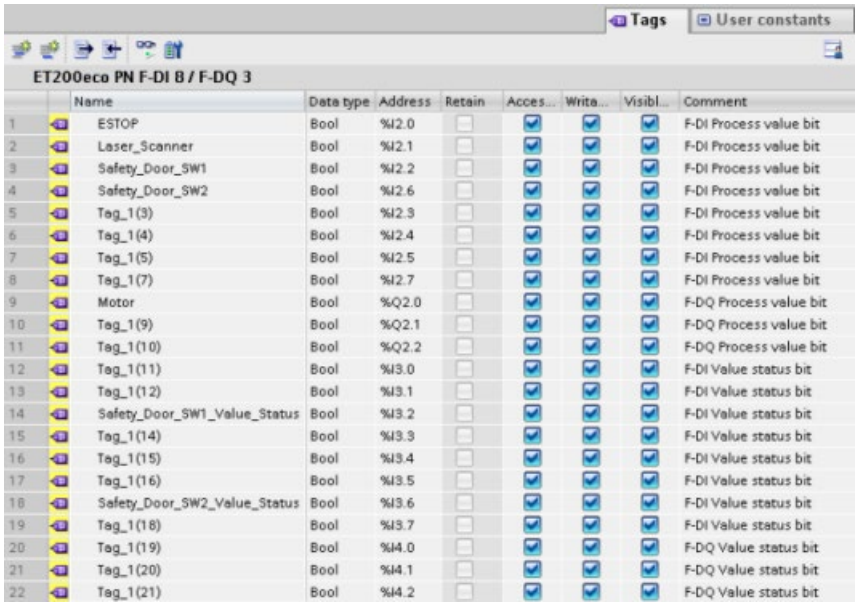
After configuring the hardware as described in Configuring (Page 39) in steps 1 to 6, the CPU creates the following standard module and fail-safe module symbolic names and DBs for programming the example:

Configured hardware	Starting input/output address	Symbolic name
ET 200eco PN 16DI standard digital inputs	IB0	IO device_1 [ET 200eco PN 16DI]
ET 200eco PN F-DI 8 / F-DQ 3 digital inputs	IB2	F00002_F-DI 8 / F-DQ 3[DB30002]
ET 200eco PN F-DI 8 / F-DQ 3 digital outputs	QB2	F00002_F-DI 8 / F-DQ 3[DB30002]

Assign the following symbolic names for the standard inputs and outputs:



Assign the following symbolic names for the fail-safe inputs and outputs:



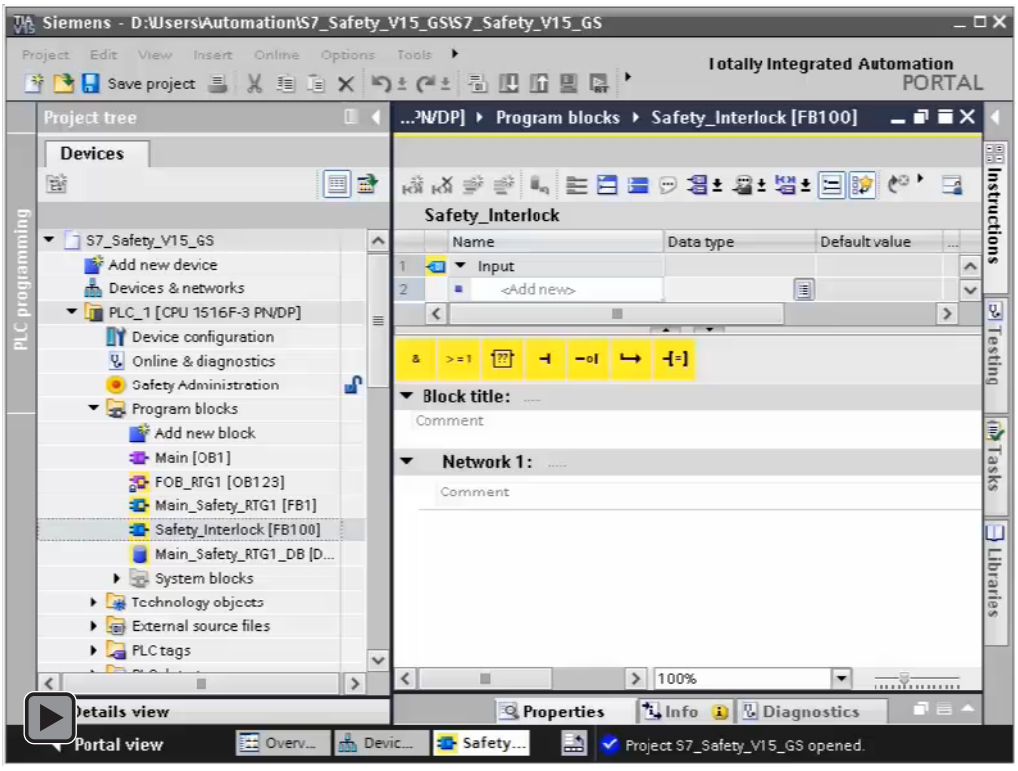
2.3.3 Step 11: Creating an F-FB

In this step, you create the F-FB where you will program the safety functions for this example.

Move your cursor over the image, and the video controls (Play, Stop, Go to the beginning, or Go to the end) appear at the bottom of the video screen.

Click the "Play" button to start the video. Move to another page to deactivate the video.

Procedure



1. Insert an F-FB. Go to the "Program blocks" folder of the fail-safe CPU and double-click "Add new block".

   The "Add new block" dialog opens.

2. Under "Name" enter "Safety_Interlock" for the name of the F-FB.
3. Click the "Function block" button on the left.
4. Select "FBD" as the language for the F-FB.
5. Under "Number" choose the "Manual" option, and enter 100.
6. Ensure that you select the "Create F-block" check box so that a fail-safe function block is created.
7. Close the dialog box with "OK"

Result

The F-FB "Safety_Interlock" is created in the "Program blocks" folder and opens automatically in the "FBD Editor".

You can now continue with programming the safety functions in the next step.

2.3.4 Step 12: Programming the safety door function

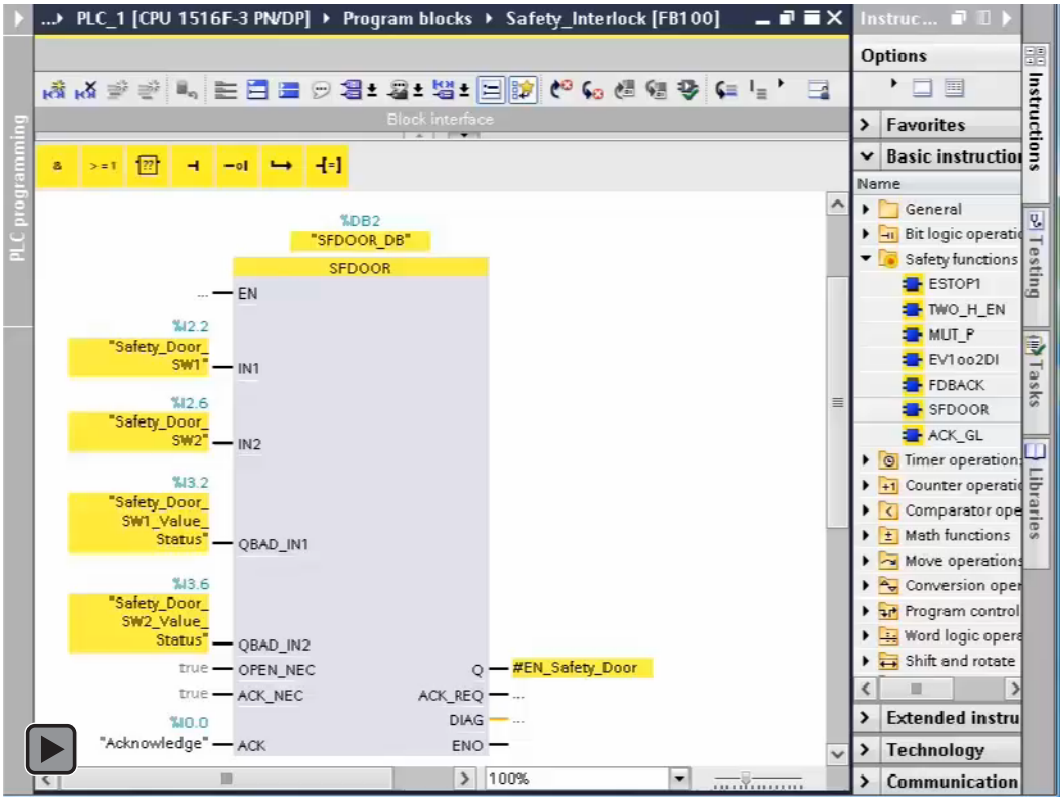
In this step, you program the safety door function for this example.

The safety door secures the application's service area. Opening the safety door results in a stop or shutdown of the production cell similar to an emergency stop.

Move your cursor over the image, and the video controls (Play, Stop, Go to the beginning, or Go to the end) appear at the bottom of the video screen.

Click the "Play" button to start the video. Move to another page to deactivate the video.

Procedure



1. In the interface of the "Safety_Interlock" F-FB, create a static tag of data type "Bool" named "EN_Safety_Door" (Enable safety door).
2. Insert the "SFDOOR" instruction from the "Safety functions" subfolder of the "Instructions" task card.

3. Click "OK" to confirm the "Call options" dialog.
4. Initialize the inputs and outputs with parameters as described in the table below.

Parameter assignment of the "SFDOOR" instruction

Inputs/outputs	Parameter	Data type	Description	Default
"Safety_Door_SW1" (I2.2)	IN1	Bool	Input 1	FALSE
"Safety_Door_SW2" (I2.6)	IN2	Bool	Input 2	FALSE
"Safe-ty_Door_SW1_Value_Status" (I3.2)	QBAD_IN1	Bool	Value status bit signal for input IN1 [1]	TRUE
"Safe-ty_Door_SW1_Value_Status" (I3.6)	QBAD_IN2	Bool	Value status bit signal for input IN2 [1]	TRUE
TRUE	OPEN_NEC	Bool	TRUE = Opening required on startup	TRUE
TRUE	ACK_NEC	Bool	TRUE = Acknowledgment required	TRUE
"Acknowledge" (I0.0)	ACK	Bool	User acknowledgement (Pushbutton)	FALSE
#EN_Safety_Door	Q	Bool	Output (Enable safety door)	FALSE
—	ACK_REQ	Bool	Acknowledgement prompt	FALSE
—	DIAG	Byte	Service information	B#16#0

[1] The two inputs QBAD_IN1 and QBAD_IN2 must be interconnected. In this example, both safety door position switches are connected through the SFDOOR and ESTOP1 program logic with the QBAD signal of the F-I/O DB of the ET 200eco PN F-DI 8 / F-DQ 3 in the FDBACK program logic.

Result

You have completed the programming of the safety door function.

2.3.5 Step 13: Programming the emergency stop function

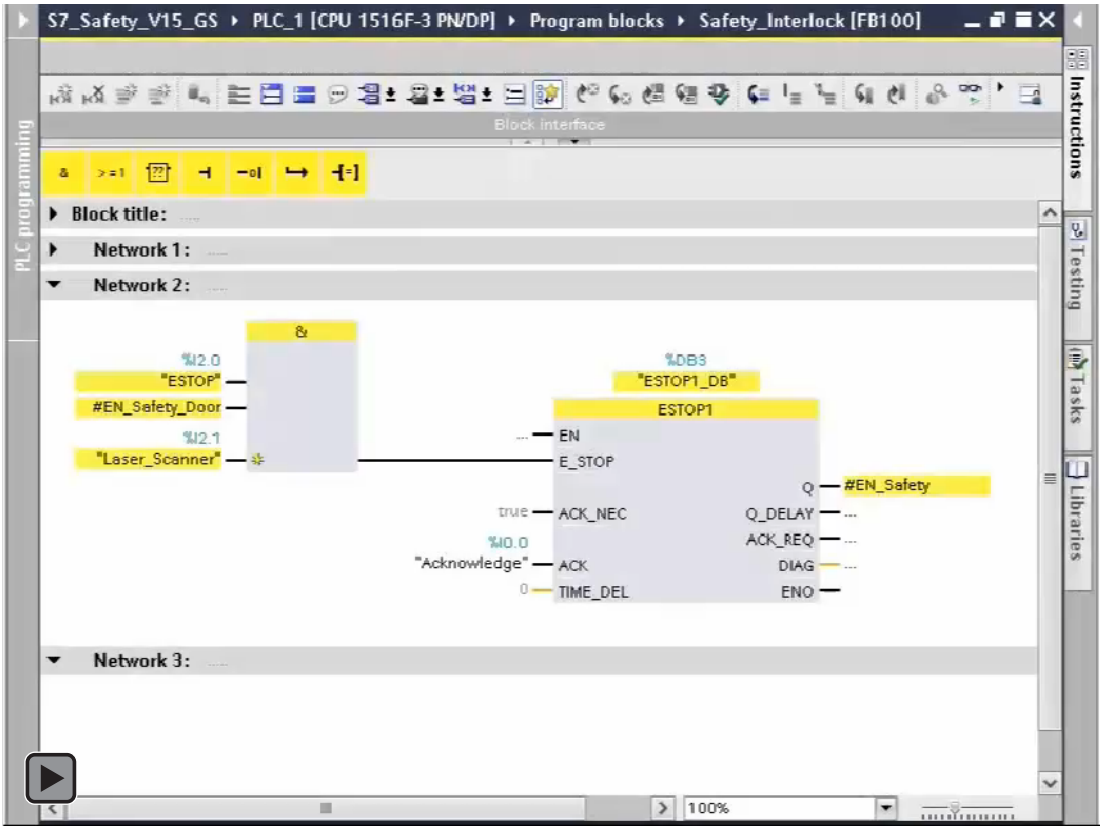
In this step, you program the emergency stop function for this example.

Used for emergencies only, the emergency stop button is a safety measure to immediately shut down all machine functions. An emergency stop button must be highly visible in color and shape and must be easy to operate in emergency situations. In this example, the emergency stop is a manual push button attached next to the safety door entrance to the service area enclosure. The emergency stop function provides shutdown in the case of an emergency stop, an open safety door, or someone entering the protected area monitored by the laser scanner.

Move your cursor over the image, and the video controls (Play, Stop, Go to the beginning, or Go to the end) appear at the bottom of the video screen.

Click the "Play" button to start the video. Move to another page to deactivate the video.

Procedure



1. In the interface of the "Safety_Interlock" F-FB, create a static tag of data type "Bool" named "EN_Safety" (Enable safety circuit).

   Note

   If the emergency stop is off, the safety door is closed, and nothing triggers the protected area laser scanner, the inputs from the emergency stop, safety door, and the laser scanner are all true. All three inputs must be true, before the ESTOP1 instruction can power "EN_Safety". When "EN_Safety" is true, then you know that your operation is back to normal and that you can startup safely.

2. Insert a new network.
3. Insert the "AND logic operation" instruction from the "Bit logic operations" subfolder of the "Instructions" task card.
4. Insert a third input to the "AND logic operation" instruction and initialize the inputs of the instruction with parameters as described in the table below.
5. Insert the "ESTOP1" instruction from the "Safety functions" subfolder of the "Instructions" task card.
6. Click "OK" to confirm the "Call options" dialog.
7. Initialize the inputs and outputs of the instruction with parameters as described in the tables below.
8. Connect the output of the "AND logic operation" instruction to the "ESTOP" input of the "ESTOP1" instruction.

Parameter assignment of the "AND logic operation" instruction

Inputs	Parameter	Data type	Description	Default
"ESTOP" (I2.0)	Input 1	Bool	Emergency STOP	FALSE
#EN_Safety_Door	Input 2	Bool	Enable safety door	FALSE
"Laser_scanner" (I2.1)	Input 3	Bool	Laser scanner	FALSE

Parameter assignment of the "ESTOP1" instruction

Inputs/outputs	Parameter	Data type	Description	Default
TRUE	ACK_NEC	Bool	TRUE = Acknowledgment required	TRUE
"Acknowledge" (I0.0)	ACK	Bool	User acknowledgement (using a pushbutton)	FALSE
T#0MS	TIME_DEL	Time	Time delay	T#0MS
#EN_Safety	Q	Bool	Enable safety circuit	FALSE
—	Q_DELAY	Bool	Enable is OFF delayed	FALSE
—	ACK_REQ	Bool	Acknowledgement prompt	FALSE
—	DIAG	Byte	Service information	B#16#0

Result

You have completed the programming of the emergency stop function.

2.3.6 Step 14: Programming the feedback monitoring

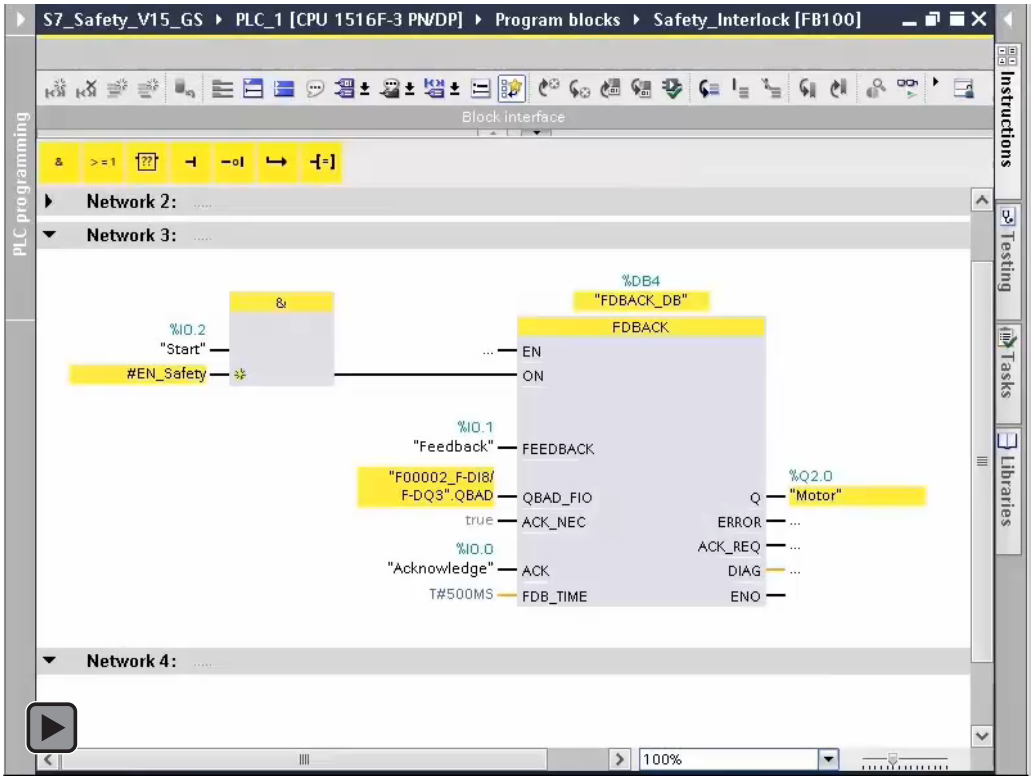
In this step, you program the feedback circuit monitoring for this example.

The feedback circuit provides protection against restarting normal operations while unsafe conditions still exist. The system can only be restarted when the emergency stop is cancelled, the safety door is closed, and the laser scanner detects no one in the protected area.

Move your cursor over the image, and the video controls (Play, Stop, Go to the beginning, or Go to the end) appear at the bottom of the video screen.

Click the "Play" button to start the video. Move to another page to deactivate the video.

Procedure



1. Insert a new network.
2. Insert the "AND logic operation" instruction from the "Bit logic operations" subfolder of the "Instructions" task card.
3. Initialize the inputs of the instruction with parameters as described in the table below

4. Insert the "FDBACK" instruction from the "Safety functions" subfolder of the "Instructions" task card.
5. Click "OK" to confirm the "Call options" dialog.
6. Initialize the inputs and outputs of the instruction with parameters as described in the tables below.
7. Connect the output of the "AND logic operation" instruction to the "ON" input of the "FDBACK" instruction.

Parameter assignment of the "AND logic operation" instruction

Inputs	Parameter	Data type	Description	Default
"Start" (I0.2)	Input 1	Bool	TRUE = Switch on output	FALSE
#EN_Safety	Input 2	Bool	Enable safety circuit	FALSE

Parameter assignment of the "FDBACK" instruction

Inputs/outputs	Parameter	Data type	Description	Default
"Feedback" (I0.1)	FEEDBACK	Bool	Readback input	TRUE (No error detected)
"F00002_4/8F-DI3F-DQ".QBAD	QBAD_FIO	Bool	QBAD signal from the fail-safe signal module DB of output Q [1]	FALSE (No error detected)
TRUE	ACK_NEC	Bool	TRUE = Acknowledgment required	TRUE
"Acknowledge" (I0.0)	ACK	Bool	User acknowledgement (via pushbutton)	FALSE
T#500MS	FDB_TIME	Time	Readback time	T#0MS
"Motor" (Q2.0)	Q	Bool	Output	FALSE
—	ERROR	Bool	Readback error	FALSE
—	ACK_REQ	Bool	Acknowledgement prompt	FALSE
—	DIAG	Byte	Service information	B#16#0

[1] In this example, this is the QBAD signal from the F-I/O DB of the ET 200eco PN F-DI 8 / F-DQ 3.

Result

You have completed the programming of the feedback monitoring.

2.3.7 Step 15: Programming the user acknowledgment for reintegration of the fail-safe module

In this step, you program the user acknowledgement for reintegration of the fail-safe module I/O for this example.

The user must acknowledge that conditions have returned to a safe state before production operations can be restarted.

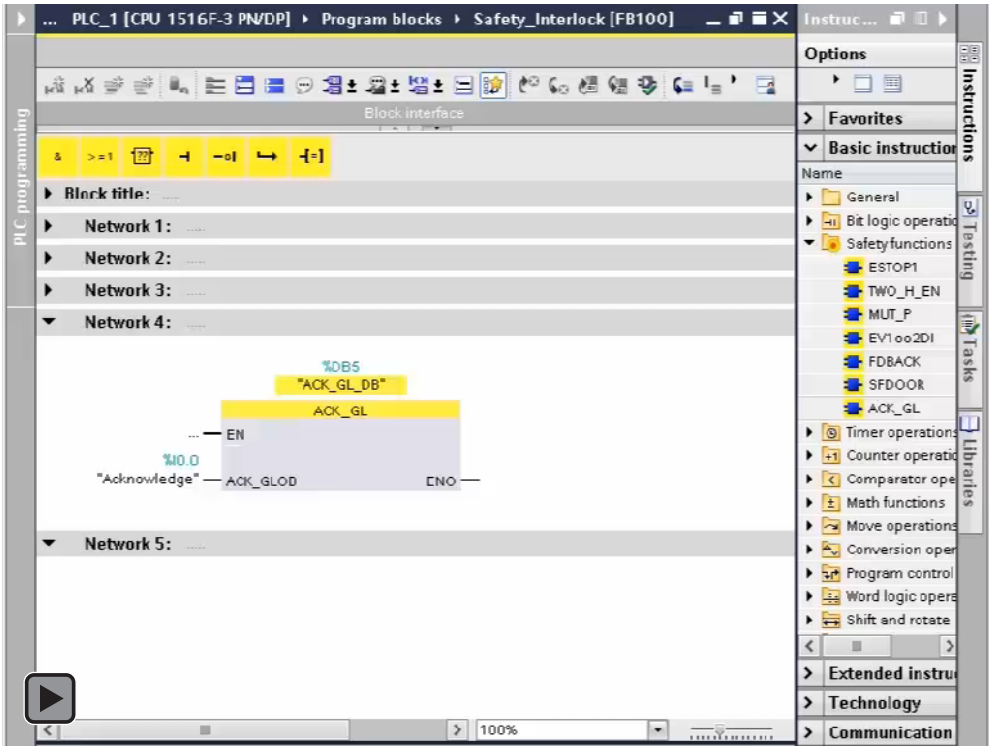
Move your cursor over the image, and the video controls (Play, Stop, Go to the beginning, or Go to the end) appear at the bottom of the video screen.

Click the "Play" button to start the video. Move to another page to deactivate the video.

Procedure

In your safety program, you must provide a user acknowledgment for the reintegration of the fail-safe module I/O. In order to acknowledge in the event of passivated F-I/O, the acknowledgement pushbutton is evaluated using a standard input. In this example, this is the "Acknowledge" input.

You can use the ACK_GL instruction to reintegrate all F-I/O of an F-runtime group.



1. Insert a new network.
2. Insert the "ACK_GL" instruction from the "Safety functions" subfolder of the "Instructions" task card.

3. Click "OK" to confirm the "Call options" dialog.
4. Initialize the input with parameters as described in the table below.

Parameter assignment of the "ACK_GL" instruction

Input	Parameter	Data type	Description	Default
"Acknowledge" (I0.0)	ACK_GLOB	Bool	Acknowledgement for reintegration	FALSE

Result

You have completed the programming of the user acknowledgment.

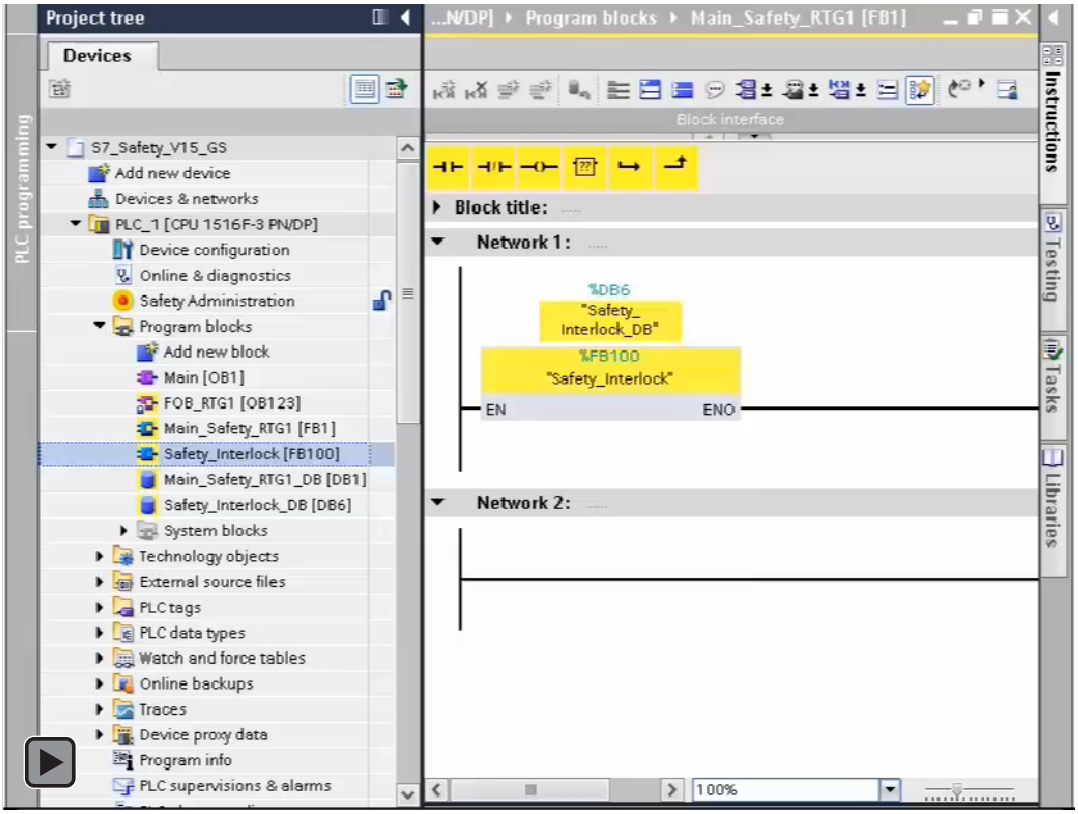
2.3.8 Step 16: Programming of the main safety block

In this step, you program the main safety block for this example.

Move your cursor over the image, and the video controls (Play, Stop, Go to the beginning, or Go to the end) appear at the bottom of the video screen.

Click the "Play" button to start the video. Move to another page to deactivate the video.

Procedure



1. Double-click in the project navigation to open the main safety block "Main_Safety".
2. Use drag-and-drop to insert the F-FB "Safety_Interlock" in Network 1 of the main safety block.
3. Click "OK" to confirm the "Call options" dialog.

Result

The main safety block cyclically calls the F-FB "Safety_Interlock".

You have now programmed the functionality according to the task definition of the example. You can proceed with the next steps to compile the safety program and download the safety program, along with the hardware configuration, to the fail-safe CPU.

Note

For simpler safety programs, you can locate the entire safety program code directly within the main safety block rather than in FBs or FCs called from the main safety block.

2.3.9 Step 17: Compiling the safety program

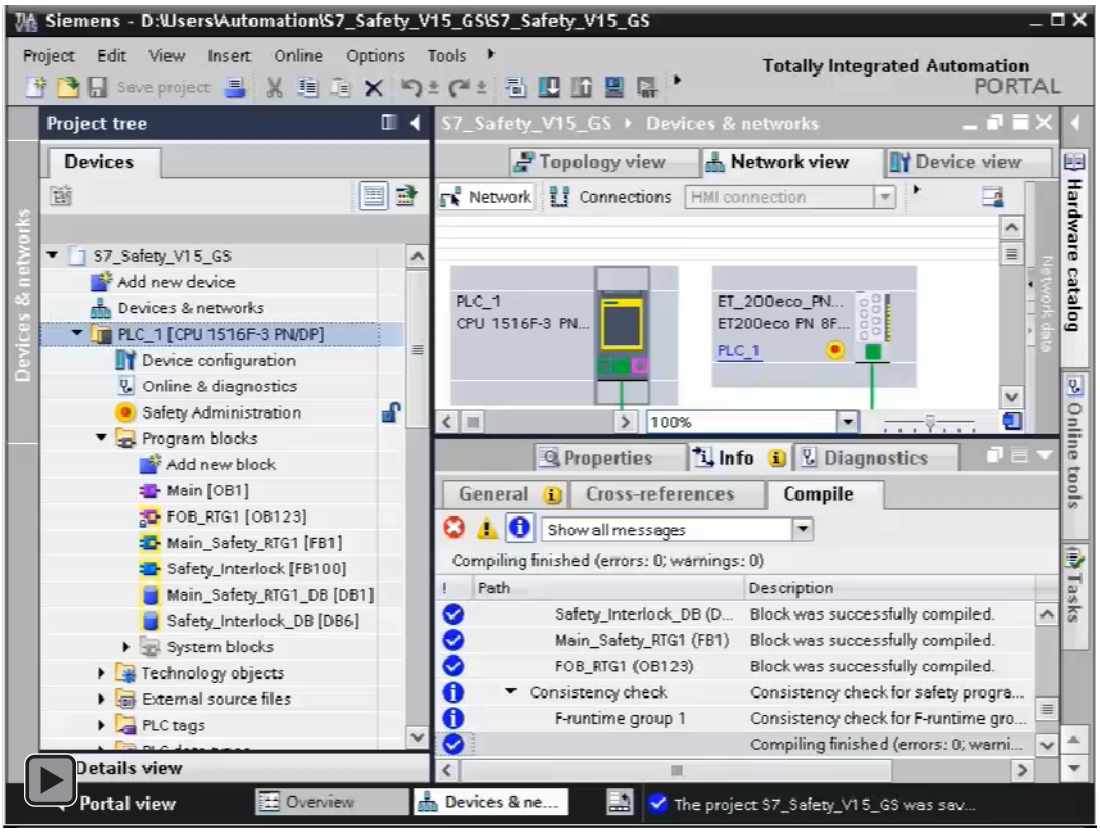
In this step, you compile the safety program and the hardware configuration.

A consistency check is performed on the execution-relevant F-blocks when the safety program is compiled, that is, the safety program is checked for errors. Any error messages are output in an error window. After a successful consistency check, the additionally required F-blocks are generated automatically and added to the F-runtime group in order to generate an executable safety program.

Move your cursor over the image, and the video controls (Play, Stop, Go to the beginning, or Go to the end) appear at the bottom of the video screen.

Click the "Play" button to start the video. Move to another page to deactivate the video.

Procedure



1. Select the fail-safe CPU in the project tree.
2. In the shortcut menu for the fail-safe CPU, select "Compile", then select "Hardware and software (only changes)".

   The CPU compiles the safety program.

Result

If compilation is successful, the result is always a consistent and executable safety program comprising all F-blocks with F-attributes. STEP 7 notifies you of this with the message "Safety program is consistent".

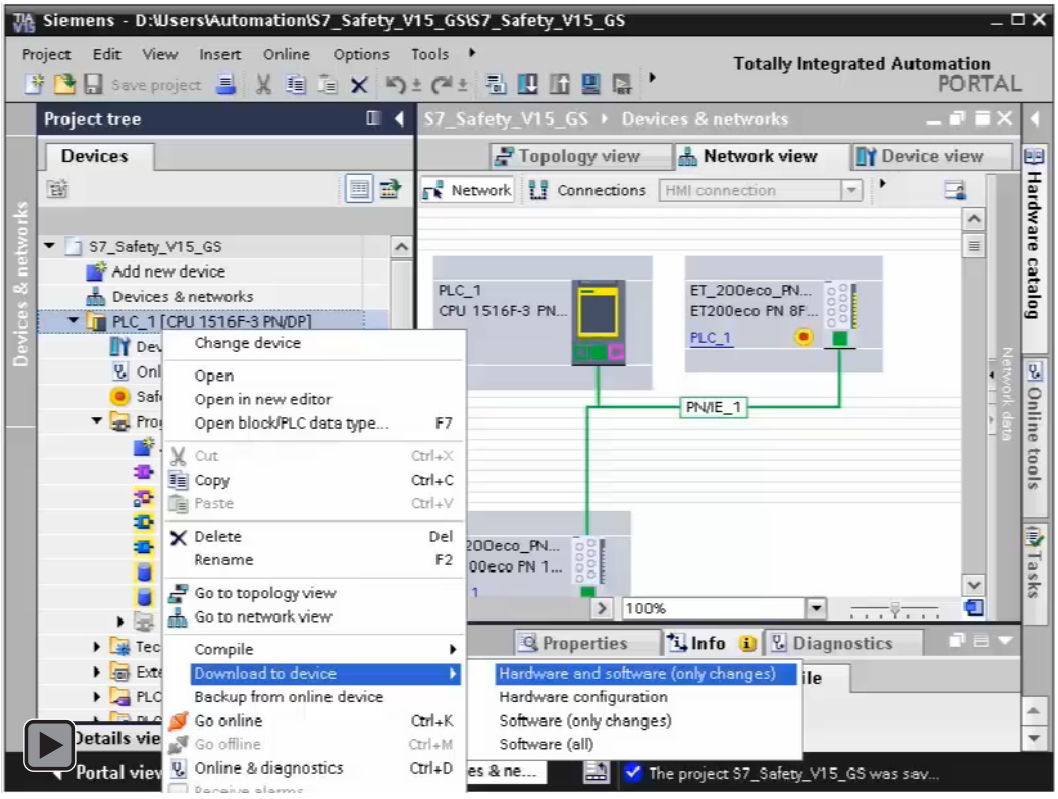
2.3.10 Step 18: Downloading the complete safety program to the fail-safe CPU and activating safety mode

In this step, you download the hardware configuration and the safety program to the fail-safe CPU.

Move your cursor over the image, and the video controls (Play, Stop, Go to the beginning, or Go to the end) appear at the bottom of the video screen.

Click the "Play" button to start the video. Move to another page to deactivate the video.

Procedure



1. In the "Project tree", select the fail-safe CPU.
2. In the shortcut menu for the fail-safe CPU, select "Download to device", then select "Hardware and software (only changes)". If an online connection to the fail-safe CPU does not yet exist, you will be prompted to establish this connection.
3. Select "Consistent download" in the "Action" column in each case.

Note

To download the entire safety program, the fail-safe CPU must be in STOP mode.

4. Click the "Load" button.

   Result: The "Load results" dialog is displayed.

5. Click the "Finish" button.
6. In the "Project tree", double-click "Safety Administration".
7. In the "Safety Administration" editor, check to see if the F-collective signatures of all F-blocks with F-attributes match online and offline to confirm whether your offline safety program blocks match what is in your connected CPU. You must be online in order to perform the signature comparison.
8. To activate safety mode, switch the fail-safe CPU from STOP to RUN mode.

   The Safety Administration editor displays the current safety mode status in the "General" area under "Safety Mode Status".

Note

Once a safety program has been created, you must perform a full function test according to your automation task (see SIMATIC Safety Configuring and Programming Manual (http://support.automation.siemens.com/WW/view/en/54110126/0/en)).

Result of programming

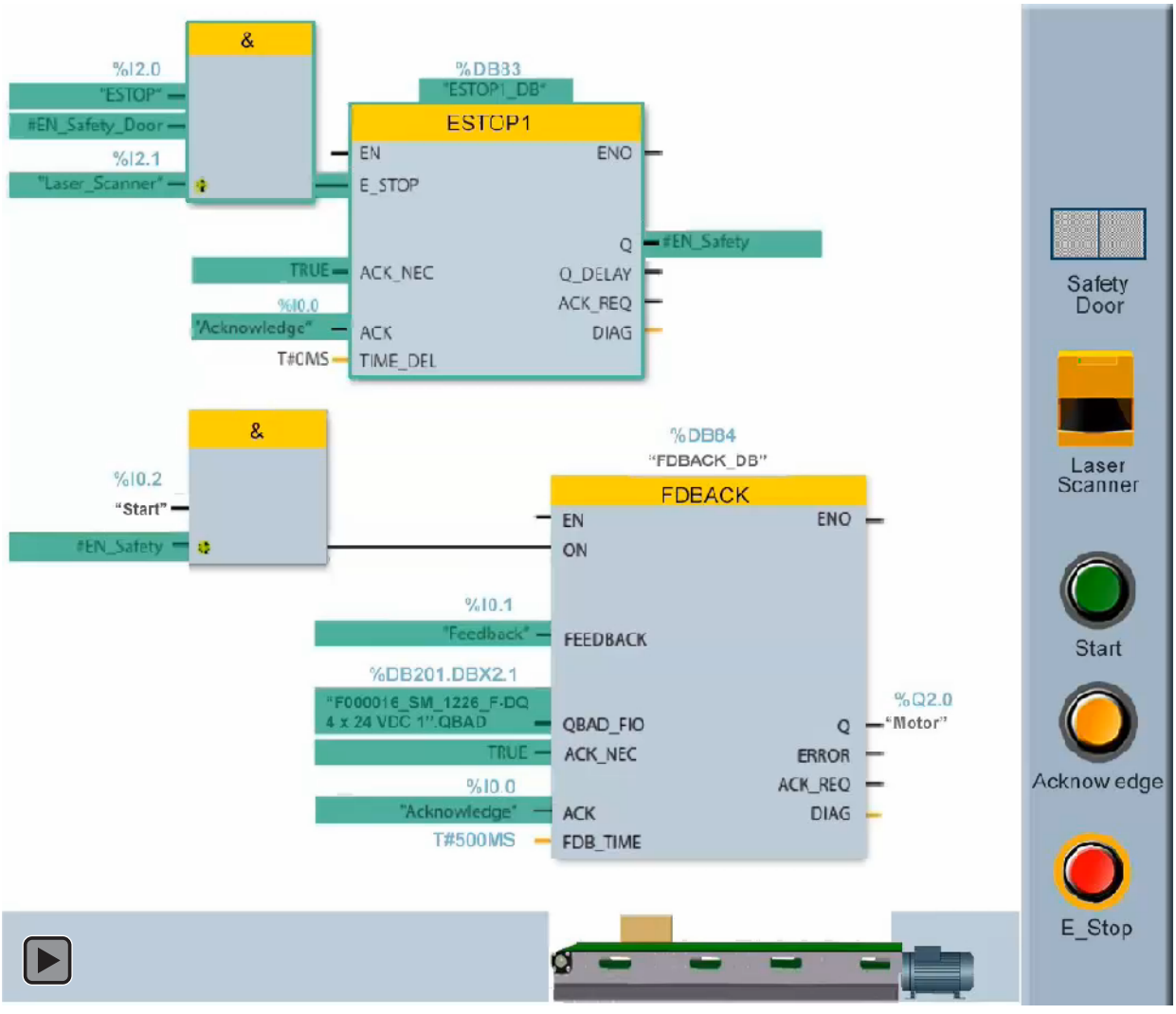
You have now finished creating the safety program according to the task definition of the example. In this instructional video, you can become familiar with the functions you just programmed.

Move your cursor over the image, and the video controls (Play, Stop, Go to the beginning, or Go to the end) appear at the bottom of the video screen.

Click the "Play" button to start the video. Move to another page to deactivate the video.

The video switches the Laser Scanner, E-Stop, and Safety Door on and off to simulate unsafe conditions. Each device operates independently of the other two devices. If you do activate a device, you must deactivate the device before continuing.

The video shows you that you must press the "Acknowledge" button to notify the system that you have returned to a safe state. Then, you can press the "Start" button to operate the system again.



The table below describes the steps and their actions:

Step	Action	Description
1	Activate the E-Stop. [1, 2]	This action prevents resumption of the operation.
2	Deactivate the E-Stop. [3]	The E-Stop deactivates.
3	Press the Acknowledge button.	The safety program requires manual acknowledgement.
4	Press the Start button.	The motor restarts.
5	Trigger the Laser Scanner. [1, 2]	This action prevents resumption of the operation.
6	Deactivate the Laser Scanner. [3]	The Laser Scanner deactivates.
7	Press the Acknowledge button.	The safety program requires manual acknowledgement.
8	Press the Start button.	The motor restarts.
9	Open the Safety Door. [1, 2]	This action prevents resumption of the operation.
10	Close the Safety Door. [3]	The Safety Door closes.
11	Press the Acknowledge button.	The safety program requires manual acknowledgement.
12	Press the Start button.	The motor restarts.

[1] You can activate the E-STOP, trigger the Laser Scanner, or open the Safety Door individually or in any order to stop operations and bring the system to a safe state.

[2] To continue operations, you must do the following steps in this order: 1. Deactivate the fail-safe device, 2. Press the Acknowledge button, and 3. Press the Start button.

[3] This action allows reintegration from safe state values to process data and, if required, acknowledgement by your safety program. You can now restart the motor.

Applications

3

This chapter presents typical application examples for connection of functional safety input and output channels, with a statement of the safety performance (SIL/Category/PL) that is possible for each example.

The PLC system typically contributes only a small part of the total probability of dangerous failure. The probability of dangerous failures of the sensors and actuators will typically be far larger than the PFH/PFD of the PLC system. Faults in the wiring system can also be a substantial contributor.

To achieve a targeted level of safety performance for each safety function, perform these actions:

- Choose an appropriate architecture
- Choose sensors and actuators that are appropriately rated
- Provide a safety program that meets the requirements of the safety function
- Provide diagnostics and proof-tests to maintain the ratings of the sensors and actuators
- Use wiring installation practices, diagnostics, and proof-tests to assure wiring integrity
- Generate and control operating and maintenance procedures for the lifetime of the installation

The S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), ET 200S/ET 200SP, ET 200eco PN, and ET 200M/ET 200MP Fail-Safe systems provide a high level of internal diagnostic coverage. Diagnostic coverage of your external circuits, sensors, and actuators depends on your design choices using features of the PLC system and other measures.

The PFH/PFD of each fail-safe PLC component is stated assuming no field proof-test within the lifetime of the product. Sensors and actuators typically require regular proof-tests to maintain an expected level of safety performance.

The reaction time of each safety function depends on the reaction time of each component, including the sensor, the PLC system, and the actuator. "Fail-Safe response times" (Page 219) gives further information on delay times through the PLC components. You must choose PLC parameters and external component reaction times to achieve a total safety reaction time goal.

In addition to the total delay from the safety demand input to the safe actuator response, you must consider these additional time-related factors. Refer to "Fail-Safe response times" (Page 219) for exact information:

- To be assured of a safety response, a safety demand signal from the input sensor must last long enough to be seen by the safety program. Your configured filter time, discrepancy resolution time, and short circuit test duration all contribute to this time.

- The ET 200eco PN F-DI 8 / F-DQ 3 digital outputs regularly test each P- and M-switch to verify that each switch is still functional and under independent control. The OFF test pulse duration can be as long as your configured "Maximum readback time". The ON test pulse duration can be as long as your configured "Maximum readback time switch on test". For a given output, the ON test pulse is only provided to one of the P or M switches at a time, but in the presence of single fault this could apply energy to your load. Your actuator should not respond to an OFF signal up to the "Maximum readback time" duration, or to an ON signal up to the "Maximum readback time switch on test" duration.
- The ET 200eco PN F-DI 8 / F-DQ 3 digital outputs expect to complete and confirm any commanded transition from the ON to OFF output state. After your program changes the process output value from "1" to "0", do not change the "0" back to a "1" until the program completes the fail-safe digital outputs' readback time. The affected output passivates on commanded "0" states that are too short to confirm.

WARNING

The safety performance of your installation depends on your design and continued maintenance of each complete safety function.

The S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), and ET 200S/ET 200SP fail-safe CPUs and ET 200eco PN F-DI 8 / F-DQ 3 module provide components for logic processing with a certified level of safety integrity when used in accordance with ratings, specifications, and instructions.

Failure to comply with these guidelines could cause damage or unpredictable operation which could result in death or severe personal injury and/or property damage.

You must choose all components of your installation and complete your design and maintenance according to accepted safety standards and practices to achieve your required level of safety. *(S807)*

3.1 Digital input applications

3.1.1 Overview

You should consider the application modes presented here along with the features of the ET 200eco PN F-DI 8 / F-DQ 3 as described in the overview. Refer to "Fail-Safe digital inputs" (Page 28).

The main features of the ET 200eco PN F-DI 8 / F-DQ 3 digital inputs include the following items:

- Configure each channel as a 1oo1 or part of a 1oo2 evaluation pair.
- The corresponding channels (x.0, x.4), (x.1, x.5), (x.2, x.6), and (x.3, x.7) form a 1oo2 channel group.
- Within this restriction, you can assign 1oo1 and 1oo2 in any order.
- Short-circuit testing requires use of the internal sensor supply. For all evaluation and sensor interconnections except for 1oo2, 2 channel - 3 wire non-equivalent, use Vs1 with inputs x.0 to x.3 and Vs2 with inputs x.4 to x.7. For evaluation and sensor interconnection for 1oo2, 2 channel - 3 wire non-equivalent, use Vs1 with inputs x.0 to x.7, and do not use Vs2.
- If you enable the short-circuit test, you configure both Vs1 and Vs2 with the same parameters. All channels that you configure for internal sensor supply are subject to the same short-circuit test. You configure a test duration (length of dark time) and test interval (time between the start of the dark tests).
- The module performs these short-circuit functions for F-DI channels:
  - Monitors the sensor supply to detect short-circuit or overload
  - Cycles the sensor supply once on each power up to assure control and readback are working. This ensures operational integrity of the sensor supply at power up even when disabled.
  - Monitors the readback during input short-circuit tests
- Configure a discrepancy time to identify unacceptable differences between 1oo2 inputs.
- Configure a filter time for each channel or each 1oo2 pair.

You can achieve Category 3 in 1oo1 configurations if you diagnose external wiring faults or exclude them according to standards by proper routing, protection, and proof-testing of conductors:

- Each F-DI input includes sufficient diagnostics and redundant components such that no single internal fault can cause a dangerous failure.
- An appropriately-rated, single sensor can reach Category 3 by internal fault tolerance.
- The external wiring of a single sensor to a single input is vulnerable to single fault dangerous failure unless additional measures are applied.

You can achieve Category 4 in 1oo2 configurations if you diagnose external wiring faults or exclude them according to standards by proper routing, protection, and proof-testing of conductors:

- With 1oo2 evaluation, a pair of F-DI inputs is not subject to dangerous internal failure within a reasonable number of accumulated internal faults.
- Appropriately-rated, external-paired sensors or equivalent redundancy can achieve Category 4.
- The duplicated external wiring of two sensors to two input points is vulnerable to accumulated fault dangerous failure unless you apply additional measures.

The fail-safe digital inputs are certified for SIL 3/PL e only when you select 1oo2 evaluation.

3.1.2 Selecting the digital input application

Input architectures for achieving Safety Integrity Level (SIL)/Category/Performance Level (PL)

Table 3- 1 Safety Integrity Level (SIL)/Category/Performance Level (PL) requirements

Application	Sensor supply *	Sensor evaluation	Channel connection	Type of sensor connection	Achievable SIL/Category/PL	
					Without short-circuit detection	With short-circuit detection
1 and 2	Internal or External	1oo1 evaluation	Single input	1 channel	2/3/d	
3	Internal	1oo2 evaluation	Two inputs	2 channel equivalent	3/3/e	3/4/e
4	External				3/3/e	
5	Internal			2 channel - 3 wire non-equivalent	3/3/e	3/4/e
6	External				3/3/e	
7	Internal			2 channel - 4 wire non-equivalent	3/3/e	3/4/e
8	External				3/3/e	

* The ET 200eco PN F-DI 8 / F-DQ 3 uses M12 connections and is intended for use outside a cabinet in IP67 applications (everything sealed). If you require the use of an external supply, cut the M12 cable and make the connection inside a sealed cabinet or inside a sealed sensor. For external supplies, do not connect the pin 1 wire (Vs1) or the pin 5 wire (Vs2) in the M12 cable. This action prevents the Vs (which may be ON due to a different channel being configured as internal) from being shorted to the external 24 V DC. In addition, make the external 24 V DC connection inside a sealed cabinet or inside a sealed sensor.

Refer to "Pin assignment of connectors" (Page 133) for further information on connector pin assignments.

3.1.3 F-DI Application Modes 1 and 2: 1oo1 evaluation of two single-channel sensors

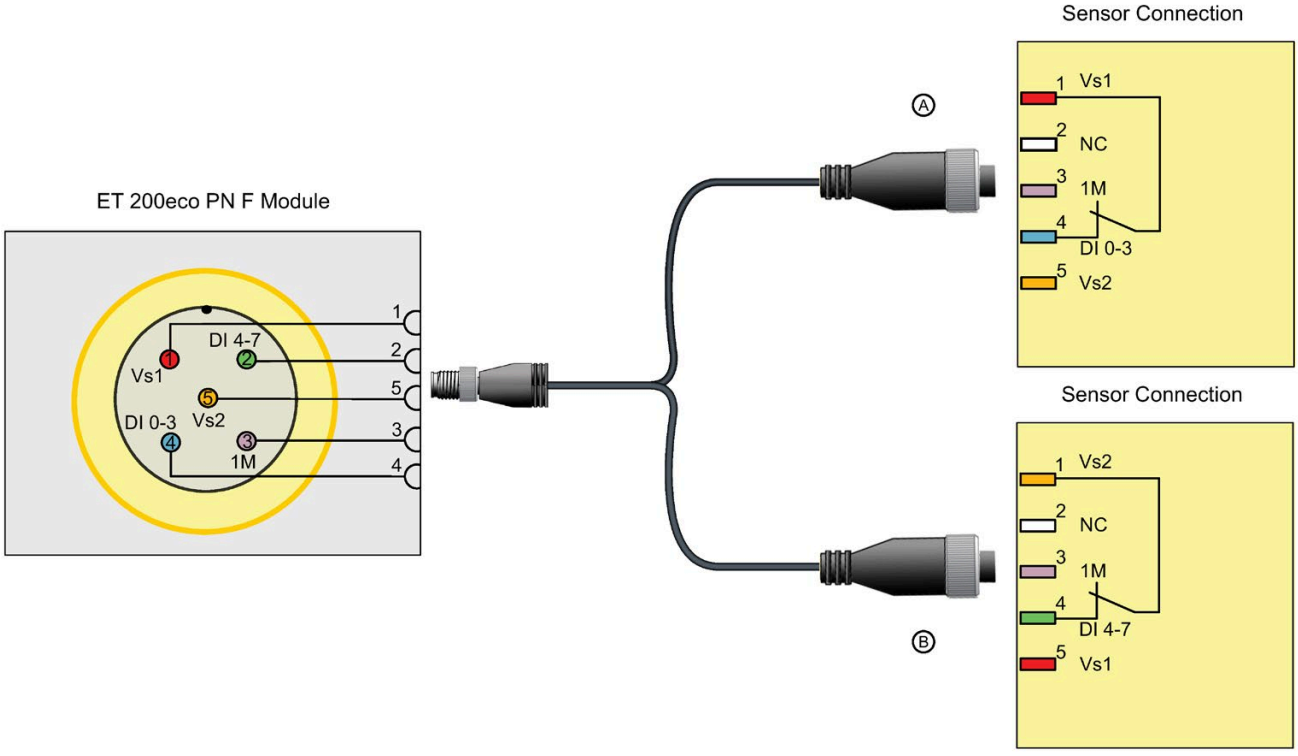
F-DI application mode 1

This application mode uses two single-channel sensors with a 1oo1 evaluation for each sensor. When you use an internal sensor supply, you can successfully perform short-circuit detection.

Note: To incorporate F-DI Application Mode 1 into a SIL 2-rated application, the sensor must be an appropriately qualified device.

Figure 3-1 F-DI Application Mode 1: Internal sensor supply (1oo1 evaluation of a single-channel sensor shown)

This application mode uses two single-channel sensors with a 1oo1 evaluation for each sensor. When you use an internal sensor supply, you can successfully perform short-circuit detection.



Note: To incorporate F-DI Application Mode 1 into a SIL 2-rated application, the sensor must be an appropriately qualified device.

Note: Use Y cable (6ES7194-6KB00-0XA0) (Page 126) for Application Mode 1.

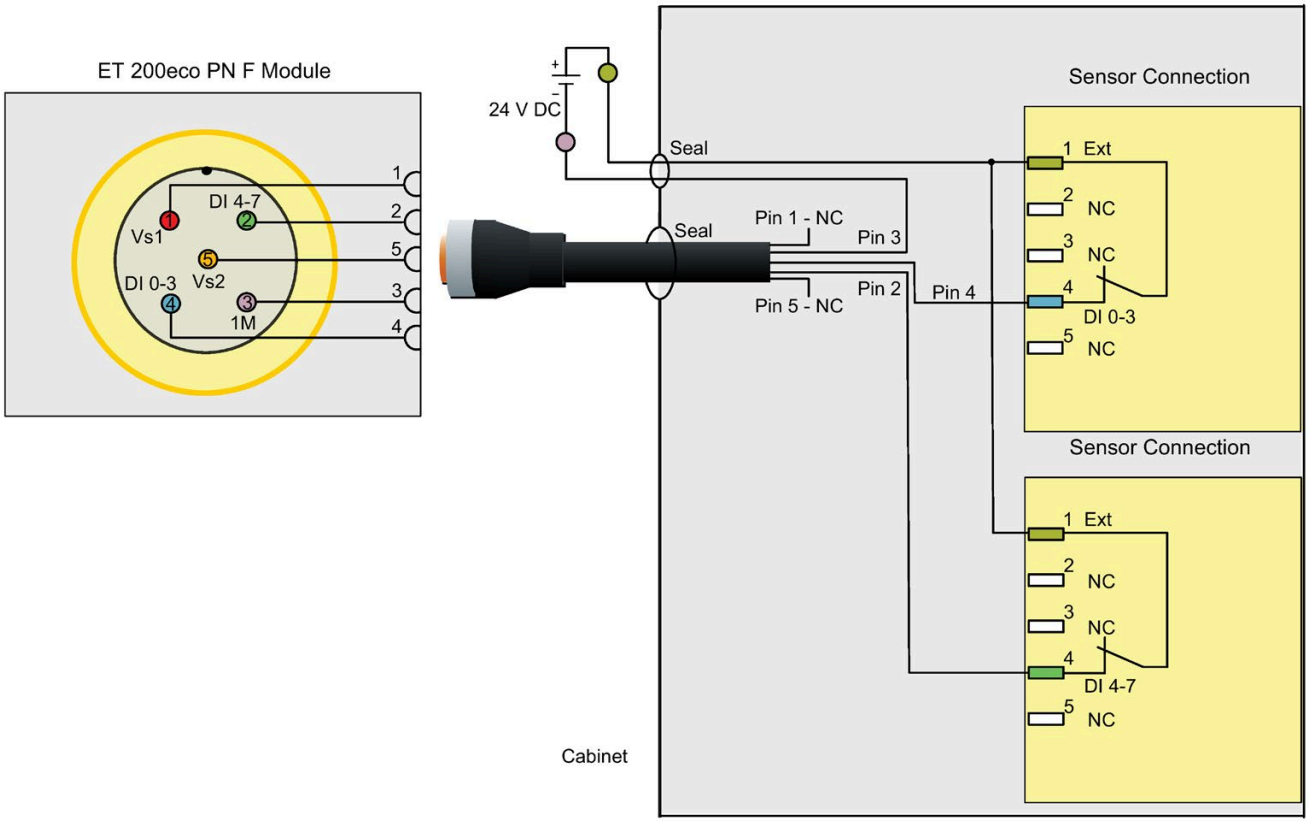
Figure 3-2 F-DI Application Mode 1: Internal sensor supply

Parameter assignment

Parameter name	Parameter value
Sensor evaluation	1oo1 evaluation
Sensor supply	Internal
Short-circuit test	Enable

F-DI application mode 2

This application mode uses two single-channel sensors with a 1oo1 evaluation for each sensor. When you use an external sensor supply, the module does not evaluate that channel for short-circuit testing.



Note: To incorporate F-DI Application Mode 2 into a SIL 2-rated application, the sensor must be an appropriately qualified device.

Figure 3-3 F-DI Application Mode 2: External sensor supply

Parameter assignment

Parameter name	Parameter value
Sensor evaluation	1oo1 evaluation
Sensor supply	External

3.1.4 F-DI Application Modes 3 and 4: 1oo2 evaluation of independent equivalent sensors

F-DI application mode 3

This application mode uses a dual channel sensor with two mechanically-coupled contacts in a 1oo2 voting with discrepancy evaluation. When you use an internal sensor supply, you can successfully perform short-circuit detection.

Note: To incorporate F-DI Application Mode 3 into a SIL 3-rated application, the sensor must be an appropriately qualified device.

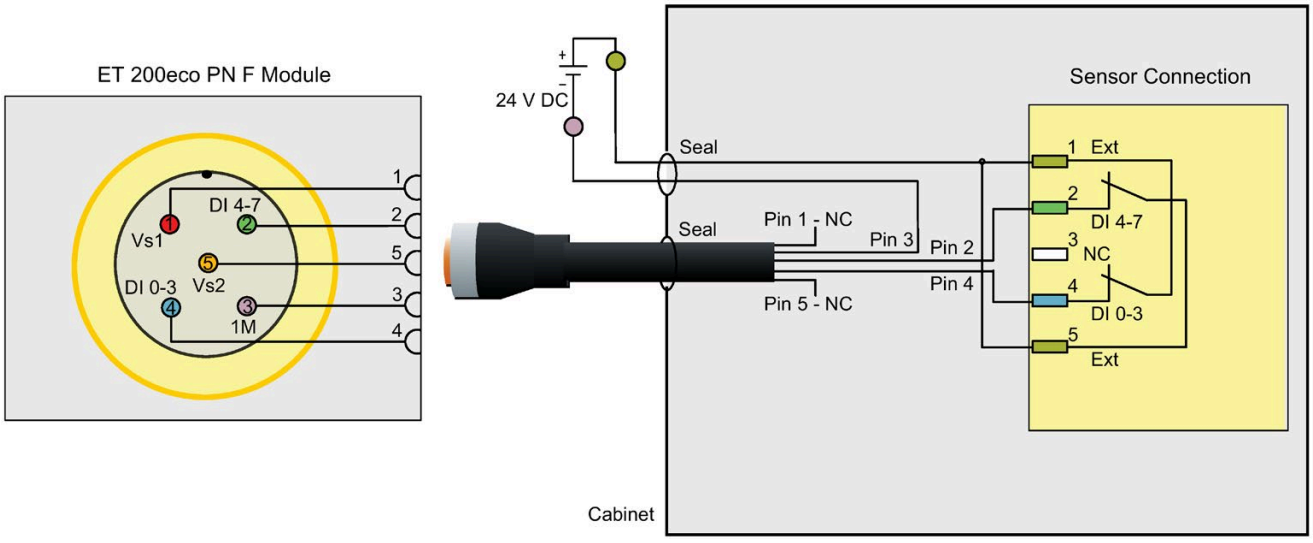
Figure 3-4 F-DI Application Mode 3: Internal sensor supply

Parameter assignment

Parameter name	Parameter value
Sensor evaluation	1oo2 evaluation, 2 channel equivalent
Sensor supply	Internal
Short-circuit test	Enable

F-DI application mode 4

This application mode uses a dual channel sensor with two mechanically-coupled contacts and a 1oo2 voting with discrepancy evaluation. When you use an external sensor supply, the module does not evaluate that channel for short-circuit testing.



Note: To incorporate F-DI Application Mode 4 into a SIL 3-rated application, the sensor must be an appropriately qualified device.

Figure 3-5 F-DI Application Mode 4: External sensor supply

Parameter assignment

Parameter name	Parameter value
Sensor evaluation	1oo2 evaluation, 2 channel equivalent
Sensor supply	External

3.1.5 F-DI Application Modes 5 and 6: 1oo2 evaluation of 3-wire, non-equivalent sensor circuit

F-DI application mode 5

This application mode uses a sensor with two non-equivalent outputs in a 1oo2 voting with discrepancy evaluation. When you use an internal sensor supply, you can successfully perform short-circuit detection. The application mode uses the following pins:

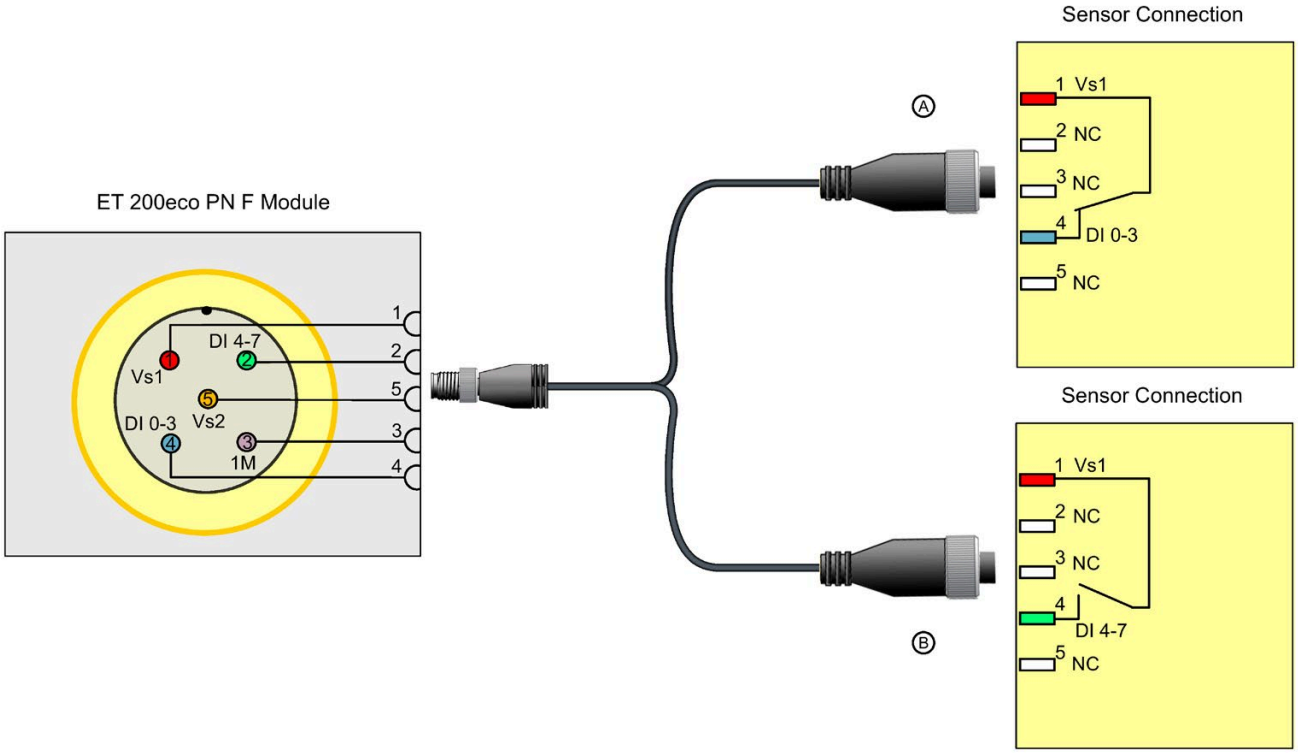
- Pin 2 (channels 4, 5, 6, and 7) is the inverted input of the non-equivalent configuration.
- Pin 4 (channels 0, 1, 2, and 3) is the non-inverted input of the non-equivalent configuration.

Note: To incorporate F-DI Application Mode 5 into a SIL 3-rated application, the sensor must be an appropriately qualified device.

Figure 3-6 F-DI Application Mode 5: Straight 5-pin cable with Internal sensor supply

This application mode uses a sensor with two non-equivalent outputs in a 1oo2 voting with discrepancy evaluation. When you use an internal sensor supply, you can successfully perform short-circuit detection. The application mode uses the following pins:

- Pin 2 (channels 4, 5, 6, and 7) is the inverted input of the non-equivalent configuration.
- Pin 4 (channels 0, 1, 2, and 3) is the non-inverted input of the non-equivalent configuration.



Note: To incorporate F-DI Application Mode 5 into a SIL 3-rated application, the sensor must be an appropriately qualified device.

Note: Use Y cable (6ES7194-6KA00-0XA0) (Page 127) for Application Mode 5.

Figure 3-7 F-DI Application Mode 5: Y cable with Internal sensor supply

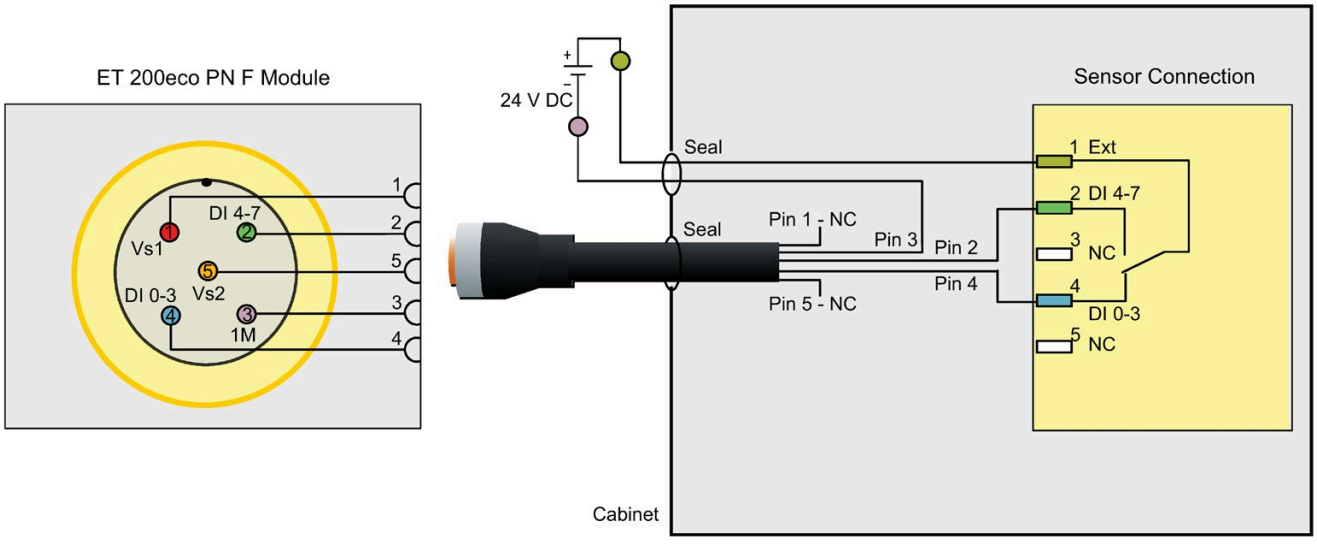
Parameter assignment

Parameter name	Parameter value
Sensor evaluation	1oo2 evaluation, 2 channel - 3 wire non-equivalent
Sensor supply	Internal
Short-circuit test	Enable

F-DI application mode 6

This application mode uses a sensor with two non-equivalent outputs in a 1oo2 voting with discrepancy evaluation. When you use an external sensor supply, the module does not evaluate that channel for short-circuit testing. The application mode uses the following pins:

- Pin 2 (channels 4, 5, 6, and 7) is the inverted input of the non-equivalent configuration.
- Pin 4 (channels 0, 1, 2, and 3) is the non-inverted input of the non-equivalent configuration.



Note: To incorporate F-DI Application Mode 6 into a SIL 3-rated application, the sensor must be an appropriately qualified device.

Figure 3-8 F-DI Application Mode 6: External sensor supply

Parameter assignment

Parameter name	Parameter value
Sensor evaluation	1oo2 evaluation, 2 channel - 3 wire non-equivalent
Sensor supply	External

3.1.6 F-DI Application Modes 7 and 8: 1oo2 evaluation of 4-wire non-equivalent sensor circuit

F-DI application mode 7

This application mode uses two single-channel sensors in non-equivalent configuration (4-wire connection) in a 1oo2 voting with discrepancy evaluation. When you use an internal sensor supply, you can successfully perform short-circuit detection. The application mode uses the following pins:

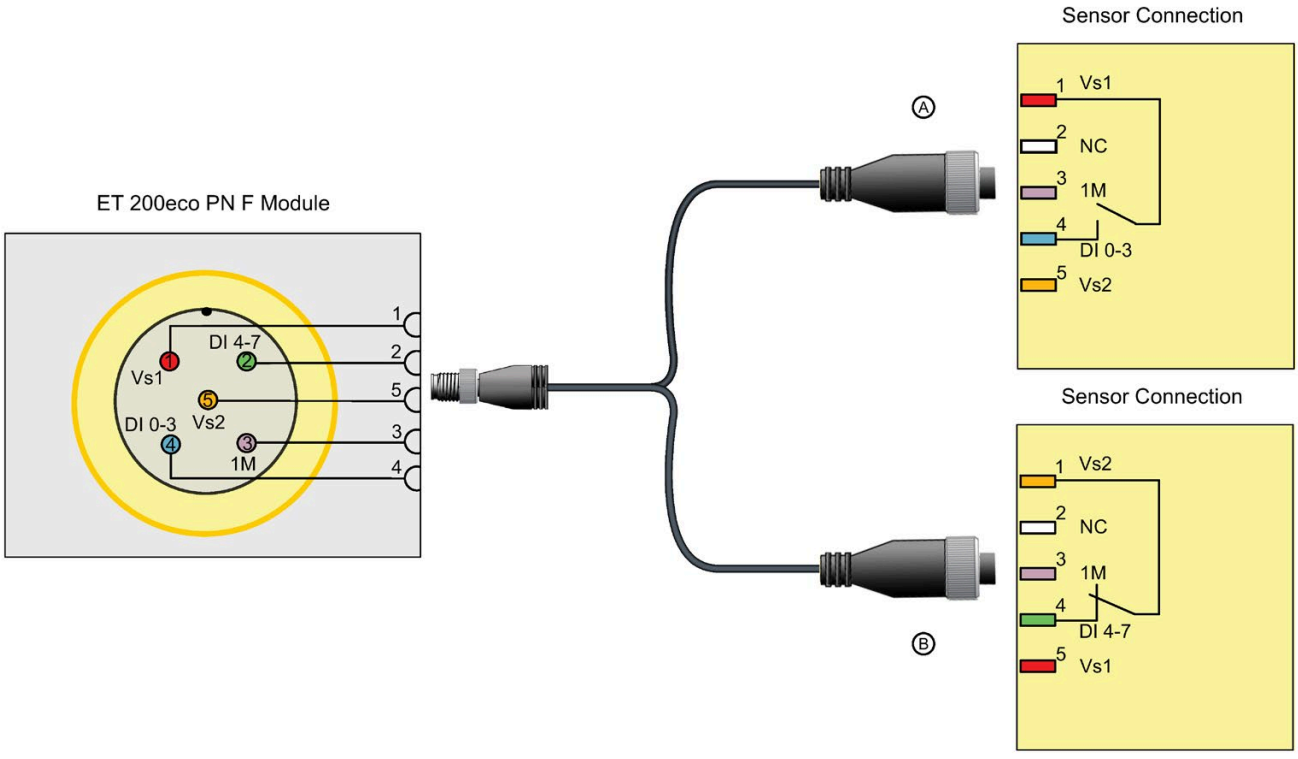
- Pin 2 (channels 4, 5, 6, and 7) is the inverted input of the non-equivalent configuration.
- Pin 4 (channels 0, 1, 2, and 3) is the non-inverted input of the non-equivalent configuration.

Note: To incorporate F-DI Application Mode 7 into a SIL 3-rated application, the sensor must be an appropriately qualified device.

Figure 3-9 F-DI Application Mode 7: Straight 5-pin cable with Internal sensor supply

This application mode uses two single-channel sensors in non-equivalent configuration (4-wire connection) in a 1oo2 voting with discrepancy evaluation. When you use an internal sensor supply, you can successfully perform short-circuit detection. The application mode uses the following pins:

- Pin 2 (channels 4, 5, 6, and 7) is the inverted input of the non-equivalent configuration.
- Pin 4 (channels 0, 1, 2, and 3) is the non-inverted input of the non-equivalent configuration.



Note: To incorporate F-DI Application Mode 7 into a SIL 3-rated application, the sensors must be appropriately qualified devices: Either SIL 3 or SIL 2 with the Systematic Capability rules defined in IEC 61508-2:2010 observed (sufficient independence in design and application or SC3).

Note: Use Y cable (6ES7194-6KB00-0XA0) (Page 126) for Application Mode 7.

Figure 3-10 F-DI Application Mode 7: Y cable with Internal sensor supply

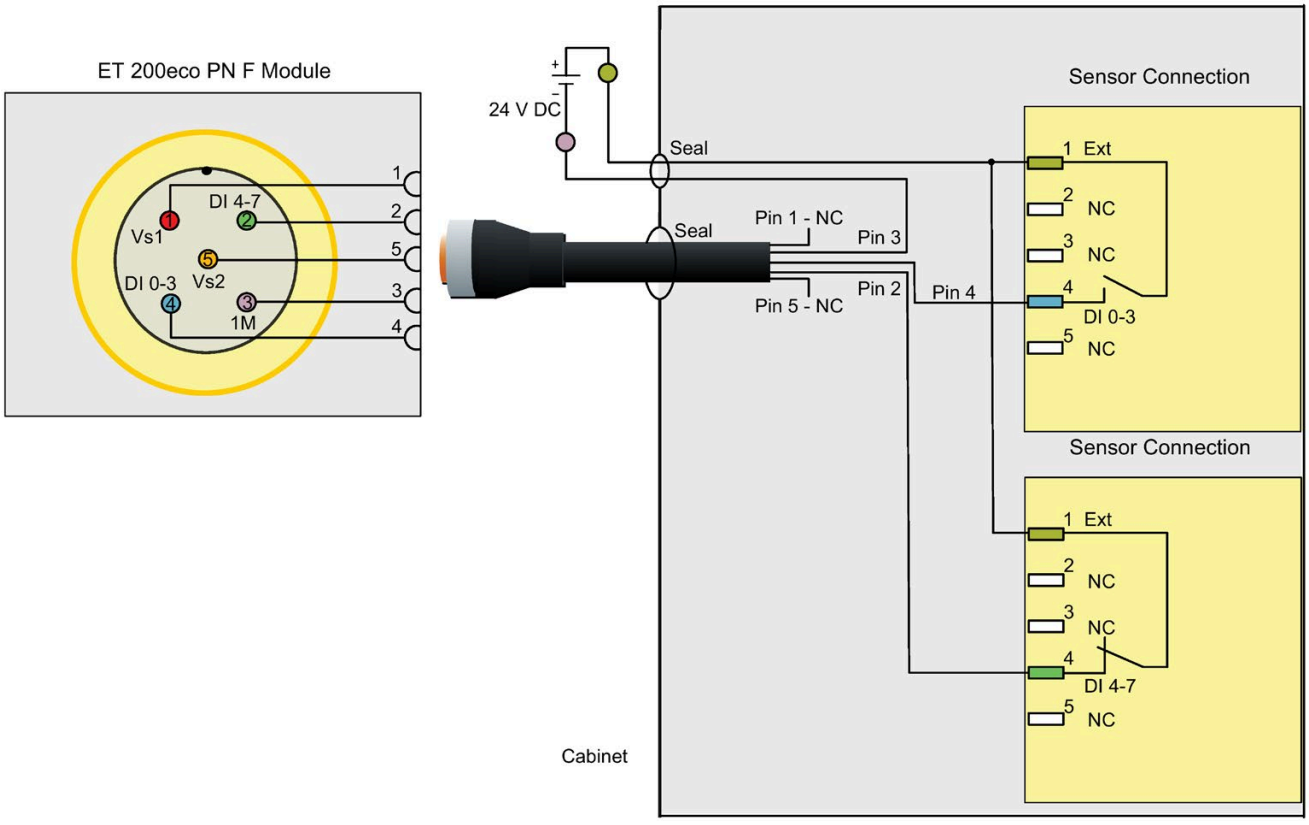
Parameter assignment

Parameter name	Parameter value
Sensor evaluation	1oo2 evaluation, 2 channel - 4 wire non-equivalent
Sensor supply	Internal
Short-circuit test	Enable

F-DI application mode 8

This application mode uses two single-channel sensors in non-equivalent configuration (4-wire connection) in a 1oo2 voting with discrepancy evaluation. When you use an external sensor supply, the module does not evaluate that channel for short-circuit testing. The application mode uses the following pins:

- Pin 2 (channels 4, 5, 6, and 7) is the inverted input of the non-equivalent configuration.
- Pin 4 (channels 0, 1, 2, and 3) is the non-inverted input of the non-equivalent configuration.



Note: To incorporate F-DI Application Mode 8 into a SIL 3-rated application, the sensors must be appropriately qualified devices: Either SIL 3 or SIL 2 with Systematic Capability rules defined in IEC 61508-2:2010 observed (sufficient independence in design and application or SC3).

Figure 3-11 F-DI Application Mode 8: External sensor supply

Parameter assignment

Parameter name	Parameter value
Sensor evaluation	1oo2 evaluation, 2 channel - 4 wire non-equivalent
Sensor supply	External

3.2 Digital output applications

3.2.1 Overview

You should consider the application modes presented here along with the features of the ET 200eco PN F-DI 8 / F-DQ 3 as described in the overview. Refer to "Fail-Safe digital outputs" (Page 29).

The main features of the ET 200eco PN F-DI 8 / F-DQ 3 digital outputs include the following items:

- The fail-safe module separately controls current flow in the P (24 V DC to load) and M (load to common) sides of the circuit.
- The voltage at P and M outputs is read back to confirm proper state.
- The P and M switches are regularly tested with short ON and OFF pulses to confirm control.
- You must configure readback times that allow the external voltage to respond, but do not cause your load to physically respond.
- Internal current limiting as described in the data sheet may be sufficient in combination with your 24 V DC supply. However, you must consider whether additional current limits or fuses are necessary. Refer to "Specifications" (Page 199) (ET 200eco PN F-DI 8 / F-DQ 3).

The module controls all output channels as 1oo2 with cross-diagnostics.

All applications shown are capable of reaching SIL 3/Category 4/PL e.

To reach Category 4, external contactors must be SIL-rated with sense contacts. Read the sense contacts back and confirm the external contactor response in your program. Siemens recommends using an F-DI input for sense contact and other safety diagnostic inputs.

3.2.2 Selecting the digital output application

Application	Description
1	Directly-connected SIL-rated actuator
2	External contactors: Separate P and M controlled contactors
3	External contactors: Parallel connected between P and M
4	External contactors: Separate output channels for each contactor

3.2.3 F-DQ Application Mode 1: Wiring a directly-connected SIL-rated actuator

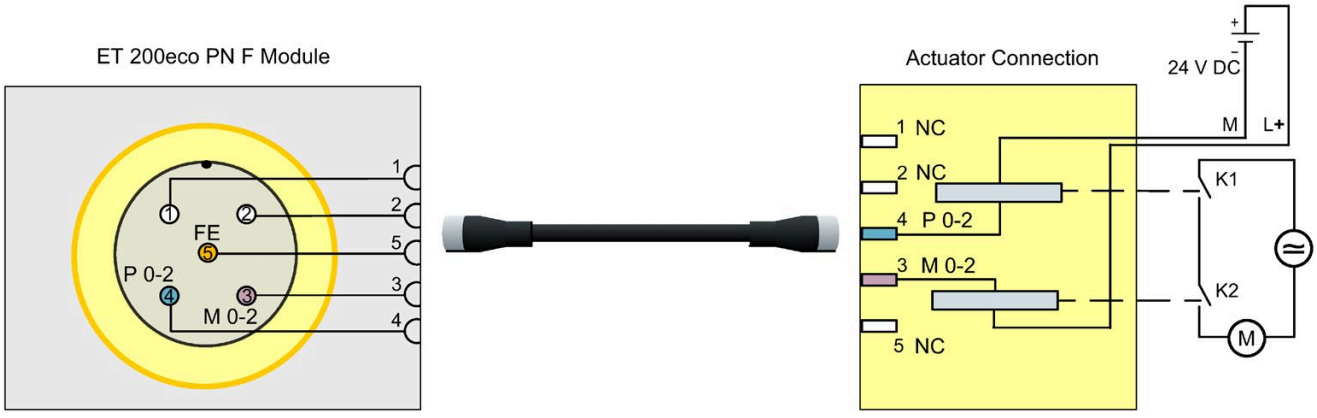
The module supports direct connection of a load between the P and M outputs of one channel (F-DQ Application Mode 1). Both switches are opened when de-energizing the load.

Note: This configuration achieves SIL 3/Category 4/PL e.

Figure 3-12 F-DQ Application Mode 1

3.2.4 F-DQ Application Mode 2: Wiring external contactors: Separate P and M controlled contactors

The module supports F-DQ Application Mode 2, where the module controls the load using series-connected, normally-open contacts of two relays. The coil of one relay connects the P-output of a channel and M. The coil of the other relay connects the M-output of the same channel and L+.



Note: This configuration achieves SIL 3/Category 4/PL e if you fulfill the following conditions:

- The CPU checks the relay status (feedback) using a separate digital input.
- You adequately protect the wiring against shorts between the P and M outputs. The CPU cannot switch off the actuator if such a fault occurs.

Figure 3-13 F-DQ Application Mode 2

3.2.5 F-DQ Application Mode 3: Wiring external contactors: Parallel connected between P and M

The module supports F-DQ Application Mode 3, where the module controls the load using the series-connected, normally-open contacts of two relays. You connect the coils of both relays, in parallel, across the outputs of one channel.

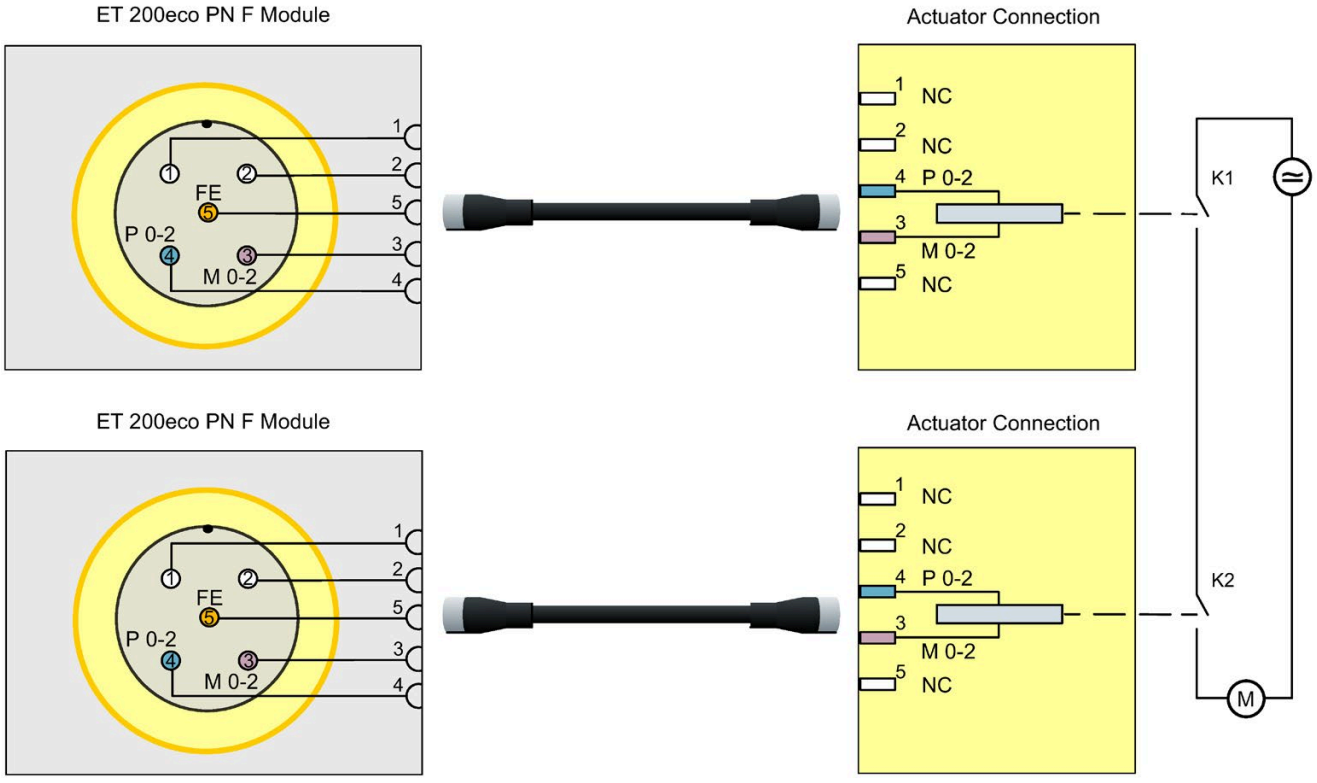
Note:

- This configuration achieves SIL 3/Category 4/PL e if the CPU checks the relay status (feedback) using a separate digital input.
- Application Mode 3 is the preferred way of controlling an actuator using relays in a safety-related application. Application Mode 3 avoids the problems mentioned for Application Mode 2, regarding short-circuits between the P and M outputs.

Figure 3-14 F-DQ Application Mode 3

3.2.6 F-DQ Application Mode 4: Wiring external contactors: Separate P and M output channels for each contactor

The module supports F-DQ Application Mode 4, where the module controls the load using the parallel-connected, normally-open contacts of two relays. Connect the coils of both relays across the outputs of two channels. In the safety program, write the same process value (ON or OFF) to both output channels.



Note: The Application Mode 4 configuration achieves SIL 3/Category 4/PL e if the CPU checks the relay status (feedback) using a separate digital input.

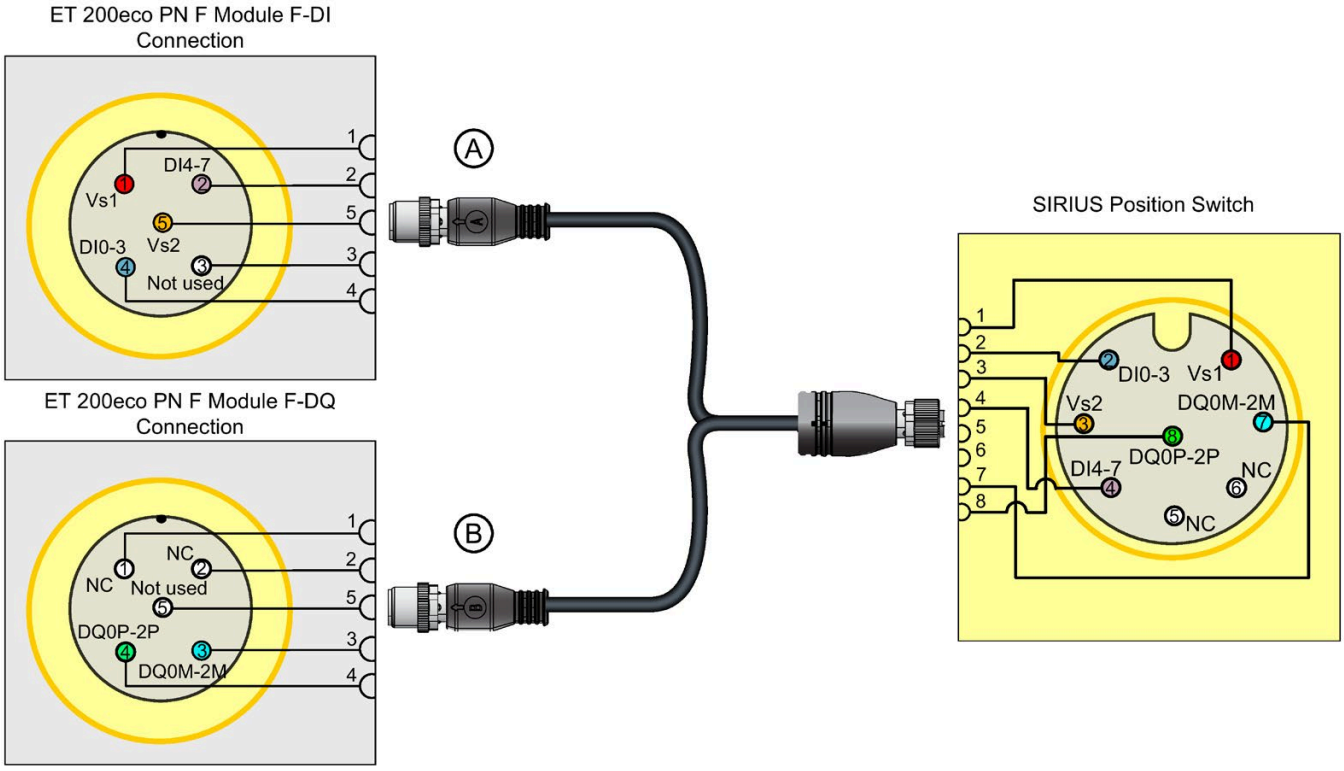
Figure 3-15 F-DQ Application Mode 4

3.3 Digital input/output applications

3.3.1 F-DI/F-DQ Application Mode 1: 1oo2 evaluation with Siemens SIRIUS safety position switch

F-DI/F-DQ application mode 1

This application mode demonstrates usage of the ET 200eco PN F connected to a Siemens SIRIUS safety position switch. The cable shown below is designed to properly connect the ET 200eco PN F-inputs and F-output to the SIRIUS device.



Note: To incorporate F-DI/F-DQ Application Mode 1 into a SIL 3-rated application, the sensors must be appropriately qualified devices: Either SIL 3 or SIL 2 with the Systematic Capability rules defined in the SIRIUS documentation. For further information, refer to the Industrial Controls, Detecting devices SIRIUS 3SE5/3SF1/3SE66/3SE67 position switches Configuration Manual (https://support.industry.siemens.com/cs/us/en/view/43920150).

Note: Use the Inverted Y cable (6ES7194-6KC00-0XA0) (Page 128) for Application Mode 1.

Figure 3-16 F-DI/F-DQ Application Mode 1

Parameter assignment

Parameter name	Parameter value
Sensor evaluation	1oo2 evaluation, 2 channel - 4 wire non-equivalent
Sensor supply	Internal
Short-circuit test	Enable

Installation

4

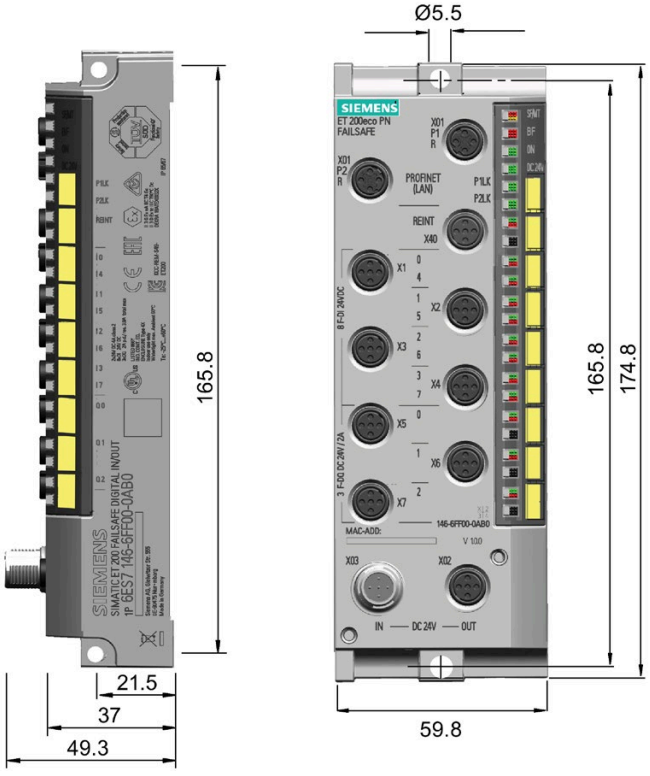
There are two installation variants:

- Without mounting rail (Page 106)
- With mounting rail (Page 107)

4.1 Installation without mounting rail

The ET 200eco PN F-DI 8 / F-DQ 3 distributed I/O device is designed for easy installation. You must mount the I/O device on a solid base. Use the appropriate fasteners to mount the I/O device to the intended material.

The figures below show the dimensional information for mounting:



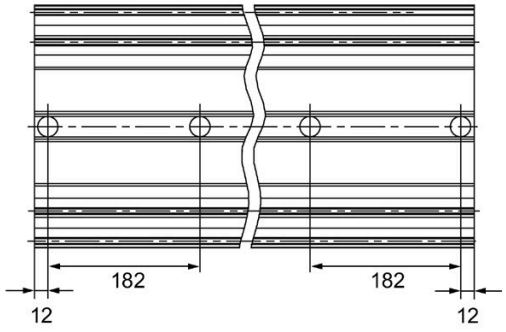
4.2 Installation with mounting rail

The mounting rail is available with a length of 500 mm. Refer to "Ordering information" (Page 212) to find the article number for this item.

Installing the mounting rail

Cut the 500-mm rail to suit your requirements and drill mounting holes for the appropriate fasteners to mount the I/O device to the intended material. You should distribute the mounting holes evenly at a pitch of 182 mm on the rail, starting at a distance of 12 mm from the edge.

Use the rack screw to bolt the I/O devices onto the mounting rail.



Note

It is not mandatory that you use this mounting rail.

4.3 Mounting position and dimensions

Mounting position

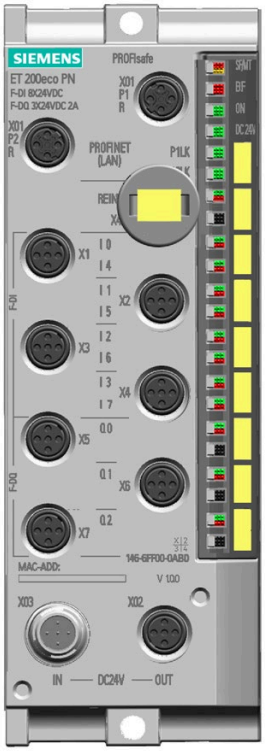
The ET 200eco PN F-DI 8 / F-DQ 3 can be mounted in any position.

Mounting and clearance dimensions

Dimension	Dimensions
Module mounting width	60 mm
Module mounting height	175 mm
Module mounting depth without eCoding Plug	49 mm
Module mounting depth with eCoding Plug	65 mm

4.4 Connecting the M12 eCoding plug

The eCoding plug (6ES7194-6KB00-0AA0) (Page 212) is a specialized plug that stores the PROFIsafe addresses that you assign to the ET 200eco PN F-DI 8 / F-DQ 3 module.

eCoding Plug (side view)	ET 200eco PN F with eCoding Plug Attached (front view)	ET 200eco PN F with eCoding Plug Attached (side view)
		

The eCoding plug stores the PROFIsafe source address, the PROFIsafe destination address, and a CRC external to the module. The ecoding plug occupies the X40 M12 connector, utilizing a B-coded plug. You use the eCoding plug to facilitate module replacement.

The eCoding plug stores assigned PROFIsafe source and destination addresses received from the fail-safe ES to its non-volatile memory. Parameterization also receives all PROFIsafe addresses. The module checks the eCoding plug PROFIsafe addresses against these parameterization PROFIsafe reference addresses.

Protection mechanisms prevent you from damaging the eCoding plug or an I/O channel due to attempted plugging of the eCoding plug into an I/O M12 connector port.

Install the eCoding plug into the M12 connector port at X40 with a torque of 0.7 Nm. Do not overtighten the eCoding plug as it could damage the threading of the eCoding plug.

⚠ WARNING

If you remove/insert the eCoding plug with the power connected, this can lead to undefined states in your system.

Death or serious personal injury and damage to the ET 200eco PN F-DI 8 / F-DQ 3 module and associated machines/equipment may result if proper precautions are not taken.

Only remove or replace the eCoding plug when the power is disconnected. Always comply with the required standards and safety guidelines when configuring a system. *(S812)*

Note

When replacing the ET200eco PN F module, transfer the eCoding plug of the failed module to the replacement module to retain the PROFIsafe address stored in the eCoding plug. Otherwise, it is necessary to use the ES to configure the PROFIsafe address in the replacement module.

4.5 Installing the terminal block

The terminal block (6ES7194-6CA00-0AA0) (Page 211) connects the ET 200eco PN F-DI 8 / F-DQ 3 and supplies the I/O device with power.

You can install the terminal block in one of two ways:

- Install the terminal block separately on each module
- Screw the terminal block onto each module

Note

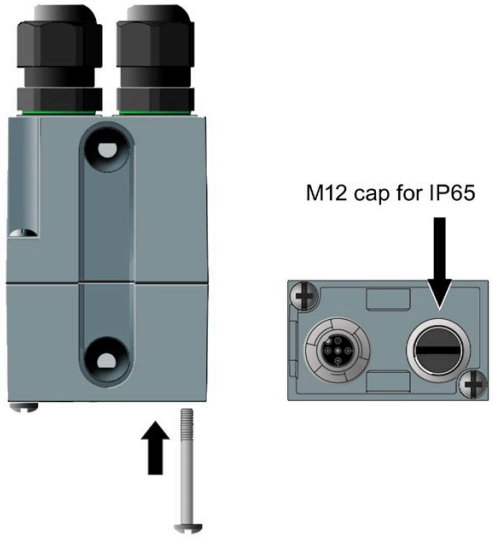
You must wire the terminal block before you install it.

Tools required

Recessed head screwdriver, medium size

Installing the terminal block separately

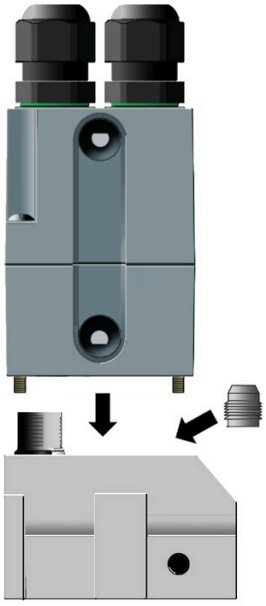
To install the terminal block separately, remove the screws and then screw them in again at the bottom of the housing:



Installing the terminal block on an I/O device

You can install the terminal block horizontally on a housing of 60 mm width.

You can attach an M12 cap to the bottom of the terminal block to implement the corresponding degree of protection. Do not attach the M12 cap to the terminal block connector; mount the M12 cap onto connector X02 of the I/O device. Bolt the terminal block onto the I/O device by tightening the screws.



Refer to the "Terminal block (Page 211)" technical specifications and "Wiring the terminal block" (Page 137) for further information.

4.6 Replacing labels

You can identify the I/O device and the I/O connectors using labels. The module has the following plastic yellow connector labels already clipped into the holder:

- One label for PROFINET device communication
- One label for the eCoding plug
- Seven labels for the I/O connectors

You can order replacement labels.

Tools required

2.5 to 4 mm slotted screwdriver

Replacing labels

1. Push the screwdriver into the small opening of the label at an angle and then pry it out.

2. Push the new label into the holder on the device. The label should snap into place.

Wiring

5

5.1 Fail-Safe system electrical design rules

5.1.1 Safe functional extra low voltage requirement (power supplies and other system components)

WARNING

Fail-safe modules must be operated with safe functional extra-low voltage (SELV, PELV) power sources.

To maintain safety of the modules' low voltage circuits, external connections to communications ports, analog circuits, 24 V DC nominal supply voltage, and I/O circuits must be powered from approved sources that meet the requirements of SELV, PELV, Class 2, Limited Voltage, or Limited Power according to various standards.

The external power supply should limit the maximum voltage to 35 V DC even under fault conditions. Please consult the manufacturer's data for the power supplies that you use. *(S813a)*

Maximum applied voltage to ET 200eco fail-safe devices

- Operational voltage: The fail-safe module's operational voltage is 20.4 V DC - 28.8 V DC, 35 V DC surge for 0.5 second. Operation of the unit to specifications is assured by design and testing. Defined transients from defined source impedances per EN 61000-4-2, 61000-4-4, 61000-4-6, as specified in the data sheet for each product, may be imposed on this voltage without disrupting operation or causing damage. Sustained operation in the range of 28.8 - 35 V DC can result in unacceptable temperature rise and thermal damage, causing the product to become inoperable.
- Absolute maximum rating regarding supply voltage: The absolute maximum rating to prevent module damage and to ensure the functional safety of the modules is 35 V DC. These power supplies must be specified by the manufacturer to limit the output voltage to 35 V DC or less under fault conditions. Otherwise, external protection must be supplied that will reliably open the circuit or limit the output voltage to less than 35 V DC to the modules.
- Surge immunity: Wiring systems subject to surges from lightning strike coupling must be equipped with external protection. This protection must be sufficient to clamp surge voltages and/or open the supply circuit to assure the PLC system is not exposed to voltages greater than 35 V DC. One specification for evaluation of protection from lightning type surges is found in EN 61000-4-5, with operational limits established by EN 61000-6-2. The ET 200eco PN F module requires external protection to maintain safe operation when subject to surge voltages defined by this standard. Refer to Appendix A.1.5.1: "Surge immunity (Page 194)" for further information.

WARNING

All power supply and fail-safe module circuits must be connected together to a common voltage reference or must be isolated SELV circuits.

The power supply M terminals on the fail-safe CPU and the fail-safe modules must be connected together or isolated as SELV. Failure to do so can result in unexpected machine or process operation, which may cause death or serious injury to personnel, and/or damage to equipment.

Connecting all M terminals together or isolating with approved SELV isolation prevents unwanted current flows in the event of a single fault in the CPU to module isolation boundary. *(S814)*

Note

Requirements for power supplies in the event of voltage interruption

To ensure adherence to IEC 61131-2 and NAMUR Recommendation NE 21, only use power packs/power supply units (230 V AC → 24 V DC) with a mains buffering time of at least 20 ms. Observe the relevant requirement in your product standards (for example, 30 ms for "burners" pursuant to EN 298) as regards possible voltage interruptions. The latest information on PS components is available on the Internet (https://mall.industry.siemens.com).

5.2 Control system electrical rules

5.2.1 General rules and regulations for operating an ET 200eco PN F-DI 8 / F-DQ 3

When operating the ET 200eco PN F-DI 8 / F-DQ 3 distributed I/O device as part of a plant or system, special rules and regulations have to be followed depending on the field of application.

This section provides an overview of the most important rules you have to observe when integrating the ET 200eco PN F distributed I/O device in a plant or system.

EMERGENCY-STOP equipment

EMERGENCY STOP equipment according to IEC 204 (corresponds to DIN VDE 113) must remain effective in all operating modes of the plant or system.

System startup after specific events

The table below identifies situations you must pay attention to when the system starts up after the occurrence of certain events:

If ...	then ...
Startup follows a power dip / failure Startup of the ET 200eco PN F after bus communication has been interrupted	Dangerous operating states must be avoided at all times. If necessary, force an "EMERGENCY OFF"!
Startup after releasing the EMERGENCY OFF equipment	Any uncontrolled or undefined startup must be avoided.

24 V DC supply

The table shows what you have to observe for the 24 V DC supply:

At ...	Requirements ...	
Buildings	External lightning protection	Take lightning protection measures (for example, lightning protection elements)
24 V DC supply lines, signal lines	Internal lightning protection	
24 V DC supply	Safe (electrical) isolation of the extra-low voltage	
Loop-through of supply voltage	Voltage drop in the case of loop-through (Refer to "Looping PROFINET and the supply voltage" (Page 143) for further information.)	

Protection against external electrical interference

The table below shows what to observe in order to protect the system against electrical interference or faults:

At ...	ensure that ...
all plants or systems in which the ET 200eco PN F is installed	the plant or system is EMC-compatible and properly grounded for the discharge of electromagnetic interference.
supply, signal, and bus lines	the wiring arrangement and installation is correct.
signal and bus lines	a wire break or conductor break does not result in undefined states of the plant or system.

5.2.2 Electrical configuration of the ET 200eco PN F-DI 8 / F-DQ 3

Electrical isolation

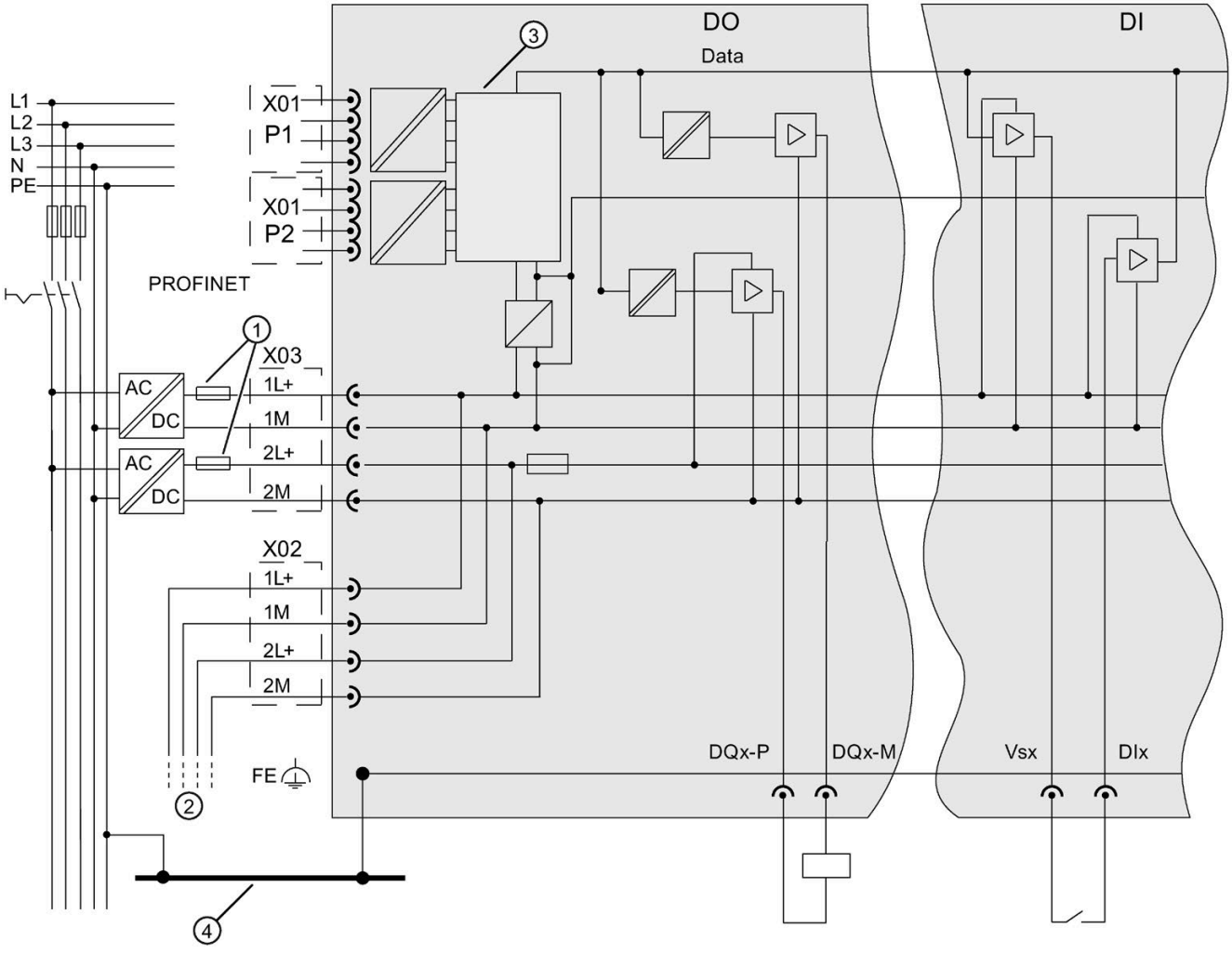
The ET 200eco PN F-DI 8 / F-DQ 3 electrical configuration features electrical isolation between:

- 1L+ supply voltage (electronic/sensor supply)

  Electrically isolated from PROFINET IO and 2L+ (load voltage supply)
- 2L+ supply voltage (load voltage supply):

  Electrically isolated from all other circuit components.
- PROFINET IO interface:

  Electrically isolated from all other circuit components.



①	Infeed of supply voltage 1L+ and 2L+ with line protection	③	Microprocessor and switch
②	Loop-through of supply voltage	④	Main ground line

Line protection

Line protection is required in accordance with DIN VDE 0100, that is, you must always provide external fusing.

You must fuse the 1L+ and 2L+ power supplies of the following devices:

- I/O device using a 24 V DC/4.0 A miniature circuit breaker with tripping characteristic type B or C
- Terminal block using a 24 V DC/10.0 A miniature circuit breaker with tripping characteristic type B or C
- Voltage distributor using a 24 V DC/8.0 A miniature circuit breaker with tripping characteristic type B or C

5.2.3 Influence of cable length on the supply voltage

If you are wiring your configuration, then you must take into account the impact of cable gauge and length on the supply voltage to the ET 200eco PN F-DI 8 / F-DQ 3.

Example

A 10 m cable with 0.75 mm^2 has a resistance of 0.5 Ω, which corresponds with a voltage drop of 2 V DC at a load of 4.0 A.

CAUTION

If you do not adhere to the maximum infeed currents and the cable cross-sections required for these currents, you will risk overheating the cable insulation and contacts resulting in damage to the device.

Electrical faults or unexpected machine operation can result in minor personal injury if proper precautions are not taken.

You must follow all instructions for installation and maintenance of a proper operating environment to ensure the equipment operates safely.

5.2.4 Guidelines for grounding and wiring

Proper grounding and wiring of all electrical equipment is important to provide electrical noise protection for your application and the ET 200eco PN F-DI 8 / F-DQ 3 module. Refer to the technical specifications (Page 199) for the ET 200eco PN F-DI 8 / F-DQ 3 wiring diagrams.

Prerequisites

Before you ground or install wiring to any electrical device, ensure that the power to that equipment has been turned off. Also, ensure that the power to any related equipment has been turned off.

Ensure that you follow all applicable electrical codes when wiring the ET 200eco PN F and related equipment. Install and operate all equipment according to all applicable national and local standards. Contact your local authorities to determine which codes and standards apply to your specific case.

WARNING

Installing or wiring the ET 200eco PN F or related equipment with power applied could cause electric shock or unexpected operation of equipment.

Failure to disable all power to the ET 200eco PN F and related equipment during installation or removal procedures could result in death, severe personal injury, and damage due to electric shock or unexpected equipment operation.

Always follow appropriate safety precautions and ensure that power to the ET 200eco PN F is disabled before attempting to install or remove the ET 200eco PN F or related equipment. *(S817)*

Always take safety into consideration as you design the grounding and wiring of your ET 200eco PN F system. Electronic control devices, such as the ET 200eco PN F, can fail and cause unexpected operation of the equipment that is being controlled or monitored:

- Fail-safe modules: Internal dangerous failures can occur on these devices with a probability as reflected in the SIL rating, PFD, and PFH as stated in this manual.
- Each control's installation: Common cause failure threats can occur such as overvoltage, over-temperature, electrical faults, EMC interference, and fire, water, or mechanical damage to the installation.

You must evaluate every control point for the threat level and consequences of failure. Your installation can require safeguards that are independent of the ET 200eco PN F to achieve an appropriate level of risk for personal injury or equipment damage.

WARNING

Control devices can fail in an unsafe condition, resulting in unexpected operation of controlled equipment.

Such unexpected operations could result in death, severe personal injury, and property damage.

When using fail-safe I/O, design safety-related control functions to account for the probability of faults, including redundancy to achieve an appropriate level of risk for the consequences of failure.

When using standard I/O, always include an emergency stop function, electromechanical overrides, or other redundant safeguards when a failure could cause personal injury or significant property damage. *(S818)*

5.2.5 Grounding the ET 200eco PN F-DI 8 / F-DQ 3 module

The best way to ground your application is to ensure that all the common and ground connections of your ET 200eco PN F-DI 8 / F-DQ 3 and related equipment are grounded to a single point. This single point should be connected directly to the earth ground for your system.

All ground wires should be as short as possible and should use a large wire size, such as 2 mm^2 (14 AWG).

When locating grounds, consider safety-grounding requirements and the proper operation of protective interrupting devices.

5.2.6 Operating the ET 200eco PN F-DI 8 / F-DQ 3 on grounded mains

This section provides information about the overall configuration of an ET 200eco PN F-DI 8 / F-DQ 3 distributed I/O device with a grounded infeed (TN-S system). The section focuses on the following topics:

- Disconnecting devices
- Short-circuit and overload protection according to DIN VDE 0100 and DIN EN 60204-1.

Supply voltages of the ET 200eco PN F

There are two supply voltages:

- 1L+: Electronic/sensor supply
- 2L+: Load supply

Definition: Grounded infeed

A TN-S system always bonds the neutral conductor to ground. A simple short-circuit to ground of a live conductor, or of a grounded component of the plant trips the disconnecting devices.

Safe electrical isolation (SELV/PELV according to IEC 60364-4-41)

You can only operate the ET 200eco PN F using power supplies/power supply units with safe electrical isolation.

Components and protective measures

Safety standards stipulate various components and protective measures for plant installation. The type of components and the degree to which the protective measures are mandatory depend on the DIN VDE regulation that applies to your plant configuration. The next table refers to the diagram below:

Compare ...	Reference to the diagram	DIN VDE 0100	DIN EN 60204
Disconnecting device for controller, sensors, and actuators	"Grounding concept for ET 200eco PN F" (See ① in figure below.)	... Part 460: Main switch	... Part 1: Disconnect switch
Short-circuit and overload protection	"Grounding concept for ET 200eco PN F" (See ② in figure below.)	... Part 725: Single-pole protection of circuits	... Part 1: with grounded secondary power circuit: **single-pole** protection
Line protection		... Part 430: Protection of cables and lines against overcurrent	-

Safe electrical isolation

You require safety isolation for the following items:

- Modules which must be supplied with ≤ 60 V DC or ≤ 25 V AC
- 24 V DC load circuits

Configuring ET 200eco PN F with grounded reference potential

Any interference currents generated within an ET 200eco PN F configuration with grounded reference potential discharge to protective earth. You must connect the terminals externally. Refer to the figure below: Connection between 1M and FE

Configuring ET 200eco PN F with ungrounded reference potential

In an ET 200eco PN F configuration with ungrounded reference potential, any interference currents discharge to protective ground through an internal RC circuit. Refer to the figure below: No connection between 1M and FE

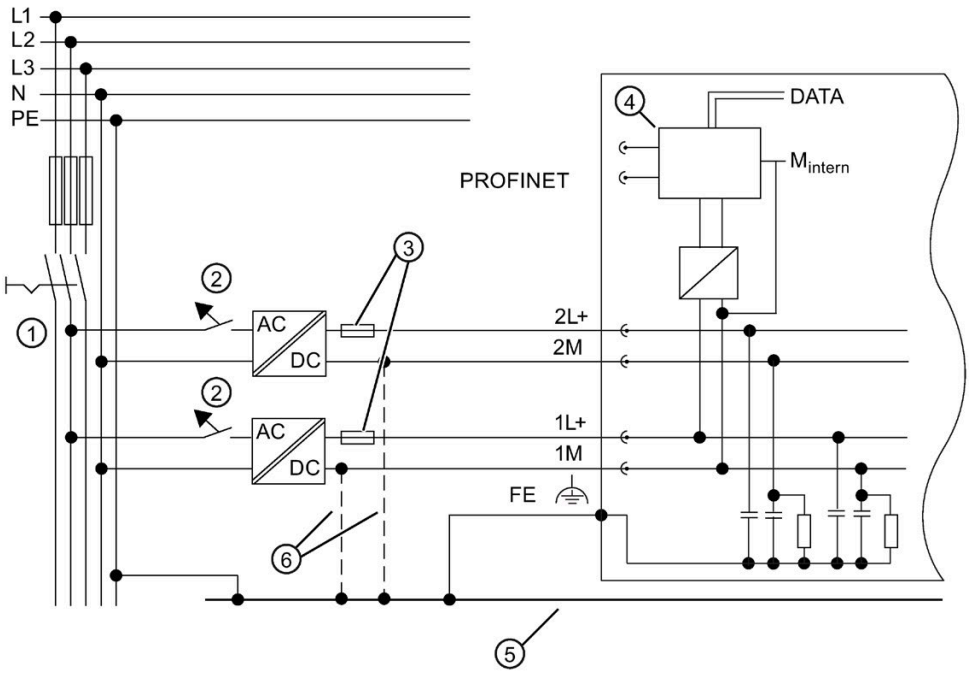
Isolation monitoring

Isolation monitoring must be provided if the following exist:

- Ungrounded ET 200eco PN F configuration
- A repetitive error that is liable to cause dangerous plant states

ET 200eco PN F in its overall configuration

The figure below shows the overall configuration of the ET 200eco PN F distributed I/O device (load voltage supply and grounding concept) with infeed from a TN-S system:



① Disconnecting device for controller, sensors, and actuators
② Short-circuit and overload protection
③ Fuses for line protection
④ Microprocessor and module switch
⑤ Main ground line
⑥ When you configure the ET 200eco PN F with ungrounded reference potential, you eliminate the connection between 1M and FE and 2M and FE.

5.2.7 Wiring the ET 200eco PN F-DI 8 / F-DQ 3

5.2.7.1 Guidelines for wiring the ET 200eco PN F-DI 8 / F-DQ 3

When designing the wiring for your ET 200eco PN F-DI 8 / F-DQ 3, provide a single disconnect switch that simultaneously removes power from all input circuits and from all output circuits. Provide over-current protection, such as a fuse or circuit breaker, to limit fault currents on supply wiring. Consider providing additional protection by placing a fuse or other current limit in each output circuit.

Install appropriate surge suppression devices for any wiring that could be subject to lightning surges.

Do not place low voltage signal wires and communications cables in the same wire tray with AC wires and high energy, rapidly switched DC wires. Always route wires in pairs, with the neutral or common wire paired with the hot or signal-carrying wire.

Use the shortest wire possible and ensure that the wire is sized properly to carry the required current.

Wire and cable should have a temperature rating 30 °C higher than the ambient temperature around the ET 200eco PN F (for example, a minimum of 85 °C-rated conductors for 55 °C ambient temperature). You should determine other wiring type and material requirements from the specific electrical circuit ratings and your installation environment.

Use shielded wires for optimum protection against electrical noise. Typically, grounding the shield at the ET 200eco PN F gives the best results. You should ground communication cable shields to ET 200eco PN F communication connector shells using connectors that engage the cable shield, or by bonding the communication cable shields to a separate ground.

When wiring input circuits that are powered by an external power supply, include an overcurrent protection device in that circuit.

Refer to "Pin assignment of connectors" (Page 133) for further information on pin assignment for PROFINET, feeding and looping the voltage, digital inputs, and digital outputs connectors.

To help prevent unwanted current flows in your installation, the ET 200eco PN F provides isolation boundaries at certain points. When you plan the wiring for your system, you should consider these isolation boundaries. Refer to the technical specifications (Page 199) for the amount of isolation provided and the location of the isolation boundaries. Circuits rated for AC line voltage include safety isolation to other circuits. Isolation boundaries between 24 V DC circuits are functional only, and you should not depend on these boundaries for safety.

5.2.7.2 Wiring the ET 200eco PN F-DI 8 / F-DQ 3 to functional earth (FE)

All ET 200eco PN I/O devices have a functional earth connection. This connection is used to suppress interference, but not for protective purposes. You establish a direct electrical connection to a point in your plant or a shield using the functional earth connection. EMC interference is discharged directly to earth through this connection. The interference immunity of the entire I/O device is increased by the discharge of the EMC interference.

Installing ET 200eco PN F I/O devices on a conductive base

You require the following items to install ET 200eco PN F I/O devices on a conductive base:

- Conductive base for installation of the I/O device
- Screwdriver to connect to the functional ground
- 2 x M5 x 8 fixing screws and washers to connect to the functional ground

To connect ET 200eco PN F I/O devices to functional earth with a conductive base, follow these steps:

1. Drill two fixing holes.
2. Bolt the I/O device with the M5 fixing screws and washers using a torque of 1.5 Nm.

Note

Grounding with a conductive base

When you fasten an I/O device of ET 200eco PN F to a conductive, grounded base, the lower fixing screw creates a conductive connection to the ground potential.
Make sure there is a low-impedance connection between the peripheral device and the conductive substrate and between the conductive substrate and the functional ground.

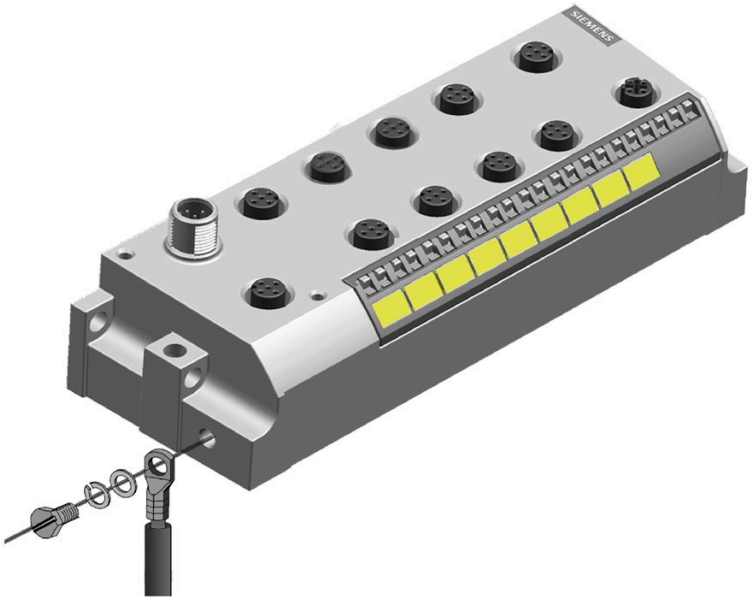
Installing ET 200eco PN F I/O devices on a non-conductive base

You require the following items to install ET 200eco PN F I/O devices on a non-conductive base:

- Non-conductive base for installation of the I/O device
- Tools to connect to the functional ground:
  - Stripping tool
  - Crimp tool
  - Screwdriver
- Accessories to connect to the functional ground:
  - M5 x 8 fixing screw and washers
  - Grounding cable (copper braid cable) with a minimum cross-section of 4 mm^2
  - Cable lug suitable for M5 screws

To connect ET 200eco PN F I/O devices to functional earth with a non-conductive base, follow these steps:

1. Drill 2 fixing holes.
2. Strip the grounding conductor and crimp on the cable lug.
3. Screw the cable lug onto the I/O device and voltage distributor (M5 fixing screw) with a torque of 1.5 Nm.



Refer to Installation "Overview" (Page 106) for further information on installing ET 200eco PN F I/O devices.

5.2.7.3 Wiring I/O devices for 1oo2 evaluation using M12 connecting cables

Connections for the sensors to the 5-pin M12 circular sockets, X1 to X4, are on the front panel of the ET 200eco PN F-DI 8 / F-DQ 3:

- Use M12 connecting cable for 1oo2 evaluation.
- The fail-safe digital input M12 connector cables are black in color.

WARNING

You may come into contact with live electrical wires connected to the main power supply.

Death or serious personal injury and damage to machines and equipment may result if proper precautions are not taken.

Shut off the supply voltage before you wire the I/O devices. *(S819)*

Requirements

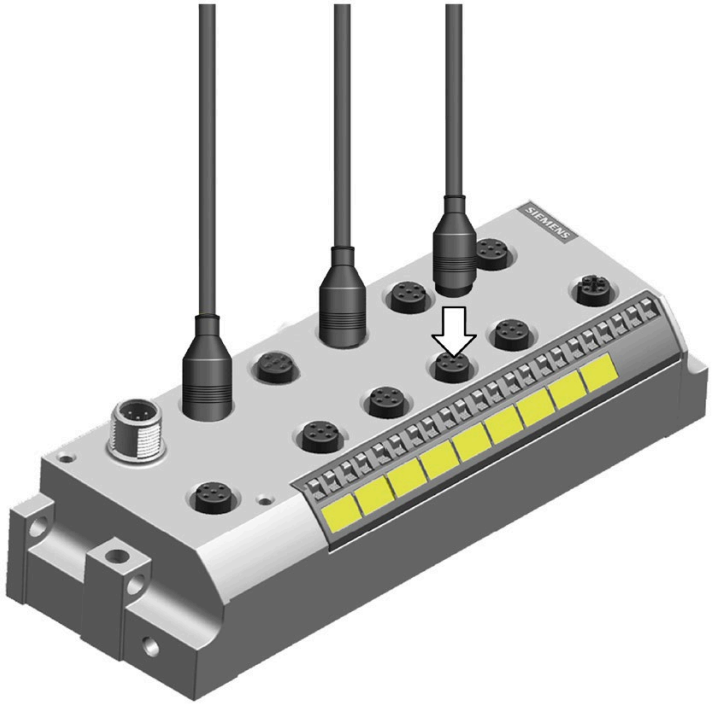
You require the following items to wire the ET 200eco PN F-DI 8 / F-DQ 3:

- Stripping tool and screwdriver for wiring the M12 cable connector, if you do not use prefabricated cables
- One of the following accessories:
  - Prefabricated cable with 5-pin M12 cable connector
  - 3-, 4-, or 5-wire copper cable (conductor cross-section must be ≤0.75 mm2) with 5-pin M12 cable connector. Refer to "Pin assignment of digital inputs" (Page 135) and "Pin assignment of digital outputs" (Page 136) for further information.
- M12 sealing caps

Refer to "Ordering information" (Page 212) to find the article numbers for these items.

To connect the ET 200eco PN F M12 connectors, follow these steps:

1. Plug the connector into the relevant circular socket connector on the I/O block. Make sure the connectors and sockets are properly interlocked (matched joint).
2. Secure the connector by tightening the knurled ring nut with a torque of 1.5 Nm.



Sealing round sockets not in use

Always seal all unused, round sockets using M12 sealing caps to achieve degree of protection IP65, IP66, or IP67. Refer to "Ordering information" (Page 212) to find the article numbers for these items.

Pin assignment of connectors

Refer to "Pin assignment of connectors" (Page 133) for further information on pin assignment for PROFINET, feeding and looping the voltage, digital input, and digital output connectors.

5.2.7.4 Wiring I/O devices for 1oo1 evaluation or 1oo2 evaluation using M12 Y cables

You can connect two one-channel sensors with 1oo1 evaluation to one input connection of the ET 200eco PN F with a Y cable. The Y cable divides the two channels for two jacks. You can use either Y cable, 6ES7194-6KB00-0XA0 (Page 126)or 6ES7194-6KA00-0XA0 (Page 127), for this application.

You can connect SIRIUS safety position switches with interlock that have M12 8-pin connectors to one input and one output connection of the ET 200eco PN F with an inverted Y cable. You can use the inverted Y cable, 6ES7194-6KC00-0XA0 (Page 128), for this application.

Refer to "Pin assignment of digital inputs" (Page 135) and "Pin assignment of digital outputs" (Page 136) for further information.

⚠ WARNING

You may come into contact with live electrical wires connected to the main power supply.

Death or serious personal injury and damage to machines and equipment may result if proper precautions are not taken.

Shut off the supply voltage before you wire the ET 200eco PN F-DI 8 / F-DQ 3. *(S820)*

Requirements

You require the following items to wire the ET 200eco PN F I/O devices:

- Stripping tool and screwdriver for wiring the M12 cable connector, if you do not use prefabricated cables
- Y cable
- M12 sealing caps

Refer to "Ordering information" (Page 212) to find the article numbers for these items.

Sealing round sockets not in use

Always seal all unused, round sockets using M12 sealing caps to achieve degree of protection IP65, IP66, or IP67. Refer to "Ordering information" (Page 212) to find the article numbers for these items.

Pin assignment of connectors

Refer to "Pin assignment of connectors" (Page 133) for further information on pin assignment for PROFINET, feeding and looping the voltage, digital inputs, and digital outputs connectors.

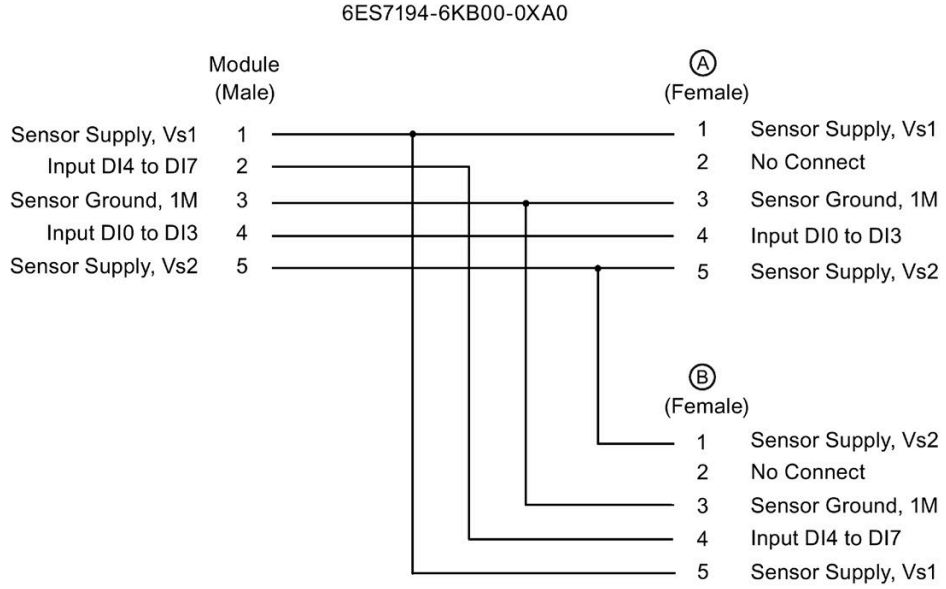
SIMATIC DP, Y cable for distributed I/O for double connection of F-DI with one cable (6ES7194-6KB00-0XA0)

Use this Y cable (6ES7194-6KB00-0XA0) for applications with the following requirements:

- Sensor connections to the 5-pin M12 circular sockets (X1 to X4) on the front panel of the I/O device
- 1oo1 evaluation (double connection of F-DI with one cable) (See the wiring diagram below.)

Refer to "Pin assignment of digital inputs" (Page 135) for further information.

The wiring of the Y cable is shown below:



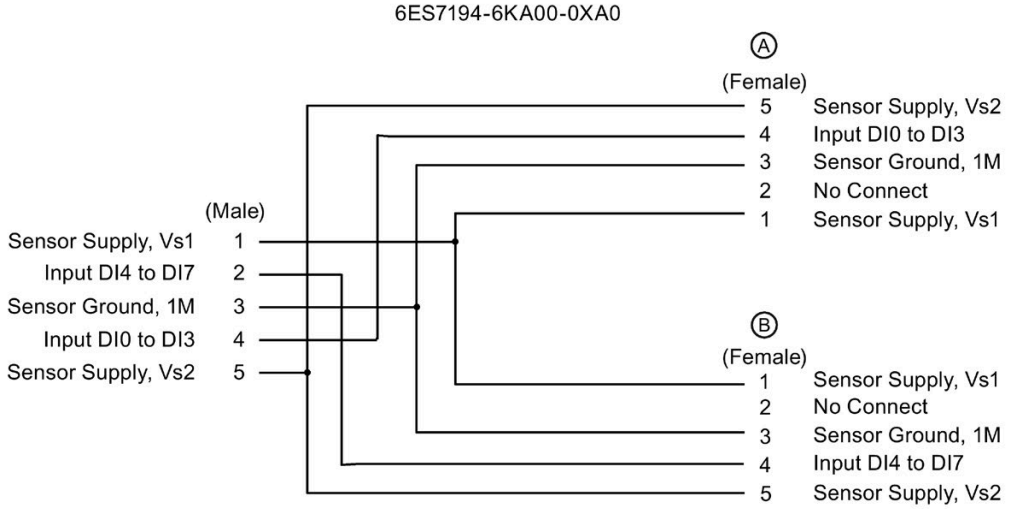
SIMATIC DP, Y cable for distributed I/O for double connection of F-DI with one cable (6ES7194-6KA00-0XA0)

Use this Y cable (6ES7194-6KA00-0XA0) for applications with the following requirements:

- Sensor connections to the 5-pin M12 circular sockets (X1 to X4) on the front panel of the I/O device
- 1oo1 evaluation (double connection of I/O with one cable) (See the wiring diagram below.)

Refer to "Pin assignment of digital inputs" (Page 133) for further information.

The wiring of the Y cable is shown below:

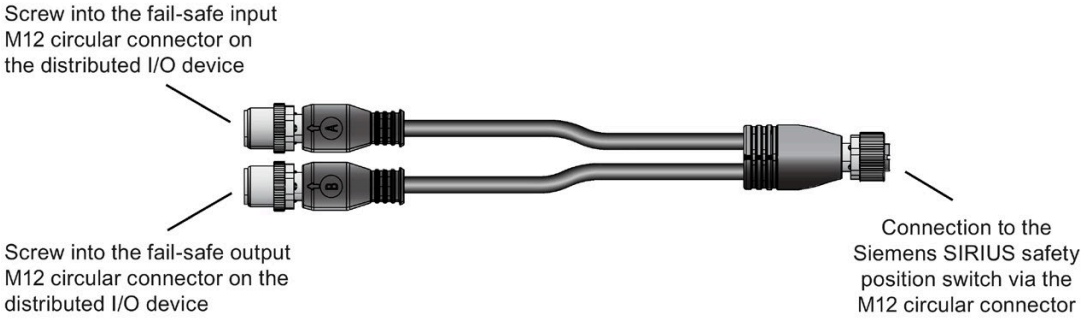


SIMATIC DP, Inverted Y cable for distributed I/O for connecting an F-DI and F-DQ with one cable (6ES7194-6KC00-0XA0)

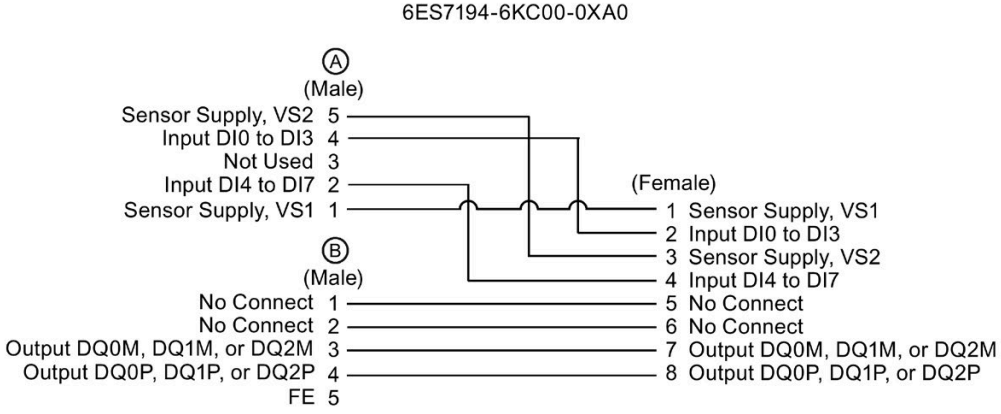
Use this inverted Y cable (6ES7194-6KC00-0XA0) for applications with the following requirements (for example, connecting a SIRIUS safety position switch):

- Sensor connections to the 5-pin M12 circular sockets (X1 to X4) on the front panel of the I/O device
- 1oo1 evaluation (connection of an F-DI and F-DQ with one cable) (See the wiring diagram below.)

Refer to "Pin assignment of digital inputs" (Page 135) and "Pin assignment of digital outputs" (Page 136) for further information.



The wiring of the inverted Y cable is shown below:



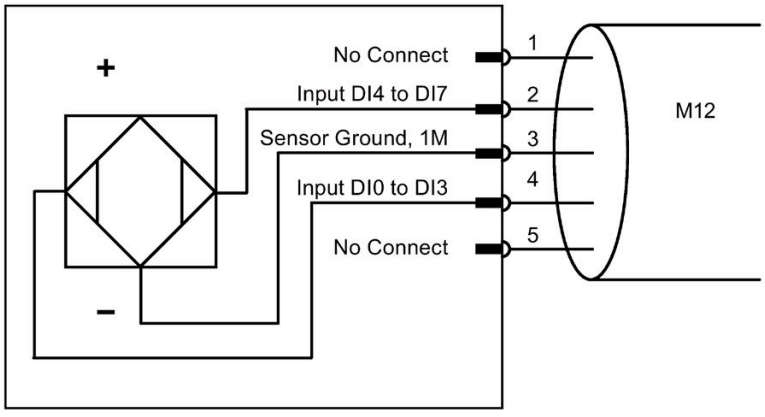
5.2.7.5 Examples of 1oo2 and 1oo1 evaluations in the ET 200eco PN F-DI 8 / F-DQ 3

You can connect field devices to the ET 200eco PN F as shown below:

Laser Scanner (1oo2 evaluation)

For the Laser Scanner, use an M12 connector cable to connect the Laser Scanner OSSD device with 1oo2 evaluation to the ET 200eco PN F:

Laser Scanner (1oo2)



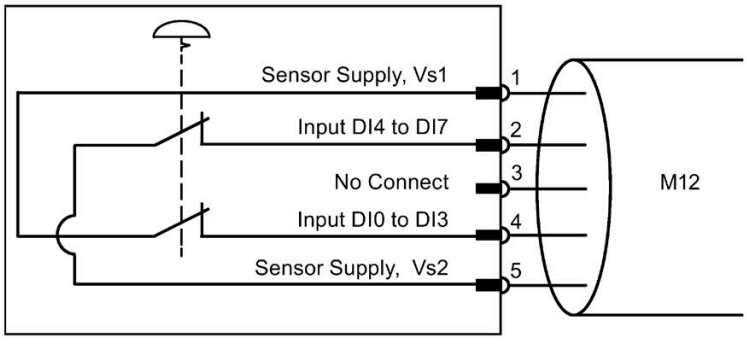
Note

Channel must be configured as an external sensor supply.

ESTOP (Emergency Stop) (1oo2 evaluation)

For the ESTOP, use an M12 connector cable to connect the ESTOP device with 1oo2 evaluation to the ET 200eco PN F:

ESTOP (1oo2)

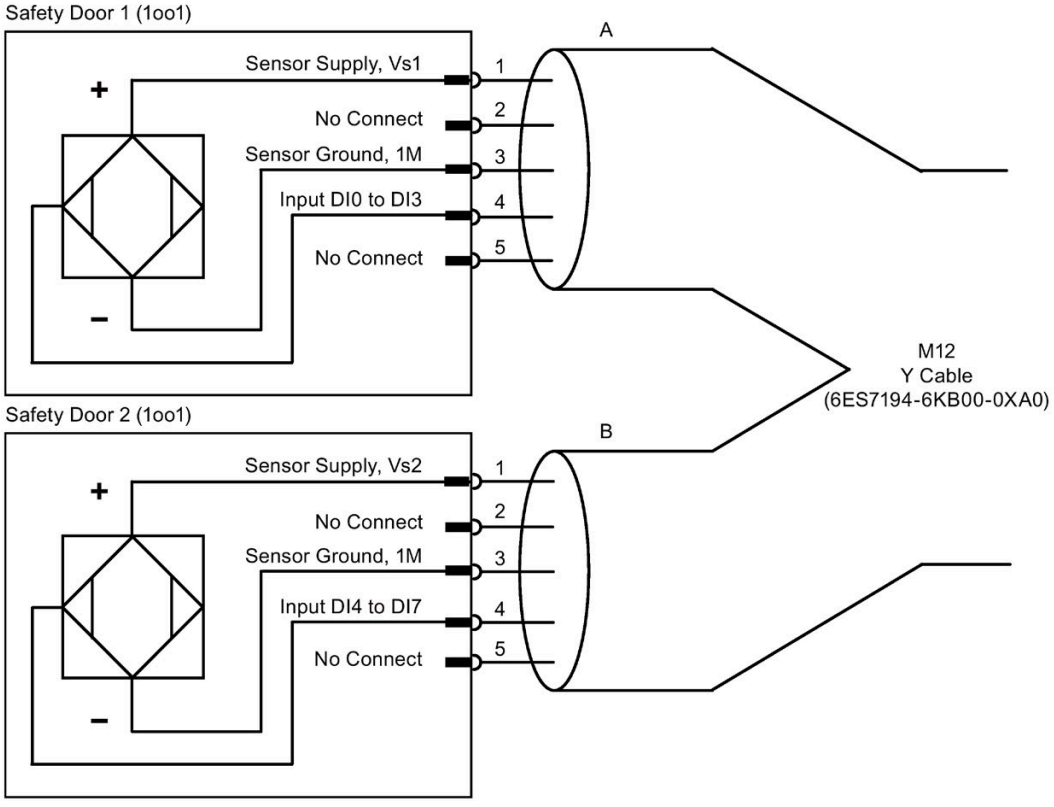


Safety Doors (1oo1 or 1oo2 evaluation)

For the Safety Doors, you can do one of the following:

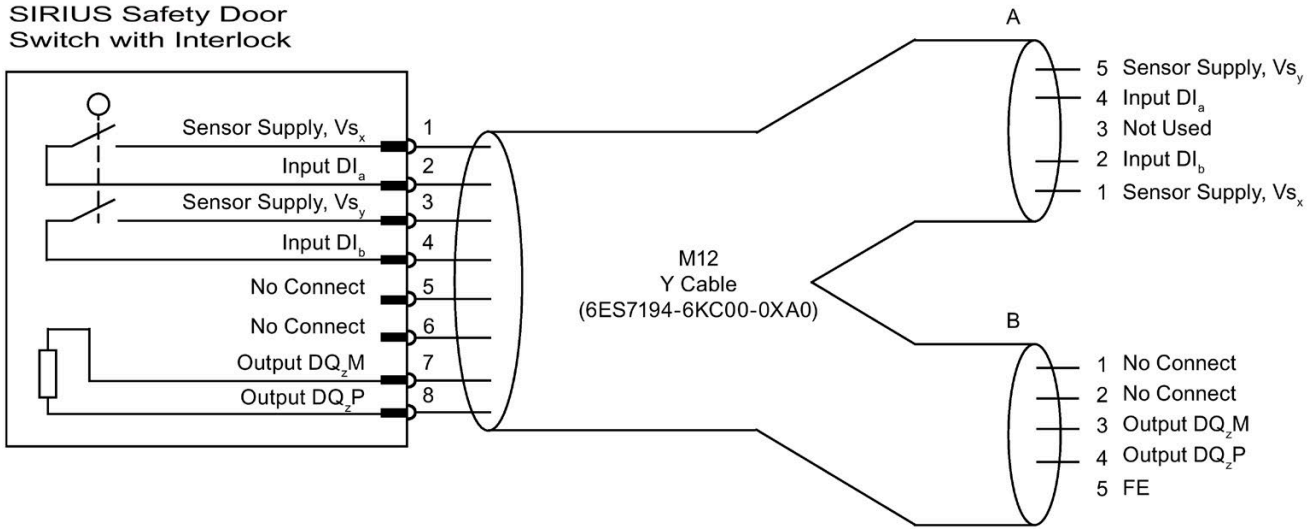
- Use the fail-safe Y cable (6ES7194-6KB00-0XA0) to connect two one-channel sensors with 1oo1 evaluation to one input connection of the ET 200eco PN F. The difference between the two cables (6ES7194-6KA00-0XA0 and 6ES7194-6KB00-0XA0) is the wiring construction in the M12 connectors.
- Use a 1oo2 evaluation, using two sensors on the same door.

Refer to "Wiring I/O devices for 1oo1 evaluation using M12 Y cables" (Page 126) to see the wiring diagram:



SIRIUS Safety position switch with interlock

For a Siemens SIRIUS safety position switch with an interlock, use the inverted Y cable to connect an F-DQ channel and F-DI channel of the ET 200eco PN F with 1oo2 evaluation for the input and the output to the position switch:

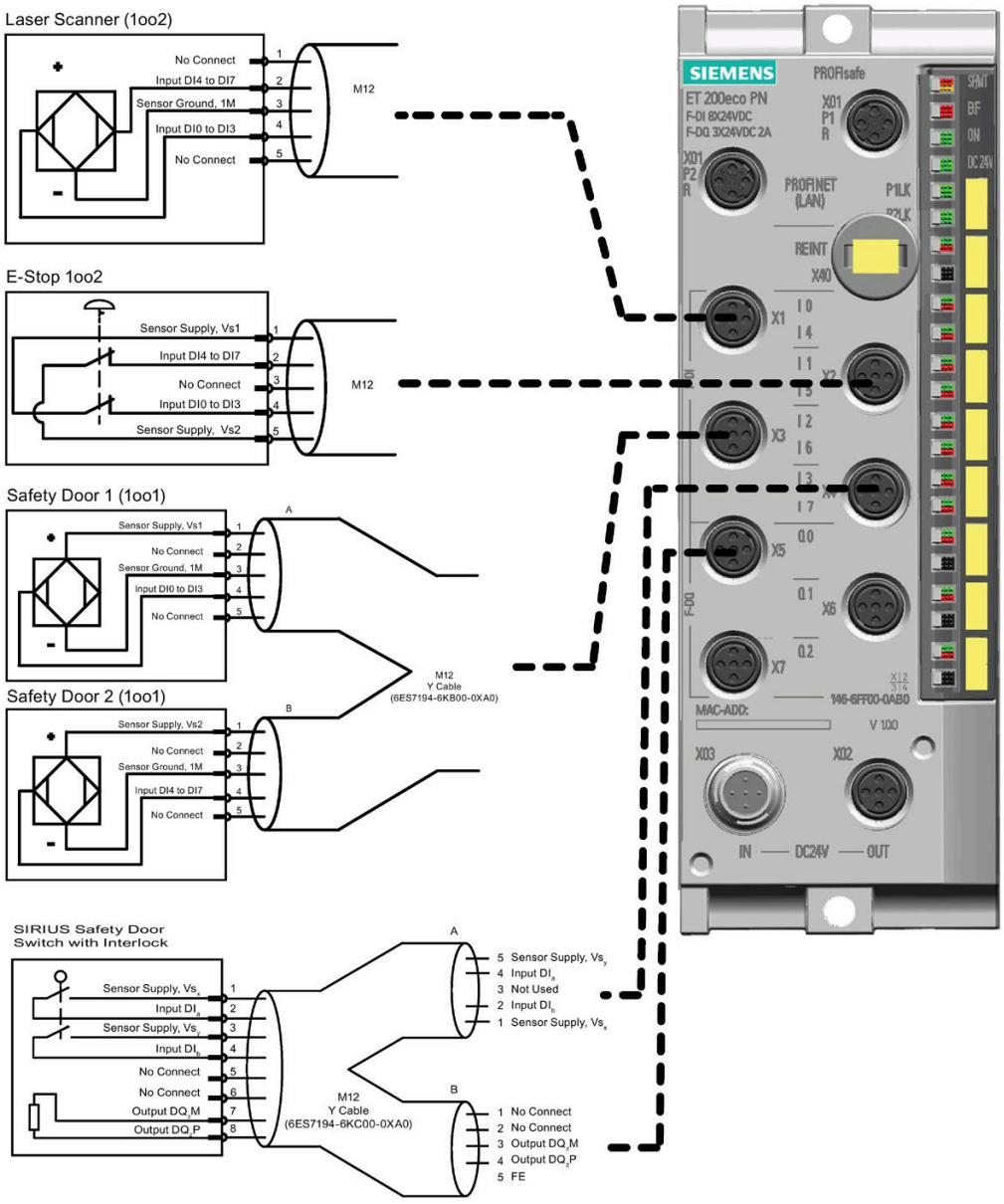


The table below shows the pin assignments for the inputs and outputs of the ET 200eco PN F:

Connector A	DI_a	DI_b	Vs_x	Vs_y
X1	0	4	1	2
X2	1	5	1	2
X3	2	6	1	2
X4	3	7	1	2
Connector B	**DQ_z**			
X5	0			
X6	1			
X7	2			

Connections to the ET 200eco PN F

Connect the example field devices to the ET 200eco PN F as shown below:



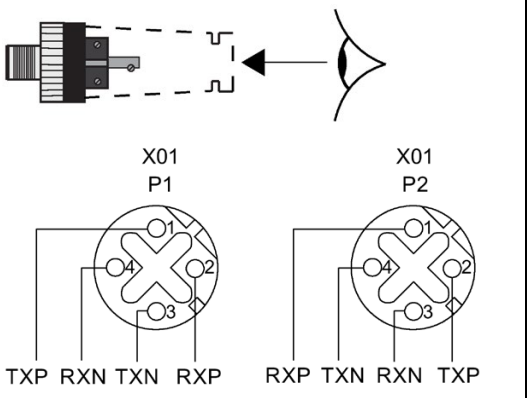
5.2.8 Pin assignment of connectors

5.2.8.1 Pin assignment of the PROFINET connector

PROFINET connector, X01 connector, port 1 and port 2

The module has a M12 connector with four female pins that are D-coded.

Table 5- 1 Pin assignment of the M12 cable connector for PROFINET connector, ports 1 and 2

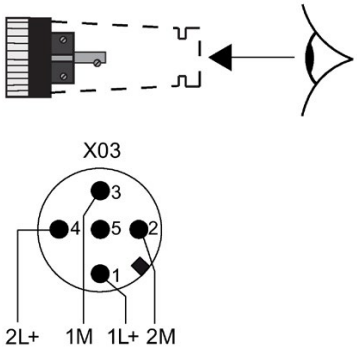
Pin	Assignment	View of the cable connector (PROFINET), port 1 and port 2
	Assignment X01 P1	
1	TXP	
2	RXP	
3	TXN	
4	RXN	
Thread	Functional earth FE	
	Assignment X01 P2	
1	RXP	
2	TXP	
3	RXN	
4	TXN	
Thread	Functional earth FE	

5.2.8.2 Pin assignment for feeding and looping the voltage

Cable connector for supply voltage infeed, X03 connector

The module has an M12 connector with five male pins that are A-coded.

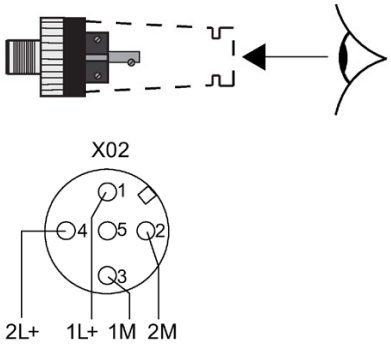
Table 5- 2 Pin assignment of the M12 cable connector for the supply voltage infeed

Pin	Assignment	View of the cable connector (wiring side)
1	Supply voltage 1L+	
2	Ground 2M	
3	Ground 1M	
4	Supply voltage 2L+	
5	Reserved	

Cable connector for loop-through of the supply voltage, X02 socket

The module has an M12 connector with five female pins that are A-coded.

Table 5- 3 Pin assignment of the M12 cable connector for loop-through of the voltage

Pin	Assignment	View of the cable connector (wiring side)
1	Supply voltage 1L+	
2	Ground 2M	
3	Ground 1M	
4	Supply voltage 2L+	
5	Reserved	

Note

The M12 sockets for the supply and I/O have the same coding.

Make sure that you wire the supply and the I/O correctly.

Note

PROFINET IO

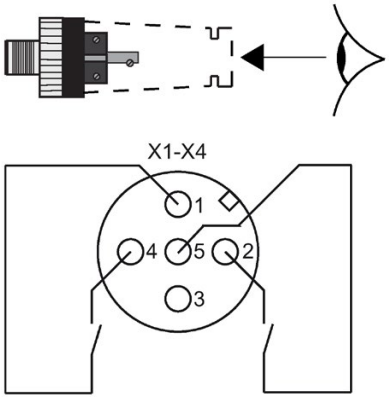
Modules with PROFINET interfaces may only be operated if all of the connected nodes are equipped with SELV/PELV power supplies (or with protection systems of equal quality).

5.2.8.3 Pin assignment of digital inputs

Cable connector for digital inputs, X1 - X4

The module has an M12 connector with five female pins that are A-coded.

Table 5- 4 Pin assignment of digital inputs

Pin	Assignment	View of the cable connector (wiring side)
1	24 V DC sensor supply Vs1	
2	Input signal DI_4: Connector X1 Input signal DI_5: Connector X2 Input signal DI_6: Connector X3 Input signal DI_7: Connector X4	
3	Sensor supply ground 1M	
4	Input signal DI_0: Connector X1 Input signal DI_1: Connector X2 Input signal DI_2: Connector X3 Input signal DI_3: Connector X4	
5	24 V DC sensor supply Vs2	

Note

The M12 sockets for the supply and I/O have the same coding.

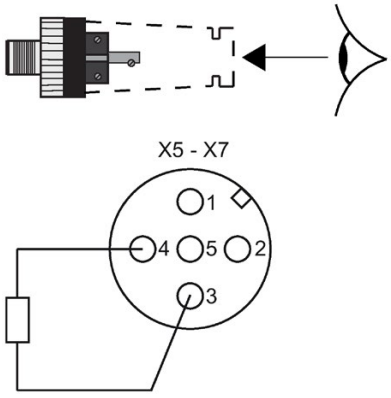
Make sure that you wire the supply and the I/O correctly.

5.2.8.4 Pin assignment of digital outputs

Cable connector for digital outputs, X5 - X7

The module has an M12 connector with five female pins that are A-coded.

Table 5- 5 Pin assignment of digital outputs

Pin	Assignment	View of the cable connector (wiring side)
1	Not used	
2	Not used	
3	Output signal DQ_0-M: Connector X5 Output signal DQ_1-M: Connector X6 Output signal DQ_2-M: Connector X7	
4	Output signal DQ_0-P: Connector X5 Output signal DQ_1-P: Connector X6 Output signal DQ_2-P: Connector X7	
5	Functional earth FE	

Note

The M12 sockets for the supply and I/O have the same coding.

Make sure that you wire the supply and the I/O correctly.

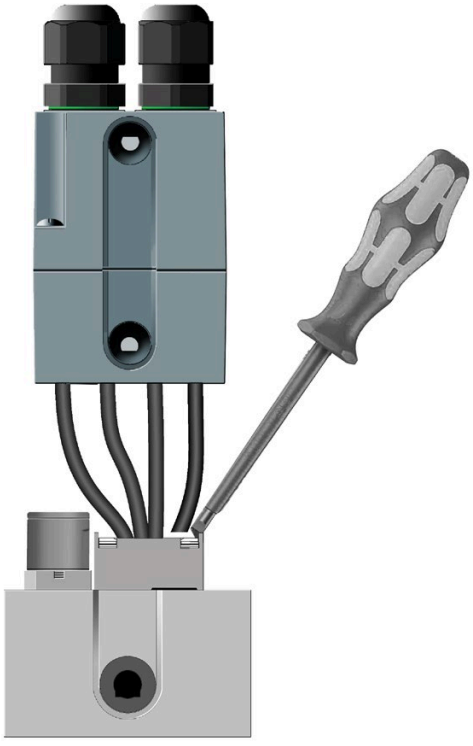
5.2.9 Wiring the terminal block

Tools required

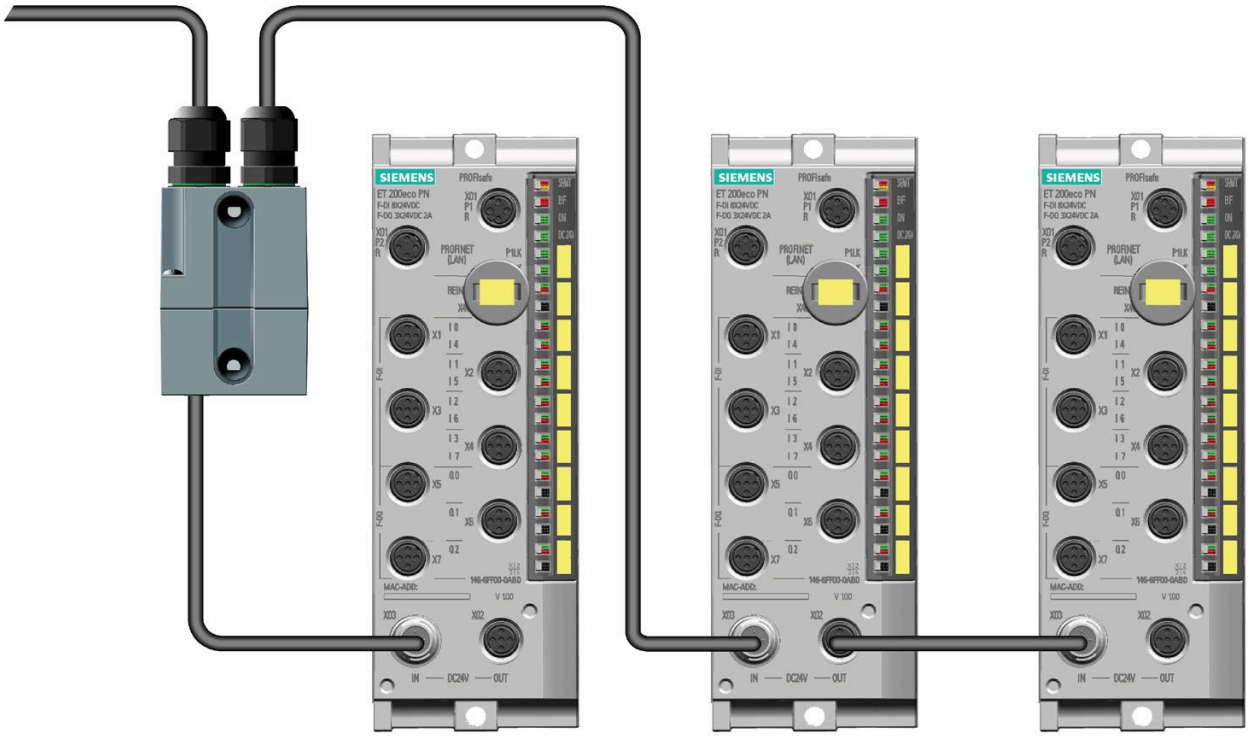
You need a medium-sized cross-tip screwdriver to screw on the terminal block and a slotted screwdriver to press down the insulation displacement terminals.

Wiring the terminal block connectors

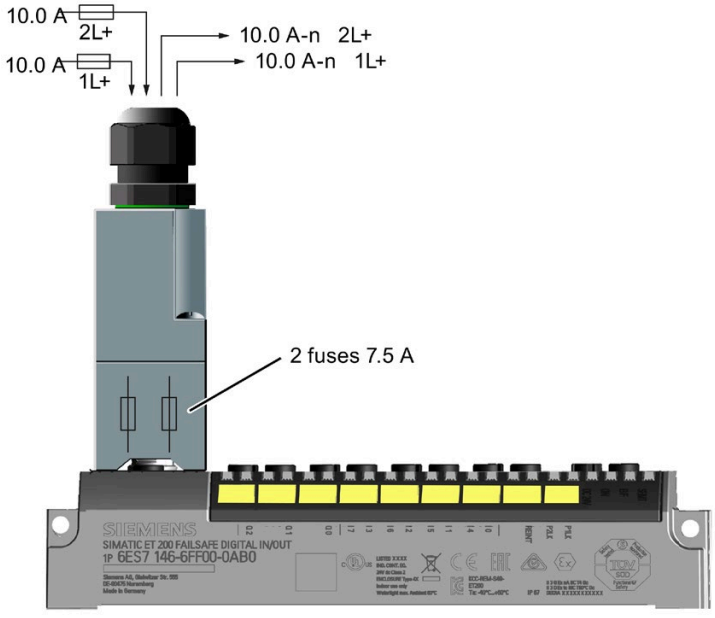
You do not have to strip the cables. You strip the cables automatically when you press down the insulation displacement terminals.



The following figure shows an example of the separate installation of the terminal block and how to wire it to several I/O devices.



You can tap a maximum load of 4.0 A from each supply voltage of the I/O device. You can loop-through the remaining supply voltages.



Pin assignment

The tables below show the terminal block pin assignments:

Table 5- 6 Pin assignment of the insulation displacement terminal block

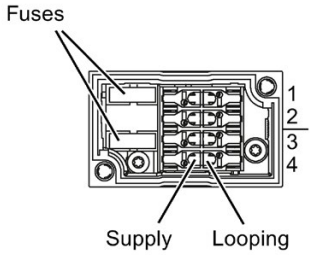
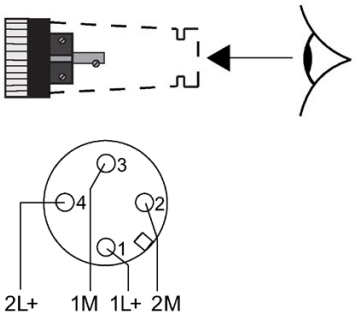
Pin	Assignment	View of the insulation displacement terminal block:
1	24 V DC 1L+	
2	Ground 1M	
3	24 V DC 2L+	
4	Ground 2M	

Table 5- 7 Pin assignment of the M12 connector

Pin	Assignment	View of the cable connector
1	24 V DC 1L+	
2	Ground 2M	
3	Ground 1M	
4	24 V DC 2L+	

Information on wiring

Keep the following considerations in mind when you wire the terminal block:

- If you wire your configuration, you must take into account the impact of cable length on the supply voltage to the ET 200eco PN (permitted tolerance).
- The maximum infeed current of the terminal block is 10.0 A for 1L+ and 10.0 A for 2L+.

  Do not exceed these values.

CAUTION

If you do not adhere to the maximum infeed currents and the cable cross-sections required for these currents, you risk overheating the cable insulation and contacts resulting in damage to the device.

Electrical faults or unexpected machine operation can result in minor personal injury if proper precautions are not taken.

You must follow all instructions for installation and maintenance of a proper operating environment to ensure the equipment operates safely.

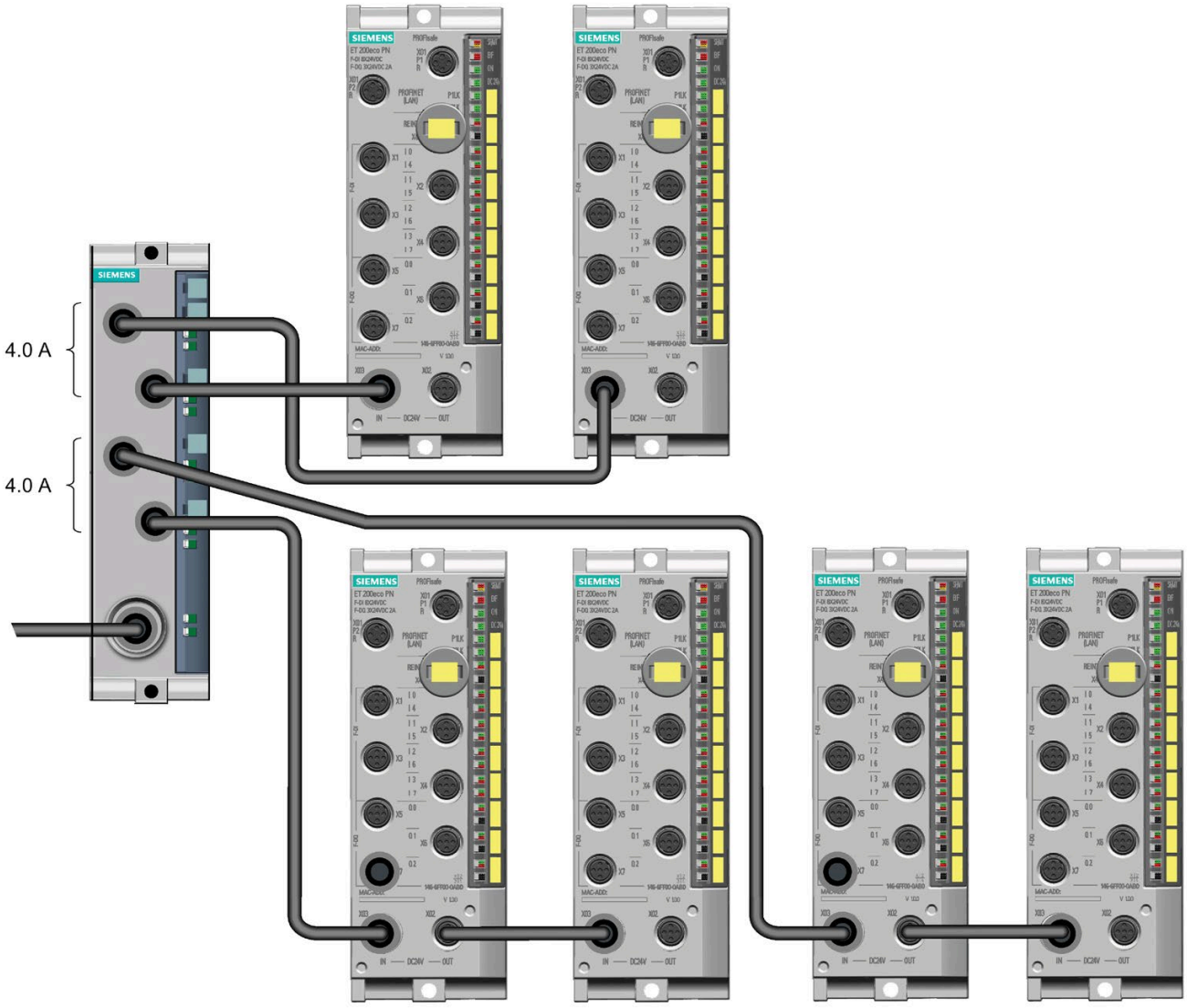
Additional information

Refer to "Installing the terminal block" (Page 109) and "Terminal block" (Page 211) technical specifications for further information.

5.2.10 Wiring the voltage distributor

Wiring the connectors

The following figure shows an example of the configuration of the PD DC 24V 1×7/8" 4×M12 voltage distributor with connected I/O devices:



Pin assignment

The tables below show the pin assignments:

Table 5- 8 Pin assignment of the 7/8" connector at the current input

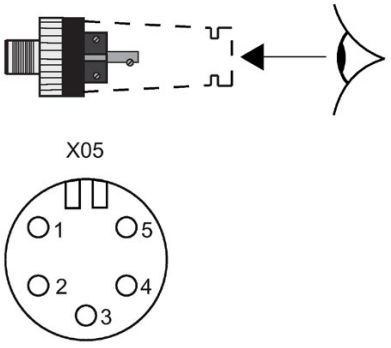
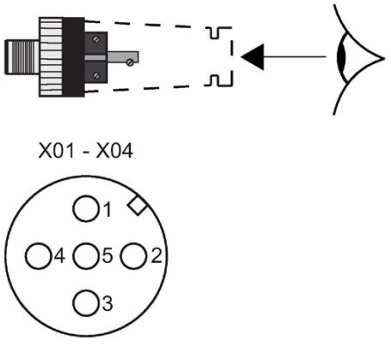
Pin	Assignment	View of the 7/8" cable connector, 24 V DC connection
1	Ground 2M	
2	Ground 1M	
3	Functional earth FE	
4	24 V DC 1L+	
5	24 V DC 2L+	

Table 5- 9 Pin assignment of the M12 connector at the current output

Pin	Assignment	View of the M12 connection plug (front view)
1	24 V DC 1L+	
2	Ground 2M	
3	Ground 1M	
4	24 V DC 2L+	
5	Not used	

Information on wiring

Keep the following considerations in mind when you wire the voltage distributor:

- If you wire your configuration, you must take into account the impact of cable length on the supply voltage to the ET 200eco PN F (permitted tolerance).
- The maximum infeed current of the voltage distributor is 8.0 A for 1L+ and 8.0 A for 2L+.

  Do not exceed these values.

CAUTION

If you do not adhere to the maximum infeed currents and the cable cross-sections required for these currents, you risk overheating the cable insulation and contacts resulting in damage to the device.

Electrical faults or unexpected machine operation can result in minor personal injury if proper precautions are not taken.

You must follow all instructions for installation and maintenance of a proper operating environment to ensure the equipment operates safely.

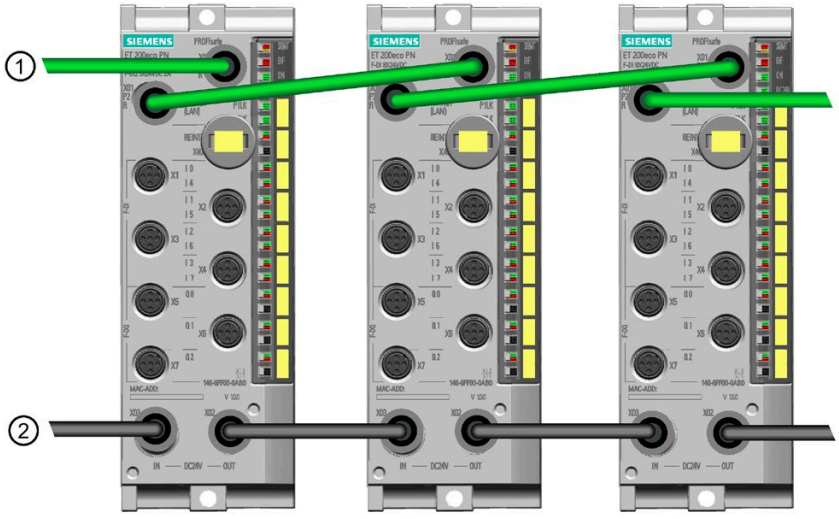
Additional information

Refer to "Voltage distributor" (Page 211) technical specifications for further information.

5.2.11 Looping PROFINET and the supply voltage

The I/O device is equipped with one connector for the infeed and one socket for loop-through of the supply voltage. The connector for infeed and the socket for loop-through are interconnected internally.

The I/O device is equipped with two sockets for PROFINET IO. One socket is available for the infeed and one socket for loop-through of the PROFINET IO.



① PROFINET
② Supply voltage

Information on wiring

Keep the following considerations in mind when you loop PROFINET and the supply voltage:

- If you wire your configuration, you must take into account the impact of cable length on the supply voltage to the ET 200eco PN F (permitted tolerance).
- The maximum infeed current of the I/O device is 4.0 A for 1L+ and 4.0 A for 2L+.

  Do not exceed these values.

CAUTION

If you do not adhere to the maximum infeed currents and the cable cross-sections required for these currents, you risk overheating the cable insulation and contacts resulting in damage to the device.

Electrical faults or unexpected machine operation can result in minor personal injury if proper precautions are not taken.

You must follow all instructions for installation and maintenance of a proper operating environment to ensure the equipment operates safely.

Reference

Refer to "Pin assignment of connectors" (Page 133) for further information on pin assignment for PROFINET and feeding and looping the voltage connectors.

5.2.12 Guidelines for inductive loads

Guidelines for inductive loads

Use suppressor circuits with inductive loads to limit the voltage rise when a control output turns off. Suppressor circuits protect your outputs from premature failure caused by the high voltage transient that occurs when current flow through an inductive load is interrupted.

In addition, suppressor circuits limit the electrical noise generated when switching inductive loads. High frequency noise from poorly suppressed inductive loads can disrupt the operation of the module. Placing an external suppressor circuit so that it is electrically across the load and physically located near the load is the most effective way to reduce electrical noise.

ET 200eco PN F-DI 8 / F-DQ 3 module DC outputs include internal suppressor circuits that are adequate for inductive loads in most applications.

A good suppressor solution is to use contactors and other inductive loads for which the manufacturer provides suppressor circuits integrated in the load device, or as an optional accessory. However, some manufacturer provided suppressor circuits may be inadequate for your application. An additional suppressor circuit may be necessary for optimal noise reduction.

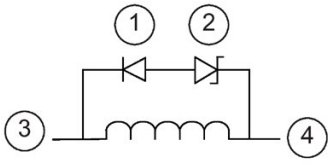
A well-controlled turn-off transient will have a ring frequency of no more than 10KHz, with less than 1KHz preferred. The data sheets list voltage thresholds for the internal suppression circuits on DC outputs. (Refer to Appendix A: "Technical specifications" (Page 199) for further information.) External suppression should limit the transient to less than this threshold to ensure that the internal suppression circuit does not attempt to suppress an excessive load.

An external suppression circuit connected directly across the load also avoids the hazard of energizing the load if suppression circuit components fail short.

Note

The effectiveness of a suppressor circuit depends on the application and must be verified for your particular usage. Ensure that all components are correctly rated and use an oscilloscope to observe the turn-off transient.

Typical suppressor circuit for DC outputs that switch DC inductive loads



① Diode
② Zener diode
③ Output channel F-DQ (P-switch)
④ Output channel F-DQ (M-switch)

In most applications, the addition of a diode ① across a DC inductive load is suitable, but if your application requires faster turn-off times, then the addition of a Zener diode ② is recommended. Be sure to size your Zener diode properly for the amount of current in your output circuit.

Configuring

6

All connected fail-safe I/O must have their operating properties configured by the STEP 7 Safety configuration software. You have the responsibility to ensure that no unconfigured modules are connected in a fail-safe automation system.

6.1 Configuring the ET 200eco PN F-DI 8 / F-DQ 3 module

You configure the ET200eco PN F-DI 8 / F-DQ 3 using the TIA Portal. STEP 7 configuration of the module requires a Hardware Support Package (HSP).

Refer to "Step 3: Configuring the ET 200eco PN F-DI 8 / F-DQ 3" (Page 44) in the Getting Started chapter for step-by-step instructions.

6.2 Configuring the ET 200eco PN F-DI 8 / F-DQ 3 module I/O properties

All connected fail-safe modules must have their operating properties configured by the STEP 7 Safety configuration software. You have the responsibility to ensure that no unconfigured modules are connected in a fail-safe automation system.

To configure fail-safe module I/O properties, follow these steps:

1. Select "Device configuration" in the project tree.
2. Place fail-safe I/O devices into your project's "Device view".

Note

The ET 200eco PN F-DI 8 / F-DQ 3 uses more I and Q memory than required for the physical number of inputs and outputs on the module. The extra bytes carry the PROFIsafe safety status and data integrity information.

The number of input (I) bytes and output (Q) bytes that the ET 200eco PN F-DI 8 / F-DQ 3 requires depends upon which PROFIsafe profile your fail-safe CPU uses. If using PROFIsafe profile V2.4 (with S7-300/S7-400), the module requires 7 input (I) bytes and 5 output (Q) bytes. If using PROFIsafe profile V2.6 (with S7-1200/S7-1500), the module requires 8 input (I) bytes and 6 output (Q) bytes.

Module	PROFIsafe profile	Input (I) bytes required	Output (Q) bytes required
ET 200eco PN F-DI 8 / F-DQ 3	V2.4 (with S7-300/S7-400)	7	5
	V2.6 (with S7-1200/S7-1500	8	6

3. Select the image of a fail-safe I/O device (on the Device view or Device overview) and view the module's "Properties" tab.
4. On the **"Properties"** view, select the **"General"** tab.
5. Click on the module properties tree and expand the branches for an I/O module. You can select a module (for example, "ET 200eco PN F-DI 8 / F-DQ 3") and see all the properties. You can also select a module branch (for example, "F-parameters", "DI-parameters", or "Channel parameters") and see a subset of the properties.
6. Select a property in the left-side property tree and then set values in the right-side property fields.
7. A successful compile and download of your hardware configuration to an S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), or ET 200S/ET 200SP fail-safe CPU automatically puts your new configuration settings in the I/O modules.

6.3 Configuring F-parameters

The image below shows the F-parameters for the ET 200eco PN F-DI 8 / F-DQ 3:

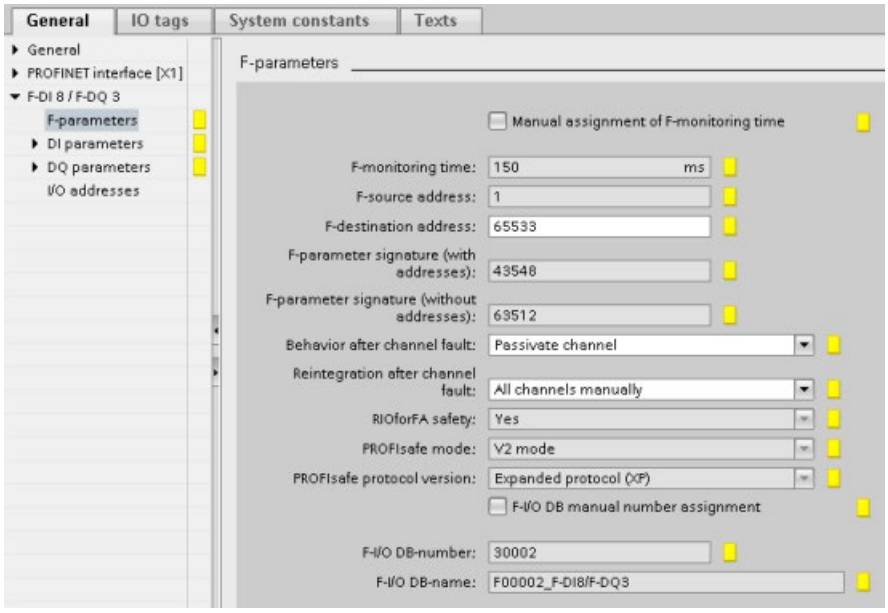


Table 6- 1 F-parameters

F-parameters	Description	Default	Options
Manual assignment of F-monitoring time	You must select the check box to change PROFIsafe F-monitoring time from the central value propagated by the fail-safe CPU.	Check box deselected	Check box: • Selected (manual assignment enabled) • Deselected (manual assignment disabled)
F-monitoring time [1]	Watchdog timer monitoring safety-related communication between the fail-safe CPU and ET 200eco PN F-DI 8 / F-DQ 3 (PROFIsafe monitoring time) Note: Disabled if "Manual assignment of F-monitoring time" check box is deselected.	150 ms	1 to 65535 ms in 1 ms steps
F-source address	Unique network-wide address for the fail-safe CPU	1 (Always disabled)	1 to 65534 Note: You can configure the F-source address using the fail-safe CPU parameter "Central F-source address".
F-destination address	Unique F-destination address for each fail-safe module (usually in descending order, starting with 65534)	65534 (Always enabled)	1 to 65534
F-parameter signature (with addresses)	Signature for all F-parameters including addresses; used to uniquely identify a given set of parameterization values	Always disabled	
F-parameter signature (without addresses)	Signature for all F-parameters without addresses; used to uniquely identify a given set of parameterization values	Always disabled	
Behavior after channel fault	Passivation response by the ET 200eco PN F-DI 8 / F-DQ 3 to channel faults such as a short-circuit, overload, or discrepancy error	Passivate channel (Always enabled)	• Passivate channel • Passivate the entire module
Reintegration after channel fault	You have two methods, manual and automatic, to reintegrate your ET 200eco PN F-DI 8 / F-DQ 3 channels after a channel fault. You can configure one of the following options: • All channels automatically (no acknowledgement necessary for reintegration) • All channels manually (acknowledgement necessary for reintegration) • Adjustable (reintegration method is selectable (manual or automatic) channel-by-channel)	All channels manually (Always enabled)	• Adjustable • All channels automatically • All channels manually

F-parameters	Description	Default	Options
F-I/O DB manual number assignment	You must select the check box to enable manual assignment of DB numbers.	Check box deselected	Check box: • Selected • Deselected
F-I/O DB number	F I/O block DB number: • Disabled if F-I/O DB manual number assignment check box is deselected (DB number derived from the Engineering Station (ES)) • Enabled if F-I/O DB manual number assignment check box is selected (edited by user)	-	-
F-I/O DB name	F I/O block DB name	Always disabled	-

[1] STEP 7 uses this number to set the F-monitoring time in each ET 200eco PN F-DI 8 / F-DQ 3 unless you select the check box for "Manual Assignment of F-monitoring time" in that module configuration and assign a different time.

Refer to the SIMATIC, Industrial Software, SIMATIC Safety - Configuring and Programming, Programming and Operating Manual (http://support.automation.siemens.com/WW/view/en/54110126/0/en) for further F-parameter information.

6.4 Configuring the ET 200eco PN F-DI 8 / F-DQ 3 module DI and channel parameters

The image below shows the sensor supply parameters for the F-DI on the ET 200eco PN F-DI 8 / F-DQ 3:

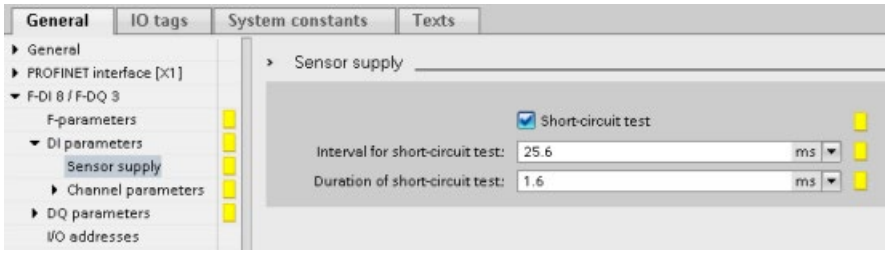
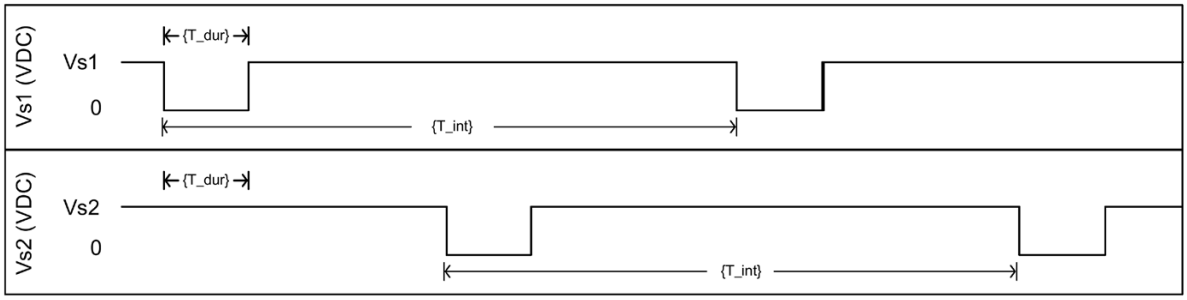


Table 6- 2 ET 200eco PN F-DI 8 / F-DQ 3 DI parameters

DI parameters	Description	Default	Options
Short-circuit test	This test creates short duration OFF pulses on the sensor power supplies. Input circuits powered by Vs1 and Vs2 are expected to be OFF during the sensor OFF time. Failure to detect OFF when a sensor supply is OFF indicates a short-circuit to a power source or another fault that prevents the input from properly detecting a "0". Input channels which fail this test are passivated. During the test, the reported process value will not change, so the configured "Duration of short-circuit test" increases the response time. An actual process "0" occurring near the beginning of a test will not be reported to the user program until after the "Duration of short-circuit test" time has elapsed. Note: The check box must be selected to activate the short-circuit test.	Check box selected	Check box: • Selected (short-circuit test enabled) • Deselected (short-circuit test disabled)
Interval for short-circuit test (see T_int in figure below)	Specifies how often the short circuit test is executed (Interval). It defines the period of time between two consecutive sensor supply off test pulses. This value is the time between the OFF pulses of the sensor supply. Refer to the figure below for further information. Note: The interval must be a minimum of eight times the duration. Note: Disabled if "Short-circuit test" check box is deselected.	25.6 ms	• 12.8 ms • 25.6 ms • 51.2 ms • 102.4 ms • 204.8 ms • 409.6 ms • 819.2 ms
Duration of short-circuit test (see T_dur in figure below)	Specifies the duration of the test pulse generated by the sensor supply. It is the period of time for which the test pulse is applied. This value is the time that the power supply remains off during the test. The short-circuit test OFF pulse must be long enough for the external sensors and wiring to respond and present a "0" to the inputs. Refer to the figure below for further information. Note: The interval must be a minimum of eight times the duration. Note: Disabled if "Short-circuit test" check box is deselected.	1.6 ms	• 1.6 ms • 3.2 ms • 6.4 ms • 12.8 ms

Vs1 and Vs2 perform short-circuit testing independently, allowing module circuitry to detect shorts between the two sensor supplies:



Vsx Vs1 or Vs2 sensor supplies (VDC)

T_int Short-circuit test interval (time period) between the OFF pulses of the sensor supply

T_dur Short-circuit test OFF pulse time duration (msec)

The image below shows the channel parameters for the F-DI on the ET 200eco PN F-DI 8 / F-DQ 3:

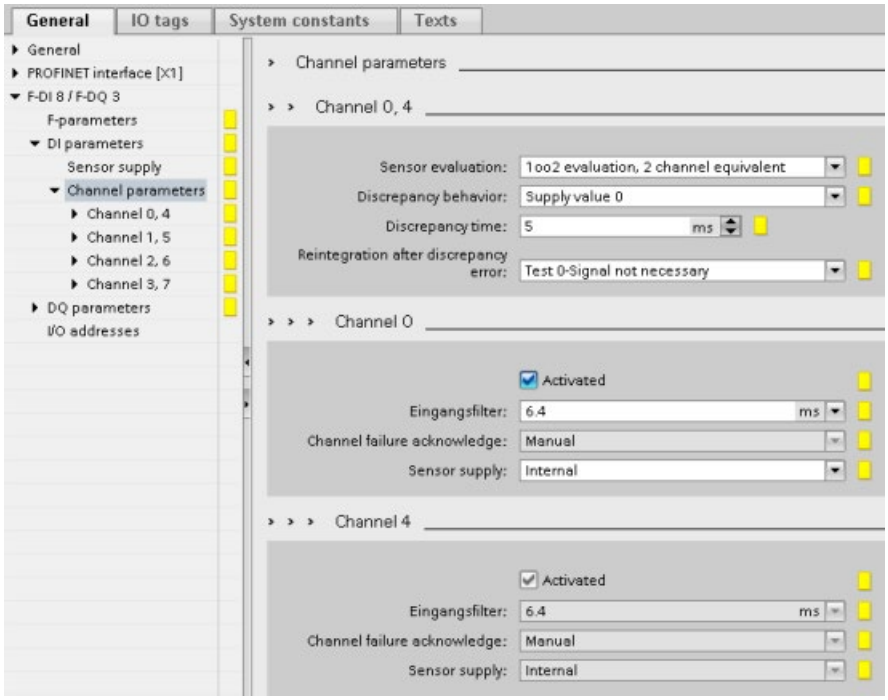


Table 6- 3 ET 200eco PN F-DI 8 / F-DQ 3 DI channel parameters

Channel parameters	Description	Default	Options
F-DI Channel Group Settings			
Sensor evaluation	Assigns whether “channel x” input operates individually (1oo1) or is paired with its companion channel "x+4" input (1oo2). Defines signal evaluation and wiring definitions. These selections correspond with the various application mode wiring examples. **1oo1 evaluation:** One sensor is connected to the module on a single channel. **1oo2 evaluation:** Two input channels are occupied by either: • **2 channel equivalent** (with equivalent signals): One two-channel equivalent sensor or two single-channel equivalent sensors are connected to the two channels, in a channel pair. • **2 channel - 3 wire non-equivalent**: One two-channel non-equivalent sensor is connected to the two channels, in a channel pair. • **2 channel - 4 wire non-equivalent** One two-channel non-equivalent sensor or two single-channel non-equivalent sensors are connected to the two channels, in a channel pair. If 1oo2 is selected, you must assign the discrepancy properties. Note: Refer to "Digital input applications" (Page 87) for illustrations of connection modes.	1oo2 evaluation, 2 channel equivalent	• 1oo1 evaluation • 1oo2 evaluation: – 2 channel equivalent – 2 channel - 3 wire non-equivalent – 2 channel - 4 wire non-equivalent
Discrepancy behavior	A 1oo2 input configuration allows a logical difference between the two signals, without error, for the configured discrepancy time. You can choose whether the reported process value should be "0" or the last valid value during the configured discrepancy time while the signals do not match. If a logical difference in 1oo2 inputs persists for more than the configured discrepancy time, the module or channel will become passivated with process value(s) set to 0.	Supply value 0	• Supply value 0 • Supply last valid value
Discrepancy time	The two signals in a 1oo2 input configuration will not change exactly at the same time, due to differences in sensors, contacts, and wiring. The discrepancy time parameter allows you to configure a normally expected duration for a mismatch between signals during transition.	5 ms	5 ms to 30000 ms in 1 ms steps

Channel parameters	Description	Default	Options
Reintegration after discrepancy time	Assigns whether a zero state must be detected on both 1oo2 inputs before a previously declared discrepancy can be cleared. A channel cannot be reintegrated until a zero has been detected on both 1oo2 signals.	Test 0-Signal not necessary	• Test 0-Signal necessary Note: The test 0-signal must be applied for at least 100 ms. • Test 0-Signal not necessary
F-DI Channel Settings			
Activated	Select the check box to activate the channel. Deselect the check box and the unused channel is deactivated. If you deactivate a channel, you also deactivate its diagnostic function.	Check box selected	Check box: • Selected (channel activated) • Deselected (channel deactivated)
Input filters	The module filters the digital inputs to remove contact bounce and short duration noise. This parameter assigns the duration of the filter time.	6.4 ms	• 0.8 ms • 1.6 ms • 3.2 ms • 6.4 ms • 12.8 ms
Channel failure acknowledge	Controls whether the channel is automatically reintegrated after a fault clears, or requires an acknowledgement (manual) in the user program. Refer to "Reactions to faults" (Page 167) for the reintegration procedure.	Manual	• Automatic • Manual Note: The configuration of the "F-Parameters": "Reintegration after channel fault" parameter can override the "Channel failure acknowledge" parameter's selection.
Sensor supply	You can assign whether to supply 24 V DC power to sensors from a sensor supply output of the module (internal) or from an external power supply (external). Note: Short-circuit tests are not performed for any channel where external power is selected.	Internal	• Internal • External

Note

When you select the channel group as 1oo2, the module enables the parameters in the first channel of the group and completely disables the parameters in the second channel of the group. The second channel derives its parameter values from the first channel's parameter values.

When you select the channel group as 1oo1, the module enables all of the parameters in both channels.

Note

Safety program access to 1oo2 input data

For 1oo2 evaluation, two paired input channels (for example, F-DI 0 and F-DI 4) are connected to one or two sensors. The F-DI performs the discrepancy analysis and sends the result to the safety program, **at the input address of the low-numbered channel** (F-DI 0, in the example).

Sensor-actuator response time is increased when you add more input discrepancy time

The discrepancy time adds directly to the maximum response time of a 1oo2 evaluation if the two signals do not agree in logical state. If you select the "Supply value 0" option, then the F-DI does not delay a transition from "1" to "0", but can delay the transition from "0" to "1". If you select the "Supply last valid value" option, then the F-DI can delay both transitions from "1" to "0' and "0" to "1". The discrepancy time is influenced by sensor specifications, installation tolerances, and wiring. For best response time, select the smallest discrepancy time that provides reliable normal operation. Refer to "Response time parameters for the ET 200eco PN F-DI 8 / F-DQ 3 digital inputs" (Page 219) for further information.

Discrepancy time variation with short circuit test

If your process input changes near a short-circuit test, a discrepancy is detected in less time than your configured discrepancy time.

With:

Tdisc = configured discrepancy time

Tsct = configured short circuit test duration

Tfilter = configured input filter time

Tda = actual discrepancy time, time between process signal changes that can be detected as a fault

The range of detected discrepancy time is:

If Tfilter < Tsct: {Tdisc - (Tfilter + Tsct)} <= Tda <= Tdisc

If Tfilter >= Tsct: {Tdisc - (2 x Tsct)} <= Tda <= Tdisc

Your configured discrepancy time should account for this variation to avoid unexpected passivations.

6.5 Configuring the ET 200eco PN F-DI 8 / F-DQ 3 module DQ and channel parameters

The image below shows the parameters for the F-DQ on the ET 200eco PN F-DI 8 / F-DQ 3:

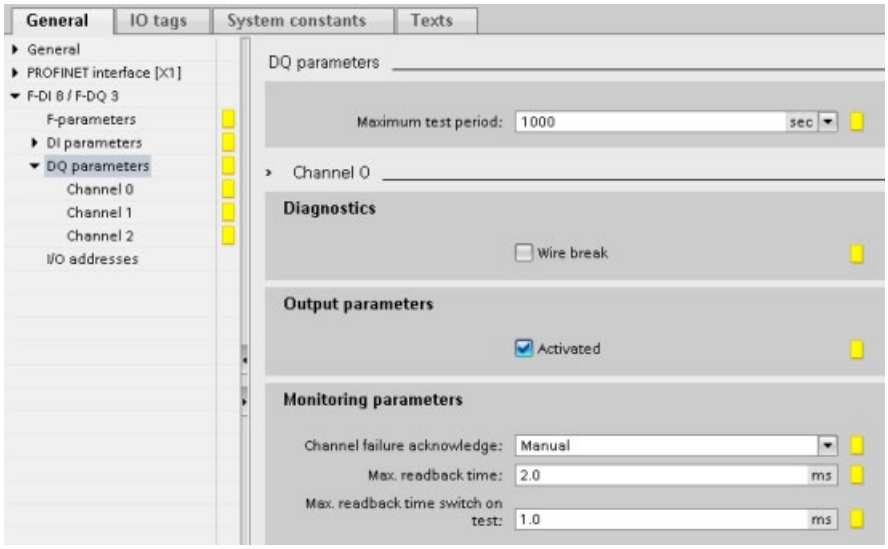


Table 6- 4 ET 200eco PN F-DI 8 / F-DQ 3 DQ parameters

DQ parameters	Description	Default	Options
Maximum test period	Assign the time interval between bit pattern tests for F-DQ DC output faults. Functional bit pattern tests are applied to the output switches. These tests detect faulted P- or M- output switches and wiring faults. Short circuits to other signals or power rails can be detected. Open circuits between the wiring terminals and the load are not detected. If an error is detected on a channel, the test interval is shortened to approx. 1 min. If an error is no longer detected, the configured test interval is used again. A persistent fault is reported to the fail-safe CPU and the affected channels are passivated.	1000 s	• 100 s • 1000 s

Table 6- 5 ET 200eco PN F-DI 8 / F-DQ 3 DQ channel parameters

Channel parameters	Description	Default	Options
Wire break	You can activate or deactivate wire break testing.	Check box deselected	Check box: • Selected (wire break activated) • Deselected (wire break deactivated)
Activated	Select the check box to activate the channel. Deselect the check box and the unused channel is deactivated. If you deactivate a channel, you also deactivate its diagnostic function.	Check box selected	Check box: • Selected (channel activated) • Deselected (channel deactivated)
Channel failure acknowledge	Controls whether the channel is automatically reintegrated after a fault clears, or requires an acknowledgement (manual) in the user program. Refer to "Reactions to faults" (Page 167) for the reintegration procedure.	Manual	• Automatic • Manual Note: The configuration of the "F-Parameters": "Reintegration after channel fault" parameter can override the "Channel failure acknowledge" parameter's selection.

Channel parameters	Description	Default	Options
Maximum readback time	The maximum readback time is a user-configured parameter that assigns the maximum time allowed for an output to reach the new state (ON or OFF) due to a process value change without generating an error. Also, this is the maximum width of a diagnostic test pulse applied to verify that an output can be turned OFF while it is ON. The time of the OFF pulse should be as long as possible, but short enough so that the actuator cannot react.	2.0 ms	1.0 ms to 400.0 ms, in 0.1 ms increments
Maximum readback time switch on test	The maximum readback time switch on test is a user-configured parameter that assigns the maximum time for which the P-switch or the M-switch of a channel that is currently in OFF state can be switched ON during a bit pattern test step. This action tests the P- and M-switches on a channel such that only one switch is turned on at a time. Unless there is a fault in the system (for example, actuator shorted to ground), the actuator is not energized during either the P- or M-switch on tests. Under single fault conditions (either internal or external to the module), test pulses applied to either the P- or the M-switch of channels in the OFF state can repeatedly energize the actuator. You must select the parameter so that the duration of such pulses is too short to cause the actuator to react and, therefore, cannot have a hazardous effect on the equipment under control.	1.0 ms	0.5 ms to 5.0 ms, in 0.1 ms increments

WARNING

In the presence of a single fault, the bit pattern tests can apply energy to the load for a duration up to the configured "Maximum readback time switch on test".

If the load can respond dangerously within the configured readback time, it can respond to bit pattern tests in the presence of a single fault, resulting in death or serious injury to personnel and/or property damage.

Always choose a maximum readback configuration time that is guaranteed not to activate the load. *(S821)*

6.6 Assigning PROFIsafe addresses

Fail-safe ET 200eco PN modules, fail-safe ET 200SP modules, fail-safe S7-1500/ET 200MP modules, and fail-safe S7-1200 modules do not have a DIP switch that allows you to set the unique F-destination address for each module. Instead, you assign the PROFIsafe address consisting of the F-source address and the F-destination address directly from STEP 7 Safety for fail-safe ET 200eco PN modules, fail-safe ET 200SP modules, and fail-safe S7-1500/ET 200MP modules.

The S7-1200 CPU automatically assigns the PROFIsafe address consisting of the F-source address and the F-destination address to the fail-safe S7-1200 modules.

6.6.1 Basic PROFIsafe address assignment steps

These are the three basic steps for assigning PROFIsafe addresses:

1. Configure the F-destination address and F-source address in the hardware configuration in STEP 7 Safety and download the hardware configuration.
2. Identify the ET 200eco PN F modules to which you want to assign the configured F-destination and F-source addresses.
3. Assign the PROFIsafe addresses to the fail-safe modules.

Note

Refer to "Step 5: Assigning PROFIsafe addresses" (Page 52) in the Getting Started chapter for an instructional video and step-by-step instructions.

Note

Refer to the "SIMATIC Safety - Configuring and Programming, Programming and Operating Manual" (http://support.automation.siemens.com/WW/view/en/54110126/0/en) for further information about PROFIsafe address identification and assignment.

6.6.2 Identifying the ET 200eco PN F modules

6.6.2.1 Identification requirements

Ensure that you download the current hardware configuration before you assign the PROFIsafe addresses.

6.6.2.2 Identification procedure

You identify the ET 200eco PN F modules using the following steps:

1. In the network view, select the ET 200eco PN F module to which you want to assign the PROFIsafe address.
2. Right-click the ET 200eco PN F module, and select "Assign PROFIsafe address" from the context menu to display the "Assign PROFIsafe address" dialog.
3. In the "Identification" field, select the method to be used for identifying the ET 200eco PN F module:
   - "By LED flashing": This is the default setting. The System Fault, Channel Fault, and Channel Status LEDs of the ET 200eco PN F module that you want to identify flashes upon identification.
   - "By serial number": If you cannot see the ET 200eco PN F module directly, you can identify the module by the serial number of the module.
4. In the "Assign" column, select the check box for the ET 200eco PN F module to which you want to assign the PROFIsafe address.
5. Click the "Identification" button, and compare the reaction of the fail-safe module to that in the table:
   - Check whether the System Fault, Channel Fault, and Channel Status LEDs of the ET 200eco PN F module whose PROFIsafe address you want to assign is flashing green.
   - If you identify using the serial number, compare the displayed serial number to the serial number of the module.
6. In the "Confirm" column, select the check box for the ET 200eco PN F module for which you want to confirm the reaction of the fail-safe module in the table.

6.6.3 Assigning PROFIsafe addresses

6.6.3.1 Assignment requirements

In order to assign PROFIsafe addresses, you must have successfully identified your ET 200eco PN F modules and installed an eCoding plug on each module.

6.6.3.2 Assignment procedure

To assign the PROFIsafe addresses, proceed as follows:

1. Use the "Assign PROFIsafe addr..." button to assign the PROFIsafe address to the ET 200eco PN F modules. You may have to enter the password of the fail-safe CPU.
2. You must answer "yes" to the "Confirm PROFIsafe address assignment" dialog within 60 seconds to assign the PROFIsafe address.

6.7 Using the eCoding plug for PROFIsafe address assignment storage

The ET 200eco PN F-DI 8 / F-DQ 3 uses an eCoding plug to store the module's PROFIsafe addresses (F-source address and F-destination address).

WARNING

If you remove/insert the eCoding plug with the power connected, this can lead to undefined states in your system.

Death or serious personal injury and damage to the ET 200eco PN F-DI 8 / F-DQ 3 module and associated machines/equipment may result if proper precautions are not taken.

Only remove or replace the eCoding plug when the power is disconnected. Always comply with the required standards and safety guidelines when configuring a system. *(S822)*

Note

When replacing the ET200eco PN F module, transfer the eCoding plug of the failed module to the replacement module to retain the PROFIsafe address stored in the eCoding plug. Otherwise, it is necessary to use the Engineering System to configure the PROFIsafe address in the replacement module.

Commissioning 7

7.1 PROFINET IO

7.1.1 Commissioning the ET 200eco PN F-DI 8 / F-DQ 3 on PROFINET IO

The commissioning of your distributed I/O system depends on the system configuration. The following procedure describes the commissioning of the ET 200eco PN F-DI 8 / F-DQ 3 distributed I/O system on an IO controller.

Requirements for the ET 200eco PN F-DI 8 / F-DQ 3 distributed I/O system on the PROFINET IO

Note

You must ensure the safety of your plant. To do so, you need to perform a complete functional test and the necessary safety checks before the final commissioning of a plant.

Plan the tests to include any possible foreseeable errors. This allows you to prevent people or plants from being placed in danger during operation.

Procedure

The following table shows the chapters in which the required actions are described:

Table 7- 1 Requirements for the ET 200eco PN F-DI 8 / F-DQ 3 distributed I/O system on the PROFINET IO

Step	Procedure	See...
1	Installing the ET 200eco PN F-DI 8 / F-DQ 3 module	"Installation" (Page 106)
2	Wiring the ET 200eco PN F-DI 8 / F-DQ 3 module	"Wiring" (Page 112)
3	Configuring the ET 200eco PN F-DI 8 / F-DQ 3 module	"Configuring" (Page 146)
4	Turning on the supply voltage for the ET 200eco PN F-DI 8 / F-DQ 3 module	"Wiring" (Page 112)

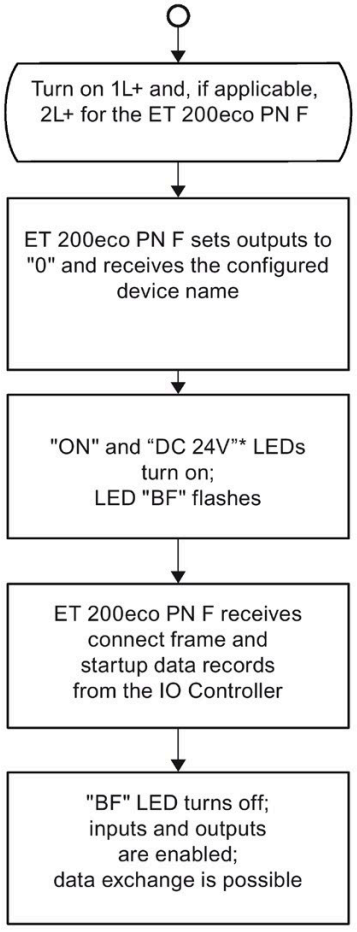
Reference

You can find additional information on assigning the PROFINET IO parameters in the PROFINET with STEP 7 V15 Function Manual (https://support.industry.siemens.com/cs/ww/en/view/49948856).

7.1.2 Startup on PROFINET IO

Principle of operation

The diagram below illustrates the startup of the ET 200eco PN F-DI 8 / F-DQ 3 on PROFINET IO:



* "DC 24V" only for digital output and if 2L+ is connected

7.2 Identification and maintenance (I&M) data

7.2.1 Reading out and entering I&M data

Identification and maintenance (I&M) data is information that is saved either as read-only or read/write on the ET 200eco PN F-DI 8 / F-DQ 3 module.

Identification data (I&M0): Manufacturer information on the module that is read-only and in some cases is also printed on the module housing (for example, article number, serial number, and firmware version).

Maintenance data (I&M1, 2, 3): Plant-dependent information (for example, installation location). You create maintenance data during configuration and write that data to the module.

The ET 200eco PN F distributed I/O module supports I&M0 to I&M3.

The I&M data supports you in the following activities:

- Checking the plant configuration
- Locating hardware changes in a system
- Correcting errors in a system

With the I&M identification data, you have the option of clearly identifying modules online.

STEP 7 displays the identification data in the "Properties..." tabs (see STEP 7 online help).

Options for reading out I&M data

You have the following options for reading the I&M data:

- Using the user program
- Using STEP 7 or HMI devices

Procedure for reading I&M data by means of the user program

To read the I&M data of the ET 200eco PN F module in the user program, use the instruction "RDREC".

Procedure for reading the I&M data using STEP 7

Note

You must have an online connection to the ET 200eco PN F module.

1. In the project navigation, under "Distributed I/O", select the I/O device (for example, "ET 200eco PN F-DI 8 / F-DQ 3").
2. Select: **Go to device > Online & Diagnostics > Diagnostics** > **General** > "Module information" field

Procedure for input of maintenance data using STEP 7

STEP 7 assigns the default module name. You have the option to enter the following data:

- Plant designation (I&M1)
- Location identifier (I&M1)
- Installation date (I&M2)
- Additional information (I&M3)

To enter the data, follow these steps:

1. In the device view of the STEP 7 hardware network editor, select the ET 200eco PN F-DI 8 / F-DQ 3 module.
2. In the module Properties, select: **General** > "Identification & Maintenance" field
3. Enter your I&M data.

Note

You must select an Options setting before you can edit and download I&M1 to 3 data. Select: **Options** > **Settings** > **Hardware configuration** > **Compile & download** > "Download" field > "Download Identification & Maintenance (I&M) data" check box

STEP 7 downloads the I&M data during the downloading of the hardware configuration.

Reference

You can find additional information on ET 200eco PN F-DI 8 / F-DQ 3 I&M data in the "Distributed I/O ET 200eco PN Operating Instructions" (https://support.industry.siemens.com/cs/document/29999018/simatic-distributed-i-o-et-200eco-pn?dti=0&lc=en-WW).

7.2.2 Data record structure for I&M data

Reading I&M data records (distributed using PROFINET IO)

You can directly access specific identification data by selecting the **Read data record** ("RDREC" instruction). You obtain the corresponding part of the identification data under the associated data record index.

The following table shows the principle behind the structure of data records:

Table 7- 2 Basic structure of data records with I&M identification data

Contents	Length (bytes)	Coding (hex)
Header information		
BlockType	2	I&M0: 0020_H I&M1: 0021_H I&M2: 0022_H I&M3: 0023_H
BlockLength	2	I&M0: 0038_H I&M1: 0038_H I&M2: 0012_H I&M3: 0038_H
BlockVersionHigh	1	01
BlockVersionLow	1	00
Identification data		
Identification data (see table below)	54 54 16 54	I&M0/Index $AFF0_H$ I&M1/Index $AFF1_H$ I&M2/Index $AFF2_H$ I&M3/Index $AFF3_H$

The following table shows the structure of data records for I&M identification data:

Table 7- 3 Data record structure for I&M identification data

Identification and maintenance data	Access	Default	Explanation
Identification data 0: (data record index AFF0 hex)			
DEVICE_MAN_ID	read (1 Word)	0x002A	Name of the manufacturer ($2A_H$ = SIEMENS AG).
DEVICE_ID	read (20 Char)	6ES7146-6FF00-0AB0	Information to order the module
DEVICE_SER_NUM	read (16 Char)	Serial number	Serial number (device-specific)
HARDWARE_REVISION	read (2 Bytes)	0x0001	Corresponding hardware version
SOFTWARE_REVISION	read (1 Char, 3 Bytes)	V01.00.00	Provides information about the firmware version of the module
MODUL_REVISION_COUNTER	read (1 Word)	0x0000	Provides information about configured changes on the module
Profile_ID	read (1 Word)	0x0000 (PROFIsafe)	Generic device
Profile_Specific_Type	read (1 Word)	0x0005 (I/O Module)	Interface modules
IM_Version	read (2 Bytes)	0x0101 (Version 1.1)	Provides information about the version of the identification data
IM_Supported	read (1 Word)	0x000E	Provides information about the existing identification data (I&M1 though I&M3)
Maintenance data 1: (data record index AFF1 hex)			
TAG_FUNCTION	Read/write (32 Bytes)	Initialized with 0x20 (Blank)	Enter an identifier for the module here that is unique plant-wide.
TAG_LOCATION	Read/write (22 Bytes)	Initialized with 0x20 (Blank)	Enter the installation location of the module here.
Maintenance data 2: (data record index AFF2 hex)			
INSTALLATION_DATE	Read/write (16 bytes)	Initialized with 0x20 (Blank)	Enter the installation date of the module here (YYYY-MM-DD HH:MM).
Maintenance data 3: (data record index AFF3 hex)			
DESCRIPTOR	Read/write (54 bytes)	Initialized with 0x20 (Blank)	Enter a comment describing the module.

Diagnostics

8

8.1 Reactions to faults

Reactions to startup of the fail-safe system and to faults

The fail-safe concept depends on the identification of a safe state for all process variables. The value "0" (de-energized) represents this safe state for digital fail-safe modules. This applies to both sensors and actuators.

The safety function requires that safe state values be applied to the fail-safe channel(s) instead of process values (passivation of the fail-safe module or channel(s)) in the following situations:

- When the fail-safe system is started up
- If module faults are detected, such as RAM or processor failures
- If errors are detected during safety-related communication between the fail-safe CPU and the fail-safe module through the PROFIsafe safety protocol (communication error)
- If module channel faults occur (for example, short-circuit and discrepancy errors)

The fail-safe CPU enters detected system faults into the diagnostic buffer.

Automatic safety measures and the PROFIsafe protocol ensure that the safe state is set if the system detects a fault.

Fail-Safe modules do not remember errors upon power cycle. When the system is powered down and then restarted, the modules detect any faults still existing again. The exception to this is a permanent deactivation fault such as "sustained over-voltage".

Fail-Safe value for fail-safe modules

If digital input channels are passivated , the fail-safe system always provides safe state values ("0") for the safety program instead of the process values applied to the fail-safe inputs.

If digital output channels are passivated in the fail-safe module digital outputs, the fail-safe system always transfers safe state values "0" to the fail-safe outputs instead of the output values provided by the safety program. The output channels are de-energized.

The passivation safe state value and the output state value in CPU STOP mode are always "0", de-energized. You cannot select or program a default "ON" state for passivation or STOP mode.

Passivation is applied to individual channels when a channel-specific diagnostic failure is detected. Failures that can affect the entire module result in passivation of all channels.

Note

In the ET 200eco PN F-DI 8 / F-DQ 3 **Properties > 4/8 F-DI 3 F-DQ > F-parameter**s > "Behavior after channel fault" field, if you select "Passivate the entire module", a single channel fault can result in passivation of all channels.

Timeout of the PROFIsafe message (F-monitoring time exceeded) passivates all module channels.

Table 8- 1 Module signal type and passivation result

Module signal type	Passivation result
Fail-safe digital inputs	• Tests are evaluated per channel, in order to allow channel-granular passivation of defective inputs. • If a channel fault occurs for a 1oo1 configuration, depending on your configuration, only the affected channel or all channels may be passivated. For a 1oo2, the channel group of two inputs in the 1oo2 configuration are passivated.
Fail-safe module digital outputs	• Tests are evaluated per channel, in order to allow channel-granular passivation of defective outputs. • Diagnostic evaluations are performed separately for each of the two switches of a channel. Depending on your configuration, failure detection for one switch may lead to passivation of only the affected channel or all channels.

Response to faults in the fail-safe system

You should prepare maintenance procedures for your system to assure that return to operation after a detected fault is controlled and documented.

The following steps must be performed:

1. Diagnosis and repair of the fault
2. Revalidation of the safety function
3. Recording in the service report

Reintegration of a fail-safe module

A channel or module can be reintegrated after successful diagnostics determine that a fault has cleared.

You can configure reintegration as automatic or manual. You can make this selection on a per channel basis in the Device Configuration. Module wide errors such as PROFIsafe communication errors or supply voltage errors must always be manually reintegrated.

Channels that you select to be automatically reintegrated are immediately reintegrated when the fault has cleared.

Channels that you select to be manually reintegrated must also be acknowledged in your program after the fault has cleared.

The "ACK_REQ" bit for that module goes true to indicate that reintegration is possible. After the "ACK_REQ" bit is true, your program can set the "ACK_REI" bit to allow the reintegration of all channels in that module that are ready to be reintegrated.

You can also acknowledge all faults in an F-runtime group using the "ACK_REI_GLOB" input of the "ACK_GL" instruction.

Some fatal diagnostic errors require a power cycle with successful diagnostics to reintegrate.

Reintegration after high stress events

High temperature, high voltage, and excessive current stress can damage electronics, reducing the reliability while components continue to work apparently as expected. Passivation does not remove the potentially damaging effects of high ambient temperature or high applied voltage. Solid state switch outputs can be damaged by high currents prior to protective device activations. The PFD and PFH reliability calculations assume the fail-safe module is operated within its specified operating parameters. When a module has passivated due to a high stress event, even though it apparently works correctly and passes all diagnostics, the probability of a future dangerous failure may be increased.

⚠WARNING

It is possible to reintegrate a channel or module while some fault is still present that is not readily detected by the module diagnostics.

Reintegration of a faulty system can result in unexpected machine or process operation, which may cause death or serious injury to personnel, and/or damage to equipment.

After any reported fault, the steps outlined in this chapter and in safety standards applicable to your system should be followed to assure that the fault is completely understood and corrected before reintegration. *(S823)*

For an exact list of faults for the module, refer to "Fault types, causes, and corrective measures" (Page 179).

At reintegration, the following occurs:

- For a fail-safe module digital input, the process values pending at the fail-safe inputs are provided for the safety program.
- For a fail-safe module digital output, the output values provided in the safety program are again transferred to the fail-safe outputs.

Safety repair time

The repair time used for PFH and PFD calculations is 100 hours.

Passivation is designed to provide the safe state of the safety function in the event of a single fault. While a channel is passivated and energy is still available to the channel, there is a possibility that additional faults can cause a dangerous failure of the safety function. You should respond to passivations by repairing the fault or taking the passivated channel out of service in less than 100 hours to preserve the safety integrity level of your system.

Deactivated fail-safe I/O are not being diagnosed and are subject to dangerous failure without warning.

If any channel passivation persists for 100 hours, the entire module is passivated and can only be recovered through power cycle.

If a repair within 100 hours is not possible, passivated fail-safe outputs should be taken out of service by physically disconnecting or opening circuits so that faults in the fail-safe module cannot apply energy to the load. To remove input channels from service in an operating PLC system, references to any passivated fail-safe inputs must be removed from any operating CPU Safety program logic that can result in activation of a safety function output.

Do not depend on channel or module passivation to maintain safe state for more than 100 hours.

Do not depend on deactivation or lack of configuration to maintain safe state in any circumstances.

Additional information on passivation and reintegration

For further information about fail-safe module access, refer to the "SIMATIC Safety - Configuring and Programming, Programming and Operating Manual" (http://support.automation.siemens.com/WW/view/en/54110126/0/en).

8.2 Fault Diagnostics

8.2.1 Overview

Diagnostics detect faults that can affect the integrity of safety-related I/O. The faults can be in the fail-safe module, communication with the CPU, or external circuits. Diagnostic information is assigned either to a single channel or to the entire fail-safe module.

Most diagnostics operate without user selection. You can configure the following diagnostic options:

- Short-circuit testing using the digital input sensor supply can be enabled. The interval and duration of short-circuit tests is configurable.
- The readback times for 24 V DC digital outputs are configurable.
- The timeout intervals for failures in the safety communication or failure of a safety program to run is configurable.

  Refer to "Configuring" (Page 146) for a complete description of these options.

The safety-critical and validated action of the diagnostics is to passivate I/O when faults are detected. The reporting of status and diagnostic results through the LED displays and diagnostic messages is subject to single point failures in electronics or software. These reports are offered as maintenance and debugging aids, but must be observed and interpreted with caution.

In the presence of single faults, any or all LED indications can be wrong. You should not rely solely on the presence or absence of red or green LED indicators to make safety decisions.

In the presence of single faults, diagnostic messages may fail to be delivered, or the numerical event ID or text message can be wrong. You should not rely solely on the presence, absence, or content of diagnostic reports to make safety decisions.

WARNING

Diagnostic and status reports through LEDs and text messages are subject to single point failure errors.

Reliance on such reported information to determine that a system or I/O point is in a safely-controlled state can result in death, severe personal injury, or property damage.

If the integrity of your fail-safe system is in doubt, you should use additional measures such as restricted access or power removal to control hazards during maintenance and debug activities. *(S824)*

8.2.2 Diagnostics performed at startup

Each fail-safe module executes self-diagnostics at power-up to assure that the electronics and software meet testable expectations before allowing the module to participate in process control. If tests are not successful, the module passivates individual channels or all channels.

In addition to internal tests, some tests create signal changes at the terminals.

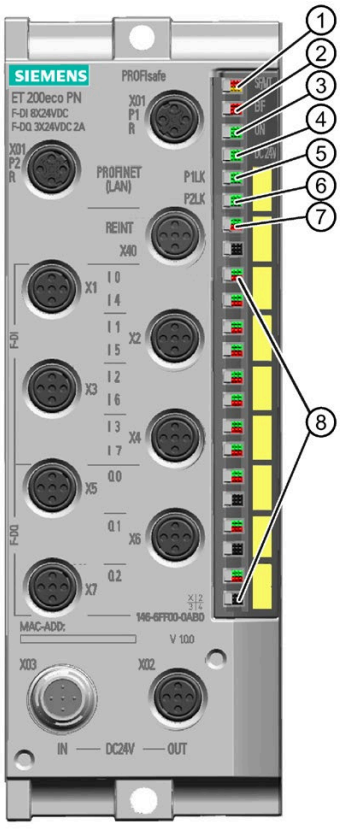
The ET 200eco PN F-DI 8 / F-DQ 3 module executes tests for its digital outputs of the P and M switches as defined by your configured parameters for "Maximum readback time" and "Maximum readback time switch on test" after receiving configuration parameters from the fail-safe CPU at power-up. P and M switch ON tests are sequenced so that normally or in the presence of a single detected fault, there is no complete PM circuit to energize the load.

The ET 200eco PN F-DI 8 / F-DQ 3 module executes tests for its digital inputs of the sensor supply at power up, including ON and OFF pulses, whether or not you have enabled the sensor supply or short-circuit testing in your configuration. If your configuration includes short-circuit testing, the F-DI also executes a short-circuit test according to your configured parameters after receiving the parameters from the fail-safe CPU at power-up.

8.2.3 Diagnostics by LED Display

8.2.3.1 Overview

The ET 200eco PN F-DI 8 / F-DQ 3 module has the following LED position, arrangement, and types:

Module	Location	LED	LED Color	Description
	①	SF/MT	Red/Yellow	System fault/Maintenance
	②	BF	Red	Bus monitoring
	③	ON	Green	Power at 1L+
	④	DC 24V	Green	Power at 2L+
	⑤	P1 LK	Green	Port to Ethernet switch connection
	⑥	P2 LK	Green	Port to Ethernet switch connection
	⑦	REINT	Green/Red	Module reintegration
	⑧	Channel Status	Green	Channel status LED for each channel
	⑧	Channel Fault	Red	Channel fault LED for each channel

Note

Each M12 channel connector has two LED light-pipes. F-DI channels use both LED light-pipes, one for each input. F-DQ channels use a single LED light-pipe.

8.2.3.2 Module LED states

Module LED states

The behavior of the module-relevant LEDs follows the definitions in the table below:

LED	LED color	Description
SF/MT (System fault and maintenance)	On red	The SF LED is controlled by incoming and outgoing diagnostic events. The SF LED is ON whenever at least one incoming event is active.
	Off	The SF LED is OFF when all incoming events have been acknowledged by outgoing events.
	On yellow	The MT LED is ON during a firmware update, once the update procedure commences within the module.
BF (Bus monitoring)	On red	The BF LED is ON whenever the IO device is not connected to an Ethernet switch.
	Flashing red	The BF LED is flashing whenever there is faulty or absent data exchange between the IO Controller and the ET 200eco PN F IO Device. Faulty or absent data exchange can include the following items: • No connect message frame • Faulty connect message frame • No data exchange between the module and the host, although the module is physically connected to the switch. Possible causes can include the following items: – Incorrect device name – Error in or no configuration – Parameterization errors or no parameterization
	Off	The BF LED is OFF whenever the IO device successfully exchanges data with the IO controller.
ON (Power at 1L+)	On green	The ON LED is ON whenever the 24 V DC supply voltage is present at 1L+.
	Off	The ON LED is OFF whenever the 24 V DC supply voltage is too low or not present at 1L+.
DC 24V (Power at 2L+)	On green	The DC 24V LED is ON whenever the 24 V DC supply voltage is present at 2L+.
	Off	The DC 24V LED is OFF whenever the 24 V DC supply voltage is too low or not present at 2L+.
	Off	The DC 24V LED is also OFF whenever the 24 V DC supply voltage is too low or not present at 1L+.

LED	LED color	Description
P1 LK and P2 LK (Port to Ethernet switch connection)	● On green	The Px LK LED is ON whenever there is a connection to Ethernet switch or IO controller.
	○ Off	The Px LK LED is OFF whenever there is no connection to the Ethernet switch or IO controller.
REINT (Module reintegration)	✶/✶ Flashing red and green	The REINT LED flashes Green/Red whenever a reintegratable module-wide diagnostic event has been resolved. This can include the following events: • Reintegratable over-voltage • Reintegratable under-voltage • Module detected PROFIsafe CRC error • Module detected PROFIsafe timeout error
	● On red	The REINT LED is ON red whenever there are compatibility issues between FW or HW revisions.
	○ Off	The REINT LED is otherwise OFF.

○- Off;●- On;✶- Flashing (Flashing frequency: 2.0 Hz)

8.2.3.3 LED states for 1oo1 input channels

The behavior of the 1oo1 input channel LEDs follows the definitions in the table below:

Description	Reintegration LEDs	Input Channel LEDs	
		Fault	Status
LED color	Green / red	Red	Green
Input state 0	○ Off	○ Off	○ Off
Input state 1	○ Off	○ Off	● On green
Channel fault	○ Off	● On red	○ Off
Channel fault resolved, awaiting reintegration	○ Off	✶/✶[1] Flashing	

○ - Off;● - On;✶- Flashing (Flashing frequency: 2.0 Hz)

[1] Alternating flashing of the separate fault (red) and status (green) LEDs for channels awaiting reintegration (flashing frequency: 2.0 Hz)

8.2.3.4 LED states for 1oo2 input channels

The behavior of the 1oo2 input channel LEDs follows the definitions in the table below:

Description	Reintegration LEDs	Primary input channel LEDs		Secondary input channel LEDs	
		Fault	Status	Fault	Status
LED color	Green / red	Red	Green	Red	Green
Input state 0 (equivalent)	○ Off	○ Off	○ Off	○ Off	○ Off
Input state 1 (equivalent)	○ Off	○ Off	● On green	○ Off	● On green
Input state 0 (non-equivalent)	○ Off	○ Off	○ Off	○ Off	● On green
Input state 1 (non-equivalent)	○ Off	○ Off	● On green	○ Off	○ Off
Discrepancy error	○ Off	● On red	○ Off	● On red	○ Off
Discrepancy error resolved, awaiting reintegration	○ Off	✶/✶[1] Flashing		✶/✶[1] Flashing	

○ - Off;● - On;✶- Flashing (Flashing frequency: 2.0 Hz)

[1] Alternating flashing of the separate fault (red) and status (green) LEDs for channels awaiting reintegration (flashing frequency: 2.0 Hz)

8.2.3.5 LED states for sensor supply behaviors

The behavior of the input LEDs due to sensor supply faults follows the definitions in the table below:

Description	Reintegration LEDs	Input Channel LEDs	
		Fault	Status
LED color	Green / red	Red	Green
Sensor supply fault; for inputs affected by the fault	○ Off	● On red	○ Off
Sensor supply fault; for inputs not affected by the fault	○ Off	○ Off	Input state

○ - Off;● - On;✶- Flashing (Flashing frequency: 2.0 Hz)

8.2.3.6 Channel LED states

The behavior of the module and channel-relevant LEDs and reintegration LEDs follows the definitions in the table below:

Description	Reintegration LEDs	Input Channel LEDs		Output Channel LEDs	
		Fault	Status	Fault	Status
LED color	Green / red	Red	Green	Red	Green
Module / System fault	○ Off	● On red	○ Off	● On red	○ Off
Module not configured, includes: under-voltage, over - voltage of 1L+ and 2L+ when not configured	○ Off	○ Off	Input state	○ Off	○ Off
States after the module is successfully configured					
Channel deactivated	○ Off	○ Off	Input state	○ Off	○ Off
No channel faults	○ Off	○ Off	Input state	○ Off	Output state
Channel faults	○ Off	● On red	○ Off	● On red	○ Off
Awaiting manual reintegration after channel fault	○ Off	✱/✱[1] Flashing		✱/✱[1] Flashing	
Awaiting manual reintegration after 1L+ voltage too high or too low	✱/✱ Flashing red and green	✱/✱[1] Flashing		✱/✱[1] Flashing	
Awaiting automatic reintegration after 1L+ voltage too high or too low	✱/✱ Flashing red and green	○ Off	Input state	○ Off	○ Off
Awaiting reintegration after PROFIsafe communication error (detected by host)	✱/✱ Flashing red and green	○ Off	Input state	○ Off	○ Off
1L+ supply or 2L+ load voltage too high / too low	○ Off	● On red	○ Off	● On red [3]	○ Off
PROFIsafe communication error (detected by module)	○ Off	○ Off	Input state	○ Off	○ Off
Identification of the F-module when assigning the PROFIsafe address	○ Off	○ Off	✱ Flashing green [2]	○ Off	✱ Flashing green [2]
PROFIsafe address does not match the configured PROFIsafe address	○ Off	● On red	○ Off	● On red	○ Off

Description	Reintegration LEDs	Input Channel LEDs		Output Channel LEDs	
		Fault	Status	Fault	Status
LED color	Green / red	Red	Green	Red	Green
Firmware Update (LED indication of FW update activity)	○ Off	○ Off	○ Off	○ Off	○ Off
Inconsistent FW versions and/or HW revisions between TPS and F-µCs	● On red	○ Off	Input state	○ Off	○ Off

○ - Off;● - On;✶- Flashing (Flashing frequency: 2.0 Hz)

1 Alternating flashing of the separate fault (red) and status (green) LEDs for channels awaiting reintegration (flashing frequency: 2.0 Hz)

2 Flashing frequency (0.5 Hz)

3 Assuming channels are activated. F-DQ channels can be deactivated. Whenever you deactivate all F-DQ channels, you do not have to power 2L+. When you deactivate all F-DQ channels, you change some F-DQ relevant behaviors (for example, 2L+ under-voltage reporting is suspended).

8.2.3.7 LED states for 24 V DC supply behaviors

The behavior of the 24 V DC LEDs follows the definitions in the table below:

Description	ON (1L+)	DC 24V (2L+)	Reintegration LEDs	Input Channel LEDs		Output Channel LEDs	
				Fault	Status	Fault	Status
LED color	Green	Green	Green / red	Red	Green	Red	Green
24 V DC module 1L+ off; 24 V DC module 2L+ off	○ Off	○ Off	○ Off	○ Off	○ Off	○ Off	○ Off
24 V DC module 1L+ off; 24 V DC module 2L+ on	○ Off	○ Off	○ Off	○ Off	○ Off	○ Off	○ Off
24 V DC module 1L+ on; 24 V DC module 2L+ off (At least one output activated)	● On green	○ Off	○ Off	● On red	○ Off	● On red	○ Off
24 V DC module 1L+ on; [1] 24 V DC module 2L+ off (All outputs deactivated)	● On green	○ Off	○ Off	○ Off	Input state	○ Off	○ Off
24 V DC module 1L+ on; 24 V DC module 2L+ on	● On green	● On green	○ Off	○ Off	Input state	○ Off	Output state

○ - Off;● - On;✶- Flashing (Flashing frequency: 2.0 Hz)

1 Whenever you deactivate all F-DQ channels, you do not have to power 2L+.

8.2.4 Fault types, causes, and corrective measures

The "Fault types, causes, and corrective measures" table below lists the messages of the ET 200eco PN F-DI 8 / F-DQ 3. These messages are displayed in the TIA Portal under "Online & diagnostics" > "Diagnostics" > "Diagnostic buffer". When you highlight an individual text line in the diagnostic buffer, the Event ID for that text item is displayed, along with module identity and location that generated the message. You may need to expand the window to see all information.

Table 8- 2 Fault types, causes, and corrective measures

Event ID	Diagnostic message	ET 200eco PN F-DI 8 / F-DQ 3 module	Description	Possible causes	Corrective measures [1]
0x0001	Short-circuit	Digital outputs	A channel problem has been detected where either the P terminal or M terminal is at an unexpected potential.	Short-circuit of the output	Eliminate the short-circuit.
				Short-circuit between channels with different signals	Eliminate the short-circuit.
				Output overload	Eliminate the overload.
				"Maximum readback time switch on test" value is configured too small	Increase "Maximum readback time switch on test" if permissible.
				Short-circuit of output to M	Eliminate the short-circuit.
				Defective output driver	Replace the fail-safe module.
0x0005	Overtemperature	Module	• Overtemperature at microcomputer • Overtemperature at I/O	Shutdown due to violation of high temperature limit value in the module case	Check the ambient temperature. Once the fault has been eliminated, the power must be switched off and on.
0x0006	Wire break	Module	WIre break failure. Note: The module detects a wire break. The module can detect a wire break when the channel is wired using a PM load, when the PV=0, and the wire break diagnostic is enabled.	Output is activated: • No load is connected to the PM output. • Output is not wired in a PM configuration. • Too small of a load is detected.	Change the output load characteristics, deactivate unused channels, or disable wire break diagnostic for the offending channels.
0x0009	Hardware revision mismatch	Module	The module detects hardware mismatch. REINT LED is ON red.		Replace module.

Event ID	Diagnostic message	ET 200eco PN F-DI 8 / F-DQ 3 module	Description	Possible causes	Corrective measures [1]
0x0010	Parameterization failure (invalid parameters)	Module	On detection of invalid parameters, the module stays in the configured state and signals the rejection of the faulty parameter to the fail-safe CPU. The module LEDs give an immediate indication of this fault.	i-Parameter CRC error	
				Invalid i-parameters (for example, invalid selection, parameter out-of-range, unsupported feature selected, and wrong value of reserved field)	
				Any PROFIsafe parameterization problem detected by the PROFIsafe driver.	
0x0010	Parameterization failure (address assignment failure)	Module	On detection of an address assignment failure that indicates a hardware fault, the module enters the fatal error state. The module performs this fault reaction if the address verification information provided by the F parameters is different than what has been previously assigned to the module.	• Indicates assignment of an incorrect F address to one or more module(s). • Missing eCoding plug	• Reinsert the eCoding plug • Reassign or reinitialize the PROFIsafe F addresses using TIAP • Replace the eCoding plug
0x0010	Parameter error	Module	When the module receives new parameters, the module checks for parameter failures.	Parameter failure detected.	
0x0040	Mismatch of safety destination address (F_Dest_Add)	Module	The PROFIsafe driver has detected a destination address mismatch. Checked after new parameters received.	• eCoding plug has been replaced with a different plug • eCoding plus is defective	• Reassign or reinitialize the PROFIsafe F addresses using TIAP • Replace the eCoding plug
0x0041	Safety destination address not valid (F_Dest_Add)	Module	The PROFIsafe driver has detected an invalid destination address. Checked after new parameters received.	• eCoding plug has been replaced with a different plug • eCoding plus is defective	• Reassign or reinitialize the PROFIsafe F addresses using TIAP • Replace the eCoding plug

Event ID	Diagnostic message	ET 200eco PN F-DI 8 / F-DQ 3 module	Description	Possible causes	Corrective measures [1]
0x0042	Safety source address not valid (F_Source_Add)	Module	The PROFIsafe driver has detected a source address mismatch or an invalid source address. Checked after new parameters received.	• eCoding plug has been replaced with a different plug • eCoding plus is defective	• Reassign or reinitialize the PROFIsafe F addresses using TIAP • Replace the eCoding plug
0x004D	PROFIsafe communication error (CRC)	Module	Transmission error in data message frame: Data inconsistent (CRC (cyclic redundancy check) error). Checked after new output telegram received.	Communication interference between the fail-safe CPU and the fail-safe module (for example, due to electromagnetic interference in excess of limits or sign-of-life monitoring error)	• Check the communications connection. • Eliminate the interference.
0x004E	PROFIsafe communication failure (timeout)	Module	Monitoring time exceeded for data message frame (timeout). Checked after new output telegram received.	F-monitoring time exceeded. Transmission error: timeout (watchdog time 1 or 2 elapsed)	• Adjust F-monitoring time. • Check Safety program and all other CPU activities for excessive execution or demands: – Interrupts – Ethernet communication – OB scheduling conflicts – Long program paths.
0x0100	Module is defective	Module	Fatal internal error	Fail-Safe module is defective.	Replace the fail-safe module. [2]
0x0103	Watchdog tripped	Module	The watchdog timer in the module communications processor timed out.	Fail-Safe module is defective.	Replace the fail-safe module.
0x0105	Short-circuit to L+	ET 200eco PN F-DI 8 / F-DQ 3 digital outputs	Output shorted to P. The fail-safe module detects a channel problem where the P-terminal is unexpectedly at L+ potential.	Short-circuit to L+	Eliminate the short-circuit.
				Short-circuit between channels with different signals	Eliminate the short-circuit.
				Defective output driver	Replace the fail-safe module.
				"Maximum readback time" value is configured too small.	Increase readback time.

Event ID	Diagnostic message	ET 200eco PN F-DI 8 / F-DQ 3 module	Description	Possible causes	Corrective measures [1]
0x0106	Short-circuit to ground	ET 200eco PN F-DI 8 / F-DQ 3 digital outputs	The fail-safe module detects a channel problem where the M-switch output terminal is unexpectedly at M potential.	Short-circuit of output to M, ground, or another channel.	Eliminate the short-circuit.
				Defective output driver	Replace the fail-safe module.
				"Maximum readback time" value is configured too small.	Increase readback time.
0x011B	Invalid/inconsistent firmware present	Module	The firmware is inconsistent after a firmware update. Inconsistency between bus ASIC firmware and failsafe firmware. Checked again after firmware update.	Inconsistent firmware version may occur between Network Interface ASIC firmware and failsafe controller firmware if the firmware update is supported.	The firmware update operation should be repeated.
0x013E	Diagnostic event queue overflow	Module	Overflow of the diagnostic events queue has occurred. A newly-occurred diagnostic event could not be queued for transmission to the CPU because the buffer is full.	This can happen if channel errors come and go very quickly (for example, discrepancy errors).	
0x0300	Discrepancy failure, channel state 0/0	ET 200eco PN F-DI 8 / F-DQ 3 digital inputs	External discrepancy failure: Channel state 0/0 with 1oo2 nonequivalent configuration	• Process signal faulty, sensor may be defective. • Configured discrepancy time too short • Short-circuit • Sensor mechanical activation or alignment out of tolerance	• Check process signal, replace sensor if necessary. • Check the configured discrepancy time. • Check the wiring. • Check that both sensors are mounted and aligned to be activated together.
0x0301	Discrepancy failure, channel state 0/1	ET 200eco PN F-DI 8 / F-DQ 3 digital inputs	External discrepancy failure: Channel state 0/1 with 1oo2 equivalent configuration		
0x0302	Discrepancy failure, channel state 1/0	ET 200eco PN F-DI 8 / F-DQ 3 digital inputs	External discrepancy failure: Channel state 1/0 with 1oo2 equivalent configuration		
0x0303	Discrepancy failure, channel state 1/1	ET 200eco PN F-DI 8 / F-DQ 3 digital inputs	External discrepancy failure: Channel state 1/1 with 1oo2 nonequivalent configuration		

Event ID	Diagnostic message	ET 200eco PN F-DI 8 / F-DQ 3 module	Description	Possible causes	Corrective measures [1]
0x0306	Internal sensor supply short-circuit to P	ET 200eco PN F-DI 8 / F-DQ 3 digital inputs	Module-provided sensor supply voltage shorted to P	Sensor supply shorted to P	Eliminate the short-circuit.
				Short-circuit test duration configured too short	Increase short-circuit test duration.
				Failed sensor supply	Replace the fail-safe module.
0x0307	Overload or internal sensor supply short-circuit to ground	ET 200eco PN F-DI 8 / F-DQ 3 digital inputs	Internal sensor supply voltage shorted to M, ground, or excessive load on sensor supply. Note: An overload condition is detected if the filtered current measurement of a channel is in the over-current threshold range of 2.4 A and 3.83 A. Overload protection is provided using current measurement of the P outputs. M outputs are short-circuit protected, but not monitored for over-current.	Short-circuit	Eliminate the short-circuit.
				Excessive load on sensor supply	Reduce load on sensor supply.
				Failed sensor supply	Replace the fail-safe module.
0x030B	Channel failure acknowledgement	Module	Channel configured for manual acknowledgement is ready to reintegrate.	Manual acknowledgement required	Manually acknowledge correction of channel fault so that reintegration can occur.
0x030D	F-address memory not accessible	Module	The memory where the F-Address is stored is not accessible.	• eCoding plug is missing • eCoding plug is defective	• Install an eCoding plug into X40 of the module • Replace the defective eCoding plug
0x030E	No valid F-address available	Module	Fail-safe address is not valid (F-address and CRC inconsistent).	• eCoding plug has never been assigned a PROFIsafe address • eCoding plug is defective	• Assign the PROFIsafe Address • Replace the eCoding plug

Event ID	Diagnostic message	ET 200eco PN F-DI 8 / F-DQ 3 module	Description	Possible causes	Corrective measures [1]
0x0311	Frequency too high	ET 200eco PN F-DI 8 / F-DQ 3 digital outputs	Switching frequency exceeded; readback not in time.	Process value from safety program changing too rapidly for module to follow	• Change Safety program logic to guarantee more time between output changes.
0x0312	Undertemperature	All	• Under-temperature at microcomputers • Under-temperature at I/O	Shutdown due to violation of low temperature limit value in the module case	• Check the ambient temperature. • Once the fault has been eliminated, the power must be switched off and on.
0x0313	Failure in the input circuit	ET 200eco PN F-DI 8 / F-DQ 3 digital inputs	Internal fault at the read circuit/test circuit	The module digital inputs detect a failure during bit pattern testing of inputs. EMI or module hardware fault.	• If intermittent, probably due to interference. Eliminate interference. • If persistent, or repeats after efforts to eliminate interference, replace the fail-safe module.
0x031C	Input shorted to P	ET 200eco PN F-DI 8 / F-DQ 3 digital inputs	Input shorted to P failure	External wiring or sensor shorts input signal to L+.	Check/correct external short-circuit.
				Input configured for internal sensor supply with short-circuit detection enabled, but wired to external L+	Make wiring and configuration agree.
				Input defective	Replace the fail-safe module.
0x031E	Read back failure	ET 200eco PN F-DI 8 / F-DQ 3 digital outputs	The module has detected a channel problem where the expected terminal voltage(s) are not reached.	"Maximum readback time" or "Maximum readback time switch on test" configured value is too small.	Increase readback time.
				Output switch failure	Replace the fail-safe module if output does not respond.

Event ID	Diagnostic message	ET 200eco PN F-DI 8 / F-DQ 3 module	Description	Possible causes	Corrective measures [1]
0x0320	Overload	ET 200eco PN F-DI 8 / F-DQ 3 digital outputs	Over load condition at the output driver that leads to passivation of the channel	Over load at output	Eliminate over load.
0x0321	Supply or load voltage too high	Module	Supply voltage (1L+) or load voltage (2L+) maximum exceeded.	Supply or load voltage is set too high.	Adjust supply or load voltage.
0x0322	Supply or load voltage too low	Module	Supply voltage (1L+) or load voltage (2L+) minimum exceeded.	Supply or load voltage is set too low.	Adjust supply or load voltage.

[1] Once the fault is eliminated, the fail-safe module must be reintegrated (returned to normal state) from passivation into the safety program.

Electromagnetic interference and diagnostic reports

Electromagnetic interference can cause communication errors, disturb external and internal signal measurements, and cause processing errors. When error reports do not apparently relate to an identifiable device failure, wiring problem, programming, or configuration error, consider sources of electromagnetic interference and installation and wiring problems that might introduce electromagnetic interference in your installation. Typical problem sources include poor suppression of inductive loads and voltage dips due to excessive load in-rush currents.

Maintenance

9

9.1 Replacing the ET 200eco PN F-DI 8 / F-DQ 3 module

Replacing modules

Replacing a module is not permitted during ongoing operation.

⚠ WARNING

If you remove/insert modules and the eCoding plug with the power connected, this can lead to undefined states in your system.

Death or serious personal injury and damage to the ET 200eco PN F-DI 8 / F-DQ 3 module and associated machines/equipment may result if proper precautions are not taken.

Only remove or replace modules and the eCoding plug when the power is disconnected. Always comply with the required standards and safety guidelines when configuring a system. *(S825)*

Note

When replacing the ET200eco PN F module, transfer the eCoding plug of the failed module to the replacement module to retain the PROFIsafe address stored in the eCoding plug. Otherwise, it is necessary to use the Engineering System to configure the PROFIsafe address in the replacement module.

Procedure

To replace a module, proceed as follows:

1. Disconnect the supply and load voltages to the module to be replaced.
2. Remove the eCoding plug.
3. Completely remove all cables connected to the module.
4. Completely remove the fixing screws of the module
5. Replace the module.
6. Fasten the module with a torque of 1.2 Nm.
7. Connect all cables.
8. Connect the eCoding plug to the module.
9. Turn the supply and load voltages.on.

Result

The disconnected I/O module and all downstream I/O modules start up again by themselves.

Note

Refer to the "Looping PROFINET and the supply voltage" (Page 143) when replacing the ET 200eco PN F module.

9.2 Resetting the ET 200eco PN F-DI 8 / F-DQ 3 module to factory settings (PROFINET)

When you "Reset to factory settings", you reset the ET 200eco PN F-DI 8 / F-DQ 3 module to the delivery state settings. This means that all information that you saved internally on the ET 200eco PN F is deleted.

Result after resetting to factory settings

The following table shows an overview of the contents of the saved items after resetting to factory settings:

Table 9- 1 Result after resetting to factory settings

Memory object	Contents
IP address	Deleted
Device name	Deleted
MAC address	Not deleted
Identification data (I&M0)	Not deleted
Maintenance data (I&M1, 2, 3,)	Deleted (optional)
Firmware version	Not deleted
Fail-Safe Addresses stored in eCoding Plug	Not affected

Note

When "Resetting to factory settings", the ET 200eco PN F assumes a substitute value behavior (takes on the non-configured state), which means that the module does not enter input data or transmit output data.

Reset options

You can go online with STEP 7 (TIA Portal) to reset an ET 200eco PN F to factory settings

The ET 200eco PN F only works with TIA Portal V15 and later. An HSP is used with TIA Portal V15. Later versions of V15 will not require an HSP.

Requirement

You need an online connection to reset an ET 200eco PN F to factory settings.

Procedure with STEP 7 (TIA Portal)

Connect the PG/PC to the PROFINET IO interface of the ET 200eco PN F distributed I/O system.

Make sure that there is an online connection to the ET 200eco PN F module which is to be reset to factory settings:

1. Navigate to "Devices & Networks" and the "Network view".
2. Right-click on the ET 200eco PN F-DI 8 / F-DQ 3 and select "Online and diagnostics".
3. Go online.
4. In the "Functions" folder, select "Reset to factory settings".
5. Select the "Retain I&M data" option button if you want to retain the I&M data, or the "Reset I&M data" option button if you want to delete the I&M data.
6. Click the "Reset" button.
7. Click "OK" in response to the confirmation prompts.

Result: This command resets the following data:

- PROFINET device name
- IP address
- SNMP parameters
- I&M data (if "Reset I&M data" is selected)

Reference

You will find more information on the procedure in the TIA Portal online help.

9.3 Firmware update

During operation, it can become necessary to update the firmware (for example, for function extensions).

Options for the firmware update

You update the firmware in the ET 200eco PN F-DI 8 / F-DQ 3 module using one of the following:

- TIA Portal
- Embedded web server executing on a SIMATIC CPU
- SIMATIC Automation Tool (SAT)

Note

Temporary network interruption

When you perform a firmware update of an ET 200eco PN F-DI 8 / F-DQ 3 I/O module, the module's PROFINET connection is temporarily interrupted due to the restart of the module. All downstream PROFINET devices are interrupted until the firmware update is complete.

Reference

You can find additional information on the procedure in the FAQs on the Internet (https://support.industry.siemens.com/cs/us/en/view/88778936) and in the online help for TIA Portal.

9.4 Cleaning modules

When wired, ET 200eco PN F-DI 8 / F-DQ 3 modules comply with the IP66/IP67 degree of protection and require no cleaning. If you do have to clean the modules, use a dry or damp cloth. Please ensure that you comply with the IP66/67 degree of protection when cleaning with liquids.

Technical specifications

A

A.1 General technical specifications

A.1.1 Standards compliance

The ET 200eco PN F design conforms to the following standards and test specifications. The test criteria for the ET 200eco PN F are based on these standards and test specifications.

Not all ET 200eco PN F models may be certified to these standards, and certification status may change without notification. It is the user's responsibility to determine applicable certifications by referring to the ratings marked on the product. Consult your local Siemens representative if you need additional information related to the latest listing of exact approvals by part number.

Siemens products will generally be in accordance with the latest released standards as of the time of product release. For European Norm (EN) standards, the effective version will be in accordance with listings in the official journal of the European Union. Product certifications including the CE declaration of conformity and certificates from listing agencies cite the exact standards applicable to each certification.

A.1.2 Fail-Safe standards and approvals

The ET 200eco PN F-DI 8 / F-DQ 3 module is certified by TÜV. The fail-safe modules are certified to the IEC 61508, ISO EN 13849, and EN 62061 standards for functional safety. For further information, refer to the current "Report to the Certificate" for the TÜV certificate "SIMATIC Safety" (http://support.automation.siemens.com/WW/view/en/49368678/134200) from the Internet.

A.1.3 PROFIsafe compatibility

- PROFIsafe address type 2
- Supports the RIOforFA-Safety profile
- Supports the PROFIsafe V2.4 profile

A.1.4 Standards and Approvals

A.1.4.1 General certifications

CE approval

The ET 200eco PN F module satisfies requirements and safety-related objectives according to the EC directives listed below and conforms to the harmonized European standards (EN) for the programmable controllers listed in the Official Journals of the European Union.

- EU Directive 2014/30/EU "Electromagnetic compatibility" (EMC Guidelines):
  - Emission standard
    EN 61000-6-4:+A1: Industrial Environment
  - Immunity standard
    EN 61000-6-2: Industrial Environment
- EC Directive 2006/42/EC (Machine Directive) "Machinery and Amending Directive 95/16/EC":
  - Safety of Machinery

    EN ISO 13849-1 and EN ISO 13849-2: Safety Related Parts of Control Systems

    EN 62061:+A2: Functional Safety of Safety Related Electrical, Electronic, and Programmable Electronic Control Systems
- EU Directive 2014/34/EU "Equipment and protective systems for use in hazardous areas" (Explosion protection directive) (ATEX):
  - EN 60079-0:+A11
  - EN 60079-15: Type of Protection 'n'
  - EN 60079-31: Dust Protection Enclosure 't'
- EC Directive 2011/65/EC (RoHS) "The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment":
  - EN 50581: "Assessment of Electrical and Electronic Products with Respect to the Restriction of Hazardous Substances"

The EU Declaration of Conformity is held on file available to competent authorities at:

Siemens AG
DI FA AS
Gleiwitzer Str. 555
DE-90475 Nuremberg
Germany

cULus approval

Underwriters Laboratories Inc. in accordance with:

- UL 61010-1 and UL 61010-2-201
- CSA C22.2 No. 61010-1 and No. 61010-2-201
- CSA C22.2 No. 94.2-15

Note

Class 2 power supply unit

The components must be supplied with a class 2 power supply unit.

ATEX approval

In accordance with EN 60079-15 (Electrical apparatus for potentially explosive atmospheres; Type of protection "n")

EN 60079-0 (Electrical apparatus for potentially explosive gas atmospheres - Part 0: General Requirements) and

EN 60079-31 (Equipment dust ignition protection by enclosure "t")

EN 60079-15: Electrical Apparatus for Potentially Explosive Atmospheres;
Type of protection 'nA'

II 3 G Ex nA IIC T4 Gc
II 3 D Ex tc IIIC T90°C Dc
DEKRA 18ATEX0032X

Refer to the "Using the ET 200eco PN in hazardous area Zone 2 / Zone 22" Product Information (https://support.industry.siemens.com/cs/ww/en/view/80484830).

Australia and New Zealand - RCM Mark (Regulatory Compliance Mark)

The ET 200eco PN F satisfies requirements of standards to AS/NZS 61000.6.4 and IEC 61000-6-4 (Class A).

Korea Certification

The ET 200eco PN F satisfies the requirements of the Korean Certification (KC Mark). It has been defined as Class A Equipment and is intended for industrial applications and has not been considered for home use.

Eurasian Customs Union approval (Belarus, Kazakhstan, Russian Federation)

EAC (Eurasion Conformity): Declaration of Conformity according to Technical Regulation of Customs Union (TR CU)

A.1.4.2 Industrial environments

The ET 200eco PN F is designed for use in industrial environments.

Table A- 1 Industrial environments

Application field	Emission requirements	Immunity requirements
Industrial	EN 61000-6-4	EN 61000-6-2

A.1.5 Electromagnetic compatibility

A.1.5.1 Electromagnetic compatibility overview

Electromagnetic Compatibility (EMC) is the ability of an electrical device to operate as intended in an electromagnetic environment and to operate without emitting levels of electromagnetic interference (EMI) that may disturb other electrical devices in the vicinity.

For safety related functions, additional EMC requirements are applied according to IEC 61326-3-1 and IEC 61326-3-2.

Table A- 2 Immunity per EN 61000-6-2

Electromagnetic compatibility - Immunity per EN 61000-6-2	
EN 61000-4-2 Electrostatic discharge	8 kV air discharge to all surfaces 6 kV contact discharge to exposed conductive surfaces
EN 61000-4-3 Radiated, radio-frequency, electromagnetic field immunity test	80 to 1000 MHz, 10 V/m, 80% AM at 1 kHz 1.4 to 6.0 GHz, 3 V/m, 80% AM at 1 kHz
EN 61000-4-4 Fast transient bursts	2 kV, 5 kHz with coupling network to AC and DC system power 2 kV, 5 kHz with coupling clamp to I/O
EN 61000-4-5 Surge immunity	AC systems - 2 kV common mode, 1kV differential mode DC systems - 2 kV common mode, 1kV differential mode For DC systems (I/O signals, DC power systems) external protection is required. Refer to "Safe functional extra low voltage requirement (power supplies and other system components)" (Page 112), "Surge immunity" for the recommended protection devices.
EN 61000-4-6 Conducted disturbances	150 kHz to 80 MHz, 10 V RMS, 80% AM at 1kHz

Table A- 3 Conducted and radiated emissions per EN 61000-6-4

Electromagnetic compatibility - Conducted and radiated emissions per EN 61000-6-4		
Conducted Emissions EN 55016, Class A, Group 1	0.15 MHz to 0.5 MHz	< 79dB (µV) quasi-peak; <66 dB (µV) average
	0.5 MHz to 5 MHz	< 73dB (µV) quasi-peak; <60 dB (µV) average
	5 MHz to 30 MHz	< 73dB (µV) quasi-peak; <60 dB (µV) average
Radiated Emissions EN 55016, Class A, Group 1	30 MHz to 230 MHz	< 40dB (µV/m) quasi-peak; measured at 10 m
	230 MHz to 1 GHz	< 47dB (µV/m) quasi-peak; measured at 10 m
	1 GHz to 6 GHz	< 76dB (uV/m) quasi peak, measured at 10 m

A.1.5.2 Surge immunity

Wiring systems subject to surges from lightning strike coupling must be equipped with external protection. You can find one specification for evaluation of protection from lightning-type surges in EN 61000-4-5, with operational limits established by EN 61000-6-2. The ET 200eco PN F requires external protection to maintain safe operation when subject to surge voltages defined by this standard. The module could issue a channel readback error and passivate the output if you do not appropriately set the "Maximum readback time".

A.1.6 Shipping and storage conditions

Table A- 4 Shipping and storage conditions

Type of conditions	Permissible range
EN 60068-2-2, Test Bb, Dry heat and EN 60068-2-1, Test Ab, Cold	-40 °C to +70 °C
EN 60068-2-30, Test Db, Damp heat	25 °C to 55 °C, 95% humidity
EN 60068-2-14, Test Na, temperature shock	-40 °C to +70 °C, dwell time 3 hours, 5 cycles
EN 60068-2-32, Free fall	0.3 m, 5 times, product packaging
EN 60068-2-6, Sinusoidal Vibration	5 - 8.4 Hz, 3.5 mm 8.4 - 500 Hz, 1 g 10 cycles per axis
EN 60068-2-27, Shock Strain	25 g, 6 ms, 1000 shocks per axis
Barometric pressure	1140 hPa to 660 hPa (corresponding to an altitude of -1000 m to 3500 m)

A.1.7 Mechanical and climatic ambient conditions

Test of mechanical ambient conditions

The table below provides important information with respect to the type and scope of the test of ambient mechanical conditions:

Table A- 5 Test of mechanical ambient conditions

Condition tested	Permissible range
Vibration (sinusoidal) conditions	
Without mounting rail	10 Hz ≤ f ≤ 58 Hz, constant amplitude 1.5 mm 58 Hz ≤ f ≤ 150 Hz, constant acceleration 20 g
With mounting rail	5 Hz ≤ f ≤ 8 Hz, constant amplitude 15 mm 8 Hz ≤ f ≤ 150 Hz, constant acceleration 5 g
Vibration (sinusoidal) test in accordance with IEC 60068-2-6	
Without mounting rail	10 Hz ≤ f ≤ 58 Hz, constant amplitude 3 mm 58 Hz ≤ f ≤ 150 Hz, constant acceleration 40 g
With mounting rail	5 Hz ≤ f ≤ 12 Hz, constant amplitude 15 mm 12 Hz ≤ f ≤ 150 Hz, constant acceleration 10 g
EN 60068-2-27 Mechanical shock	15 g, 11 ms pulse, 6 shocks in each of 3 axes
Shock, tested in accordance with IEC 60068-2-27	Type of shock: Half-sine; Shock intensity: 30 g peak value, 18 ms duration Direction of shock: 3 shocks in each +/- direction at each of the three vertically-aligned axes

Climatic ambient conditions

The following table shows the permissible climatic ambient conditions for the ET 200eco PN F-DI 8 / F-DQ 3 module:

Table A- 6 Climatic ambient conditions

Ambient conditions	Permissible range
Ambient temperature range	-25 °C to 60 °C, all mounting positions
Relative humidity	5% to 100% condensing humidity or sprayed water Note: Refer to the ET 200eco PN F-DI 8 / F-DQ 3 "Degree of protection IP66/67" (Page 197) for information on the IP67 rating.
Barometric pressure	1140 hPa to 795 hPa (corresponding to an altitude of -1000 m to 2000 m)
Concentration of contaminants	SO2: < 0.5 ppm with relative humidity < 60% non-condensing H2S: < 0.1 ppm with relative humidity < 60%, non-condensing
EN 60068-2-14, Test Nb, temperature change	-25 °C to 60 °C

Extended environmental conditions for outdoor use: This product does not support outdoor use.

A.1.8 Information on protection class, degree of protection, and rated voltages

A.1.8.1 Contamination level and overvoltage category in accordance with IEC 61010-2-201

The following levels are provided:

- Pollution degree 2
- Overvoltage category: II, unless otherwise noted

A.1.8.2 Protection class in accordance with IEC 61010-2-201

Protection Class II is provided according to IEC 61010-2-201:

- The ET 200eco PN F including only connections to SELV / PELV achieves Protection Class III.
- The ET 200eco PN F does not require a protective earth connection. A functional earth connection is provided and is used for non-safety purposes such as interference immunity improvement.

A.1.8.3 Degree of protection IP66/67

The following degrees of protection in accordance with IEC 60529 is provided for the ET 200eco PN F module:

- Degree of Protection IP 65 (Degree of protection according to IEC 60529):
  - Protection against the ingress of dust and full touch protection
  - Water projected by a nozzle against the module from any direction shall have no harmful effect.
- Degree of Protection IP 66 (Degree of protection according to IEC 60529):
  - Protection against the ingress of dust and full touch protection
  - Water projected by powerful jets against the module from any direction shall have no harmful effect.
- Degree of Protection IP 67 (Degree of protection according to IEC 60529):
  - Protection against the ingress of dust and full touch protection
  - Protection against water when the module is immersed at specified pressures over a specified time period (water must not enter the module in harmful quantities)

A.1.8.4 Rated voltages

Rated voltage	Tolerance	Notes
24 V DC	20.4 V DC to 28.8 V DC	Refer to "Safe functional extra low voltage requirement (power supplies and other system components)" (Page 112) for additional requirements of a 24 V DC power source.

When you suddenly apply 24 V DC power to the ET 200eco PN F modules, short-term current flows can occur which briefly mimic the effect of "1" signals at process outputs and inputs. Digital outputs can trigger to ON state for approximately 50.0 microseconds at power application. The modules deliberately test functional safety P- and M-switch outputs ON at different times for up to the user-configurable "Maximum readback time switch on test" (0.5 ms to 5.0 ms) during the power up sequence and as a cyclic bit pattern test. This test pulse can energize the load in the presence of a switch or wiring fault on the opposite side of the load circuit. Such short pulses are typically not a hazard for electromechanical loads, but you must consider the effect. High-speed electronic receiver circuits can detect short pulses and improperly interpret the short pulses as deliberate "1" signals.

WARNING

Short term current and voltage pulses can occur on 24 V DC I/O circuits near the time that power is applied.

Such short term pulses can cause unexpected activation or position changes in machinery, resulting in death or serious injury to personnel and/or property damage.

If your installation includes receivers which can be responsive to short pulses as described above, you should apply measures such as power sequencing or progressive removal of safety lockouts to assure that unexpected machine operations do not occur. *(S827)*

A.2 ET 200eco PN F-DI 8 x 24 VDC, 4xM12 / F-DQ 3 x 24 VDC/2.0A PM, 3xM12 technical specifications

A.2.1 Overview

Module model	Digital inputs	Digital outputs
ET 200eco PN F-DI 8 x 24 VDC, 4xM12 / F-DQ 3 x 24 VDC/2.0A PM, 3xM12	4 x 24 V DC (1oo2), 8 x 24 V DC (1oo1), or a mix	3 x 24 V DC

A.2.2 Specifications

A.2.2.1 ET 200eco PN F technical specifications

Technical Data	Value
Dimensions and weight	
Dimensions W x H x D (mm)	60 x 175 x 49
Weight (without packaging)	940 g
Module-specific data	
Transmission rate	100 Mbps full duplex
Transmission mode	100BASE-TX
Autonegotiation	Yes
Bus protocol	PROFINET IO: RT • Minimum update time of 250 microseconds Note: No IRT support, but module will participate within an IRT topology

Technical Data	Value		
Supported Ethernet services	PROFINET IO (Device): • ping • ARP • LLDP • Network diagnostics (SNMP)/MIB-2 • DCP • MRP - Media redundancy • I&M0-3 • Port diagnostics • Resetting to factory settings using PROFINET IO • FW update using PROFINET IO • Deactivating of ports (yes) • Device replacement with topological configuration		
PROFINET interface			
Connection socket	2 x M12 D-coded		
Switch function	Yes, internal		
Auto-crossover	Yes, if autonegotiation is enabled		
Manufacturer ID (Vendor ID)	$002A_H$		
Device ID (DeviceID)	0306_H		
Maximum achievable safety class			
Number of channels	1-channel input	2-channel input	Output channel
In accordance with IEC 61508:2010	SIL 2	SIL 3	SIL 3
In accordance with EN ISO 13849-1:2015	Cat 3, PL d	Cat 4, PL e	Cat 4, PL e
Fail-safe performance characteristics			
Safety Integrity Level (SIL)	SIL 2	SIL 3	SIL 3
PFD_avg [1]	≤6e-4	≤1e-5	≤2e-5
PFH [2]	≤1e-8	≤2e-10	≤7e-9
Useful Lifetime (Mission Time) [3]	20 years	20 years	20 years
Safety repair time	100 hours	100 hours	100 hours
Voltages and currents			
Supply voltage 1L+	24 V DC		
• Permissible range	20.4 V DC to 28.8 V DC		
• Surge voltage	35 V DC for 0.5 s		
• Reverse polarity protection	Yes		
• Infeed current 1L+	4.0 A (maximum)		
• Hold up time (loss of power)	0.1 ms at 20.4 V DC		
Supply voltage 2L+	24 V DC		

Technical Data	Value
• Permissible range	20.4 V DC to 28.8 V DC
• Surge voltage	35 V DC for 0.5 s
• Reverse polarity protection	Yes
• Infeed current 2L+	4.0 A (maximum)
• Hold up time (loss of power)	None for outputs 0.1 ms at 20.4 V DC for internal power
Current consumption	
From supply voltage (1L+)	Typical 200 mA (no sensor supply output current)
From supply voltage (2L+)	Typical 70 mA (no digital output activated)
Power loss of the device	9.0 W
Total current of the Sensor Supply outputs: All mounting positions to 60ºC	1.6 A through 1L+ (maximum)
Total current of the outputs: All mounting positions to 60ºC	3.9 A per 2L+ (maximum)
Insulation	
Insulation test voltage	DC 707 V (type test)
Ethernet interface	1500 V_{RMS} (IEEE802.3)
Electrical isolation	
Between 1L+ and 2L+	Yes
Between 1L+, digital inputs and sensor supply outputs	No
Between input channels	No
Between 2L+ and digital outputs	No
Between output channels	No
Between Ethernet and all other circuit elements	Yes
Status, interrupts, diagnostics	
Interrupts	No
Diagnostic function	
Group error/maintenance	Red/yellow "SF/MT" LED
Bus monitoring PROFINET IO	Red "BF" LED
Monitoring of supply voltage 1L+	Green "ON" LED
Monitoring of supply voltage 2L+	Green "DC 24V" LED
Existing connection to network	Green "P1 LK" and P2 LK" LED; LED for PROFINET IO infeed and loop-through
Host-directed reintegration	Red/green "REINT" LED
Digital input status	Green LED
Fault at digital input	Red LED
Digital output status	Green LED
Fault at digital output	Red LED
Diagnostic information can be read	Yes

Technical Data	Value
Monitoring for	
Failure of 1L+ and 2L+	Yes, under- and over-voltage
Sensor supply short-circuit	Yes
Digital input short-circuit	Yes, per channel
Digital output short-circuit	Yes, per channel
Digital input wire break	No
Digital output wire break	Yes, at PV=0, per channel
Sensor supply	
Number of sensor supplies	2 x 1L+
Voltage range	1L+ minus 2.0 V DC minimum
Load current	800 mA per sensor supply
Short-circuit protection	Yes, electronic Threshold: 1.4 A to 4.5 A
Sensor selection data / Digital inputs	
Number of inputs	
1oo1 evaluation	8 (maximum)
1oo2 evaluation	4 (maximum)
Type	Sink, Type 1 according to IEC 61131
Rated voltage	24 V DC at 5 mA, typical
Surge voltage	35 V DC for 0.5 s
Logic "1" signal	15 V DC at 3 mA to 30 V DC at 6 mA
Logic "0" signal	-30 V DC to 5 V DC
Connection of 2-wire proximity switch (BERO):	Not possible
• Permissible quiescent current	0.5 mA (maximum)
Filter delay (Configurable) [4]	• 0.8 ms • 1.6 ms • 3.2 ms • 6.4 ms • 12.8 ms
Cable length, shielded	30 m (maximum)
Cable length, unshielded	30 m (maximum)
Number of Inputs that can be controlled simultaneously	8, in all mounting positions
Actuator selection data/ Digital outputs	
Number of outputs	3
Type	P- and M- switching
Logic "1" signal at maximum current	2L+ minus 2.0 V DC (minimum): • P-switch: 2L+ minus 1.5 V DC (maximum) • M-switch: 0.5 V DC (maximum)

Technical Data	Value
Logic "1" current	• 2.0 A (nominal) • 10 mA to 2.4 A
Lamp load	10.0 W (maximum)
Logic 0 current (residual)	• P-switch: 0.5 mA (maximum) • M-switch: 0.5 mA (maximum)
Wire break monitoring	Yes, only when output is off
Output overload protection: [5] • M-switch • P-switch	Yes, electronic in addition to internal non-replaceable fuse. Threshold of 10.0 A to 34.0 A turns M-switch OFF. Threshold of 2.4 A to 4.4 A, 30 ms time constant filter, measured at P-switch, turns both switches OFF. 7.0 A fuse can open for large faults.
Inductive clamp voltage	• P-switch: -26 V DC referenced to 2M • M-switch: +48 V DC referenced to 2M
Number of Outputs that can be controlled simultaneously	3, in all mounting positions
Parallel connection of 2 outputs	Not possible
Control of a digital input	Not possible
Switching frequency	
With resistive load	30 Hz symmetrical (maximum)
With inductive load in accordance with IEC 60947-5-1, DC13	0.1 Hz symmetrical (maximum)
With lamp load	10 Hz symmetrical (maximum)
Reverse polarity protection [6]	Yes, except loads connected between M-switch and L+ will conduct if M and L+ are reversed.
Cable length, shielded	30 m (maximum)
Cable length, unshielded	30 m (maximum)

1 Operation in Low Demand Mode (Average probability of a dangerous failure on demand), PFD_avg

2 Operation in High Demand or Continuous Mode (Average frequency of a dangerous failure per hour), PFH

3 Maximum useful lifetime of this product

References

[4] Refer to "Response time parameters for the ET 200eco PN F-DI 8 / F-DQ 3 digital inputs" (Page 219) for further information.

[5] Refer to "Fuse and electronic overload protection" (Page 204) for more information.

[6] Refer to "Digital Output Application Mode 2" (Page 101) for more information.

A.2.2.2 Fuse and electronic overload protection

Overload protection attempts to protect the module from damage from moderate faults in the range of 2.4 A to 15.0 A at the P switch. Above 15.0 A on each P-switch fuse, the internal non-replaceable fuse can open. Supply your ET 200eco PN F-DI 8 / F-DQ 3 digital outputs from a source limited to less than 15.0 A, or use an external fuse or non-shorting load element to prevent opening of the internal fuse.

The internal electronic limiting causes the channel to passivate and reports as an overload. If no damage results, you can reintegrate the channel after removal of the external fault.

A.2.2.3 Switching of loads

Connecting capacitive loads

Load capacitance can delay the voltage response as seen at the P- and M- switches of the ET 200eco PN F-DI 8 / F-DQ 3 digital outputs. For a capacitive load with capacitance C across P and M, and a parallel load resistance R, the "Maximum readback time" needs to be in the range of 2.0 to 2.5 time constant (R * C) of the load. This allows enough time for an appreciable voltage change to be seen when you briefly de-energize an energized load during bit pattern testing. If the resulting "Maximum readback time" is too long for your application, you can reduce this time constant by adding parallel resistance across the load to reduce the realized R * C time constant.

Alternatively, you can add a diode between the P-output and the load (capacitor and resistors) so that when you turn off the output, the voltage on the capacitor is not present at the P-output. Typically, power supplies with input capacitors that have reverse voltage protection have this diode built into the power supply. Using the added diode, you can greatly reduce the "Maximum readback time" to some portion of the hold-up time of the power supply/capacitor. This reduced "Maximum readback time" allows the load to operate normally (load stays ON) during the bit pattern tests.

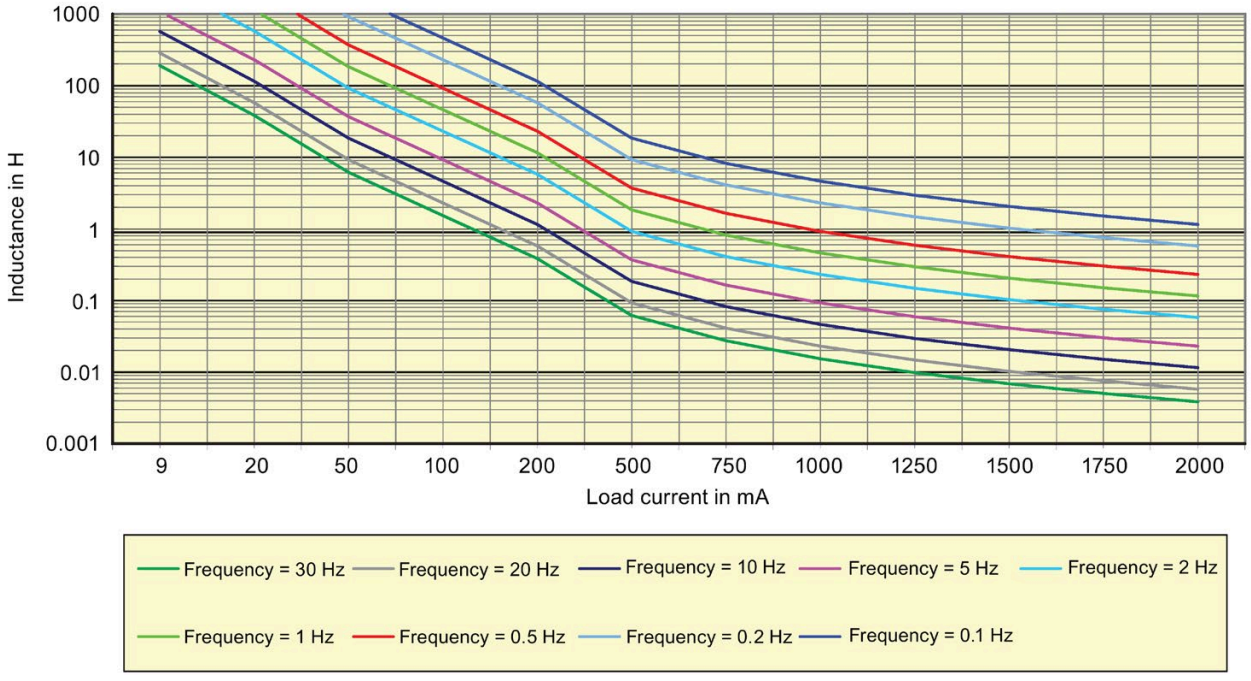
Stray capacitance between the load circuit and ground, M, and P increases the time required for the "Maximum readback time switch on test". When module diagnostics switch "ON" a P or M switch to a de-energized load during bit pattern testing, both sides of the load are driven towards L+ or M, limited by stray capacitance. This effect is typically small.

Your "Maximum readback time switch on test" should be long enough for the load circuit voltage to react, but short enough that if one side of the load faults to P or M, testing of the opposite switch should not cause the load to mechanically react.

Capacitive loads (including power supplies with input capacitors) with low series resistance can have a large inrush current. If you have a large capacitive load, you should add series resistance to reduce the inrush current to reduce the risk of opened fuses or overcurrent fault detection on normal load switch ON events.

Switching of inductive loads

The graph below shows the maximum permitted inductive load and switching frequency allowed using only the internal suppression circuits of the ET 200eco PN F-DI 8 / F-DQ 3 digital outputs. You should equip larger or more frequently switched inductive loads with external suppression circuits to avoid early failure of the ET 200eco PN F-DI 8 / F-DQ 3 digital output switch. The external suppression must conduct the load current at a voltage less than the internal suppression threshold to avoid overloading the internal suppression. Refer to "Guidelines for inductive loads" (Page 144) for more information:



WARNING

Unsuppressed inductive loads can lead to failures.

The following failures can result:

- Unsuppressed inductive loads can lead to early "stuck-on"' failures of the ET 200eco PN F-DI 8 / F-DQ 3 digital outputs.
- Unsuppressed inductive load switching generates an EMI hazard to the PLC system and correct processing of the safety function.

Death or serious personal injury and damage to machines and equipment may result if proper precautions are not taken.

You should use suppressor circuits with inductive loads to limit the voltage rise when a control output turns off and to limit the electrical noise generated when switching inductive loads. *(S831)*

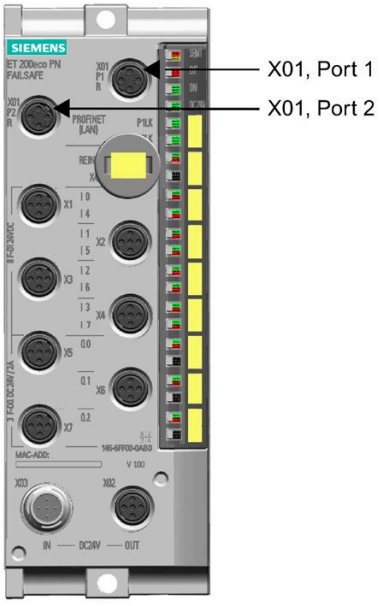
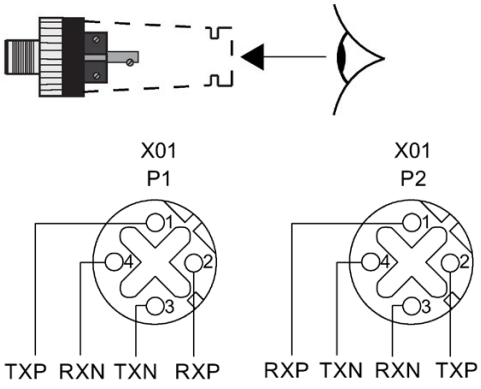
A.2.3 Wiring diagrams

A.2.3.1 Pin assignment of the PROFINET connector

PROFINET connector, X01 connector, port 1 and port 2

The module has a M12 connector with four female pins that are D-coded.

Table A- 7 Pin assignment of the M12 cable connector for PROFINET connector, ports 1 and 2

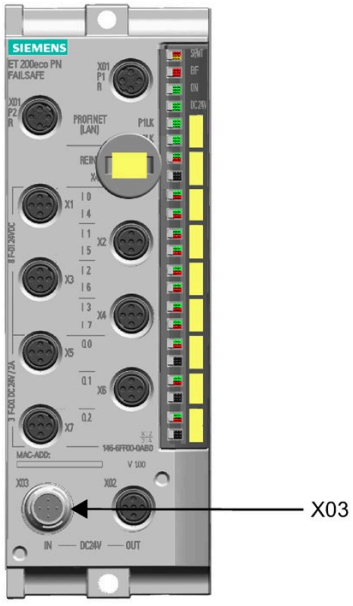
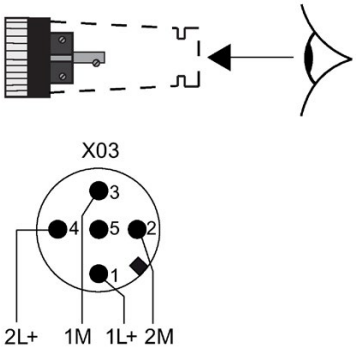
ET 200eco PN F	Pin	Assignment	View of the cable connector (PROFINET), port 1 and port 2
		**Assignment X01 P1**	
	1	TXP	
	2	RXP	
	3	TXN	
	4	RXN	
	Thread	Functional earth FE	
		Assignment X01 P2	
	1	RXP	
	2	TXP	
	3	RXN	
	4	TXN	
	Thread	Functional earth FE	

A.2.3.2 Pin assignment for feeding and looping the voltage

Cable connector for supply voltage infeed, X03 connector

The module has an M12 connector with five male pins that are A-coded.

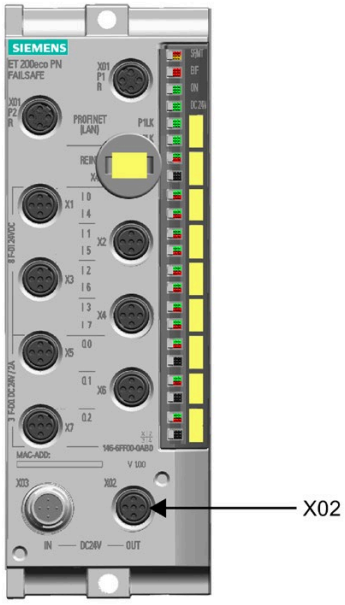
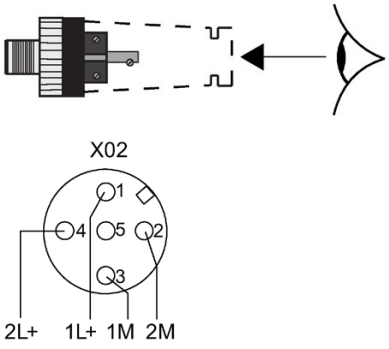
Table A- 8 Pin assignment of the M12 cable connector for the supply voltage infeed

ET 200eco PN F	Pin	Assignment	View of the cable connector (wiring side)
	1	Supply voltage 1L+	
	2	Ground 2M	
	3	Ground 1M	
	4	Supply voltage 2L+	
	5	Reserved	

Cable connector for loop-through of the supply voltage, X02 socket

The module has an M12 connector with five female pins that are A-coded.

Table A- 9 Pin assignment of the M12 cable connector for loop-through of the voltage

ET 200eco PN F	Pin	Assignment	View of the cable connector (wiring side)
	1	Supply voltage 1L+	
	2	Ground 2M	
	3	Ground 1M	
	4	Supply voltage 2L+	
	5	Reserved	

Note

The M12 sockets for the supply and I/O have the same coding.

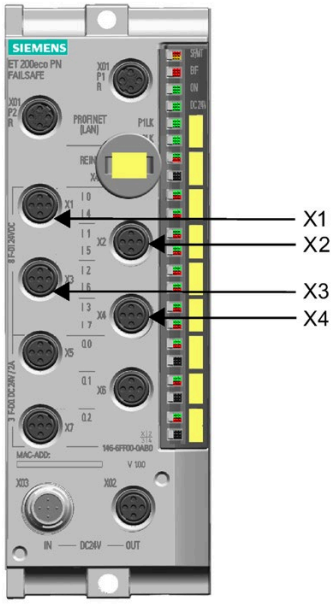
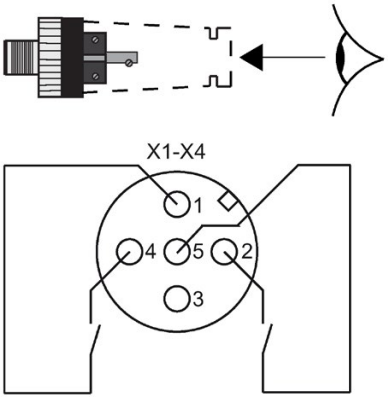
Make sure that you wire the supply and the I/O correctly.

A.2.3.3 Pin assignment of digital inputs

Cable connector for digital inputs, X1 - X4

The module has an M12 connector with five female pins that are A-coded.

Table A- 10 Pin assignment of digital inputs

ET 200eco PN F	Pin	Assignment	View of the cable connector (wiring side)
	1	24 V DC sensor supply Vs1	
	2	Input signal DI4: Connector X1 Input signal DI5: Connector X2 Input signal DI6: Connector X3 Input signal DI7: Connector X4	
	3	Sensor supply ground 1M	
	4	Input signal DI0: Connector X1 Input signal DI1: Connector X2 Input signal DI2: Connector X3 Input signal DI3: Connector X4	
	5	24 V DC sensor supply Vs2	

When using the Y cable, pin 4 of the module connector is assigned to pin 4 of the A connector, and pin 2 of the module connector is assigned to pin 4 of the B connector.

Note

The M12 sockets for the supply and I/O have the same coding.

Make sure that you wire the supply and the I/O correctly.

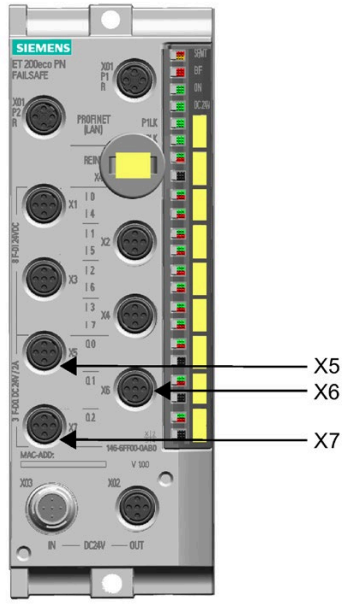
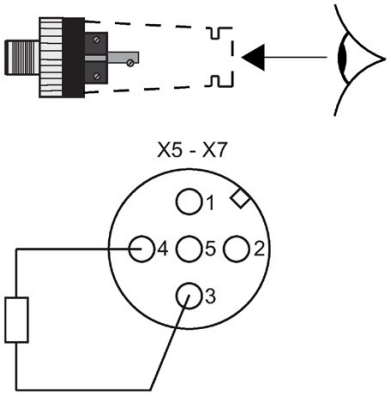
Refer to "Digital input applications" (Page 88) for alternate applications wiring.

A.2.3.4 Pin assignment of digital outputs

Cable connector for digital outputs, X5 - X7

The module has an M12 connector with five female pins that are A-coded.

Table A- 11 Pin assignment of digital outputs

ET 200eco PN F	Pin	Assignment	View of the cable connector (wiring side)
	1	Not used	
	2	Not used	
	3	Output signal DQ0-M: Connector X5 Output signal DQ1-M: Connector X6 Output signal DQ2-M: Connector X7	
	4	Output signal DQ0-P: Connector X5 Output signal DQ1-P: Connector X6 Output signal DQ2-P: Connector X7	
	5	Functional earth FE	

Note

The M12 sockets for the supply and I/O have the same coding.

Make sure that you wire the supply and the I/O correctly.

Refer to "Digital output applications" (Page 100) for alternate applications wiring.

A.3 Terminal block

Refer to "Installing the terminal block" (Page 109) and "Wiring the terminal block" (Page 137) for installation and wiring information.

Refer to the "Distributed I/O ET 200eco PN Operating Instructions" (https://support.industry.siemens.com/cs/document/29999018/simatic-distributed-i-o-et-200eco-pn?dti=0&lc=en-WW) for ET 200eco PN system terminal block technical specification information.

A.4 Voltage distributor

Refer to "Wiring the voltage distributor" (Page 141) for wiring information.

Refer to the "Distributed I/O ET 200eco PN Operating Instructions" (https://support.industry.siemens.com/cs/document/29999018/simatic-distributed-i-o-et-200eco-pn?dti=0&lc=en-WW) for ET 200eco PN system voltage distributor technical specification information.

Ordering information

B

B.1 ET 200eco PN F-DI 8 x 24 VDC, 4xM12 / F-DQ 3 x 24 VDC/2.0A PM, 3xM12

Table B- 1 ET 200eco PN F-DI 8 / F-DQ 3 module

Item		Article number
Digital inputs and digital outputs	ET 200eco PN F-DI 8 x 24 VDC, 4xM12 / F-DQ 3 x 24 VDC/2.0A PM, 3xM12	6ES7146-6FF00-0AB0

B.2 Accessories for the ET 200eco PN F-DI 8 / F-DQ 3 module

CAUTION

In order to maintain the IP66/67 rating of the ET 200eco PN F-DI 8 / F-DQ 3 module, you can only utilize the appropriately approved accessories, some are listed below, for connection to the ET 200eco PN F-DI 8 / F-DQ 3 module.

Failure to use listed accessories can allow for ingress of water or dust into the ET 200eco PN F-DI 8 / F-DQ 3 module causing damage to the module. Electrical faults or unexpected machine operation can result in minor personal injury if proper precautions are not taken.

You must follow all instructions for installation and maintenance of a proper operating environment to ensure the equipment operates safely.

The table below contains the article numbers for the accessories of the ET 200eco PN F-DI 8 / F-DQ 3 module:

Table B- 2 Accessories for the ET 200eco PN F-DI 8 / F-DQ 3 module

Designation		Article number
Accessories		
eCoding plug Stores the F-destination and F-source addresses; occupies X40 M12 connector, utilizing a B-coded plug		6ES7194-6KB00-0AA0
Voltage distributor PD 24 V DC 1x7/8" 4×M12		6ES7148-6CB00-0AA0
Terminal block		6ES7194-6CA00-0AA0 *
Mounting rail, 500 mm		6ES7194-6GA00-0AA0
Profile screws, 50 items		6ES7194-6MA00-0AA0
AS interface accessory M12 cover for IP67 devices		3RK1901-1KA00
Labels 10 x 7 mm, yellow, 816 items per pack		6ES7194-6HA00-0AA0
Accessories for the interface "PROFINET M12 connection X1 P1/P2 LAN"		
SIMATIC NET IE M12 Plug pro M12 connector with rugged metal housing and quick connection technology, with 180° cable exit (D-coded), for SCALANCE X208pro and ET 200pro PN	1 pack = 1 units	6GK1901-0DB10-6AA0 *
	1 pack = 8 units	6GK1901-0DB10-6AA8 *
Connector for PROFINET 4-core, shielded		3RK1902-2DA00
SIMATIC NET IE FC M12 plug pro, M12 connector with rugged metal housing and FC connection technology, axial cable exit (D-coded), for SCALANCE X208pro and ET 200pro PN	1 pack = 1 units	6GK1901-0DB20-6AA0 *
	1 pack = 8 units	6GK1901-0DB20-6AA8 *
PROFINET M12 connecting cables		
SIMATIC NET; IE FC TP Standard Cable, GP 2x2 (PROFINET TYPE A), TP installation cable for connection to FC outlet RJ45, for universal usage, 4-wire, shielded CAT 5, sold in meters, delivery unit maximum length of 2000 m, minimum order length 20 m		6XV1840-2AH10
SIMATIC NET; IE FC TP trailing Cable, GP 2x2 (PROFINET TYPE C), TP installation cable for connection to FC outlet RJ45, for drag chain use, 4-wire, shielded CAT 5, sold in meters (5 million bend cycles), delivery unit maximum length of 2000 m, minimum order length 20 m		6XV1840-3AH10
SIMATIC NET; IE FC TP trailing Cable, GP 2x2 (PROFINET TYPE C), TP installation cable for connection to FC outlet RJ45, for drag chain use, 4-wire, CAT 5, sold in meters (1 million bend cycles), delivery unit maximum length of 1000 m, minimum order length 20 m		6XV1870-2D
SIMATIC NET; IE FC TP Marine Cable, TP installation cable for connection to FC outlet RJ45, ratified by ship builders, 4-wire, shielded CAT 5, sold in meters, delivery unit maximum length of 1000 m, minimum order length 20 m		6XV1840-4AH10
SIMATIC NET; IE FC TP Torsion Cable, 2x2 (PROFINET TYPE C), TP installation cable, 4-wire, for use in highly flexible applications (torsion), sold in meters, delivery unit maximum of 1000 m, minimum order amount 20 m		6XV1870-2F
SIMATIC NET, IE Connecting Cable M12-180/M12-180,	0.3 m	6XV1870-8AE30 *

Designation		Article number
preassembled IE FC Trailing Cable GP, with 2 x M12 connectors (D-coded)	0.5 m	6XV1870-8AE50 *
	1.0 m	6XV1870-8AH10 *
	1.5 m	6XV1870-8AH15 *
	2.0 m	6XV1870-8AH20 *
	3.0 m	6XV1870-8AH30 *
	5.0 m	6XV1870-8AH50 *
	10.0 m	6XV1870-8AN10 *
	15.0 m	6XV1870-8AN15 *
Bus line for PROFINET, converted on both sides, 4-wire, shielded, converted with 2 x M12 D coded, angled	3.0 m	6RK1902-2NB30
	5.0 m	6RK1902-2NB50
	10.0 m	6RK1902-2NC10
Bus line for PROFINET, converted on one side, 4-wire, shielded, converted with 1 x M12 D coded	3.0 m	3RK1902-2HB30
	3.0 m	3RK1902-2HB50
	10.0 m	3RK1902-2HC10
Miscellaneous		
AS interface accessory M12 sealing cap for IP67 modules		3RX9802-0AA00 *
Accessory for the interface "M12-socket X1 to X4/X5 to X7"		
Preassembled cable		
Control cable Pre-assembled at one end M12 connector angled, 5-pole with 1.5 m cable 5 x 0.34 mm2 A-coded max. 4 A PUR sheath black	1.5 m	3RK1902-4HB15-5AA0 *
Control cable Pre-assembled at one end M12 connector angled, 5-pole with 5 m cable 5 x 0.34 mm2 A-coded max. 4 A PUR sheath black	5.0 m	3RK1902-4HB50-5AA0 *
Control cable Pre-assembled at one end M12 connector angled, 5-pole with 10 m cable 5 x 0.34 mm2 A-coded max. 4 A PUR sheath black	10.0 m	3RK1902-4HC01-5AA0 *
Connecting cable M12-M12, 3-pin, PUR cable, 3 × 0.34 mm^2, type E, L, IP67, NO, straight female connector M12 to straight male connector M12	1.5 m	3RK1902-4PB15-3AA0
Y cable		
SIMATIC DP, Y cable for distributed I/O for double connection of standard inputs with one cable, 5-pin M12, 200 mm		6ES7194-6KA00-0XA0
SIMATIC DP, Y cable for distributed I/O for double connection of F-DI with one cable, 5-pin M12, 200 mm		6ES7194-6KB00-0XA0
SIMATIC DP, Inverted Y cable for distributed I/O for connecting an F-DI and F-DQ with one cable, 5-pin M12, 200 mm		6ES7194-6KC00-0XA0
SIRIUS safety position switch		3SE5324-0SD21-1AE4 3SE5324-0SD21-1AE5
Accessories for the interface "DC 24 V IN/OUT M12 (X02/X03)"		
SIMATIC NET, IE Power M12 Cable Connector pro, connection socket for connecting SCALANCE W-700/X208pro for 24 V DC supply voltage, 4-pin, A-coded, with mounting instructions, 3 items		6GK1907-0DC10-6AA3

Designation		Article number
SIMATIC NET, IE Power M12 Plug pro, plug connector for connecting Power Supply PS791-1 pro for 24 V DC supply voltage, 4-pin, A-coded, with mounting instructions, 3 items		6GK1907-0DB10-6AA3
Power Connecting Cable M12-180/M12-180 for power supply of the ET 200, preassembled cable with M12 connector and M12 socket, A-coded, 5-pin	0.3 m	6XV1801-5DE30 *
	0.5 m	6XV1801-5DE50 *
	1.0 m	6XV1801-5DH10 *
	1.5 m	6XV1801-5DH15 *
	2.0 m	6XV1801-5DH20 *
	3.0 m	6XV1801-5DH30 *
	5.0 m	6XV1801-5DH50 *
	10.0 m	6XV1801-5DN10 *
	15.0 m	6XV1801-5DN15 *

* All of the items with UL certification have an asterisk (*) following their article number.

B.3 Accessories for voltage distributors

The table below contains the article numbers for the accessories of the voltage distributors:

Table B- 3 Accessories for voltage distributors

Designation		Article number
Accessories for the interface "DC 24V IN 7/8" (X05)"		
7/8" connector with axial cable exit for field assembly ET 200, female insert		6KG19050FB00
24 V socket - 7/8" angled, 5-pin		3RK1902-3DA00
SIMATIC NET, Energy Cable, 5-wire power cable, stranded wire, 5 × 1.5mm^2, suitable for cable carriers, delivery unit max. 1000 m, minimum order amount 20 m		6XV1830-8AH10
Power Connecting Cable M12-180/M12-180 for power supply of the ET 200, preassembled cable with M12 connector and M12 socket, A-coded, 5-pin	0.3 m	6XV1801-5DE30
SIMATIC NET, 7/8" connector for power supply of the ET200, preassembled cable with 2 7/8" connectors, 5-pin	1.5 m	6XV1822-5BH15
	2.0 m	6XV1822-5BH20
	3.0 m	6XV1822-5BH30
	5.0 m	6XV1822-5BH50
	10.0 m	6XV1822-5BN10
	15.0 m	6XV1822-5BN15
Power cable 7/8" for 24 V, assembled with 2 x 7/8 both sides angled, 1.5 mm^2, pin - socket 5-pin	1.5 m	(on request)
	2.0 m	(on request)
	3.0 m	3RK1902-3NB30
	5.0 m	3RK1902-3NB50
	10.0 m	3RK1902-3NC10
	15.0 m	(on request)
Power cable 7/8" for 24 V, assembled with 1 x 7/8" one side angled, 1.5 mm^2, socket, 5-pin	3.0 m	3RK1902-3GB30
	5.0 m	3RK1902-3GB50
	10.0 m	3RK1902-3GC10

B.4 Spare fuses for terminal blocks

The table below contains the article numbers for spare parts:

Table B- 4 Spare parts: Article numbers

Designation	Article number
Spare fuses for terminal block (miniature copper flat fuse, type FK1, 7.5 A, fast-blow)	6ES7194-6HB00-0AA0

B.5 Documentation

The tables below contain the ISBN or article numbers of additional documentation resources:

PROFINET IO

Technical book	Contents	Article number
Automating with PROFINET - Industrial Communication based on Industrial Ethernet	This book provides an introduction to PROFINET technology.	Commercial book number: ISBN 3-89578-244-0

SIMATIC Manual Collection

Designation	Contents	Article number
SIMATIC Manual Collection	Contains all SIMATIC manuals in electronic format	6ES7998-8XC01-8YE0

Technical Product Data - CD ROM

Designation	Contents	Article number
Technical Product Data for CAx Applications	Contains the following technical product data for CAD/CAE systems: • Technical data according to ECAD component standard V1.2 • Graphical data (drawings) • Circuit-diagram macros	6ES7991-0CC00-0YX0

B.6 Programming software

The table below contains the article numbers for applicable programming and visualization software:

Table B- 5 Programming and visualization software

SIMATIC software		Article number
Programming software	STEP 7 Professional V15	6ES7822-1AA05-0YA5
	STEP 7 Safety Advanced V15	6ES7833-1FA15-0YA5
Visualization software	WinCC Basic V15	6AV2100-0AA01-0AA0
	WinCC Comfort V15	6AV2101-0AA01-0AA5
	WinCC Advanced V15	6AV2102-0AA01-0AA5
	WinCC Professional 512 PowerTags V15	6AV2103-0DA01-0AA5
	WinCC Professional 4096 PowerTags V15	6AV2103-0HA01-0AA5
	WinCC Professional max. PowerTags V15	6AV2103-0XA01-0AA5

Fail-Safe response times

C

C.1 Maximum response time of the system

Calculating the maximum response time of the system

You can calculate your maximum system response time using the "SIMATIC STEP 7 Safety Advanced: F-Execution Times, F-Runtimes, F-Monitoring and Reaction Times" (http://support.automation.siemens.com/WW/view/en/49368678/133100).) Excel file (RT_calculator). Use your configured individual fail-safe module timing parameters and the module characteristic parameters found in this appendix to determine the maximum response time of your system.

Data transport delays included

The T_{CYCLE} parameter values given below include an allowance for the fail-safe module to acquire and deliver PROFIsafe messages in transactions with the PLC I/O bus. The execution time of the Safety FB in the fail-safe CPU includes the physical transport delay time for PROFIsafe messages moving between the fail-safe module location and the fail-safe CPU. There are no separate transport delay parameters that you must include in your calculations.

C.2 Response time parameters for the ET 200eco PN F-DI 8 / F-DQ 3 digital inputs

Maximum Device Acknowledge Time of the ET 200eco PN F-DI 8 / F-DQ 3 module

T_{DAT_i} 16 ms	Device Acknowledge Time: This is the maximum time for the PROFIsafe message from the fail-safe module's digital inputs to include a response to a new Virtual Monitoring Number. You enter this value in the RT_calculator for a calculation of F-monitoring time.

Maximum response time of the ET 200eco PN F-DI 8 / F-DQ 3 digital inputs

1oo1 evaluation:

$T_{WCDT\_i} = T_{filter} + T_{sct} + 2 \times T_{cycle}$

$T_{OFDT\_i} = T_{WCDT\_i} + T_{scf}$

1oo2 evaluation:

$T_{WCDT\_i} = T_{filter} + T_{sct} + 2 \times T_{cycle}$

$T_{OFDT\_i} = T_{WCDT\_i} + MAX (T_{sct}, T_{dis})$

Where:

T_{WCDT_i}	Worst Case Delay Time: Maximum response time of the fail-safe module's digital inputs from a signal transition at the digital input to the reliable availability of the safety message frame available for the fail-safe CPU request.
T_{OFDT_i}	One Fault Delay Time: Maximum response time for the fail-safe module's digital inputs to report a channel as passivated.
T_{filter}	Configured "Input filters" time for the channel
T_{DIS}	Discrepancy time: • Configured "Discrepancy time" for 1oo2 channels changing from "0" to "1" • Configured "Discrepancy time" for 1oo2 channels changing from "1" to "0" and "Supply last valid value" option configured for discrepancy behavior • "0" for 1oo2 channels changing from "1" to "0" and "Supply value 0" option configured for discrepancy behavior • "0" for 1oo1 channels You should include the expected discrepancy time between your sensor inputs in your external sensor delay. Your configured T_{DIS} contributes to T_{OFDT_i} as the time delay for the fail-safe module's digital inputs to passivate the channel due to fault case extension of the discrepancy time. This parameter can be listed separately in the RT_calculator. Do not include T_{DIS} in the value of T_{OFDT} that you enter into the RT_calculator if you enter T_{DIS} as a separate item.
T_{sct}	Time delay for short-circuit test duration: • "0" if no short-circuit test configured • "0" for 1oo2 channels changing from "1" to "0" and "Supply value 0" option configured for discrepancy behavior • "Duration of short-circuit test" + "Input filters" time if short-circuit test is configured (Confirmation: "Input filters" can occur twice in equation for T_{WCDT_i} if short-circuit test is configured.)
T_{scf}	Time delay for short-circuit fault detection: • Configured "Interval for short-circuit test", when operating in high demand or continuous mode and depending on the short-circuit test to achieve your required level of safety integrity • "0" when not depending on the short-circuit test to achieve your required level of safety integrity
T_{cycle} 9 ms	Internal cycle time of the fail-safe module

The term "2 x T_{cycle}" allows for other input delays to complete just after the beginning of a cycle. The fail-safe module's digital inputs process and report the changed input data on the next cycle.

C.3 Response time parameters for the ET 200eco PN F-DI 8 / F-DQ 3 digital outputs

Maximum response time of the ET 200eco PN F-DI 8 / F-DQ 3 digital outputs

$T_{WCDT\_q} = T_{rb} + MAX (T_{rb}, T_{rb\_swon}) + 2 \times T_{cycleq}$

$T_{OFDT\_q} = T_{WCDT\_q}$

Where:

T_{WCDT_q}	Maximum response time of the fail-safe module's digital outputs from the receipt of a safety message frame from the safety program in the fail-safe CPU to the signal tran-si-tion at the digital output
T_{OFDT_q}	One Fault Delay Time: Maximum response time for the module's digital outputs to turn an output OFF upon detection of a channel or module fault
T_{rb}	Configured "Maximum readback time" for the channel
T_{rb_swon}	Configured "Maximum readback time switch on test" for the channel
T_{cycleq} 9 ms	Internal cycle time of the fail-safe module

The term "2 x T_{cycleq}" allows for a new process value to be delivered from the fail-safe CPU just after the beginning of a cycle. The fail-safe module's digital outputs process the changed output request and apply new data to the output switches on the next cycle.

After the fail-safe module's digital outputs command the output switch to change, the actual voltage on the load might not be realized until the configured readback time completes. If a bit pattern test is in progress, the new process value cannot be applied to the switches until the applicable readback time completes.

Minimum permissible OFF time for ET 200eco PN F-DI 8 / F-DQ 3 digital outputs

The fail-safe module's digital outputs expect to complete and confirm each ON to OFF transition before receiving a new command to go from OFF to ON. A process value of "0" presented for less than T_{WCDT_q} can cause the channel to passivate.

Glossary

1oo1

A functional safety architecture with no redundancy. The safety function requires 1 out of 1 provided signal/logic channels for implementation. A single dangerous fault results in dangerous loss of the safety function.

1oo2

A functional safety architecture with two channels. The safety function requires 1 out of 2 provided signal/logic channels for implementation. The safety function is still fulfilled in the presence of a dangerous fault in one channel.

Access protection

Fail-safe systems must be protected from dangerous, unauthorized access. Access protection for F-Systems is implemented through assignment of two passwords (for the fail-safe CPU and the safety program).

Actuator

Field device that converts the electrical signal from the PLC into an action of controlled machinery. In this manual, the term can include interposing contactors and relays that control machinery, as well as directly connected motors or solenoids.

Category

Category according to EN ISO 13849 defines architectural requirements for functional safety. The products in this manual can fulfill Category 2 to Category 4. Category 4 requires that no single fault can be dangerous and no undetected accumulation of faults can be dangerous.

See also Overvoltage category.

Channel

In IEC 61508 terminology, a channel is a single signal/logic path that supports a safety function. The definition of 1oo1 and 1oo2 above uses channel in this sense. In most uses in this manual, a channel refers to one process value, whether implemented as 1oo1 or 1oo2.

Channel fault

A fault that causes one process value to be passivated, such as a detected wiring fault on one input. Other channels in the module can continue to support a safety function.

See also Module fault:

- ET 200eco PN F-DI 8 / F-DQ 3 digital inputs:
  - When configured as 1oo1, a detected fault related to one digital input terminal results in the process value being set to "0". The 1oo1 configuration is exposed to the risk of a single undetected fault (for example, a sensor stuck ON).
  - When configured as 1oo2, both associated digital input terminals are represented by a single process value. A detected fault related to either digital input in the 1oo2 pair, or a failure of the two inputs to compare, results in the process value being set to "0".
- ET 200eco PN F-DI 8 / F-DQ 3 digital outputs:
  - Always operate as 1oo2 using P and M for outputs, with two DC switches required to be ON to supply energy to the load
  - A detected fault associated with either switch results in an attempt to turn off both switches and a report to the user program that the channel is passivated.

CRC signature

The CRC (Cyclic Redundancy Check) signature is a cyclic redundancy checksum that confirms the integrity of the PROFIsafe message contents and sequence.

Cyclic interrupt / cycle time

The start-to-start user configured time delay between executions of the safety program.

Dark test / dark time

The test or time in which a "0" signal is deliberately created to confirm that "0" can be controlled or detected when needed. On inputs, the F-DI performs a dark test by briefly turning off the sensor supply. On DC outputs, the F-DQ DC performs a dark test by briefly turning off one of the P or M output switches.

Discrepancy time (of inputs)

The configured discrepancy time during which you expect 1oo2 inputs to disagree due to mechanical and electrical differences in input signals. The module interprets differences between inputs lasting longer than the discrepancy time as a channel fault.

eCoding plug

The eCoding plug stores the F-source and F-destination addresses external to the module. The ecoding plug occupies the X40 M12 connector, utilizing a B-coded plug. You use the eCoding plug to facilitate module replacement.

Equivalent (input)

A 1oo2 input channel where both signal inputs interpret high voltage as a process value "1" and low voltage as a process value "0".

ES

Engineering **S**ystem (ES): An engineering system is a PC-based configuration system that enables convenient, visual adaptation of the process control system to the task at hand.

Fail-safe

A system or component designed to reliably provide a defined, safe result in the event of a fault.

Fail-safe modules

You can use the following fail-safe modules with S7-1200/1500, S7-300/400, ET 200pro (IP67 compliant), or ET 200S/ET 200SP Fail-Safe:

- ET 200eco PN, ET 200SP, ET 200S, ET 200pro, and ET 200iSP fail-safe modules in the ET 200eco PN, ET 200SP, ET 200S, ET 200pro, and ET 200iSP distributed I/O systems
- ET 200MP fail-safe modules in a distributed I/O ET 200MP system
- S7-1200 fail-safe signal modules centrally in an S7-1200 system

These modules are equipped with integrated safety functions for fail-safe operation and operate in accordance with the PROFIsafe bus profile.

F-FBs /F-FCs

Fail-safe function blocks (FB) and function calls (FC) are program units in which you program the safety program in F-FBD or F-LAD. FBs include an instance DB (Data Block) that retains information about that particular usage of the function in your program. For example, each specific instance of a timer has a DB to retain the results of each timer update. FCs do not include an instance DB, and no information is carried over between calls to FCs.

F-I/O

A general term for fail-safe input and output modules

F-monitoring time

The F-monitoring time is the amount of time a fail-safe module or CPU waits for an error-free communication including the expected new Virtual Monitoring Number before passivating channels.

F-runtime group

An F-runtime group consists of an F-OB (cycle OB or cyclic interrupt OB) that calls a main safety block (FB or FC). Additional user-specific safety functions must then be called from this main safety block.

F-system

A fail-safe system

Light test / light time

The test or time in which a "1" signal is deliberately created to confirm that "1" can be controlled or detected when needed. The module described in this manual does not deliberately conduct light tests that can affect your program or the output load. The module produces ON test pulses up to the Maximum readback time switch on test on each of the P and M output switches individually, but does not intentionally turn on both P and M switches at the same time for a test when the commanded process value is "0". In the unlikely event of an undetected fault on the opposite switch, the test pulses can result in energy applied to the load.

M

Refers to the 24 V DC power circuit 0 V DC reference. In the context of the module outputs, M can refer to the switch output connecting the load to M.

M12 cable connectors

Threaded, IP66/67 - dust tight, waterproof, circular connectors that provide a simple, reliable connection to industrial components that protects the interconnection from foreign particulates, dust, water, and hazardous substances.

Module fault

A fault that affects all channels of a fail-safe module. The fail-safe module attempts to passivate all channels in the module.

See also Channel fault.

Non-equivalent (input)

A 1oo2 input channel where one signal input interprets high voltage as a process value "1" and the redundant signal input interprets high voltage as a process value "0". A common configuration is complementary normally-open and normally-closed switches connected to the same process event.

Overvoltage category

A definition of transient voltage threat due to lightning strikes and other sources, generally associated with how closely the circuit is coupled to outdoor electrical wiring. Category III represents a higher voltage level threat than Category II.

P

Refers to the 24 V DC positive supply. In the context of the module outputs, P can refer to the switch output connecting the load to P.

Passivate / passivated / passivation

The fail-safe CPU or fail-safe module has identified a channel or module as faulty. The fail-safe CPU or fail-safe module supplies the fail-safe process value "0" instead of any detection or logic evaluation that can result in process value "1".

PELV

Protective Extra Low Voltage = extra low voltage with safe isolation

PFD_avg

Average probability of a dangerous failure on demand

An estimate of how likely a safety function will fail to perform as expected when required to function only rarely (on demand). PFD is typically used for safety function applications that are required to operate in response to unusual accidental or emergency events occurring less frequently than once per year.

PFH

Average frequency of a dangerous failure per hour

The average frequency of dangerous failures for systems that are required more frequently than once per year to initiate or maintain a safe state. Most safety functions associated with routine machine operation use PFH as a defining safety metric.

PL

Performance Level (PL): Levels "a" through "e" are defined in EN ISO 13849, with level "e" being the high level of safety performance. A higher PL is associated with a lower probability of dangerous failure.

PM

Refers to the DC output point including a switch to P and a switch to M. The typical application is for the load to be connected between the P and M switches, sometimes called "PM mode".

Process value bit

The data bit accessible to the user program representing the process value. If an input channel is passivated, the process value bit is set to "0". If an output channel is passivated, the user program can set the process value bit to "1", but this is not effective at the module outputs.

PROFIsafe

A communication protocol providing for secure transport of safety information, including provisions for sequence and time monitoring of messages.

PROFIsafe address

A unique identifier for every F-IO in a network including central F-IOs. The PROFIsafe address consists of the F-source address and the F-destination address.

Proof-test / Proof-test interval

A proof-test is a verification that a safety component or system operates as expected. Immediately after each successful proof-test, the safety component or system is considered to have a minimum probability of dangerous failure. The probability of dangerous failure increases with time until the next proof-test. The maximum probability of dangerous failure is calculated assuming the component or system is tested or replaced within the proof-test interval.

PV

Process value

A process value is the current measured value of a process variable which is being monitored or controlled. An example of this might be the temperature of a heating system. The current temperature is called the process variable, while the desired temperature is known as the set-point. The set point is usually abbreviated as SP, and the process value is usually abbreviated as PV.

Reintegration

The procedure that allows a passivated channel or module to become active again after diagnostics indicate that faults are removed or corrected.

Safe state

The basic principle behind the safety concept is the identification of a safe state for all process variables. The value "0" (de-energized) represents this safe state for digital fail-safe modules. This applies to both sensors and actuators.

Safety Administration Editor (SAE)

A view in the TIA Portal, for each PLC, allowing the user to configure safety program scheduling and time out parameters, identify the safety blocks and data types, and set protection for the safety program.

Safety function (context: PLC internals)

The term "safety function" can refer to PLC system internal features, including program block elements, that contribute to the development of your safety program and the assurance that your user or application safety function is executed as designed.

Safety function (context: user or application level)

One specific action of a safety system. While the term can be used for general goals (for example, "Protect the operator from the saw blade"), safety system analysis typically includes decomposing the general goal into elemental specific actions designed to minimize risk (for example, "When the hand control is released, turn off the motor" or "Keep the access guard locked until the motor has been deenergized for at least 60 seconds"). Each of these items can be considered a safety function.

Safety mode

1. Safety mode is the operating mode of the fail-safe modules that allows safety-related communication using safety message frames. ET 200eco PN F fail-safe modules are designed for safety mode only.
2. Operating mode of the safety program: In safety mode of the safety program, all safety mechanisms for fault detection and fault reaction are activated. The safety program cannot be modified during operation in safety mode. Safety mode can be deactivated by the user (deactivated safety mode).

Safety program

The safety program is a safety-related user program.

SELV

Safety Extra Low Voltage

Sensor

Field device that converts a physical quantity (for example, location, temperature, or speed) into an electrical signal that can be read by the PLC. The only fail-safe sensor inputs presently available for the ET 200eco PN F are digital (binary) ON/OFF inputs operating at 24 V DC nominal.

SIL

Safety Integrity Level (SIL) values 1 through 4 are defined in IEC 61508. A higher safety integrity level is associated with a lower probability of dangerous failure.

Standard user program

The standard user program is a non-safety-related user program.

TIA Portal

Totally Integrated Automation Portal

The TIA Portal is the key to the full performance capability of Totally Integrated Automation. The software optimizes all plant, machine, and process sequences.

Value status

The data bit accessible to the user program indicating whether or not a safety I/O channel is passivated. If the value status bit is "0", the channel is passivated or deactivated. For a 1oo2 input, the low numbered value status bit is effective, and the high numbered status value bit is always "0". If encountered, consider the terms "Quality bit" and "Qualifier" synonymous to "Value status (bit)".

Index

E

F

G

H

I

L

M

N

O

P

R

S

T

U

V

W

Y