OPERATING INSTRUCTIONS

Flexi Soft Modular Safety Controller

Hardware

SICK
Sensor Intelligence.

Described product

Flexi Soft Modular Safety Controller

Hardware

Manufacturer

SICK AG
Erwin-Sick-Str. 1
79183 Waldkirch
Germany

Legal information

Original document

This document is an original document of SICK AG.

Contents

1 About this document

1.1 Purpose of this document

These operating instructions contain the information required during the life cycle of the Flexi Soft modular safety controller.

These operating instructions are to be made available to all those who work with the Flexi Soft modular safety controller.

There are operating instructions and mounting instructions for the Flexi Soft system, each covering clearly defined fields of application.

Table 1: Overview of the Flexi Soft documentation

Document type	Title	Contents	Purpose	Part number
Operating instructions	Flexi Soft Modular Safety Controller Hardware	Description of the Flexi Soft modules and their functions	Instructions for technical personnel working for the machine manufacturer or operator on the safe mounting, electrical installation, and maintenance of the Flexi Soft safety controller	8012999
Operating instructions	Flexi Soft in the Flexi Soft Designer Configuration software	Description of the software-based configuration of the Flexi Soft safety controller along with important diagnostics functions and detailed notes on identifying and rectifying errors	Instructions for technical personnel working for the machine manufacturer or operator on the safe configuration and commissioning, as well as the safe operation, of the Flexi Soft safety controller	8012998
Operating instructions	Safety Designer Configuration software	Description of the installation and general basic principles of operation	To provide technical personnel working for the machine manufacturer/operator with instructions so that they can use the Safety Designer configuration software	8018178
Operating instructions	Flexi Soft in the Safety Designer Configuration software	Description of the software-based configuration of the Flexi Soft safety controller along with important diagnostics functions and detailed notes on identifying and rectifying errors	Instructions for technical personnel working for the machine manufacturer or operator on the safe configuration and commissioning, as well as the safe operation, of the Flexi Soft safety controller	8013926
Operating instructions	Flexi Soft Gateways Hardware	Description of the Flexi Soft gateways and their functions	To provide technical personnel working for the machine manufacturer/operator with instructions so that they can safely carry out the mounting, electrical installation, and maintenance work for the Flexi Soft gateways	8012662
Operating instructions	Flexi Soft Gateways in Flexi Soft Designer Configuration software	Description of the software-based configuration of the Flexi Soft gateway, information about data exchange in networks as well as about the status, planning, and associated mapping	To provide technical personnel working for the machine manufacturer/operator with instructions so that they can safely configure and commission the Flexi Soft gateways	8012483

Document type	Title	Contents	Purpose	Part number
Operating instructions	Flexi Soft Gateways in the Safety Designer Configuration software	Description of the software-based configuration of the Flexi Soft gateway, information about data exchange in networks as well as about the status, planning, and associated mapping	To provide technical personnel working for the machine manufacturer/operator with instructions so that they can safely configure and commission the Flexi Soft gateways	8018170
Operating instructions	Flexi Loop safe series connection Hardware	Description of the Flexi Loop safe series connection and its functions	To provide technical personnel working for the machine manufacturer/operator with instructions so that they can safely carry out the mounting, electrical installation, and maintenance work for the Flexi Loop safe series connection	8015834
Operating instructions	Flexi Loop in the Flexi Soft Designer configuration software	Description of how to configure and set the parameters for the Flexi Loop safe series connection using software	To provide technical personnel working for the machine manufacturer/operator with instructions so that they can safely configure and commission the Flexi Loop safe series connection	8014521
Mounting instructions	Flexi Soft FX3-EBX3 and FX3-EBX4 Encoder/Motor Feedback Connection Boxes	Description of FX3-EBX3 and FX3-EBX4 encoder/motor feedback connection boxes	To provide technical personnel working for the machine manufacturer/operator with instructions so that they can safely carry out the mounting, electrical installation, commissioning, and maintenance work for FX3-EBX3 and FX3-EBX4 encoder/motor feedback connection boxes	8015600
Mounting instructions	Flexi Soft FX3-EBX1 Optimized Dual Encoder/Motor Feedback Connection Box	Description of the FX3-EBX1 optimized dual encoder/motor feedback connection box	To provide technical personnel working for the machine manufacturer/operator with instructions so that they can safely carry out the mounting, electrical installation, commissioning, and maintenance work for the FX3-EBX1 optimized dual encoder/motor feedback connection box	8019030

1.2 Scope

These operating instructions apply to all modules of the Flexi Soft safety controller with the exception of the Flexi Soft gateway.

This document forms an integral part of SICK part number 8012999 (the “Flexi Soft modular safety controller hardware” in operating instructions in all available languages).

These operating instructions provide technical personnel of the machine manufacturer or the machine operator instructions regarding the safe assembly, electrical installation, commissioning, operation and maintenance of the Flexi Soft modular safety controller.

These operating instructions do not provide information on operating the machine in which a safety controller is integrated. For information about this, refer to the operating instructions of the specific machine.

1.3 Information depth

These operating instructions contain information about the modular Flexi Soft safety controller on the following topics:

- Mounting
- Electrical installation
- Hardware commissioning
- Fault diagnosis and troubleshooting
- Ordering information
- Conformity and approval

The planning and use of SICK protective devices requires technical skills that are not covered by this document.

The official and legal regulations for operating the Flexi Soft modular safety controller must always be complied with.

1.4 Target group

These operating instructions are intended for planning engineers, developers, and operators of plants and systems that are to be protected by means of a Flexi Soft modular safety controller. They are also intended for people who integrate the Flexi Soft safety controller into a machine, carry out its commissioning, or who are in charge of maintenance.

1.5 Further information

www.sick.com

The following information is available via the Internet:

- The Flexi Soft operating instructions in various languages for viewing and printing
- The Flexi Soft Designer configuration software
- The Safety Designer configuration software
- Configuration aids
- Example applications
- Data sheets
- Product and application animations
- CAD data for drawings and dimensional drawings
- EDS, ESI, GSD, and GSDML files
- Certificates (such as the EU declaration of conformity)
- Guide for Safe Machinery (six steps to a safe machine)

1.6 Symbols and document conventions

The following symbols are used in these operating instructions:

Safety notes and other notes

DANGER
Indicates a situation presenting imminent danger, which will lead to death or serious injuries if not prevented.

WARNING
Indicates a situation presenting possible danger, which may lead to death or serious injuries if not prevented.

CAUTION
Indicates a situation presenting possible danger, which may lead to moderate or minor injuries if not prevented.

NOTICE
Indicates a situation presenting possible danger, which may lead to property damage if not prevented.

NOTE
Indicates useful tips and recommendations.

Instructions to action

▶ The arrow denotes instructions to action. Read carefully and follow the instructions for action.

LED symbols

These symbols indicate the status of an LED:

○ The LED is off.
☼ The LED is flashing.
● The LED is illuminated continuously.

2 On safety

This chapter contains general safety information about the Flexi Soft modular safety controller.

More safety information about specific usage situations for the Flexi Soft modular safety controller is provided in the respective chapters.

2.1 General safety notes

WARNING
Improper mounting or use

The target safety-related level may not be achieved in the event of non-compliance.

- When mounting, installing, and using the Flexi Soft safety controller, remember to observe all applicable standards and directives.
- Observe the relevant national and international legal provisions for the installation and use of the Flexi Soft safety controller, its commissioning, and technical inspections repeated at regular intervals.
- The manufacturer and operator of the machine on which the Flexi Soft safety controller is used are responsible for liaising with the relevant authorities about all applicable safety regulations/rules and for ensuring compliance with these.
- The notes, in particular the test notes, in these operating instructions (e.g. regarding use, mounting, installation, or integration into the machine controller) must always be observed.
- The thorough checks must be carried out by qualified safety personnel or specially qualified and authorized personnel, and must be recorded and documented by a third party to ensure that the tests can be reconstructed and retraced at any time.

2.2 Intended use

The Flexi Soft modular safety controller is an adjustable control for safety applications.

It is to be used in accordance with the following standards:

- IEC 61508 up to SIL3
- EN 62061 up to SILCL3
- EN ISO 13849-1 up to performance level e

The safety level actually achieved is determined by the external wiring, how the wiring is implemented, the configuration, the selection of command triggers, and how they are arranged on the machine.

The Flexi Soft system satisfies the requirements for industrial areas in accordance with the generic standard for emitted interference. Consequently, the Flexi Soft system is only suitable for use in industrial environments.

The Flexi Soft system must only be used within the limits of the prescribed and specified technical data and operating conditions at all times.

NOTICE
Incorrect use, improper modification or manipulation of the Flexi Soft system will invalidate any warranty from SICK; in addition, any responsibility and liability of SICK for damage and secondary damage caused by this is excluded.

The external power supply of the Flexi Soft modules must be capable of buffering brief power failures of 20 ms as specified in EN 60204-1, for example. Suitable PELV and SELV power supply units are available as accessories from SICK.

UL/CSA applications:

If the product is being used in accordance with UL 508 or CSA C 22.2 No. 142, the following conditions must also be met:

- To protect the device's 24-volt voltage supply, use a fuse with a maximum voltage of 4 A and a minimum of 30 V DC in accordance with UL 248.
- For wiring, only use copper wires with a temperature resistance of at least 60 °C / 75 °C, wire cross-section AWG 30–12 for screw terminals and/or AWG 24–16 for spring terminals.
- Tighten the screw terminals with a torque of 5 to 7 lb-in.
- Only use the devices in an environment with maximum degree of contamination 2.

NOTE

The safety functions have not be evaluated by UL. Authorization is in accordance with UL 508, general applications.

2.3 Requirements for the qualification of personnel

Only qualified safety personnel are permitted to configure, mount, connect, commission, and maintain the Flexi Soft modular safety controller.

Project planning

A person who has expertise and experience in the selection and use of protective devices on machines and is familiar with the relevant technical rules and national work safety regulations is considered qualified for project planning.

Mechanical mounting and commissioning

A person who has expertise and experience in the relevant field and is sufficiently familiar with the application of the protective device on the machine to assess whether or not it can be operated safely is considered qualified for mechanical installation and commissioning.

Electrical installation

A person who has expertise and experience in the relevant field and is sufficiently familiar with the application of the protective device on the machine to assess whether or not it can be operated safely is considered qualified for electrical installation and commissioning.

Configuration

A person who has expertise and experience in the relevant field and is sufficiently familiar with the application of the protective device on the machine to assess whether or not it can be operated safely is considered qualified for configuration.

Operation and maintenance

A person who has expertise and experience in the relevant field, is familiar with the application of the protective device on the machine, and has received instructions from the operator in how to operate the machine is considered qualified for operation and maintenance.

3 Product description

This chapter provides information about the properties of the Flexi Soft system and describes its construction and operating principle.

3.1 System characteristics

Sensors and switching elements (e.g. light curtains, laser scanners, switches, sensors, encoders, emergency stop pushbutton) are connected to the Flexi Soft modular safety controller and are linked logically. The corresponding actuators of the machines or systems can be switched off safely via the switching outputs of the safety controller.

The Flexi Soft system is distinguished by the following system characteristics:

- Modular design: 1 main module, up to 2 different gateways, and up to 12 expansion modules [1)]
- Up to 96 safe digital inputs
- Up to 12 safe analog inputs [2)]
- Up to 48 safe digital outputs or up to 96 non-safe digital outputs
- Configurable
- .Use of up to 255 logic and application-specific function blocks
- Logic function blocks, including, e.g., AND, OR, NOT, XNOR, XOR
- Application-specific function blocks including, e.g., emergency stop, two-hand, muting, presses, ramp-down detection, operating mode selector switch, reset, restart
- Can be integrated into different networks with gateways (EtherNet/IP™, Modbus TCP, PROFINET IO, PROFIBUS DP, DeviceNet, CANopen and EtherCAT)
- Safe gateway for EFI-pro
- 2 EFI interfaces on FX3-CPU1, FX3-CPU2, and FX3-CPU3 main modules (see "FX3-CPU1 main module", page 19)

The Flexi Soft Designer and Safety Designer configuration softwares are available for configuration of the control tasks.

NOTE
The available range of performance of the Flexi Soft systems depends on the configuration software used, see "Version, compatibility, and features", page 14.

You will find the configuration software on the Internet: www.sick.com

1) The number of expansion modules is limited by the capacity of the FLEXBUS+ backplane bus. A Drive Monitor (FX3-MOCx) requires twice the bus capacity of the other expansion modules. Therefore, each FX3-MOCx reduces the maximum possible number of expansion modules that can be used by two.

2) Each FX3-ANA0 expansion module provides two analog inputs, which are combined to form one safe channel. An FX3-ANA0 can therefore safely detect an analog process variable using two sensors.

3.2 Version, compatibility, and features

There are different firmware versions and function packages (so-called “Steps”) for the Flexi Soft product family that permit realization of the different functions. This section provides an overview of which firmware version, which function package and/or which version of the Flexi Soft Designer configuration software or Safety Designer configuration software is needed to use a certain function or a certain device.

Table 2: Modules, firmware versions, and software versions you will need

	Necessary module with firmware from version	Available from Flexi Soft Designer	Available from Safety Designer
Function blocks and logic			
Offline simulation of logic	Unrestricted	V1.2.0	V1.6.x
Import and export of partial applications	Unrestricted	V1.3.0	V1.6.x
Automatic circuit diagrams	Unrestricted	V1.3.0	V1.6.x
Central tag name editor	Unrestricted	V1.3.0	V1.6.x
Documentation for function blocks of main modules in logic editor	Unrestricted	V1.3.0	N. a. [1)]
Matrix of input and output connections	Unrestricted	V1.3.0	V1.6.x
Invertible inputs for the function blocks AND, OR, RS Flip-Flop and Routing n:n	FX3-CPUx V2.00.0 (Step 2.xx)	V1.3.0	V1.6.x
Function block for ramp-down detection	FX3-CPUx V1.11.0 (Step 1.xx)	V1.3.0	V1.6.x
Function blocks for configurable switch-on delay and configurable switch-off delay	FX3-CPUx V2.00.0 (Step 2.xx)	V1.3.0	V1.6.x
Speed to Bool function block	FX3-MOC0 V1.10.0	V1.7.0	V1.6.x
Motion Status to Bool function block	FX3-MOC0 V1.10.0	V1.7.0	V1.6.x
Verification possible even without identical hardware	FX3-CPUx V2.00.0 (Step 2.xx)	V1.3.0	V1.6.x
Status input data and status output data in logic	FX3-CPUx V2.00.0 (Step 2.xx) and FX3-XTIO, FX3-XTDI, or FX3-XTDS, each V2.00.0 (Step 2.xx)	V1.3.0	V1.6.x
Easy applications for FX3-MOC0	FX3-MOC0 V1.10.0	V1.7.1	N. a.
Special functions			
Two S3000 safety laser scanners at one EFI interface	FX3-CPU1 V1.00.0	V1.2.2	N. a.
Flexi Link	FX3-CPU1 V2.00.0 (Step 2.xx)	V1.3.0	N. a.
Flexi Loop	FX3-CPUx V3.00.0 (Step 3.xx) and FX3-XTIO, FX3-XTDI, or FX3-XTDS, each V3.00.0 (Step 3.xx)	V1.6.0	N. a.
Flexi Line	FX3-CPU3 V3.00.0 (Step 3.xx)	V1.6.0	N. a.
Automatic configuration of connected EFI-enabled safety sensors (automatic configuration recovery)	FX3-CPU2 V3.00.0 (Step 3.xx)	V1.5.0 (FX3-CPU2) V1.6.0 (FX3-CPU3)	N. a.
Deactivation of test signals Q1 to Q4 on the FX3-XTIO possible	FX3-XTIO V2.00.0 (Step 2.xx)	V1.3.0	V1.6.x
Fast shut-off with bypass at FX3-XTIO	FX3-CPUx and FX3-XTIO, each V2.00.0 (Step 2.xx)	V1.3.0	V1.6.x
Multiple safety mats at FX3-XTIO/FX3-XTDI	FX3-XTIO or FX3-XTDI, each V1.13.0	V1.3.0	V1.6.x
Data recorder	FX3-CPUx V2.00.0 (Step 2.xx)	V1.5.0	V1.6.x

	Necessary module with firmware from version	Available from Flexi Soft Designer	Available from Safety Designer
Extended cross-circuit detection time for the switching of increased capacitive loads at FX3-XTIO	FX3-XTIO V3.00.0 (Step 3.xx)	V1.6.0	V1.6.x
Configurable filter time for in/out filters and out/in filters at inputs I1 to I8 at FX3-XTIO/FX3-XTDI/FX3-XTDS	FX3-XTIO, FX3-XTDI, or FX3-XTDS, each V3.00.0 (Step 3.xx)	V1.6.0	V1.6.x
Optimization of logic execution time	FX3-CPUx V4.00.0 (Step 4.xx)	V1.7.1	V1.6.x
Devices			
FX3-CPU0	No limitation	V1.2.0	V1.6.x
FX3-CPU1	No limitation	V1.2.0	N. a.
FX3-CPU2	No limitation	V1.2.0	N. a.
FX3-CPU3	No limitation	V1.2.0	N. a.
FX3-XTIO	No limitation	V1.2.0	V1.6.x
FX3-XTDI	No limitation	V1.2.0	V1.6.x
Gateways for PROFINET IO, Modbus TCP and EtherNet/IP™	FX3-CPUx V1.11.0 (Step 1.xx)	V1.2.0	V1.6.x
CC-Link gateway	FX3-CPUx V1.11.0 (Step 1.xx)	V1.3.0	N. a.
CANopen gateway	FX3-CPUx V1.11.0 (Step 1.xx)	V1.3.0	V1.6.x
EtherCAT gateway	FX3-CPUx V2.00.0 (Step 2.xx)	V1.3.0	V1.6.x
EFI-pro gateway	FX3-CPUx V4.00.0 (Step 4.xx)	N. a.	V1.6.x
Speed Monitor MOC3SA	Unrestricted	V1.3.0	V1.6.x
FX3-MOC0	FX3-CPUx V2.50.0	V1.5.0	N. a.
FX3-MOC1	FX3-CPUx V2.50.0	V1.8.0	V1.6.x
FX3-XTDS	Unrestricted	V1.6.0	V1.6.x
FX0-STIO	Unrestricted	V1.6.0	V1.6.x
FX3-ANA0	FX3-CPUx V4.00.0 (Step 4.xx)	V1.8.0	V1.7.0
Conformities			
RoHS conformity FX3-XTIO	FX3-XTIO V1.01.0	–	–

1) N. a. = Not available
2) All other modules as from market introduction.

NOTE

- More recent modules are backward compatible so that each module can be replaced by one with a higher firmware version.
- Flexi Soft Designer Version ≥ V1.4.0 can also be used to configure devices with a later version of the firmware, even if Flexi Soft Designer does not yet recognize the new firmware. In such cases, the user will only be able to access the function packages (Step 1.xx, Step 2.xx, Step 3.xx, or Step 4.xx) that are supported by the available version of Flexi Soft Designer.
- A corresponding new version of the configuration software is needed in order to use the full functional scope of modules with a later firmware version.
- The configuration software is not upwards-compatible. In other words, a project created with a more recent version of the configuration software cannot be opened with an older version.
- The function package (Step 1.xx, Step 2.xx, Step 3.xx, or Step 4.xx) must be selected in the hardware configuration menu of the configuration software. The availability of a desired function package in the configuration software is shown in the table.
- To use the Step N.xx function package, the relevant module must have a minimum firmware version of VN.00.0. If you try to transfer a configuration in a module with a lower firmware version, an error message is displayed.
- The hardware version of the Flexi Soft modules can be seen in the hardware configuration of the configuration software in online status or in the report if the system was previously online.
- You will find the **firmware version** of the Flexi Soft modules on the type label of the Flexi Soft modules in the firmware version field.
- The date of manufacture of a device can be found in the S/N field on the type label in the format yywwnnnn (yy = year, ww = calendar week, nnnn = sequential serial number in the calendar week).
- The version of the configuration software can be found by selecting **Info** in the **Extras** menu.
- The latest version of the configuration software can be found on the Internet at www.sick.com.

3.3 Construction and function

System construction

A Flexi Soft system consists of the following modules:

- 1 Flexi Soft system plug
- 1 Flexi Soft main module
- Up to 2 Flexi Soft gateways
- Up to 12 Flexi Soft expansion modules [3)]
- In addition, up to 8 UE410-2RO relay modules and/or up to 4 UE410-4RO relay modules (i.e., a maximum of 16 safe relay outputs)

NOTE

Only those modules listed here can be connected to a Flexi Soft system; other modules are not permitted.

3) The number of expansion modules is limited by the capacity of the FLEXBUS+ backplane bus. A Drive Monitor (FX3-MOCx) requires twice the bus capacity of the other expansion modules. Therefore, each FX3-MOCx reduces the maximum possible number of expansion modules that can be used by two.

Figure 1: Example minimum construction of the Flexi Soft system with FX3-CPU0 and FX3-XTDI or FX3-CPU1 and FX3-XTIO

Figure 2: Maximum structure of the Flexi Soft system (without relay modules)

Table 3: Overview of modules

Model	Type	Inputs	Outputs	Function blocks	Max. number
Main modules					
FX3-CPU0	Main module	–	–	255	1
FX3-CPU1	Main module with EFI	4 [1]	–		
FX3-CPU2	Main module with EFI and ACR	4 [1]	–		
FX3-CPU3	Main module with EFI and ACR and Flexi Line	8 [2]	–		
Gateways					
FX0-GENT	EtherNet/IP™ gateway	2 [3]	–	–	2
FX0-GMOD	Modbus TCP gateway	2 [3]	–	–	
FX0-GPNT	PROFINET IO gateway	2 [3]	–	–	
FX0-GETC	EtherCAT gateway	2 [3]	–	–	
FX0-GPRO	PROFIBUS DP gateway	1 [4]	–	–	
FX0-GCAN	CANopen gateway	1 [4]	–	–	
FX0-GDEV	DeviceNet gateway	1 [4]	–	–	
FX3-GEPR	EFI-pro gateway	2 [3]	–	–	1
Expansion modules					
FX3-XTIO	I/O module	8	4	–	12
FX3-XTDI	I/O module	8	–	–	
FX3-XTDS	I/O module	8	4–6 [5]	–	
FX0-STIO	I/O module	6–8 [6]	6–8 [6]	–	
FX3-ANA0	Analog input module	2 [7]	–	–	
FX3-MOC0	Drive Monitor	–	–	10	6 [8]
FX3-MOC1	Drive Monitor	–	–	25	
Relay modules					
UE410-2RO	Relay module	–	2	–	8 [9]
UE410-4RO	Relay module	–	4	–	4 [9]

1) EFI connections.
2) EFI and Flexi Line connections.
3) RJ-45 female connectors.
4) RS-485 female connector.
5) Non-safe outputs. Test outputs XY1 and XY2 can be used as additional non-safe outputs.
6) The FX0-STIO features 6 non-safe inputs and 6 non-safe outputs. In addition, connections IY7 and IY8 can be used as non-safe inputs as well as non-safe outputs.
7) Each FX3-ANA0 expansion module provides two analog inputs, which are combined to form one safe channel. An FX3-ANA0 can therefore safely detect the size of an analog process using two sensors.
8) Each FX3-MOCx module reduces the maximum possible number of expansion modules that can be used by two.
9) Maximum 16 safe relay outputs.

3.4 Modules

This chapter provides information about the properties and functions of the available modules and system components.

3.4.1 FX3-CPU0 main module

Description

The FX3-CPU0 main module is the CPU for the entire system. It is where all signals are monitored and their logic is processed on the basis of the configuration stored in the system plug. The system outputs are switched further to the processing of the signals. The FLEXBUS+ internal bus provides the data interface.

NOTE
The FX3-CPU0 main module can only be operated together with the FX3-MPL0 system plug.

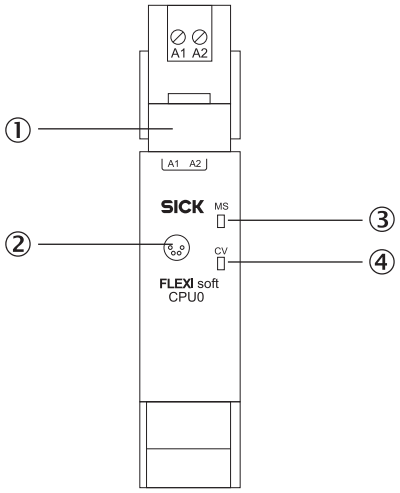


Figure 3: FX3-CPU0 main module

① FX3-MPL0 system plug
② RS-232 interface
③ MS LED (**M**odule **S**tatus)
④ CV LED (**C**onfiguration **V**erified)

3.4.2 FX3-CPU1 main module

Description

The functions of the FX3-CPU1 main module are the same as those of the FX3-CPU0 main module.

Additionally, this module has 2 EFI interfaces. When EFI-enabled devices are connected, the following functions are supported:

- Transfer configuration to the connected EFI-enabled devices
- Import configuration from the connected EFI-enabled devices
- Diagnose the connected EFI-enabled devices
- Exchange process data between main module and EFI-enabled devices
- Connect up to four FX3-CPU1 main modules to one Flexi-Link system (see "Flexi Link", page 45)

More information about EFI interfaces: see "Enhanced Function Interface (EFI)", page 44

NOTE
The FX3-CPU1 main module can only be operated together with the FX3-MPL0 system plug.

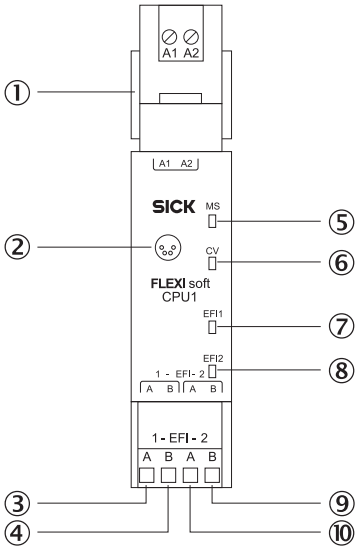


Figure 4: FX3-CPU1 main module

① FX3-MPL0 system plug
② RS-232 interface
③ EFI1_A
④ EFI1_B
⑤ MS LED (Module Status)
⑥ CV LED (Configuration Verified)
⑦ EFI1 LED
⑧ EFI2 LED
⑨ EFI2_B
⑩ EFI2_A

3.4.3 FX3-CPU2 main module

Description

The functions of the FX3-CPU2 main module are the same as those of the FX3-CPU1 main module.

Furthermore, the FX3-CPU2 main module has an automated function for configuring connected EFI-enabled devices (ACR). More information: see "Automatic configuration recovery (ACR)", page 48 and the “Flexi Soft in the Flexi Soft Designer Configuration Software” operating instructions.

NOTE
The FX3-CPU2 main module can only be operated together with the FX3-MPL1 system plug.

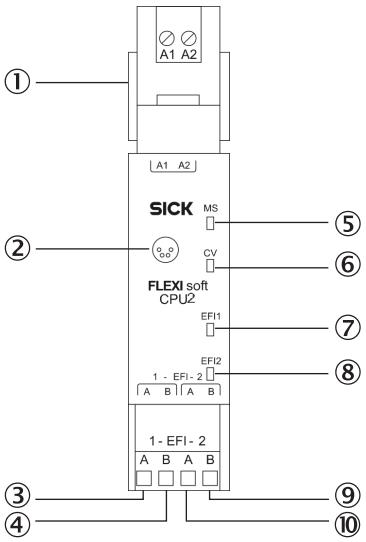


Figure 5: FX3-CPU2 main module

① FX3-MPL1 system plug
② RS-232 interface
③ EFI1_A
④ EFI1_B
⑤ MS LED (**M**odule **S**tatus)
⑥ CV LED (**C**onfiguration **V**erified)
⑦ EFI1 LED
⑧ EFI2 LED
⑨ EFI2_B
⑩ EFI2_A

3.4.4 FX3-CPU3 main module

Description

The functions of the FX3-CPU3 main module are the same as those of the FX3-CPU2 main module.

This module also has a Flexi Line interface to support the safe networking of up to 32 Flexi Soft stations (see "Flexi Line", page 46).

NOTE
The FX3-CPU3 main module can only be operated together with the FX3-MPL1 system plug.

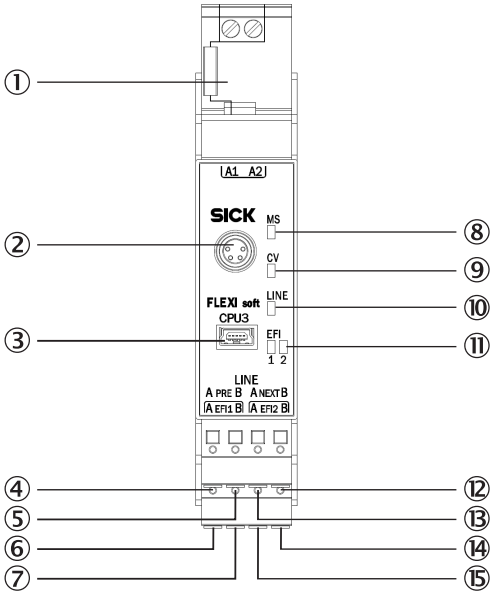


Figure 6: FX3-CPU3 main module

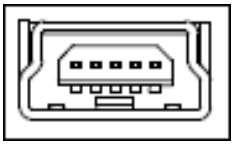
① FX3-MPL1 system plug
② RS-232 interface
③ USB interface
④ Line_PRE_A (previous)
⑤ Line_PRE_B (previous)
⑥ EFI1_A
⑦ EFI1_B
⑧ MS LED (**M**odule **S**tatus)
⑨ CV LED (**C**onfiguration **V**erified)
⑩ LINE LED
⑪ EFI1 and EFI2 LEDs
⑫ Line_NEXT_B (next)
⑬ Line_NEXT_A (next)
⑭ EFI2_B
⑮ EFI2_A

USB interface

The FX3-CPU3 main module has a USB interface which supports the following functions:

- Transfer of the configuration from the configuration software to the system plug
- Import of the configuration into the configuration software from the system plug
- Diagnosis of the Flexi Soft safety controller in conjunction with the configuration software

Table 4: USB interface on the FX3-CPU3 main module

	USB version	Connection type
	2.0	Mini-B

3.4.5 FX3-MPL0 and FX3-MPL1 system plugs

There is a system plug at each main module. The system configuration for the entire Flexi Soft system is stored only in the system plug. This is beneficial when replacing modules, because it means that a full reconfiguration of the Flexi Soft system is not required.

System plug variants

There are two system plug variants, each of which can only be used in conjunction with certain main modules.

Table 5: System plug variants

System plug	Terminal color	Compatible main modules	Functions
FX3-MPL0	Black	• FX3-CPU0 • FX3-CPU1	• Flexi Soft system power supply • Storage of system configuration (without EFI-enabled devices)
FX3-MPL1	Yellow	• FX3-CPU2 • FX3-CPU3	• Flexi Soft system power supply • Storage of system configuration (with EFI-enabled devices) • Automated configuration of connected EFI-capable safety sensors (automated configuration recovery)

NOTE

- The electrical power supply for the main module, the internal logic of all expansion modules and gateways on the FLEXBUS+, and its inputs (I1 to I8) and test outputs (X1 to X8 plus XY1 and XY2) is provided exclusively via the system plug. The power for the outputs (Q1 to Q4, Y1 to Y6, and IY7 and IY8), on the other hand, is supplied separately.
- The data saved in the system plug is retained even in the event of a power supply failure.
- Clearly and unambiguously mark all connections (connecting cables and plug connectors) on the safety controller to avoid mix-ups. The Flexi Soft system features several connections of the same design. Therefore, you must make sure that no unplugged connecting cables or plug connectors are accidentally connected to the wrong connection point.

3.4.6 FX3-XTIO I/O module

Description

The FX3-XTIO module is an input/output expansion module with 8 safe inputs and 4 safe outputs. It has 2 test pulse generators, one for test output X1 and one for test output X2.

The FX3-XTIO module supports the following functions:

- Monitoring of the connected safety devices (see "Connection of devices", page 74)
- Forwarding of information at inputs I1 to I8 to the main module
- Receipt of control signals from the main module and corresponding switching of outputs
- Fast shut-off: direct shutdown of the actuators connected to the module.

This reduces the response time of the overall system. The response times of the devices at the inputs and outputs are extended by 8 ms in order to shut down the outputs. Run times on the FLEXBUS+ internal bus and the logic execution time are not relevant in this case (see "Maximum response time of the Flexi Soft system", page 126).

- Activation or deactivation of the test signals at outputs Q1 to Q4

The FX3-XTIO module cannot be operated alone; an FX3-CPUx main module is always necessary.

Multiple FX3-XTIO modules can be used at the same time (see "Construction and function", page 16).

The power supply to the internal logic and the test outputs is provided via the system plug and the FLEXBUS+ internal bus.

The power supply to outputs Q1 to Q4 on the FX3-XTIO must be provided directly via A1/A2 at the corresponding module.

WARNING

Ineffectiveness of the protective device due to unrecognized short-circuits between the test pulse generators

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

▶ Configure the test outputs of the Flexi Soft expansion modules with test gaps ≤ 4 ms and a test period ≥ 200 ms.

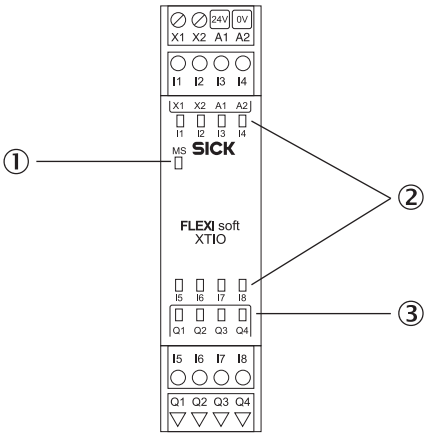


Figure 7: FX3-XTIO I/O module

① MS LED (**M**odule **S**tatus)

② 8 input LEDs

③ 4 output LEDs

3.4.6.1 Internal structure

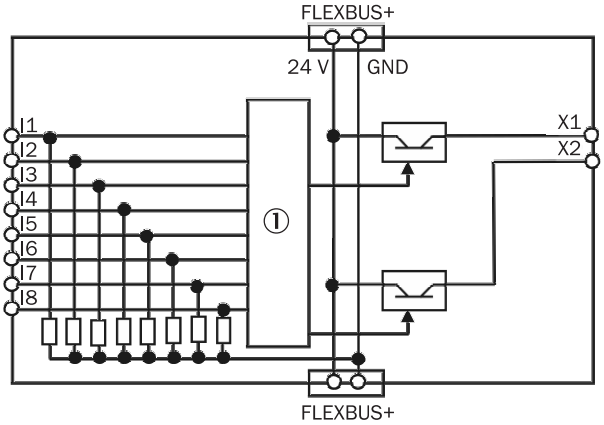


Figure 8: Internal structure of the FX3-XTIO – safe inputs and test outputs

① Internal logic

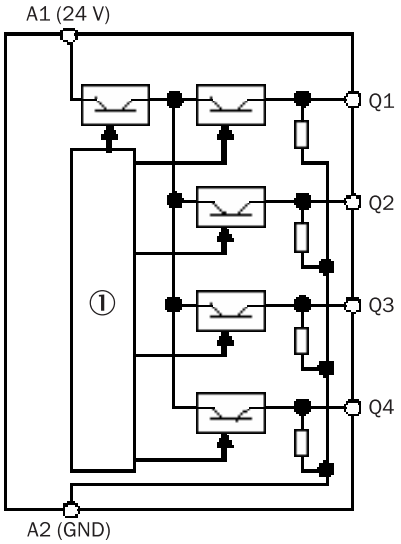


Figure 9: Internal structure of the FX3-XTIO – safe outputs

① Internal logic

3.4.6.2 Deactivation of test signals at outputs Q1 to Q4 on the FX3-XTIO

With the FX3-XTIO Step ≥ 2.xx (firmware versions V2.00.0), it is possible to deactivate the test pulses at one or more outputs of FX3-XTIO modules.

Deactivating the test pulses at one or more of the outputs (Q1 to Q4) of an FX3-XTIO module reduces the safety parameters of all the outputs (Q1 to Q4) of the module concerned. If the test pulses are deactivated, a short-circuit cannot be recognized after 24 V if the output is high. Therefore, in the case of a recognized internal hardware error, the switch-off capability of the other outputs can be impaired by the reverse current of 24 V via the output whose test pulse has been deactivated. This must be taken into account to ensure that the application is in line with an appropriate risk analysis and risk avoidance strategy.

WARNING
Reduced safety parameters by deactivating test pulses
The target safety-related level may not be achieved in the event of non-compliance.

If the test pulse is deactivated at one or several of the safe outputs Q1 to Q4, take the following measures:

- ▶ Use protected or separate cabling.
- ▶ At least once a year, either switch off all outputs without test pulses simultaneously for at least one second using the logic program of the main module or restart the Flexi Soft system by switching off the voltage supply.

3.4.6.3 Extended error detection time for cross-circuits at outputs Q1 to Q4 on the FX3-XTIO for the switching of increased capacitive loads

WARNING
Extended error recognition time due to switching of higher capacitive loads
The target safety-related level may not be achieved in the event of non-compliance.

- ▶ Pay attention to the extended error recognition time.

With the FX3-XTIO Step ≥ 3.xx (firmware version V3.00.0), it is possible to configure an extended fault detection time for cross-circuits that affect outputs Q1 to Q4 of FX3-XTIO modules.

This may be necessary to switch loads where the voltage at the load does not drop to the Low level as quickly as expected, with the result that if the standard error detection time is set, a cross-circuit error occurs immediately after switching off (change from High to Low). Examples of such instances include:

- Loads with a capacitance that is higher than the standard level permitted for the output, such as the supply voltage of PLC output cards that require safety-related switching.
  For this application, the test signal for the input must also be deactivated (see "Deactivation of test signals at outputs Q1 to Q4 on the FX3-XTIO", page 25).
  Safety-capable inputs on fail-safe PLCs generally also have capacitance at the inputs.
- Inductive loads which cause an overshoot in the positive voltage range after the induction voltage has died down.

Table 6: Maximum permissible time until Low level is reached after output (Q1 to Q4) is deactivated

FX3-XTIO firmware version	Switching of increased capacitive loads	Maximum permissible time until Low level (≤ 3.5 V) is reached after output (Q1 to Q4) is deactivated
≤ V2.11.0	Not possible	3 ms
≥ V3.00.0	Deactivated	3 ms
	Activated	43 ms

Once the output has been deactivated, the capacitance that exceeds the standard value permitted for the output must be discharged by the user until the Low level is reached. If this condition is not met within the maximum permissible time, it results in a cross-circuit fault at the corresponding output regardless of whether test pulses are activated or deactivated for the output concerned.

WARNING
Loss or impairment of the safety-related switch-off capability due to PLC output card errors

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

- ▶ Use one PLC output that is suitable for safety-related deactivation of the outputs by means of supply voltage switching.
- ▶ Take suitable measures to prevent cross-circuits e.g. using protected wiring.
- ▶ When using a buffer capacitor in the voltage supply of the PLC output card, observe the possibly extended response time.

For information about this, see also the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions.

3.4.6.4 Fault detection time and fault response time when using single-channel outputs on the FX3-XTIO

The fault detection time plus the fault response time of the FX3-XTIO depends on the configuration of the respective output.

In the case of an internal hardware fault, outputs (Q1 to Q4), which would normally be on low, may switch off with a delay and/or may briefly switch to high until the fault has been recognized and the fault reaction has been carried out.

WARNING
Ineffectiveness of the protective device due to brief switching to high for single-channel outputs

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

The target safety-related level may not be achieved in the event of non-compliance.

- ▶ For risk analysis and risk avoidance strategy, consider the following:
  - Brief switching to high or delayed switching off of single-channel outputs
  - Fault detection time and fault response time

Table 7: Fault detection time and fault response time on the FX3-XTIO

FX3-XTIO firmware version	Switching higher capacitive loads	Fault detection time + fault response time
≤ V2.11.0	Not possible	≤ 10 ms
≥ V3.00.0	Deactivated	≤ 10 ms
	Enabled	≤ 50 ms

3.4.7 FX3-XTDI I/O module

Description

The FX3-XTDI module is an input expansion module with 8 safe inputs. It has 2 test pulse generators, one for test outputs X1, X3, X5 and X7 and one for test outputs X2, X4, X6 and X8.

The FX3-XTDI module supports the following functions:

- Monitoring of the connected safety devices (see "Connection of devices", page 74)
- Forwarding of information at inputs I1 to I8 to the main module

The FX3-XTDI module cannot be operated alone; an FX3-CPUx main module is always necessary.

Multiple FX3-XTDI modules can be used at the same time (see "Construction and function", page 16).

The power supply to the internal logic and the test outputs is provided via the system plug and the FLEXBUS+ internal bus.

WARNING

Ineffectiveness of the protective device due to unrecognized short-circuits between the test pulse generators

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

- Exclude short-circuits between the odd-numbered test outputs X1, X3, X5 and X7 through suitable wiring (e.g. separate routing, protected cables).
- Exclude short-circuits between the even-numbered test outputs X2, X4, X6 and X8 through suitable wiring (e.g. separate routing, protected cables).
- Configure the test outputs of the Flexi Soft expansion modules with test gaps ≤ 4 ms and a test period ≥ 200 ms.

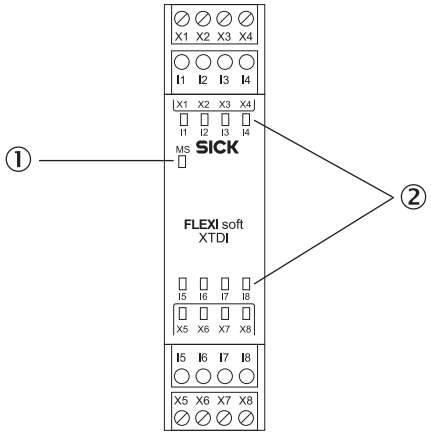


Figure 10: FX3-XTDI I/O module

① MS LED (**M**odule **S**tatus)

② 8 input LEDs

3.4.7.1 Internal structure

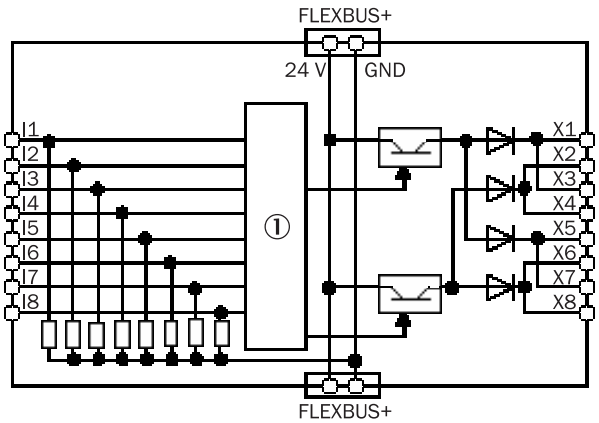


Figure 11: Internal structure of the FX3-XTDI – safe inputs and test outputs

① Internal logic

3.4.8 FX3-XTDS I/O module

Description

The FX3-XTDS module is an input/output expansion module with 8 safe inputs and 4 non-safe outputs. It has 2 test pulse generators, one for test output XY1 and one for test output XY2.

The FX3-XTDS module supports the following functions:

- Monitoring of the connected safety devices (see "Connection of devices", page 74)
- Forwarding of information at inputs I1 to I8 to the main module
- Receipt of control signals from the main module and corresponding switching of outputs
- Outputs XY1 and XY2 can be used as either test outputs or non-safe outputs.

WARNING
Improper use of the non-safe outputs

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

▶ Do not use the FX3-XTDS outputs for safety functions.

The FX3-XTDS module cannot be operated alone; an FX3-CPUx main module is always necessary.

Multiple FX3-XTDS modules can be used at the same time (see "Construction and function", page 16).

The power supply to the internal logic and the test outputs is provided via the system plug and the FLEXBUS+ internal bus.

The power supply to outputs Y3 to Y6 on the FX3-XTDS must be provided directly via A1/A2 at the corresponding module.

WARNING
Ineffectiveness of the protective device due to unrecognized short-circuits between the test pulse generators

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

▶ Configure the test outputs of the Flexi Soft expansion modules with test gaps ≤ 4 ms and a test period ≥ 200 ms.

NOTE
If both outputs XY1 and XY2 are used as non-safe outputs, then it is nevertheless possible to connect a tested element to one of these inputs I1 to I8. However, this element is marked red in the hardware configuration as a warning.

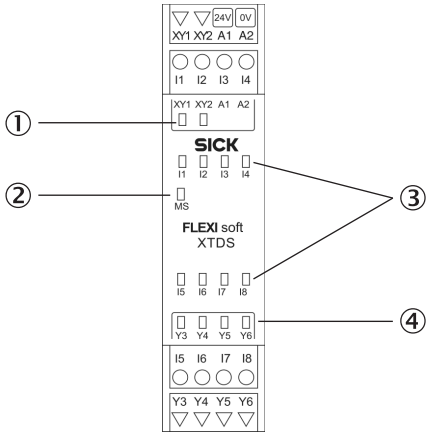


Figure 12: FX3-XTDS I/O module

① 2 LEDs for test outputs or non-safe outputs
② MS LED (**M**odule **S**tatus)
③ 8 input LEDs
④ 4 output LEDs

3.4.8.1 Internal structure

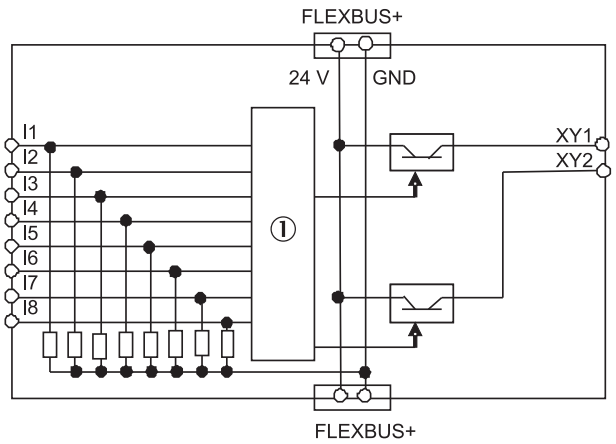


Figure 13: Internal structure of the FX3-XTDS – safe inputs and test outputs

① Internal logic

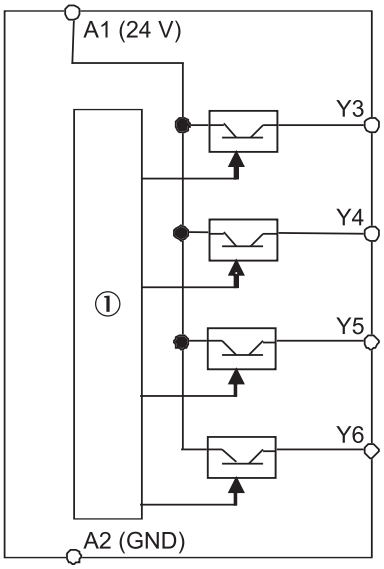


Figure 14: Internal structure of the FX3-XTDS – non-safe outputs

① Internal logic

3.4.9 FX0-STIO I/O module

Description

The FX0-STIO module is an expansion module with 6 non-safe inputs, 6 non-safe outputs, and 2 connections that can be used as either non-safe inputs or non-safe outputs.

The FX0-STIO module supports the following functions:

- Forwarding of information at inputs I1 to I6 to the main module
- Receipt of control signals from the main module and corresponding switching of outputs

WARNING

Improper use of the non-safe modules

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

The target safety-related level may not be achieved in the event of non-compliance.

▶ Do not use the FX0-STIO for safety-related functions.

The FX0-STIO module cannot be operated alone; an FX3-CPUx main module is always necessary.

Multiple FX0-STIO modules can be used at the same time (see "Construction and function", page 16).

The power supply to the internal logic is provided via the system plug and the FLEXBUS + internal bus.

The power supply to outputs Y1 to Y6 as well as to connections IY7 and IY8 on the FX0-STIO must be provided directly via A1/A2 at the corresponding module.

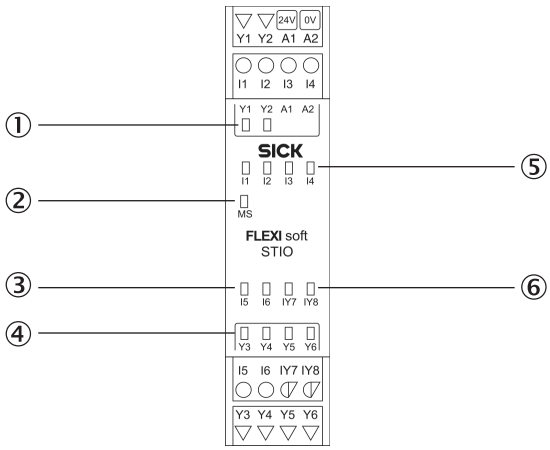


Figure 15: FX0-STIO I/O module

① 2 output LEDs
② MS LED (**M**odule **S**tatus)
③ 2 input LEDs
④ 4 output LEDs
⑤ 4 input LEDs
⑥ 2 LEDs for configurable inputs or outputs

Use of connections IY7 and IY8 on the FX0-STIO

The IY7 and IY8 connections on a FX0-STIO module can be used either as non-safe inputs or non-safe outputs.

3.4.9.1 Internal structure

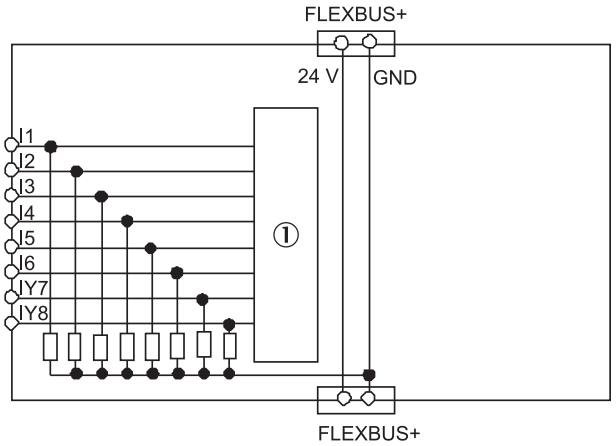


Figure 16: Internal structure of the FX0-STIO – non-safe inputs

① Internal logic

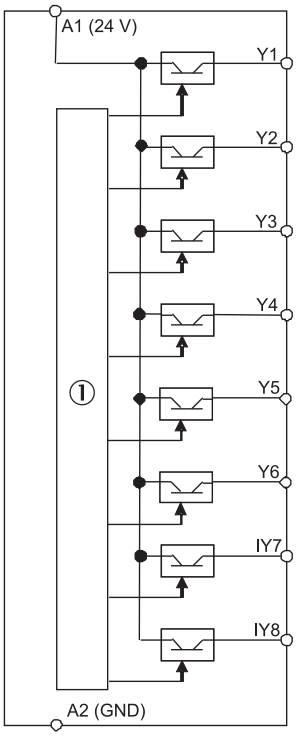


Figure 17: Internal structure of the FX0-STIO – non-safe outputs

① Internal logic

3.4.10 Drive Monitor FX3-MOC0

Description

The Drive Monitor FX3-MOC is an expansion module for the safe movement monitoring of drive systems. In this context, movement means the speed level, speed ramp and standstill position. The module has an interface to connect two encoders (e.g. A/B incremental encoders, linear encoders, motor feedback systems or linear distance measurement systems).

The FX3-MOC0 supports the following functions:

- Connection of two encoders for one or two axes
  - A/B incremental encoders HTL 24 V, HTL 12 V, TTL, max. 300 kHz
  - A/B incremental encoder RS-422, max. 1 MHz [4)]
  - Sine-cosine encoder 1 V_{PP}, max. 120 kHz
  - SSI encoder, RS-422, max. 1 MBaud
- Standstill monitoring
- Speed monitoring
- Direction monitoring
- Processing of information from the encoders and control signals from the main module in the internal logic of the FX3-MOC0. A dedicated logic editor with a number of function blocks is available for this purpose.
- Forwarding of information from the internal logic to the main module

NOTE

The sine/cosine signals of a HIPERFACE® interface can also be connected to the encoder connection of the FX3-MOC0. In this way, the HIPERFACE® interface can be used like a sine/cosine encoder.

Other HIPERFACE® functions cannot be used.

4) Only possible for encoder 1 (ENC1).

The FX3-MOC0 cannot be operated alone, but always requires an FX3-CPUx main module with the following firmware version:

- FX3-CPU0 and FX3-CPU1: ≥ V2.50.0
- All other FX3-CPUx modules (FX3-CPU2, etc): all firmware versions

Up to 6 FX3-MOC0 modules can be used at the same time (see "Construction and function", page 16). Each FX3-MOC0 connected reduces the possible number of other expansion modules by two.

The power supply to the internal logic is provided via the system plug and the FLEXBUS + internal bus.

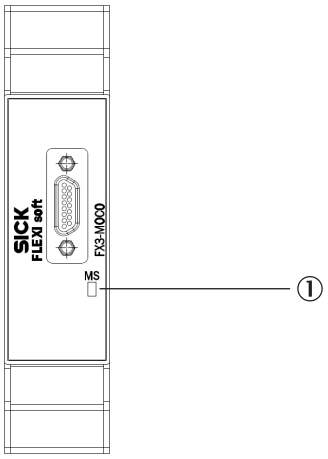


Figure 18: Drive Monitor FX3-MOC0

① MS LED (**M**odule **S**tatus)

WARNING

Ineffectiveness of the protective device due to selection of an unsuitable encoder

The target safety-related level may not be achieved in the event of non-compliance.

- ▶ Select a suitable encoder.
- ▶ Take suitable measures against the encoder's systematic errors and common causes of error.

Choosing the right encoder is crucial to achieving the desired safety integrity level (SIL) and performance level (PL). Systematic faults and common cause faults (CCF), in particular, need to be minimized in this case.

Table 8: Achievable SIL and PL

Use of encoders	Possible axes per FX3-MOC0	Achievable SIL (IEC 61508), SILCL (EN 62061) or PL (EN ISO 13849-1) [1]	Available functions for detecting encoder errors
One sine-cosine safety encoder (e.g., DFS60S Pro)	2	SIL2, SILCL2, PL d	• Sine-cosine analog voltage monitoring [2] • Monitoring of the ID code of the encoder/ motor feedback connection box in order to detect a break in the FX3-MOC0 connection cable [3]

Use of encoders	Possible axes per FX3-MOC0	Achievable SIL (IEC 61508), SILCL (EN 62061) or PL (EN ISO 13849-1) [1]	Available functions for detecting encoder errors
Two encoders with relative position, chosen from the following: • A/B • Sine-cosine • SSI They can be the same type or different types	1	SIL3, SILCL3, PL e	• Speed comparison function block [4] • Monitoring of the ID code of the encoder/ motor feedback connection box in order to detect a break in the FX3-MOC0 connection cable [3]

1) Actual values: see table 142, page 152.
2) Can be configured for sine-cosine encoders in the hardware configuration of the configuration software.
3) Can be used by any type of encoder supported in the hardware configuration of the configuration software.
4) Can be used in the FX3-MOC0 logic. For detailed information, see the “Flexi Soft in the Flexi Soft Designer Configuration Software” operating instructions.

Suitable measures against common causes of error

The following notes are identical for all FX3-MOCx modules.

In particular when both encoders are used for redundant monitoring of an axis, the following possibilities must be taken into account, among others:

- The common GND connection can be interrupted by the common connecting cable on the FX3-MOCx for both encoders as a common reference potential for both encoders.
- The supply voltage for the encoder can be too low or completely interrupted.
- The common supply voltage for both encoders can be too high. This may damage both encoders. When using PELV/SELV voltage supplies without additional protective measures, you must usually assume a voltage increase to 60 V here.
- The entire encoder connection to the FX3-MOCx can be interrupted.

The following options are available to detect errors in the encoder system with the Flexi Soft safety controller:

- Use at least one encoder/motor feedback connection box. A description of this function can be found in the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions in the “Encoder connection type and monitoring of ID identifier” section.
- Use a sine/cosine encoder with activated sine/cosine analog voltage monitoring. [5] A description of this function can be found in the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions in the “Sine-cosine analog voltage monitoring” section.
- Use an SSI encoder with evaluation of error bits. A bit in the SSI data is needed which takes on an inverted state if the watched error occurs, for example because the supply voltage of the encoders is too low or because one or several of the cables from the encoder to the FX3-MOCx are disconnected. A description of this function can be found in the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions in the “SSI encoder” section.

5) Configurable for sine/cosine encoders in the hardware configuration of the configuration software.

- There is no possibility to detect faults immediately using the encoder signals when using A/B incremental encoders. [6)]
- Additionally, in certain cases there will be the option to check the plausibility of the encoder's motion signal using another signal from the process in conjunction with the logic of the Drive Monitor and main module, e.g. with a signal "drive running/not running".

There are the following options to control the voltage increase within the limits of a PELV/SELV voltage supply, as long as the faults to be accepted are not controlled by one of the selected monitoring functions:

- ▶ Use separate voltage supplies for both encoders.
- ▶ Use encoders that are equipped for the increased supply voltage to be accepted.
- ▶ Either use the voltage supply of the FX3-MOCx module for the encoder (ENC1_24V and/or ENC2_24V) directly or via the encoder/motor feedback connection box. If the supply voltage for the Flexi Soft system exceeds 35 V at the system plug of the main module, then the system switches into a safe state, i.e. the safe outputs are switched off. In this way, safe switching off in the application in the event of a voltage increase can be controlled. In this case, it is still possible for the encoder to be damaged.

3.4.11 Drive Monitor FX3-MOC1

Description

The Drive Monitor FX3-MOC1 is an expansion module for the safe movement monitoring of drive systems. In this context, movement means speed level, speed ramp and position. The module has an interface to connect two encoders (e.g. A/B incremental encoders, linear encoders, motor feedback systems or linear distance measurement systems).

The FX3-MOC1 offers the following functions:

- Connection of two encoders for one or two axes
  - A/B incremental encoders HTL 24 V, HTL 12 V, TTL, max. 300 kHz
  - A/B incremental encoder RS-422, max. 1 MHz [7)]
  - Sine-cosine encoder 1 V_{PP}, max. 120 kHz
  - SSI encoder, RS-422, max. 1 MBaud
- Position monitoring
- Standstill monitoring
- Speed monitoring
- Speed cross check
- Direction monitoring
- Processing of information from the encoders and control signals from the main module in the internal logic of the FX3-MOC1. A dedicated logic editor with a number of function blocks is available for this purpose.
- Forwarding of information from the internal logic to the main module

NOTE

The sine/cosine signals of a HIPERFACE® interface can also be connected to the encoder connection of the FX3-MOC1. In this way, the HIPERFACE® interface can be used like a sine/cosine encoder.

Other HIPERFACE® functions cannot be used.

The FX3-MOC1 cannot be operated alone, but always requires an FX3-CPUx main module with the following firmware version:

6) This also applies for A/B incremental encoders with 2 output pairs. Fault detection based on the inverted output signals would allow for cable monitoring, although it would not be possible to detect all faults to be accepted in an A/B incremental encoder such as a static state of the output level.

7) Only possible for encoder 1 (ENC1).

- FX3-CPU0 and FX3-CPU1: ≥ V2.50.0
- All other FX3-CPUx modules (FX3-CPU2, etc.): all firmware versions

Up to 6 FX3-MOC1 modules can be used at the same time (see "Construction and function", page 16). Each FX3-MOC1 connected reduces the possible number of other expansion modules by two.

The internal logic is supplied with voltage via the system plug and the internal FLEXBUS + bus.

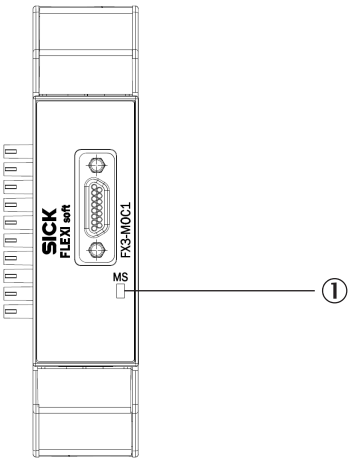


Figure 19: Drive Monitor FX3-MOC1

① MS LED (**m**odule **s**tatus)

WARNING
Ineffectiveness of the protective device due to selection of an unsuitable encoder
The target safety-related level may not be achieved in the event of non-compliance.

- ▶ Select a suitable encoder.
- ▶ Take suitable measures against the encoder's systematic errors and common causes of error.

Choosing the right encoder is crucial to achieving the desired safety integrity level (SIL) and performance level (PL). Systematic faults and common cause faults (CCF), in particular, need to be minimized in this case.

Table 9: Achievable SIL and PL

Use of encoders	Possible axes per FX3-MOC1	Achievable SIL (IEC 61508), SILCL (EN 62061) or PL (EN ISO 13849-1) [1]	Available functions for detecting encoder errors
A sine/cosine safety encoder (e.g. DFS60S Pro)	2	SIL2, SILCL2, PL d for speed monitoring (incl. direction and standstill monitoring)	• Sine-cosine analog voltage monitoring [2] • Monitoring of the ID code of the encoder connection box in order to detect a break in the FX3-MOC1 connection cable [3] (possible but not necessary, as sine-cosine analog voltage monitoring can detect a break in the connection cable)
One sine-cosine safety encoder (e.g., DFS60S Pro) with • Safe Plc cam (i.e., with corresponding SIL, SILCL, or PL) • Position by Reference function block • Reference run after restart	2	SIL2, SILCL2, PL d for position monitoring (incl. speed, direction, and standstill monitoring)	

Use of encoders	Possible axes per FX3-MOC1	Achievable SIL (IEC 61508), SILCL (EN 62061) or PL (EN ISO 13849-1) [1]	Available functions for detecting encoder errors
Two encoders with relative position, chosen from the following: • A/B • Sine-cosine • SSI They can be the same type or different types	1	SIL3, SILCL3, PL e for speed monitoring (incl. direction and standstill monitoring)	• Speed comparison function block [4] • Function block position comparison [4] • Monitoring of the ID code of the encoder/ motor feedback connection box in order to detect a break in the FX3-MOC1 connection cable [3]
A safety encoder with absolute position with • SSI + sine-cosine with • Initial referencing during commissioning • Position by Reference with Restore function block	1	SIL3, SILCL3, PL e for position monitoring (incl. speed, direction, and standstill monitoring)	• Function block position comparison [4] • Monitoring of the ID identifier of the encoder/ motor feedback connection box for detecting a tear in the FX3-MOC1 connecting cable [3]
Two encoders with absolute position, chosen from the following: • A/B • Sine-cosine • SSI A/B and sine-cosine must each be supplemented as follows: a) • Plc cam (not safe) • Position by Reference without Restore function block • Reference run after restart Or b) (possible for a maximum of one encoder) • Initial referencing during commissioning • Position by Reference with Restore function block	1		

1) Actual values: see table 145, page 158.
2) Can be configured for sine-cosine encoders in the hardware configuration of the configuration software.
3) Can be used by any type of encoder supported in the hardware configuration of the configuration software.
4) Can be used in the FX3-MOC1 logics. For details, see the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions.

Suitable measures against common causes of error

The following notes are identical for all FX3-MOCx modules.

In particular when both encoders are used for redundant monitoring of an axis, the following possibilities must be taken into account, among others:

- The common GND connection can be interrupted by the common connecting cable on the FX3-MOCx for both encoders as a common reference potential for both encoders.
- The supply voltage for the encoder can be too low or completely interrupted.

- The common supply voltage for both encoders can be too high. This may damage both encoders. When using PELV/SELV voltage supplies without additional protective measures, you must usually assume a voltage increase to 60 V here.
- The entire encoder connection to the FX3-MOCx can be interrupted.

The following options are available to detect errors in the encoder system with the Flexi Soft safety controller:

- Use at least one encoder/motor feedback connection box. A description of this function can be found in the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions in the “Encoder connection type and monitoring of ID identifier” section.
- Use a sine/cosine encoder with activated sine/cosine analog voltage monitoring. [8] A description of this function can be found in the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions in the “Sine-cosine analog voltage monitoring” section.
- Use an SSI encoder with evaluation of error bits. A bit in the SSI data is needed which takes on an inverted state if the watched error occurs, for example because the supply voltage of the encoders is too low or because one or several of the cables from the encoder to the FX3-MOCx are disconnected. A description of this function can be found in the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions in the “SSI encoder” section.
- There is no possibility to detect faults immediately using the encoder signals when using A/B incremental encoders. [9]
- Additionally, in certain cases there will be the option to check the plausibility of the encoder’s motion signal using another signal from the process in conjunction with the logic of the Drive Monitor and main module, e.g. with a signal "drive running/not running".

There are the following options to control the voltage increase within the limits of a PELV/SELV voltage supply, as long as the faults to be accepted are not controlled by one of the selected monitoring functions:

- ▶ Use separate voltage supplies for both encoders.
- ▶ Use encoders that are equipped for the increased supply voltage to be accepted.
- ▶ Either use the voltage supply of the FX3-MOCx module for the encoder (ENC1_24V and/or ENC2_24V) directly or via the encoder/motor feedback connection box. If the supply voltage for the Flexi Soft system exceeds 35 V at the system plug of the main module, then the system switches into a safe state, i.e. the safe outputs are switched off. In this way, safe switching off in the application in the event of a voltage increase can be controlled. In this case, it is still possible for the encoder to be damaged.

3.4.12 FX3-ANA0 analog input module

Function

The FX3-ANA0 analog input module has two analog inputs for connecting analog signal transmitters (sensors). Both inputs form an input pair and are used to detect an analog process variable. As part of a safety function, the FX3-ANA0 monitors whether the current value of this process variable (measured value) is within the permitted process range. It can also assign the measured value to one of up to 15 configurable signal ranges.

8) Configurable for sine/cosine encoders in the hardware configuration of the configuration software.

9) This also applies for A/B incremental encoders with 2 output pairs. Fault detection based on the inverted output signals would allow for cable monitoring, although it would not be possible to detect all faults to be accepted in an A/B incremental encoder such as a static state of the output level.

NOTE
In some applications, adherence to the ratio of the detected sensor values must be monitored. It is not possible for the FX3-ANA0 to perform an explicit calculation of the ratio between different values.

The FX3-ANA0 analog input module offers the following functions:

- Plausibility check of the analog values detected at inputs AI1 and AI2
- Configurable evaluation of the detected analog values in the module
- Monitoring of up to 15 different process areas. A process area consists of an upper and a lower process area limit. If the measured process size of one of these limits is exceeded or undercut, the **Release** bit is set to 0. The process area to be monitored can be selected in ongoing operation.
- Subdivision of the maximum monitoring range into up to 15 configurable signal ranges
- Output of bits for **Enable** and the number of the current signal range to the main module for evaluation in the logic editor
- Output of sensor values via a gateway (16-bit, non-synchronous output, non-safe transmission)

The FX3-ANA0 analog input module cannot be operated alone; an FX3-CPUx main module is always required.

Multiple FX3-ANA0 can be used at the same time (see "Construction and function", page 16).

The FX3-ANA0 is supplied with voltage via the main module system plug and the internal FLEXBUS+ bus.

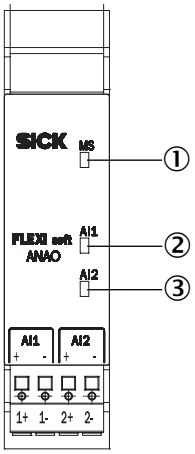


Figure 20: FX3-ANA0 analog input module

① MS LED (module status)
② LED AI1
③ LED AI2

Configuration

The FX3-ANA0 is configured using the Flexi Soft Designer or Safety Designer configuration software.

NOTE
Devices with firmware < V2.00.0 are not supported by the Safety Designer configuration software.

For detailed information on configuring the FX3-ANA0, see the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions.

Sensors

WARNING
Ineffectiveness of the protective device due to selection of unsuitable sensors
The target safety-related level may not be achieved in the event of non-compliance.

- Select suitable sensors.
- Take suitable measures against the sensors’ systematic errors and common causes of error.

Choosing the right sensors is crucial to achieving the desired safety integrity level (SIL) and performance level (PL). Systematic faults and common cause faults (CCF), in particular, need to be minimized in this case.

Sensors featuring diverse redundancy are supported for the safe measurement of a process variable. The characteristic lines of the sensors are standardized in the module for this purpose. The standardized measured values of the two sensors are compared with one another in order to check their plausibility.

Uniformly redundant sensors can also be used. In this case, the characteristic lines of both sensors must have identical configurations.

Depending on the process variable, a time delay can occur at sensors which are attached at a distance from one another within a local area, or which have different transceivers. This transit time difference can be taken into account during the plausibility check.

Instead of two redundant sensors, an individual single-channel or dual-channel safety sensor can be used. A single-channel safety sensor must be connected in series to both inputs.

For information on connecting the sensors, see "Connecting analog sensors", page 94.

For detailed information on configuring the connected sensors, see the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions.

3.4.13 UE410-2RO/UE410-4RO relay modules

Description

The UE410-2RO/UE410-4RO relay modules provide dual-channel, contact-based outputs with what are known as positively guided relay contacts.

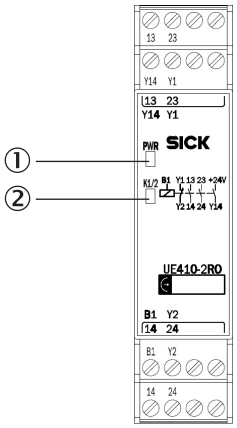


Figure 21: UE410-2RO relay module

① PWR LED (power)
② K1/2 LED

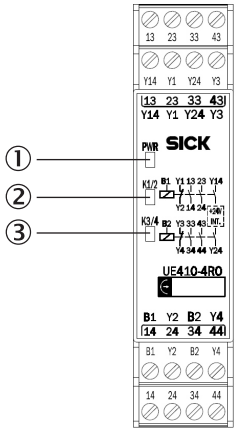


Figure 22: UE410-4RO relay module

① PWR LED (power)
② K1/2 LED
③ K3/4 LED

NOTE

The relay modules do not communicate via the internal FLEXBUS+ bus. They are therefore incapable of receiving any control signals from the main module.

A maximum of 4 UE410-4RO relay modules or 8 UE410-2RO relay modules can be connected to a Flexi Soft system; in other words, a maximum of 16 safe relay outputs may be available.

Other modules from the Flexi Classic product family cannot be integrated into the Flexi Soft system.

3.4.13.1 Internal structure

UE410-2RO

The UE410-2RO relay module has a control input (B1). This controls two internal relays and provides a redundant cut-off path, consisting of:

- Two safe enabling current paths (13/14, 23/24), dual-channel and volt-free
- One signaling current path (Y14), dual-channel and connected internally to 24 V DC
- One feedback circuit external device monitoring (Y1/Y2), dual-channel and volt-free

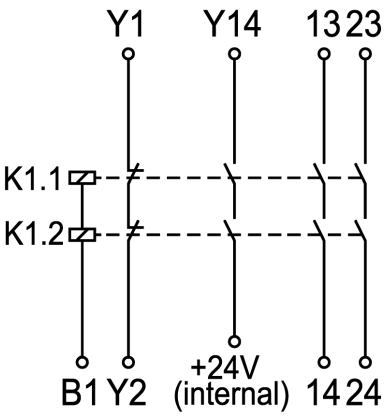


Figure 23: Internal structure of the UE410-2RO

UE410-4RO

The UE410-4RO relay module has two control inputs (B1, B2). These each control two internal relays. Two independent, redundant cut-off paths are therefore available.

Control input (B1) actuates two internal relays and provides a redundant cut-off path consisting of:

- Two safe enabling current paths (13/14, 23/24), dual-channel and volt-free
- One signaling current path (Y14), dual-channel and connected internally to 24 V DC
- One feedback circuit external device monitoring (Y1/Y2), dual-channel and volt-free

Control input (B2) actuates two internal relays and provides a redundant cut-off path consisting of:

- Two safe enabling current paths (33/34, 43/44), dual-channel and volt-free
- One signaling current path (Y24), dual-channel and connected internally to 24 V DC
- One feedback circuit external device monitoring (Y3/Y4), dual-channel and volt-free

This means that the UE410-4RO relay module has twice the number of functions as the UE410-2RO.

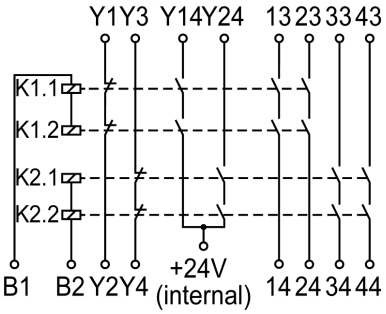


Figure 24: Internal structure of the UE410-4RO

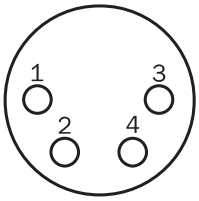
3.5 Interfaces

3.5.1 RS-232

Each main module has an RS-232 interface with the following functions:

- Transfer configuration from the configuration software to the system plug
- Import configuration from the system plug into the configuration software
- Diagnose the Flexi Soft system with the configuration software
- Continuous diagnostics of the Flexi Soft system via a connected PLC As such the RS-232 interface can provide an alternative to a gateway.

Table 10: Pin assignment of the RS-232 interface on the FX3-CPUx

Male connector/ Female connector	Pin	Signal	Color	Computer-side pin assignmentRS-232 D-Sub (9-pin)
	1	Reserved	Brown	–
	2	RxD	White	Pin 3
	3	GND (connected electrically internally to connection A2 on the main module)	Blue	Pin 5
	4	TxD	Black	Pin 2

NOTICE
Ground loops

The device may be damaged if this is not observed.

- Avoid ground loops between the GND connection of the RS-232 interface and the A2 connection of the main module, for instance by using optocouplers.
- If the RS-232 interface of the main module is permanently connected (e.g. as an alternative to a gateway), then observe the maximum permitted length of cable of 3 m.

3.5.2 USB

The FX3-CPU3 main module has a USB interface with the following functions:

- Transfer configuration from the configuration software to the system plug
- Import configuration from the system plug into the configuration software
- Diagnose the Flexi Soft system with the configuration software

3.5.3 Enhanced Function Interface (EFI)

The FX3-CPU1, FX3-CPU2, and FX3-CPU3 main modules each have 2 EFI interfaces. The properties, the functions, and the benefits of these interfaces are described in this section.

The general EFI description of operation and the combination options of SICK products regarding EFI can be found in the “EFI - enhanced function interface” technical information (SICK part number 8012611).

Definition

An EFI interface is safe communication interface between SICK devices. Information can be read from EFI-enabled devices and commands can be sent to EFI-enabled devices.

Properties

- Each EFI interface can support up to 4 SICK devices, as long as the EFI-enabled devices support this number.
- Device connection via 2-wire cable
- Various possible device combinations
  - Sensor with sensor in same product family
  - Sensor with safety controllers and gateways
  - Connection of up to four FX3-CPU1, FX3-CPU2, or FX3-CPU3 main modules to one Flexi Link system (see "Flexi Link", page 45)
- Transfer of status information (process data) between SICK devices with EFI interface
- Transfer of configuration from the configuration software to EFI-enabled devices
- Import of configuration from EFI-enabled devices into the configuration software
- Activation/use of advanced software functions

Functions

Alongside the product-specific functions of each of the EFI-enabled devices, the following functions are available:

General functions

- Status information (process data) from the EFI-enabled devices is available in the controller and at the sensor.
- Diagnostic information from all EFI-enabled devices is available in the controller.
- Transfer of configuration information

Special functions
- Simultaneous protective field evaluation
- Protective field switching
- Function switching
- Operating mode selection
- Signal routing
- Remote diagnostic information via Ethernet
- Information about the location of an interruption in a protective field in the case of host-guest applications.
- Expansion of signals and forwarding of results

Benefits

- **Installation is quicker and less expensive** (only 2 conductors) when signals from multiple sensors are used
- **Decrease the material costs** with the savings potential of function blocks, inputs and outputs
- **Higher availability** thanks to the provision of diagnostic information with high information content for quick and accurate possible actions

3.6 Special functions

3.6.1 Flexi Link

Overview

Flexi Link allows you to combine up to four Flexi Soft stations via EFI for safe data exchange. Only main modules FX3-CPU1 and higher can be used in a Flexi Link system. FX3-CPU0 main modules cannot be connected.

The process data of each station (inputs and outputs, logic results, etc.) can be made available to all other stations in the Flexi Link system. The teach function can be used to deactivate individual stations temporarily without impairing the operation of the overall system.

Features
- Safe connection of up to four Flexi Soft stations via EFI
- Connection via EFI1 or EFI1+2
- Transmission/receipt of up to 52 bits of information per station (26 bits per EFI interface)
- A tag name that is valid globally can be assigned to each bit.
- Teaching simulates the presence of stations that have been temporarily suspended (switched off).
- Any station can be used for access in order to address and configure the entire system with the configuration software.
- The configuration of the entire Flexi Link system is saved in a unique project file.

System requirements and restrictions

The following minimum system requirements must be met for Flexi Link:

Table 11: System requirements for Flexi Link

System component	Version
Hardware	FX3-CPU1, FX3-CPU2, or FX3-CPU3 with firmware version ≥ V2.00.0
Software	Flexi Soft Designer version ≥ V1.3.0

The Flexi Link system can either by connected via EFI1 only or via EFI1+2. The number of pieces of data per station that can be made available to the other stations in the same Flexi Link system depends on which connection type is used.

Table 12: Available data depending on connection type

Type of connection	Data availability per station
EFI1	26 bits
EFI1+2	52 bits

NOTE

- You cannot use Flexi Link and EFI communication at the same time, i.e., it is not possible to connect other EFI-enabled devices to EFI2 if you are using EFI1 for Flexi Link.
- The process data sent from any station is received by all other stations at virtually the same time. However, the data is not necessarily processed (logic) at the same time, because the stations are not synchronized.
- The data is consistent within EFI1 and consistent within EFI2. However, the data from EFI1 and the data from EFI2 may be inconsistent for a short period of time because it is transmitted separately.

3.6.2 Flexi Line

Overview

Flexi Line allows you to network up to 32 Flexi Soft stations safely. Only main modules FX3-CPU3 and higher can be used in a Flexi Line system. It is not possible to connect any of the other main modules (FX3-CPU0, FX3-CPU1, FX3-CPU2).

A single process image is defined for the entire Flexi Line system. Each byte in this process image is valid either globally, i.e., in the entire system, or locally, i.e., only for the corresponding station and its neighbor stations. Each Flexi Line station uses this process image to communicate with its neighbor stations. Thanks to the topology, addresses are not required in order for communication to take place.

Features

- Safe connection of up to 32 Flexi Soft stations via the Flexi Line interface
- Topology without addresses: If the sequence of the stations changes, simply confirm the new arrangement by performing a teach-in operation.
- The EFI interface remains available without restrictions:
  - EFI-enabled devices can be connected.
  - A Flexi Link system can be connected.
- A global process image is defined for all stations.
- Bytes that are valid globally or locally can be defined in the process image.
- The process image can contain up to 12 bytes or 96 bits.
- The maximum cable length between 2 stations is 1,000 meters. The possible total length of a system with 32 stations is, therefore, 31 kilometers.

System requirements and restrictions

The following minimum system requirements must be met for Flexi Line:

Table 13: System requirements for Flexi Line

System component	Version
Hardware	FX3-CPU3, every firmware version
Software	Flexi Soft Designer version ≥ V1.6.0

NOTE

- You can even use Flexi Link or EFI communication simultaneously with Flexi Line, i.e., it is possible to connect either EFI-enabled devices or Flexi Link stations.
- The process image is transferred from station to station at a fixed update rate. However, the data is not necessarily processed (logic) at the same time, because the stations are not synchronized.
- The update rate of the Flexi Line system is determined by the maximum cable length between two stations and the size of the process image.

Table 14: Update rate of a Flexi Line system dependent on the maximum cable length and the size of the process image

Max. cable length	32 bits	64 bits	96 bits
125 m	2 ms	2 ms	4 ms
250 m	2 ms	4 ms	8 ms
500 m	4 ms	8 ms	12 ms
1,000 m	8 ms	12 ms	20 ms

3.6.3 Muting

General description

Muting automatically and temporarily overrides the safety-related functions provided by a control system or a safety device. Muting is used to move specific objects (pallets loaded with goods, for example) through an electro-sensitive protective device such as a safety light curtain and into a hazardous area. During this transport operation, the muting function overrides monitoring by the electro-sensitive protective device.

For the further approach, observe the notes in the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions.

SICK muting sensors

A selection of optical muting sensors are presented below. You can use these sensors by type (light or dark switching).

Table 15: Selection and settings of optical SICK muting sensors in muting applications

Model	Function
W9-3	Light/dark switching, complementary
W12-3	
W18-3	
W27-3	
W24-3	Light/dark switching, switchable

NOTE

The following criteria apply when selecting and setting optical SICK muting sensors in muting applications:

- Outputs must be PNP-switching.
- Note the output level in the table below.

Table 16: Output level of muting sensors

Output level of muting sensors	State
High	Activated, material detected
Low	Deactivated, no material detected

3.6.4 Automatic configuration recovery (ACR)

When an FX3-MPL1 system plug is used, EFI-enabled devices of the same type can be detected and automatically reconfigured further to a replacement (automatic configuration recovery). Advantages:

- Configuration backup of EFI sensors in FX3-CPU2 and FX3-CPU3
- Rapid device replacement without reconfiguration with the corresponding configuration software
- Quick and easy duplication of equipment in series machine manufacture

ACR can be used to restore the configuration of the following device families:

- S3000 with firmware version ≥ B02.41, **not** in Compatibility mode. For details, refer to the “Compatibility mode” chapter of the S3000 operating instructions (SICK part number 8009791).
- S300 with firmware version ≥ 02.10, **not** in Compatibility mode. For details, refer to the “Compatibility mode” chapter of the S300 operating instructions (SICK part number 8010946).
- S300 Mini
- M4000
- C4000

ACR **cannot** be used to restore the configuration of the following devices:

- UE product family (UE402/UE403, UE44xx, UE41xx, UExx40)
- Devices in the Flexi Soft product family (FX3-CPUx)

Please also refer to the information in the operating instructions for the EFI-enabled devices you are using.

The “Flexi Soft in the Flexi Soft Designer Configuration Software” operating instructions contain more information on using the ACR function.

4 Mounting

WARNING
Ineffectiveness of the protective device due to unsuitable mounting location
The target safety-related level may not be achieved in the event of non-compliance.

- ▶ Mount the Flexi Soft system in an environment corresponding to enclosure rating IP54 (EN 60529), e.g. inside a control cabinet with enclosure rating IP54.

NOTICE
Improper mounting
The device may be damaged if this is not observed.

- ▶ Switch off the supply voltage before adding or removing modules.
- ▶ Ensure suitable ESD protective measures during mounting.

Assignment of the modules:

- Within a Flexi Soft system, the FX3-CPUx main module is always located on the far left.
- Up to two gateways can be used per system. The two optional gateways must be mounted directly to the right of the main module of the Flexi Soft system.
- All other Flexi Soft expansion modules (e.g. the FX3-XTIO, FX3-XTDI, or FX3-MOCx) must be mounted to the right of the gateways. The expansion modules can be mounted in any order.
- Any additional relay modules (the UE410-2RO or UE410-4RO) must be mounted to the right of the expansion modules.

Mounting the modules:

- The modules are housed in a 22.5 mm wide housing for standard 35 mm rails in accordance with EN 60715 (DIN mounting rail).
- The modules are interconnected via a FLEXBUS+ plug connector, which is integrated into the housing. The Flexi Soft modules must be pushed approximately 10 mm apart before a module can be removed from the DIN mounting rail.
- The modules must be installed in the control cabinet so that the minimum distance of the Flexi Soft modules to the control cabinet is upheld. This distance is 50 mm above and below the modules and 25 mm to the front and back.
- The Flexi Soft system must be installed vertically so that optimal air circulation is possible.
- Modules with ventilation slots (e.g., the EtherCAT gateway) must be mounted so that the air can circulate vertically. The ventilation slots must be positioned at the top and bottom.

- ▶ Mount the modules in accordance with EN 50274.
- ▶ Make sure that the voltage supply for the Flexi Soft system is switched off.
- ▶ Implement suitable measures to prevent any foreign bodies from entering the connector openings, particularly those of the system plug.

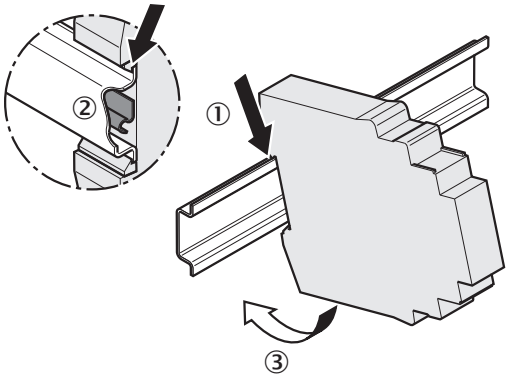


Figure 25: Mounting the module on the DIN mounting rail

- ▶ Hook the device onto the DIN mounting rail (①).
- ▶ The grounding clip (②) must sit flush against the DIN mounting rail so that it is secure and can conduct electricity effectively.
- ▶ Snap the module into place on the DIN mounting rail by applying slight pressure in the direction of the arrow (③).

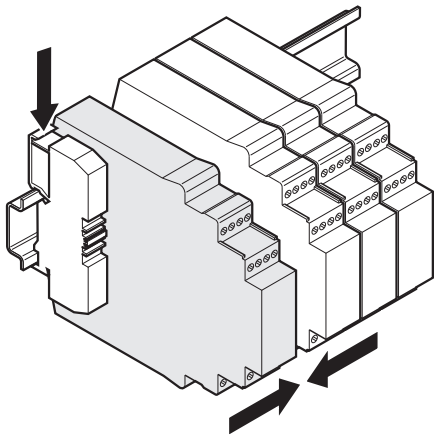


Figure 26: Attaching the end pieces

- ▶ Slide the modules together one by one (as indicated by the arrows) until the side-mounted plug connector engages.
- ▶ Mount the end pieces on the left- and right-hand sides.

The following steps are necessary after mounting and installation:

- Establish the electrical connections (see "Electrical installation", page 51)
- Configuration (“Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions)
- Check the installation (see "Checks before initial commissioning", page 102)

NOTE

To mount and remove the encoder/motor feedback connection boxes, see the mounting instructions for the encoder/motor feedback connection boxes at www.sick.com.

5 Electrical installation

NOTE

This chapter deals with the electrical installation of the Flexi Soft system inside the control cabinet. You will find additional information about the electrical connection of other devices to the Flexi Soft system in the section about the corresponding device: (see "Connection of devices", page 74).

5.1 Requirements to be met by the electrical installation

WARNING

Electrical voltage

There is a risk of injury from electrocution while connecting the devices.

- Disconnect the power for the entire plant/machine.

WARNING

Unintended start of the plant/machine

The plant/machine could inadvertently start while you are connecting the devices.

- Disconnect the power for the entire plant/machine.

WARNING

Ineffectiveness of the protective device due to non-compliance with safety standards

The target safety-related level may not be achieved in the event of non-compliance.

- Observe the relevant safety standards (e.g. EN 62061, or EN ISO 13849-1) for all the safety-related parts of the plant (wiring, connected sensors and control devices, configuration, external device monitoring).

NOTE

For the electrical installation, observe the following:

- The Flexi Soft safety controller meets the EMC requirements stipulated by generic standard EN 61000-6-2 for the industrial sector.
- Industrial safety devices by SICK are only suitable for local direct current applications. If the device is being used on power supply networks, e.g., in accordance with IEC 61326-3-1, additional protective measures must be taken.
- Machines on which safety devices are being used must be installed and dimensioned as appropriate for the lightning zone in accordance with EN 62305-1. The required level can be achieved by using external protective devices. The devices used to provide protection against overvoltage must meet the requirements set out in EN 61643-11.
- The equipment must prevent common-mode disturbance as set out in IEC 61000-4-16 in the frequency range from 0 Hz to 150 kHz.
- To establish full EMC safety, you must connect the DIN mounting rail to functional earth (FE).
- The external voltage supply of the Flexi Soft modules must be capable of buffering brief power failures of 20 ms as specified in EN 60204-1, for example.
- The power supply and all connected signals must meet the requirements for low voltages with safe isolation (SELV, PELV) as set out in EN 60664 and EN 50178 (electronic equipment for use in power installations).
- If the RS-232 interface on the main module is used as an alternative to a gateway, then the maximum permitted length of cable is 3 m.
- The GND of the RS-232 interface is connected internally to the GND connection of the main module's voltage supply (A2). Avoid ground loops between the GND connection of the RS-232 interface and the A2 connection of the main module, for instance by using optocouplers.
- Depending on the external loads and in particular in the case of inductive loads, additional external safety measures such as varistors or RC elements may be necessary in order to protect the outputs. For information on limitations in operation: see "Technical data", page 126. It must be considered that the response times may be extended depending on the type of suppressor.
- When modules are exchanged, the correct assignment of the terminals must be ensured, e.g. by labelling or routing the cables correspondingly.

Electrical installation

- ▶ Carry out the electrical installation work in conformity with EN 60204-1.
- ▶ Connect the shielding of all fieldbus and Ethernet cables to the functional earth (FE) directly at the control cabinet entry point.
- ▶ Connect the GND connections of the actuators to the outputs Q1 to Q4 in star formation with the GND connection of the voltage supply. Otherwise, an actuator (e.g. relay) could switch unintentionally if the common GND cable tears off, at least one output is high and at least one output for the actuators is low.
- ▶ Make sure that all the Flexi Soft system modules, the connected protective devices (e.g., the EFI-enabled devices), and the voltage supplies are all connected to the same ground. The ground of the RS-232 interface is connected internally to the ground of the main module's voltage supply (A2).

WARNING
Unintended high status at the inputs due to reverse current in case of loss of ground connection

The target safety-related level may not be achieved in the event of non-compliance.

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

If several safe inputs are switched in parallel:

- Check whether this reverse current might lead to an unintentional high state, see "Data sheet", page 135.
- Consider this possible error source in the risk analysis and risk avoidance strategy.

5.2 Description of the terminals

5.2.1 FX3-CPU0 main module

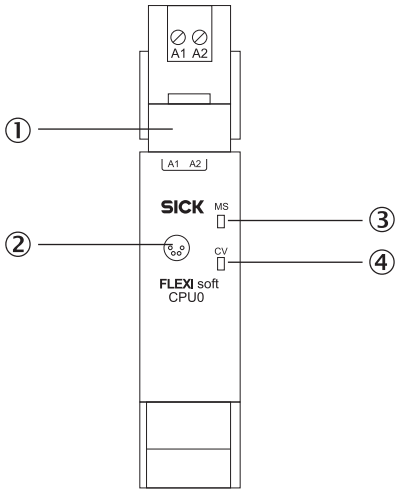


Figure 27: FX3-CPU0 main module

① FX3-MPL0 system plug
② RS-232 interface
③ MS LED (**M**odule **S**tatus)
④ CV LED (**C**onfiguration **V**erified)

Table 17: Pin assignment on the FX3-CPU0 main module with FX3-MLP0 system plug

Terminal	Pin assignment
A1	24 V power supply for all modules, with the exception of the supply to the outputs (Q1 ... Q4)
A2	Power supply GND

5.2.2 FX3-CPU1 and FX3-CPU2 main modules

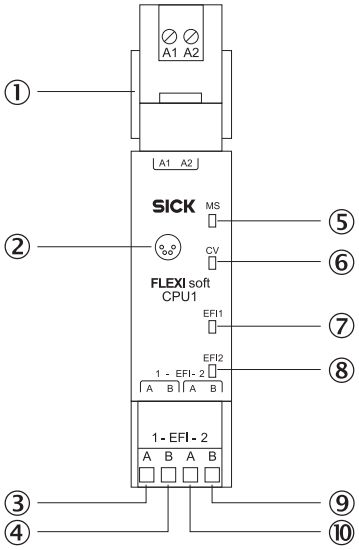


Figure 28: FX3-CPU1 main module

① FX3-MPL0 system plug
② RS-232 interface
③ EFI1_A
④ EFI1_B
⑤ MS LED (Module Status)
⑥ CV LED (Configuration Verified)
⑦ EFI1 LED
⑧ EFI2 LED
⑨ EFI2_B
⑩ EFI2_A

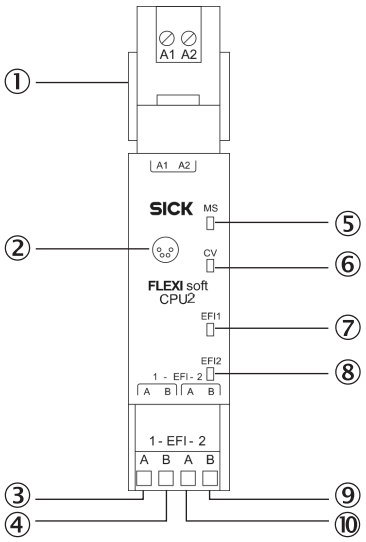


Figure 29: FX3-CPU2 main module

① FX3-MPL1 system plug
② RS-232 interface
③ EFI1_A
④ EFI1_B

⑤ MS LED (**M**odule **S**tatus)
⑥ CV LED (**C**onfiguration **V**erified)
⑦ EFI1 LED
⑧ EFI2 LED
⑨ EFI2_B
⑩ EFI2_A

Table 18: Pin assignment at FX3-CPU1 main module with FX3-MPL0 system plug and at FX3-CPU2 main module with FX3-MPL1 system plug

Terminal	Pin assignment
A1	24 V power supply for all modules, with the exception of the supply to the outputs (Q1 ... Q4)
A2	Power supply GND
EFI1_A	Connections for EFI or for Flexi Link
EFI1_B	
EFI2_A	
EFI2_B	

5.2.3 FX3-CPU3 main module

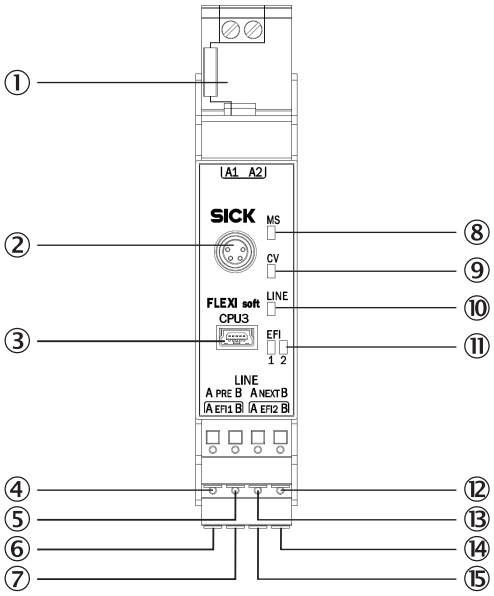


Figure 30: FX3-CPU3 main module

① FX3-MPL1 system plug
② RS-232 interface
③ USB interface
④ Line_PRE_A (previous)
⑤ Line_PRE_B (previous)
⑥ EFI1_A
⑦ EFI1_B
⑧ MS LED (**M**odule **S**tatus)
⑨ CV LED (**C**onfiguration **V**erified)
⑩ LINE LED
⑪ EFI1 and EFI2 LEDs
⑫ Line_NEXT_B (next)

⑬ Line_NEXT_A (next)
⑭ EFI2_B
⑮ EFI2_A

Table 19: Pin assignment on the FX3-CPU3 main module with FX3-MLP1 system plug

Terminal	Pin assignment
A1	24 V power supply for all modules, with the exception of the supply to the outputs (Q1 ... Q4)
A2	Power supply GND
EFI1_A	Connections for EFI or for Flexi Link
EFI1_B	
EFI2_B	
EFI2_A	
Line_PRE_A	Connections for Flexi Line
Line_PRE_B	
Line_NEXT_A	
Line_NEXT_B	

5.2.4 FX3-XTIO I/O module

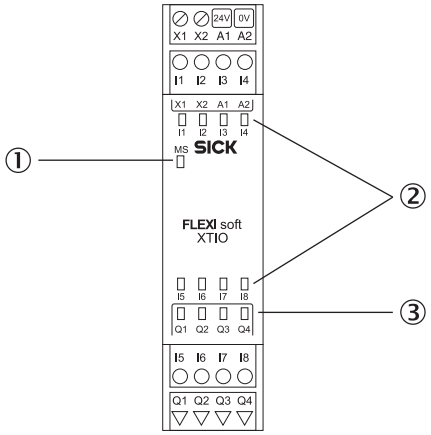


Figure 31: FX3-XTIO I/O module

① MS LED (**M**odule **S**tatus)
② 8 input LEDs
③ 4 output LEDs

Table 20: Pin assignment for the FX3-XTIO I/O module

Terminal	Pin assignment
A1	24 V
A2	GND
I1 ... I8	Safe inputs 1 to 8
Q1 ... Q4	Safe outputs 1 to 4
X1/X2	Test output 1/Test output 2

NOTE

Use of the test outputs

The FX3-XTIO has two test outputs.

- For each device to be tested, one test output must be used of the same module to which the device is connected.
- If the device to be tested is connected to an odd-numbered input (I1, I3, I5, I7), then test output X1 must be used. If the device to be tested is connected to an even-numbered input (I2, I4, I6, I8), then test output X2 must be used.

5.2.5 FX3-XTDI I/O module

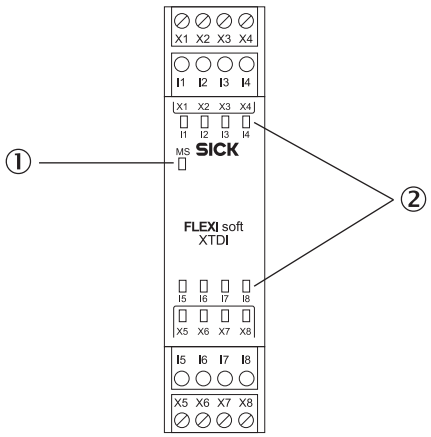


Figure 32: FX3-XTDI I/O module

① MS LED (**M**odule **S**tatus)

② 8 input LEDs

Table 21: Pin assignment for the FX3-XTDI I/O module

Terminal	Pin assignment
I1 ... I8	Safe inputs 1 to 8
X1/X3/X5/X7	Test output 1 (test signal generator 1)
X2/X4/X6/X8	Test output 2 (test signal generator 2)

NOTE

Use of the test outputs

The FX3-XTDI has eight test outputs.

- For each device to be tested, one test output must be used of the same module to which the device is connected.
- If the device to be tested is connected to an odd-numbered input (I1, I3, I5, I7), then an odd-numbered test output (X1, X3, X5, X7) must be used. If the device to be tested is connected to an even-numbered input (I2, I4, I6, I8), then an even-numbered test output (X2, X4, X6, X8) must be used.

5.2.6 FX3-XTDS I/O module

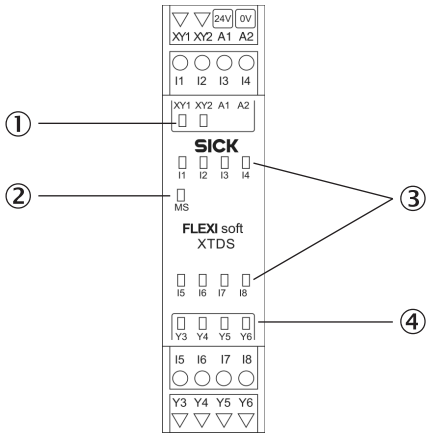


Figure 33: FX3-XTDS I/O module

① 2 LEDs for test outputs or non-safe outputs
② MS LED (**M**odule **S**tatus)
③ 8 input LEDs
④ 4 output LEDs

Table 22: Pin assignment for the FX3-XTDS I/O module

Terminal	Pin assignment
A1	24 V
A2	GND
I1 ... I8	Safe inputs 1 to 8
Y3 ... Y6	Non-safe outputs 3 to 6
XY1/XY2	Test output 1/Test output 2 or non-safe output 1/non-safe output 2

NOTE

Use of the test outputs

The FX3-XTDS has two optional test outputs.

- For each device to be tested, one test output must be used of the same module to which the device is connected.
- If the device to be tested is connected to an odd-numbered input (I1, I3, I5, I7), then test output XY1 must be used. If the device to be tested is connected to an even-numbered input (I2, I4, I6, I8), then test output XY2 must be used.

5.2.7 FX0-STIO I/O module

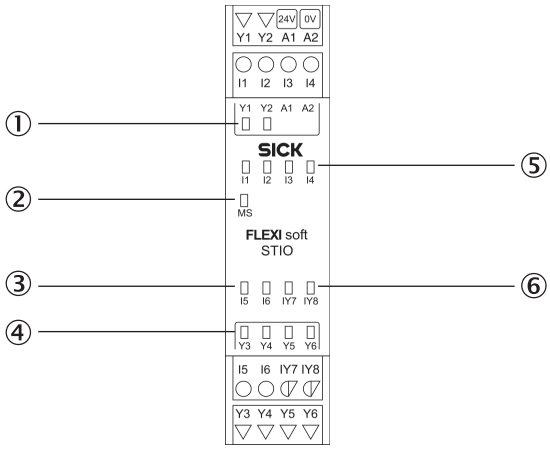


Figure 34: FX0-STIO I/O module

① 2 output LEDs
② MS LED (**M**odule **S**tatus)
③ 2 input LEDs
④ 4 output LEDs
⑤ 4 input LEDs
⑥ 2 LEDs for configurable inputs or outputs

Table 23: Pin assignment for the FX0-STIO I/O module

Terminal	Pin assignment
A1	24 V
A2	GND
I1 ... I6	Non-safe inputs 1 to 6
IY7, IY8	Non-safe inputs 7 and 8 or non-safe outputs 7 and 8 (configurable)
Y1 ... Y6	Non-safe inputs 1 to 6

5.2.8 Drive Monitor FX3-MOCx

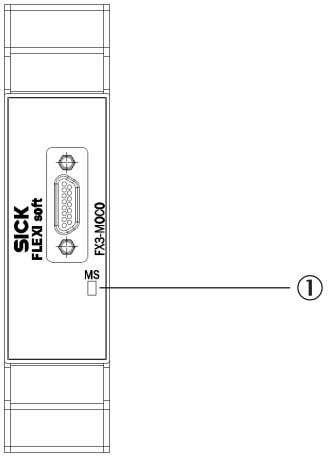


Figure 35: Drive Monitor FX3-MOCx

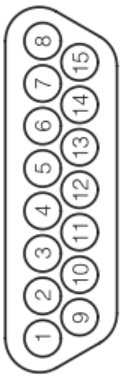
① MS LED (**M**odule **S**tatus)

A 15-pin Micro D-Sub male connector is positioned on the front of the FX3-MOCx for connecting up to two encoders.

NOTE

- To make installation easier, we recommend using the connection cables and the encoder/motor feedback connection boxes that are available as accessories (see "Accessories", page 182).
- The signals are assigned based on the type of encoder being used (see "Connection of encoders", page 89).

Table 24: Pin assignment of the Micro-D-Sub male connector of the FX3-MOCx

Male connector	Pin	Signal name	Encoder	Wiring [1]					
				Sine/Cosine encoder		A/B incremental encoder, 2 pairs of outputs (HTL 24 V, HTL 12 V, TTL)	A/B incremental encoder, 2 outputs (HTL 24 V, HTL 12 V, TTL)	A/B incremental encoder, 2 pairs of outputs (RS-422)	SSI encoder
	1	ENC1_A+	1	Cos+	Cos	A+	A	A+	Data+
	9	ENC1_A–		Cos–	Cos_Ref	A–	GND	A–	Data–
	2	ENC1_B+		Sin+	Sin	B+	B	–	–
	10	ENC1_B–		Sin–	Sin_Ref	B–	GND	–	–
	3	ENC1_C+		–	–	–	–	B+	Clock+
	11	ENC1_C–		–	–	–	–	B–	Clock -
	4	ENC1_24V		24 V voltage supply for encoder 1					
	8	ENC2_A+	2	Cos+	Cos	A+	A	–	Data+
	15	ENC2_A–		Cos–	Cos_Ref	A–	GND	–	Data–
	7	ENC2_B+		Sin+	Sin	B+	B	–	–
	14	ENC2_B–		Sin–	Sin_Ref	B–	GND	–	–
	6	ENC2_C+		–	–	–	–	–	Clock+
	13	ENC2_C–		–	–	–	–	–	Clock -
	5	ENC2_24V		24 V voltage supply for encoder 2					
	12	ENC_0V	1 & 2	GND connection for encoder 1 and 2					

[1] A combination of different encoder types is possible.

5.2.9 FX3-EBX1, FX3-EBX3, and FX3-EBX4 encoder/motor feedback connection boxes

The encoder/motor feedback connection boxes that are available as accessories facilitate the connection of encoders to the encoder interface of FX3-MOCx modules. They are particularly useful for encoders which are being used not only for an FX3-MOCx but also for motor feedback in a drive system.

There are additional terminals on all encoder/motor feedback connection boxes. These are designed for forwarding signals which are not required for the FX3-MOCx module but can still be transmitted in the encoder cable (brake actuation, temperature sensor, etc.).

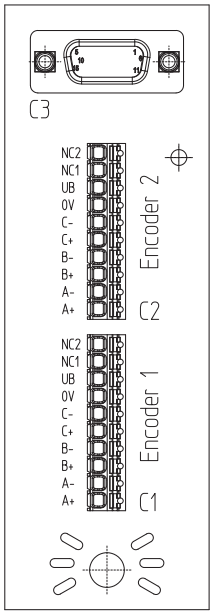
The following encoder/motor feedback connection boxes are available:

- **FX3-EBX1 optimized dual encoder/motor feedback connection box**: Facility for connecting two encoders, two additional free terminals per encoder for forwarding signals.
- **FX3-EBX3 encoder/motor feedback connection box**: Facility for connecting one encoder, ten additional free terminals for forwarding signals. Normally used in combination with a motor feedback system.
- **FX3-EBX4 dual encoder/motor feedback connection box**: Facility for connecting two encoders, two additional free terminals for encoder 1 for forwarding signals.

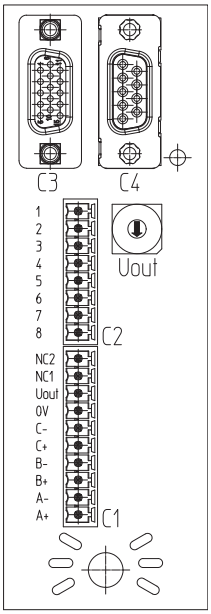
For information on recommended connection types see "Connection of encoders", page 89.

The FX3-EBX3 and FX3-EBX4 encoder/motor feedback connection boxes have an on-board voltage supply for encoders and a shielding hood for the plug-in spring terminals C1 and C2 to provide protection against electromagnetic interference. The on-board voltage supply is fed from the FX3-MOCx and can be switched between 5 V, 7 V, 12 V, and 24 V (nominal).

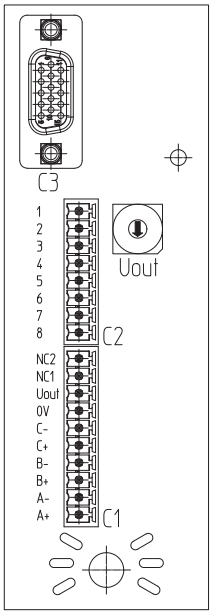
Table 25: Connections on the encoder/motor feedback connection boxes (front view)



Optimized dual encoder/ motor feedback connection box FX3-EBX1



Encoder/motor feedback connection box FX3-EBX3



Dual encoder/motor feedback connection box FX3-EBX4

Description

Table 26: Description of the connections on the encoder/motor feedback connection boxes

	Optimized dual encoder/ motor feedback connection box FX3-EBX1	Encoder/motor feedback connection box FX3-EBX3	Dual encoder/motor feedback connection box FX3-EBX4
C1	• Spring terminals for the connection of encoder signals from an encoder • 2 free terminals for forwarding other signals	• Plug-in spring terminals for the connection of encoder signals from an encoder • 2 free terminals for forwarding other signals	
C2	• Spring terminals for the connection of encoder signals from a second encoder • 2 free terminals for forwarding other signals	• Plug-in spring terminals with 8 free terminals for forwarding other signals	• Plug-in spring terminals for the connection of encoder signals from a second encoder

	Optimized dual encoder/ motor feedback connection box FX3-EBX1	Encoder/motor feedback connection box FX3-EBX3	Dual encoder/motor feedback connection box FX3-EBX4
C3	• 15-pin HD D-Sub female connector with M3 screws for connecting the connection cable to the FX3-MOCx		
C4	–	• 9-pin D-Sub female connector with M3 screws for connecting a second FX3-EBX3 encoder/ motor feedback connection box (to forward the ENC2_x signals from the 15-pin HD D-Sub female connector)	–
U_{out}	–	• Selector switch for the on-board voltage supply for encoders, fed from the FX3-MOCx, can be switched between 5 V, 7 V, 12 V, and 24 V (nominal)	
	• Terminals for shielding the two cables from the encoder and to the motor controller for a low-resistance connection of the cable shields		
	• ID code in combination with the voltage supply, for evaluation by the FX3-MOCx		

WARNING

Ineffectiveness of the protective device due to unsuitable mounting location

The target safety-related level may not be achieved in the event of non-compliance.

▶ Mount the encoder/motor feedback connection boxes in an environment corresponding to enclosure rating IP54 (EN 60529), e.g. inside a control cabinet with enclosure rating IP54.

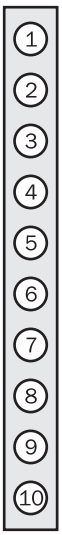
FX3-EBX1 optimized dual encoder/motor feedback connection box

Table 27: Pin assignment for encoder connection C1 on the FX3-EBX1

Terminal strip	Terminal	Signal	Wiring					
			Sine-cosine encoder		A/B incremental encoder, 2 pairs of outputs (HTL 24 V, HTL 12 V, TTL)	A/B incremental encoder, 2 outputs (HTL 24 V, HTL 12 V, TTL)	A/B incremental encoder, 2 pairs of outputs (RS-422)	SSI encoder
	1	NC2	Not connected to the FX3-EBX1 [1]					
	2	NC1	Not connected to the FX3-EBX1 [1]					
	3	ENC1_24V	24 V voltage supply for encoder					
	4	ENC1_0V	GND connection for encoder					
	5	ENC1_C–	–	–	–	–	B–	Clock–
	6	ENC1_C+	–	–	–	–	B+	Clock+
	7	ENC1_B–	Sin–	Sin_Ref	B–	GND	–	–
	8	ENC1_B+	Sin+	Sin	B+	B	–	–
	9	ENC1_A–	Cos–	Cos_Ref	A–	GND	A–	Data–
	10	ENC1_A+	Cos+	Cos	A+	A	A+	Data+

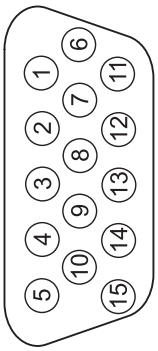
[1] For forwarding a signal; e.g., for an external voltage supply.

Table 28: Pin assignment for encoder connection C2 on the FX3-EBX1

Terminal strip	Terminal	Signal	Wiring					
			Sine-cosine encoder		A/B incremental encoder, 2 pairs of outputs (HTL 24 V, HTL 12 V, TTL)	A/B incremental encoder, 2 outputs (HTL 24 V, HTL 12 V, TTL)	A/B incremental encoder, 2 pairs of outputs (RS-422)	SSI encoder
	1	NC2	Not connected to the FX3-EBX1 [1]					
	2	NC1	Not connected to the FX3-EBX1 [1]					
	3	ENC2_24V	24 V voltage supply for encoder					
	4	ENC2_0V	GND connection for encoder					
	5	ENC2_C–	–	–	–	–	–	Clock–
	6	ENC2_C+	–	–	–	–	–	Clock+
	7	ENC2_B–	Sin–	Sin_Ref	B–	GND	–	–
	8	ENC2_B+	Sin+	Sin	B+	B	–	–
	9	ENC2_A–	Cos–	Cos_Ref	A–	GND	–	Data–
	10	ENC2_A+	Cos+	Cos	A+	A	–	Data+

1) For forwarding a signal; e.g., for an external voltage supply.

Table 29: Pin assignment for HD D-Sub female connector C3 on the FX3-EBX1 for connection to the FX3-MOCx

Female connector	Pin	Signal
	1	ENC1_A+
	2	ENC1_A–
	3	ENC1_24V
	4	ENC2_A+
	5	ENC2_A–
	6	ENC1_B+
	7	ENC1_B–
	8	ENC_0V
	9	ENC2_B+
	10	ENC2_B–
	11	ENC1_C+
	12	ENC1_C–
	13	ENC2_24V
	14	ENC2_C+
	15	ENC2_C–

FX3-EBX3 encoder/motor feedback connection box

Table 30: Pin assignment for encoder connection C1 on the FX3-EBX3

Terminal strip	Terminal	Signal	Wiring					
			Sine-cosine encoder		A/B incremental encoder, 2 pairs of outputs (HTL 24 V, HTL 12 V, TTL)	A/B incremental encoder, 2 outputs (HTL 24 V, HTL 12 V, TTL)	A/B incremental encoder, 2 pairs of outputs (RS-422) [1]	SSI encoder
	1	NC2	Not connected to the FX3-EBX3 [2]					
	2	NC1	Not connected to the FX3-EBX3 [2]					
	3	U_{out}	Encoder voltage supply from the on-board voltage supply of this FX3-EBX3, can be switched between 5 V, 7 V, 12 V, and 24 V (nominal)					
	4	ENCx_0V [3]	GND connection for encoder					
	5	ENCx_C– [3]	–	–	–	–	B–	Clock–
	6	ENCx_C+ [3]	–	–	–	–	B+	Clock+
	7	ENCx_B– [3]	Sin–	Sin_Ref	B–	GND	–	–
	8	ENCx_B+ [3]	Sin+	Sin	B+	B	–	–
	9	ENCx_A– [3]	Cos–	Cos_Ref	A–	GND	A–	Data–
	10	ENCx_A+ [3]	Cos+	Cos	A+	A	A+	Data+

1) Only for encoder 1, i.e., if it is the first encoder/motor feedback connection box.
2) For forwarding a signal; e.g., for an external voltage supply (rather than using U_{out}).
3) x = 1 if it is the first encoder/motor feedback connection box, i.e., if the C3 plug connector is connected directly to the FX3-MOCx.
x = 2 if it is the second encoder/motor feedback connection box, i.e., if the C3 plug connector is connected directly to another encoder/motor feedback connection box.

Table 31: Pin assignment for terminals C2 on the FX3-EBX3

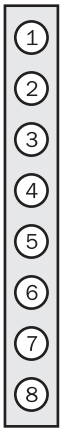
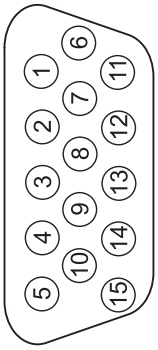
Terminal strip	Terminal	Signal	Description
	1	NC	Not connected to the FX3-EBX3, only for forwarding signals
	2	NC	
	3	NC	
	4	NC	
	5	NC	
	6	NC	
	7	NC	
	8	NC	

Table 32: Pin assignment for HD D-Sub female connector C3 on the FX3-EBX3 for connection to the FX3-MOCx

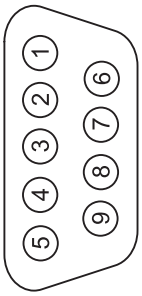
Female connector	Pin	Signal
	1	ENC1_A+
	2	ENC1_A–
	3	ENC1_24V
	4	ENC2_A+
	5	ENC2_A–
	6	ENC1_B+
	7	ENC1_B–
	8	ENC_0V
	9	ENC2_B+
	10	ENC2_B–
	11	ENC1_C+
	12	ENC1_C–
	13	ENC2_24V
	14	ENC2_C+
	15	ENC2_C–

The FX3-EBX3 encoder/motor feedback connection box also has a 9-pin D-Sub female connector for connecting a second encoder/motor feedback connection box FX3-EBX3.

NOTE

- It is not permitted to connect an FX3-EBX4 dual encoder/motor feedback connection box in this case.
- A maximum of two FX3-EBX3 encoder/motor feedback connection boxes are permitted for each FX3-MOCx module.

Table 33: Pin assignment for D-SUB female connector C4 on the FX3-EBX3

Female connector	Pin	Signal
	1	ENC_A+
	2	ENC_B+
	3	ENC_C+
	4	Reserved (ID code in combination with the voltage supply)
	5	ENC_24V
	6	ENC_A–
	7	ENC_B–
	8	ENC_C–
	9	ENC_0V

FX3-EBX4 dual encoder/motor feedback connection box

Table 34: Pin assignment for encoder connection C1 on the FX3-EBX4

Terminal strip	Terminal	Signal	Wiring					
			Sine-cosine encoder		A/B incremental encoder, 2 pairs of outputs (HTL 24 V, HTL 12 V, TTL)	A/B incremental encoder, 2 outputs (HTL 24 V, HTL 12 V, TTL)	A/B incremental encoder, 2 pairs of outputs (RS-422)	SSI encoder
	1	NC2	Not connected to the FX3-EBX4 [1]					
	2	NC1	Not connected to the FX3-EBX4 [1]					
	3	U_{out}	Encoder voltage supply from the on-board voltage supply of this FX3-EBX4, can be switched between 5 V, 7 V, 12 V, and 24 V (nominal)					
	4	ENC1_0V	GND connection for encoder					
	5	ENC1_C–	–	–	–	–	B–	Clock–
	6	ENC1_C+	–	–	–	–	B+	Clock+
	7	ENC1_B–	Sin–	Sin_Ref	B–	GND	–	–
	8	ENC1_B+	Sin+	Sin	B+	B	–	–
	9	ENC1_A–	Cos–	Cos_Ref	A–	GND	A–	Data–
	10	ENC1_A+	Cos+	Cos	A+	A	A+	Data+

[1] For forwarding a signal; e.g., for an external voltage supply (rather than using U_{out}).

Table 35: Pin assignment for encoder connection C2 on the FX3-EBX4

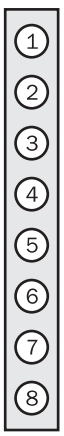
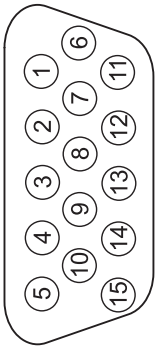
Terminal strip	Terminal	Signal	Wiring					
			Sine-cosine encoder		A/B incremental encoder, 2 pairs of outputs (HTL 24 V, HTL 12 V, TTL)	A/B incremental encoder, 2 outputs (HTL 24 V, HTL 12 V, TTL)	A/B incremental encoder, 2 pairs of outputs (RS-422)	SSI encoder
	1	U_{out}	Encoder voltage supply from the on-board voltage supply of this FX3-EBX4, can be switched between 5 V, 7 V, 12 V, and 24 V (nominal)					
	2	ENC2_0V	GND connection for encoder					
	3	ENC2_C–	–	–	–	–	–	Clock–
	4	ENC2_C+	–	–	–	–	–	Clock+
	5	ENC2_B–	Sin–	Sin_Ref	B–	GND	–	–
	6	ENC2_B+	Sin+	Sin	B+	B	–	–
	7	ENC2_A–	Cos–	Cos_Ref	A–	GND	–	Data–
	8	ENC2_A+	Cos+	Cos	A+	A	–	Data+

Table 36: Pin assignment for HD D-Sub female connector C3 on the FX3-EBX4 for connection to the FX3-MOCx

Female connector	Pin	Signal
	1	ENC1_A+
	2	ENC1_A–
	3	ENC1_24V
	4	ENC2_A+
	5	ENC2_A–
	6	ENC1_B+
	7	ENC1_B–
	8	ENC_0V
	9	ENC2_B+
	10	ENC2_B–
	11	ENC1_C+
	12	ENC1_C–
	13	ENC2_24V
	14	ENC2_C+
	15	ENC2_C–

On-board power supply U_{out} (FX3-EBX3 and FX3-EBX4 only)

On-board voltage supply which can be used as an option for the encoders, fed from the FX3-MOCx (C3.ENC1_24V and C3.ENC2_24V). The output voltage U_{out} can be switched between 5 V, 7 V, 12 V, and 24 V (nominal) using a rotary switch.

Table 37: Setting the supply voltage for the encoders at FX3-EBX3 and FX3-EBX4

Switch setting	Supply voltage U_{out}	Notes
0	5 V	Tolerance U_{out}: 5%
1	7 V	
2	12 V	
3	24 V nominal	Depends on the voltage level of the Flexi Soft voltage supply at the system plug

NOTICE

The voltage peaks when switching the supply voltage

The encoder/motor feedback connection box may be damaged in the event of non-compliance.

- ▶ Only actuate the rotary switch for the supply voltage on the encoder/motor feedback connection box when the voltage supply is switched off.

5.2.10 Encoder connection cables

Connection cable with open ends for connecting two encoders

Table 38: Connection cable with open ends for connecting two encoders (SICK part numbers 2067893 and 2077263)

Open ends	Micro D-sub male connector for the FX3-MOCx		Wiring [1]				
Color coding	**Pin**	**Signal name**	**Sine-cosine encoder**		**A/B incremental encoder, 2 pairs of outputs (HTL 24 V, HTL 12 V, TTL)**	**A/B incremental encoder, 2 outputs (HTL 24 V, HTL 12 V, TTL)**	**A/B incremental encoder, 2 pairs of outputs (RS-422)**	**SSI encoder**
Encoder 1								
White	1	ENC1_A+	Cos+	Cos	A+	A	A+	Data+
Brown	9	ENC1_A–	Cos–	Cos_Ref	A–	GND	A–	Data–
Green	2	ENC1_B+	Sin+	Sin	B+	B	–	–
Yellow	10	ENC1_B–	Sin–	Sin_Ref	B–	GND	–	–
Gray	3	ENC1_C+	–	–	–	–	B+	Clock+
Pink	11	ENC1_C–	–	–	–	–	B–	Clock–
Encoder 2								
Black	8	ENC2_A+	Cos+	Cos	A+	A	–	Data+
Violet	15	ENC2_A–	Cos–	Cos_Ref	A–	GND	–	Data–
Gray/pink	7	ENC2_B+	Sin+	Sin	B+	B	–	–
Red/blue	14	ENC2_B–	Sin–	Sin_Ref	B–	GND	–	–
White/green	6	ENC2_C+	–	–	–	–	–	Clock+
Brown/green	13	ENC2_C–	–	–	–	–	–	Clock–
Voltage supply								
Blue	4	ENC1_24V	24 V voltage supply for encoder 1					
Red	5	ENC2_24V	24 V voltage supply for encoder 2					
White/yellow	12	ENC_0V	GND connection for encoder 1 and 2					

[1] It is possible to combine different encoder types.

Y-connection cable with two M12 female connectors from two encoders

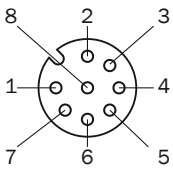


Figure 36: M12 female connector, 8-pin

Table 39: Y connection cable with two M12 female connectors, 8-pin, for connecting two encoders (SICK part number 2094381)

2× M12, female connector, 8-pin	Micro D-sub male connector for the FX3-MOCx		Wiring [1]					
Pin	Pin	Signal name	Sine-cosine encoder		A/B incremental encoder, 2 pairs of outputs (HTL 24 V, HTL 12 V, TTL) [2]	A/B incremental encoder, 2 outputs (HTL 24 V, HTL 12 V, TTL) [2]	A/B incremental encoder, 2 pairs of outputs (RS-422)	SSI encoder [2]
Encoder 1								
1	9	ENC1_A–	Cos–	Cos_Ref	A–	GND	–	Data–
2	1	ENC1_A+	Cos+	Cos	A+	A	–	Data+
3	10	ENC1_B–	Sin–	Sin_Ref	B–	GND	–	–
4	2	ENC1_B+	Sin+	Sin	B+	B	–	–
5	3	ENC1_C+	–	–	–	–	–	Clock+
6	11	ENC1_C–	–	–	–	–	–	Clock–
7	12	ENC_0V	GND connection for encoder 1					
8	4	ENC1_24V	24 V voltage supply for encoder 1					
Encoder 2								
1	15	ENC2_A–	Cos–	Cos_Ref	A–	GND	–	Data–
2	8	ENC2_A+	Cos+	Cos	A+	A	–	Data+
3	14	ENC2_B–	Sin–	Sin_Ref	B–	GND	–	–
4	7	ENC2_B+	Sin+	Sin	B+	B	–	–
5	6	ENC2_C+	–	–	–	–	–	Clock+
6	13	ENC2_C–	–	–	–	–	–	Clock–
7	12	ENC_0V	GND connection for encoder 2					
8	5	ENC2_24V	24 V voltage supply for encoder 2					

1) It is possible to combine different encoder types.
2) Consider potentially required measures for common cause failures. See "Drive Monitor FX3-MOC0", page 33 or "Drive Monitor FX3-MOC1", page 36.

Connection cable with M12 female connector for direct connection of a safety encoder

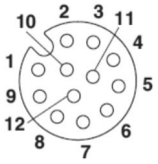


Figure 37: Female connector, M12, 12-pin

Table 40: Connection cable with M12 female connector, 12-pin, for direct connection of a safety encoder (SICK part numbers 2094372, 2094434, 2094435, and 2094436)

1 × M12, female connector, 12-pin	Micro D-sub male connector for the FX3-MOCx		Wiring
Pin	Pin	Signal name	SSI + sine-cosine encoder
1	–	–	–
2	1	ENC1_A+	Data+
3	9	ENC1_A–	Data–
4	11	ENC1_C–	Clock–
5	4	ENC1_24V	24 V voltage supply for encoder
6	8	ENC2_A+	Cos+
7	15	ENC2_A–	Cos–
8	7	ENC2_B+	Sin+
9	14	ENC2_B–	Sin–
10	–	–	–
11	3	ENC1_C+	Clock+
12	12	ENC_0V	GND connection for encoder

Connection cable with M12 female connector for direct connection of a sine-cosine encoder

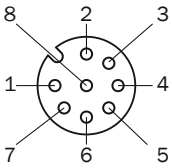


Figure 38: Female connector, M12, 8-pin

Table 41: Connection cable with M12 female connector, 8-pin, for direct connection of a sine-cosine encoder (e.g., DFS60S Pro) (SICK part numbers 2094403, 2094426, 2094427, and 2094428)

1× M12, female connector, 8-pin	Micro D-sub male connector for the FX3-MOCx		Wiring
Pin	Pin	Signal name	Sine-cosine encoder
1	9	ENC1_A–	Cos–
2	1	ENC1_A+	Cos+
3	10	ENC1_B–	Sin–
4	2	ENC1_B+	Sin+
5	3	ENC1_C+	–
6	11	ENC1_C–	–
7	12	ENC_0V	GND connection for encoder
8	4	ENC1_24V	24 V voltage supply for encoder

5.2.11 FX3-ANA0 analog input module

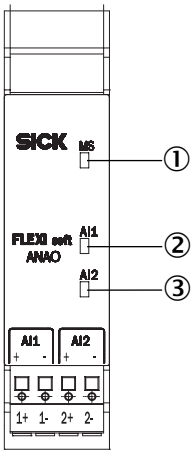


Figure 39: FX3-ANA0 analog input module

① MS LED (module status)
② LED AI1
③ LED AI2

Table 42: Pin assignment for the FX3-ANA0 analog input module

Terminal	Pin assignment
1+, 1–	Analog input AI1
2+, 2–	Analog input AI2

5.2.12 UE410-2RO and UE410-4RO relay modules

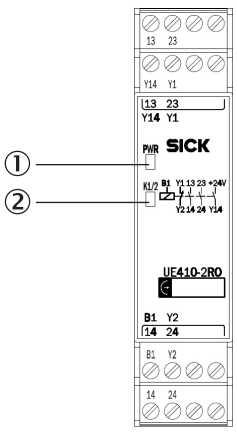


Figure 40: UE410-2RO relay module

① PWR LED (power)
② K1/2 LED

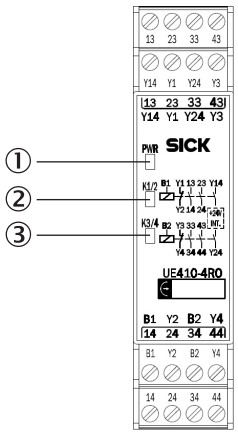


Figure 41: UE410-4RO relay module

① PWR LED (power)
② K1/2 LED
③ K3/4 LED

Table 43: Pin assignment for the UE410-2RO relay module

Terminal	Pin assignment
B1	Wiring of relay K1/K2
13/14 and 23/24	Safety contacts for cutoff circuit K1/K2
Y1/Y2	Feedback circuit external device monitoring (EDM), normally closed
Y14	Safety contact K1/K2, current-limited, normally open (see "Technical data", page 126)

Table 44: Pin assignment for the UE410-4RO relay module

Terminal	Pin assignment
B1	Wiring of relay K1/K2
B2	Wiring of relay K3/K4
13/14 and 23/24	Safety contacts for cut-off circuit outputs K1/K2
33/34 and 43/44	Safety contacts for cut-off circuit outputs K1/K2
Y1/Y2	Feedback circuit external device monitoring K1/K2, normally closed
Y3/Y4	Feedback circuit external device monitoring K3/K4, normally closed
Y14	Safety contact K1/K2, current-limited, normally open (see "Technical data", page 126)
Y24	Safety contact K3/K4, current-limited, normally open (see "Technical data", page 126)

The UE410-2RO/UE410-4RO relay modules cannot be used alone, but must be switched via a module FX3-XTIO. To do so, a control output of the module FX3-XTIO (Q1 to Q4) must be connected with a control input of the relay module (B1, B2).

In addition, the feedback contacts Y1/Y2 on UE410-2RO and the feedback contacts Y1/Y2 and Y3/Y4 on relay module UE410-4RO must be connected with the FX3-XTIO.

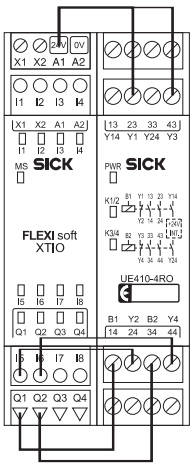


Figure 42: Example of integrating a relay module into the Flexi Soft system

WARNING

Limited safety without external device monitoring

The target safety-related level may not be achieved in the event of non-compliance.

- Monitor the feedback contacts using an EDM (external device monitoring) function block in the Flexi Soft logic editor.

5.3 Wiring for the power supply to a Flexi Soft system

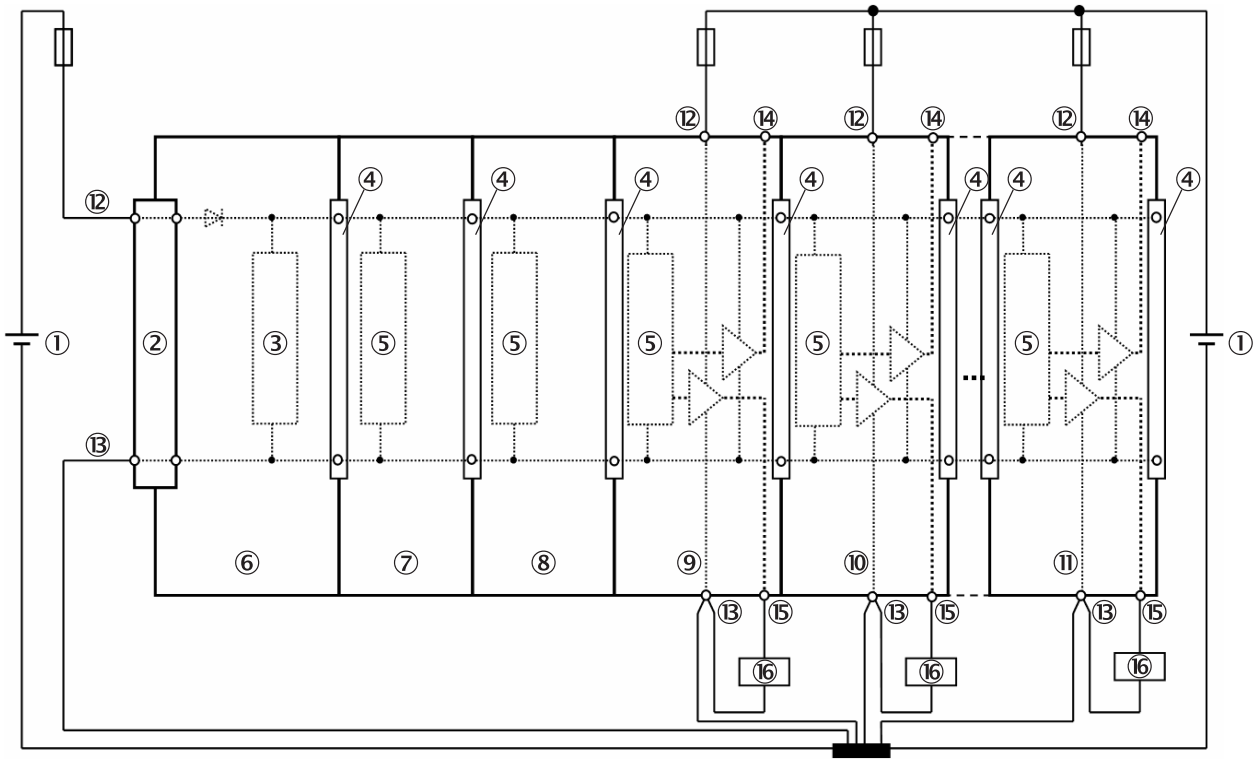


Figure 43: Wiring for the power supply to a Flexi Soft system

① 24 V DC
② System plug
③ Logic
④ FLEXBUS+
⑤ Application
⑥ Main module
⑦ Gateway 1
⑧ Gateway 2
⑨ Expansion module 1
⑩ Expansion module 2
⑪ Expansion module n
⑫ A1 (24 V)
⑬ A2 (GND)
⑭ Test outputs (X1 ... X8)
⑮ Outputs (Q1 ... Q4)
⑯ Actuator

5.4 Connection of devices

This section describes connecting safe and non-safe sensors, actuators and switching elements on the Flexi Soft system and provides mounting information on selected functions.

Sensors

WARNING
Ineffectiveness of the protective device due to unrecognized switching signals between the safety sensors

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

- ▶ Select the minimum switch-off time of the connected sensors to be greater than the logic execution time of the Flexi Soft system. Observe the minimum switch-off time indicated in the technical data of the sensors.
- ▶ Observe the safety notes and description of operation of the connected sensors. In case of doubt, contact the device manufacturer.
- ▶ Observe the instructions on commissioning and daily thorough checking in the operating instructions of the connected sensors.

Single-channel inputs

WARNING
Ineffectiveness of the protective device due to unexpected pulses or delayed falling signal edges at single-channel inputs

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

The target safety-related level may not be achieved in the event of non-compliance.

- ▶ Protect single-channel inputs against short-circuits and cross-circuits.
  - ▷ Use protected wiring for the signal concerned to prevent the risk of cross-circuits with other signals
  - ▷ No cross-circuit detection, i.e., no connection to a test output

On a single-channel input with test pulses, which was previously in the low state, a short-circuit to high may be interpreted as a pulse by the logic due to the fault detection. The short-circuit to High causes the signal to switch to High and then back to Low at the end of the fault detection time. As a result, single-channel signals with test pulses require particular attention:

- If a short-circuit to High occurs on a single-channel input with test pulses and this was already in the High state, the logic interprets this signal as a delayed falling signal edge (High–Low).
- If a dangerous state could potentially arise because of an unexpected pulse or a delayed falling signal edge (High–Low) on a single-channel input, then concrete measures must be implemented.
  This is particularly important in the case of the following inputs:
  - **Reset** input on the reset function block
  - **Restart** input on the restart function block
  - **Restart** input on the function blocks for press applications
  - **Override** input on the muting function blocks
  - **Reset** input on a valve monitoring function block
  - **Reset to zero** input and **Set to start value** on an event counter function block

Test outputs

WARNING
Ineffectiveness of the protective device due to incorrect connection of test outputs
The target safety-related level may not be achieved in the event of non-compliance.

- For each device to be tested, use a test output of the same module to which the device is connected.
- For devices connected to an odd-numbered input (I1, I3, I5, I7) use an odd-numbered test output (X1, X3, X5, X7, XY1). For devices connected to an even-numbered input (I12, I4, I6, I8) use an even-numbered test output (X2, X4, X6, X8, XY2).
- Observe the notes on using test pulses in the corresponding chapters of these operating instructions ("FX3-XTIO I/O module", page 23, "FX3-XTDI I/O module", page 27 and "FX3-XTDS I/O module", page 29).

5.4.1 Safety command devices and electro-mechanical safety switches

5.4.1.1 Emergency stop pushbutton (e.g., ES21)

Table 45: Connection for emergency stop pushbutton

Electrical connection: example with FX3-XTIO	
Single-channel, at 24 V	Contact between 24 V and I1
Single-channel, at test output	Contact between X2 and I2
Dual-channel, at 24 V	Channel 1: contact between 24 V and I3 Channel 2: contact between 24 V and I4
Dual-channel, at test output	Channel 1: contact between X1 and I5 Channel 2: contact between X2 and I6

The dual-channel emergency stop pushbuttons preconfigured in the configuration software have equivalent switching contacts. You will find suitable elements among the volt-free contacts for the implementation of dual-channel complementary switching contacts.

Table 46: Functions with ES21

Function	Notes
Tested	Possible
Series connection/ cascading	If emergency stop pushbuttons are connected in series, the maximum conductor resistance must not exceed 100 Ω (see "Technical data", page 126).
Discrepancy time	See the report in the configuration software

NOTE
You will find more information in the operating instructions for the ES21 emergency stop pushbutton.

5.4.1.2 Electro-mechanical safety switches and locking devices

Table 47: Connection of electro-mechanical safety switches

Electrical connection: example with FX3-XTIO	
Single-channel, at 24 V	Contact between 24 V and I1
Single-channel, at test output	Contact between X2 and I2
Dual-channel, at 24 V	Channel 1: contact between 24 V and I3 Channel 2: contact between 24 V and I4

Electrical connection: example with FX3-XTIO	
Dual-channel, at test output	Channel 1: contact between X1 and I5 Channel 2: contact between X2 and I6

Table 48: Connection of locking devices

Electrical connection: example with FX3-XTIO	
Single-channel, at 24 V	Contact between 24 V and I1 Coil at Q1
Single-channel, at test output	Contact between X1 and I1 Coil at Q1
Dual-channel, at 24 V	Channel 1: contact between 24 V and I1 Channel 2: contact between 24 V and I2 Coil at Q1
Dual-channel, at test output	Channel 1: contact between X1 and I1 Channel 2: contact between X2 and I2 Coil at Q1

Table 49: Functions with electro-mechanical safety switches and locking devices

Function	Notes
Tested	Possible
Series connection/ cascading	If safety switches are connected in series, the maximum conductor resistance must not exceed 100 Ω (see "Technical data", page 126).
Discrepancy time	See the report in the configuration software

NOTE

You will find more information in the operating instructions for the electro-mechanical safety switches.

5.4.1.3 Enabling switch E100

Table 50: Connection of the E100

Electrical connection: example with FX3-XTIO	
2 positions, at 24 V	Channel 1: contact E31 between 24 V and I1 Channel 2: contact E41 between 24 V and I2
2 positions, at test output	Channel 1: contact E31 between X1 and I3 Channel 2: contact E41 between X2 and I4
3 positions, at 24 V	Channel 1: contact E13 between 24 V and I5 Channel 2: contact E23 between 24 V and I6 Channel 3: contact E31 between 24 V and I7 Channel 4: contact E41 between 24 V and I8
3 positions, at test output	Channel 1: contact E13 between 24 V and I1 Channel 2: contact E23 between 24 V and I2 Channel 3: contact E31 between X1 and I3 Channel 4: contact E41 between X2 and I4

Table 51: Functions with the E100

Function	Notes
Tested	Possible
Series connection	Not possible
Discrepancy time	See the report in the configuration software

NOTE
You will find more information in the operating instructions for the enabling switch E100.

5.4.1.4 Two-hand control

Table 52: Connection of the two-hand control

Electrical connection: example with FX3-XTIO	
Type IIIA, at 24 V	Channel 1: contact between 24 V and I1 Channel 2: contact between 24 V and I2
Type IIIC, at 24 V	Channel 1: left-hand normally open between 24 V and I1 Channel 2: left-hand normally closed between 24 V and I2 Channel 3: right-hand normally open between 24 V and I3 Channel 4: right-hand normally closed between 24 V and I4

Type IIIA

With type IIIA, two equivalent inputs (N/O contacts for the 2 two-hand switches) are monitored.

A valid input signal is only generated if the ON state (High level) is present at both inputs within a period of 0.5 s (synchronous changeover, both two-hand switches actuated) and both were previously in the OFF state (Low level).

Table 53: Functions with type IIIA two-hand control

Function	Notes
Tested	Possible
Series connection/ cascading	Not possible
Discrepancy time	Fixed preset value: 500 ms See function block for type IIIA two-hand in the logic of the main module, with which these outputs are to be evaluated.

Type IIIC

With type IIIC, two pairs of complementary inputs (N/O contact / N/C contact pair) are monitored.

A valid input signal is only generated if the ON state (High/Low level) is present at both inputs within a period of 0.5 s (synchronous changeover, both two-hand switches actuated) and both were previously in the OFF state (Low/High level).

Table 54: Functions with type IIIC two-hand control

Function	Notes
Tested	Possible
Series connection/ cascading	Not possible
Discrepancy time	Possible: 0–500 ms See function block for type IIIC two-hand in the logic of the main module, with which these outputs are to be evaluated.
Synchronization time	Fixed preset value: 500 ms See function block for type IIIC two-hand in the logic of the main module, with which these outputs are to be evaluated.

5.4.1.5 Pressure-sensitive safety mats and bumpers

Table 55: Connection of pressure-sensitive safety mats and bumpers

Electrical connection: example with FX3-XTIO	
Pressure-sensitive safety mat which triggers a short-circuit in 4-conductor technology, at test output	Channel 1: Connection between X1 and I1 Channel 2: Connection between X2 and I2

Table 56: Function of pressure-sensitive safety mats and bumpers

Function	Notes
Parallel wiring	Possible
Number of safety mats or bumpers per FX3-XTIO, FX3-XTDI or FX3-XTDS	Max. 1 without diode module Max. 4 without diode module

WARNING

Ineffectiveness of the protective device due to unrecognized switching signals between the safety sensors

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

- ▶ Configure the test periods of the test outputs as shorter than the duration of the switch-off condition for the safety sensors.

5.4.1.6 Diode module DM8-A4K

The diode module DM8-A4K serves as a connection adapter when multiple pressure-sensitive safety mats that trigger short-circuits are connected to an FX3-XTIO or FX3-XTDI module. It decouples test outputs X1 and X2, thus increasing them fourfold.

NOTE

The diode module DM8-A4K does not constitute a safety component according to the Machinery Directive. Therefore, it does not have to be taken into account when calculating the safety integrity level (SIL according to IEC 61508 and SILCL according to EN 62061) and the performance level (PL according to EN ISO 13849-1).

Electrical connection

Table 57: Connection of multiple pressure-sensitive safety mats with diode module DM8-A4K connected upstream

Electrical connection: example with FX3-XTIO or FX3-XTDI	
Pressure-sensitive safety mat which triggers a short-circuit in 4-conductor technology, at test output and with diode module DM8-A4K connected upstream	Channel 1: Contact from X1 to I1 via diode Channel 2: Contact from X2 to I2 via diode Channels 3 to 8 as shown in the circuit diagram: see figure 44, page 80

Circuit diagrams

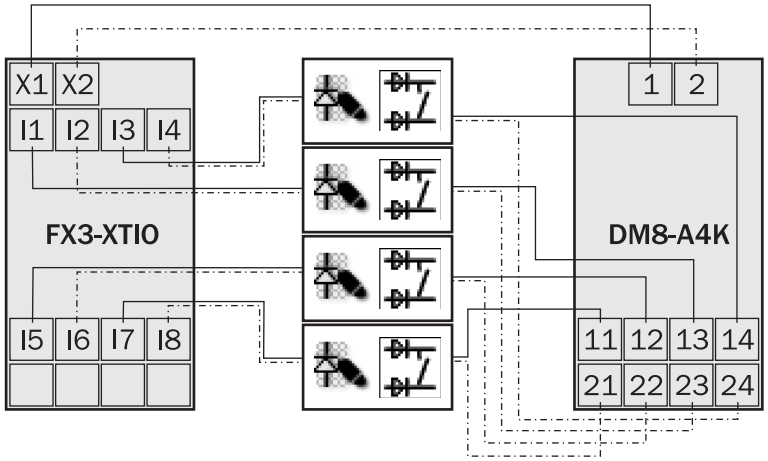


Figure 44: Circuit diagram for multiple pressure-sensitive safety mats with diode module DM8-A4K connected to the FX3-XTIO upstream

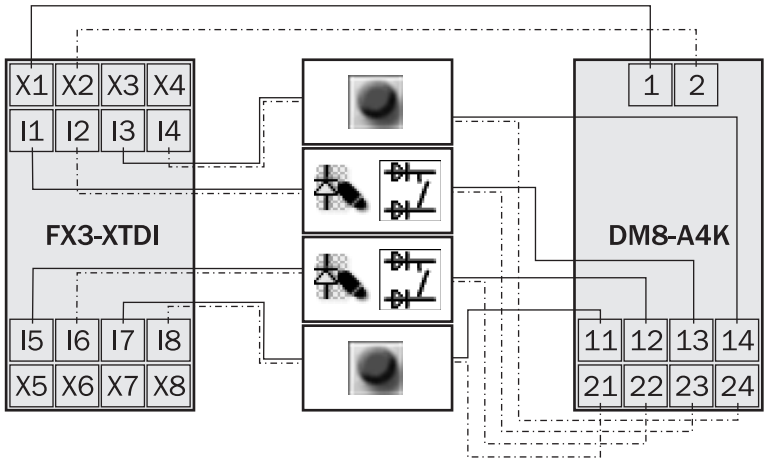


Figure 45: Circuit diagram for multiple pressure-sensitive safety mats with diode module DM8-A4K connected to the FX3-XTDI upstream

NOTE

Instead of a pressure-sensitive safety mat, you can also connect a safety switch or an emergency stop pushbutton, for example (see figure 45, page 80).

Internal circuitry for diode module DM8-A4K

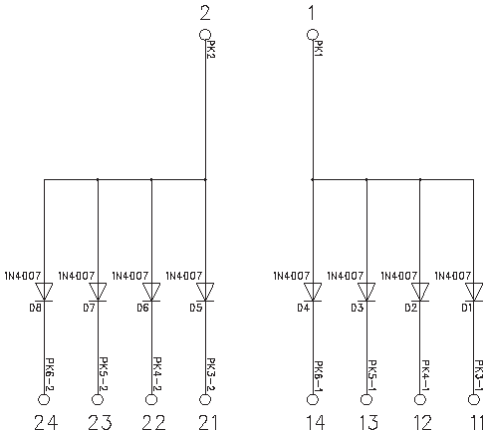


Figure 46: Internal circuitry for diode module DM8-A4K

5.4.1.7 Operating mode selector switch

Table 58: Connection of operating mode selector switch

Electrical connection: example with FX3-XTIO	
Operating mode selector switch (1 of 2), at 24 V	Channel 1: contact between 24 V and I1 Channel 2: contact between 24 V and I2
Operating mode selector switch (1 of 2), at test output	Channel 1: contact between X1 and I1 Channel 2: contact between X1 and I3

Table 59: Function with operating mode selector switch

Function	Notes
Tested	Possible

NOTE

- Operating mode selector switches without test signals support between 2 and 8 operating modes; operating mode selector switches with test signals support between 2 and 4 operating modes.
- When wiring the tested operating mode selector switch, please remember that if you are using a test output with an odd number (X1, X3, X5, X7), inputs with odd numbers (I1, I3, I5, I7) must be used; if you are using a test output with an even number (X2, X4, X6, X8), inputs with even numbers (I2, I4, I6, I8) must be used.
- You will find more information in the operating instructions for the operating mode selector switches.

5.4.1.8 Volt-free contacts

The configuration software provides a range of volt-free contacts for “free” arrangement of contact elements. This enables a variety of N/C / N/O combinations to be implemented with and without testing. There are also start and stop button, reset button, and external device monitoring (EDM) elements available.

Table 60: Functions with volt-free contacts

Function	Notes
Tested	Possible
Series connection	Possible
Discrepancy time	See the report in the configuration software

5.4.2 Non-contact safety switches

5.4.2.1 Magnetic safety switches (e.g., RE)

Table 61: Connection of magnetic safety switches with equivalent inputs (RE13, RE27)

Electrical connection: example with FX3-XTIO	
At test output	Channel 1: contact between X1 and I1 Channel 2: contact between X2 and I2

Table 62: Connection of magnetic safety switches with complementary inputs (e.g., RE11, RE21, RE31, RE300)

Electrical connection: example with FX3-XTIO	
At test output	N/C contact between X1 and I3 N/O contact between X2 and I4

Table 63: Functions with magnetic safety switches

Function	**Notes**
Tested	Possible
Series connection/ cascading	Possible; note max. conductor resistance of 100 Ω and ensure test signal time is set correctly
Discrepancy time	Pre-setting: 1.5 s, see the report in the configuration software

NOTE
You will find more information in the operating instructions for the magnetic safety switches.

5.4.2.2 Inductive safety switches IN4000 and IN4000 Direct

Table 64: Connection of inductive safety switches

Electrical connection: example with FX3-XTIO	
IN4000	Test input TI (IN4000) at X1 Output Q (IN4000) at I1
IN4000 Direct (with OSSD)	OSSD1 (IN4000) at I3 OSSD2 (IN4000) at I4

Table 65: Functions with inductive safety switches

Function	**Notes**
Tested	Necessary on the IN4000
Series connection/ cascading	**IN4000 Direct** cannot be cascaded **IN4000**: up to 6 sensors per input Maximum OFF-ON delay for cascade: 10 ms (otherwise the test gap will trigger a shutdown). Note max. conductor resistance of 100 Ω and ensure test signal time is set correctly

NOTE
You will find more information in the operating instructions for the inductive safety switches.

5.4.2.3 Transponders T4000 Compact and T4000 Direct

Table 66: Connection of the transponders

Electrical connection: example with FX3-XTIO	
T4000 Compact (at 24 V)	24 V at +LA, I1 at LA 24 V at +LB, I2 at LB
T4000 Compact (at test output)	X1 at +LA, I3 at LA X2 at +LB, I4 at LB
T4000 Direct (with OSSD)	24 V at UB (T4000), I5 at OA 24 V at UB (T4000), I6 at OB

Table 67: Functions with transponders

Function	Notes
Tested	Possible for T4000 Compact Not necessary for the T4000 Direct, as self-monitoring
Series connection/ cascading	T4000 Compact cannot be cascaded T4000 Direct: Note the maximum conductor resistance of 100 Ω (see "Technical data", page 126).

NOTE

You will find more information in the operating instructions for the T4000 Compact and T4000 Direct transponders.

5.4.3 Testable single-beam photoelectric safety switches

5.4.3.1 Type 2 testable single-beam photoelectric safety switches

Table 68: Connection of type 2 testable single-beam photoelectric safety switches

Electrical connection: example with FX3-XTIO	
Wx12/24/27, Vx18	Test input TI (sender) at X1 Output Q (receiver) at I1
L21, L27/L28	Test input TI (sender) at X2 Output Q (receiver) at I2

WARNING

Impairment of fault detection due to cross-circuit

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

- Prevent cross-circuits between the connection from the test output of the Flexi Soft module to the test input of the sender and the connection from the output of the receiver to the safe input of the Flexi Soft module with protected or separate cabling.

Table 69: Functions with type 2 testable single-beam photoelectric safety switches

Function	Notes
Tested	Possible
Series connection/ cascading	Wx12/24/27, Vx18: • Maximum 2 pairs per input can be cascaded with test gap = 4 ms (standard element in the configuration software) • Maximum 5 pairs per input can be cascaded with test gap = 12 ms (user-defined element required in the configuration software) L21: • Maximum 10 pairs per input can be cascaded with test gap = 4 ms (standard element in the configuration software) • Maximum 25 pairs per input can be cascaded with test gap = 8 ms (user-defined element required in the configuration software) L27/L28: • Maximum 7 pairs per input can be cascaded with test gap = 4 ms (standard element in the configuration software) • Maximum 18 pairs per input can be cascaded with test gap = 12 ms (user-defined element required in the configuration software) ▶ Observe max. conductor resistance of 100 Ω.

NOTE
For more information, please refer to the operating instructions for the testable type 2 single-beam photoelectric safety switches.

5.4.3.2 Type 4 testable single-beam photoelectric safety switches

Table 70: Connection of type 4 testable single-beam photoelectric safety switches

Electrical connection: example with FX3-XTIO	
L41	Test input TI (sender) at X1 Output Q (receiver) at I1

WARNING
Impairment of fault detection due to cross-circuit
The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

▶ Prevent cross-circuits between the connection from the test output of the Flexi Soft module to the test input of the sender and the connection from the output of the receiver to the safe input of the Flexi Soft module with protected or separate cabling.

Table 71: Functions with type 4 testable single-beam photoelectric safety switches

Function	Notes
Tested	Necessary
Series connection/ cascading	L41: • Maximum 10 pairs per input can be cascaded with test gap = 4 ms (standard element in the configuration software) • Maximum 25 pairs per input can be cascaded with test gap = 8 ms (user-defined element required in the configuration software) Note the maximum conductor resistance of 100 Ω.

NOTE

For more information, please refer to the operating instructions for the testable type 4 single-beam photoelectric safety switches.

5.4.3.3 User-defined testable single-beam photoelectric safety switches

For information on creating customized elements, please refer to the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions.

NOTE

- Configure the user-defined element in the configuration software for the Flexi Soft system with the minimum value for the desired test gap.
- Regardless of the test gap, the total OFF-ON delay for the cascade must be shorter than the maximum OFF-ON delay for the corresponding test output (as shown in the configuration software report) –2 ms. If it is not, the test gap will lead to shutdown. For FX3-XTIO or FX3-XTDI modules, this value is = 12 ms – 2 ms = 10 ms.

WARNING

Impairment of fault detection due to cross-circuit

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

- ▶ Prevent cross-circuits between the connection from the test output of the Flexi Soft module to the test input of the sender and the connection from the output of the receiver to the safe input of the Flexi Soft module with protected or separate cabling.

5.4.3.4 Mounting instructions for testable single-beam photoelectric safety switches

WARNING

Ineffectiveness of the protective device due to improper mounting or improper use

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

The target safety-related level may not be achieved in the event of non-compliance.

- ▶ Use single-beam photoelectric safety switches only as access protection as per EN ISO 13855.
- ▶ Do not use single-beam photoelectric safety switches as finger and hand protection.
- ▶ Complying with the minimum distance to reflective surfaces.
- ▶ Comply with the safety distance between the light beam and hazardous point for access protection.
- ▶ Observe the operating instructions of each sensor.

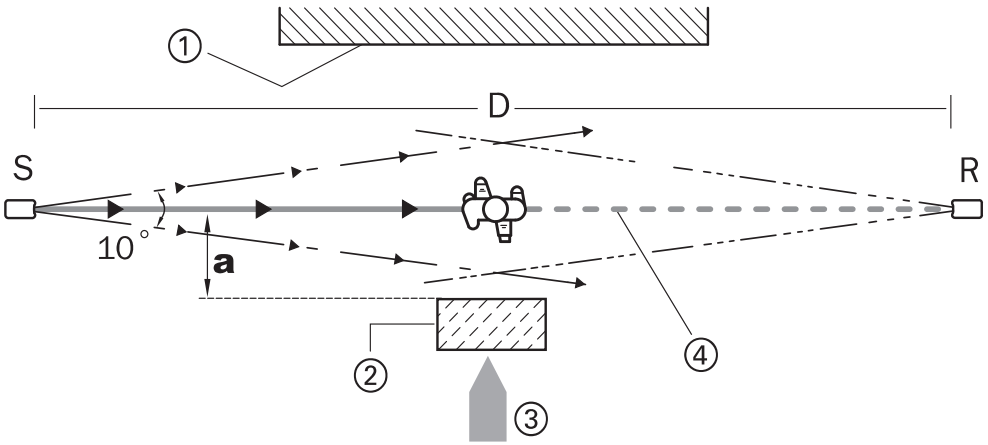


Figure 47: Minimum distance a to reflective surfaces, correct mounting and alignment

S: Sender
R: Receiver
D: Distance between sender and receiver
a: Minimum distance to reflective surface
①: Limit to hazardous area
②: Reflective surface
③: Entry direction to hazardous area
④: Optical axis

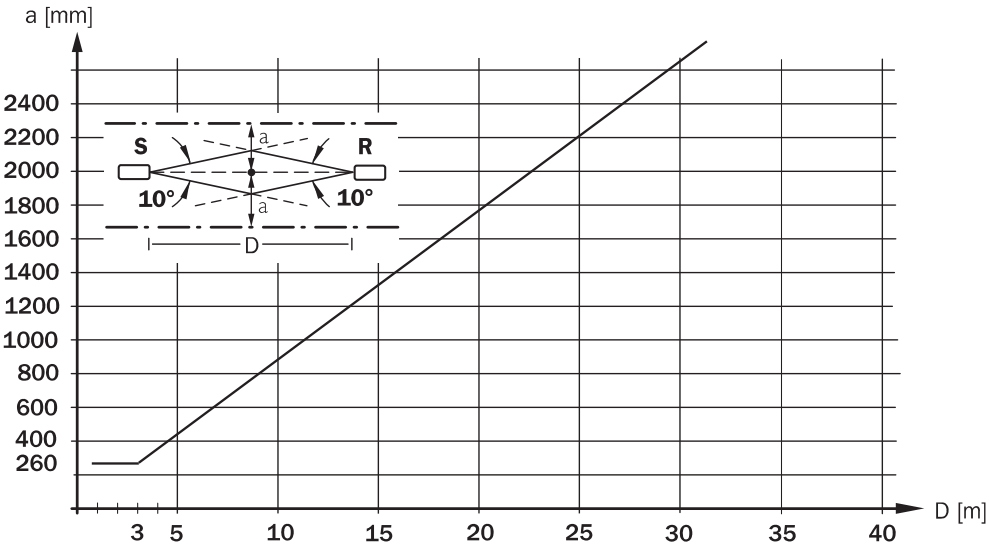


Figure 48: Minimum distance a based on distance D for testable single-beam photoelectric safety switches with aperture angle of 10° (e.g., Wx12/24/27, Vx18)

NOTE
Each set of operating instructions contains the diagrams for L21, L27/L28 and L41.

WARNING
Ineffectiveness of the protective device due to mutual optical interference

If several single-beam photoelectric safety switch pairs are used:

- Observe the aperture angle of the sensors to exclude mutual optical interference.
- Ensure that the light beam from each sender only reaches the associated receiver. To do so, mutual mounting (among other things) of the sender and receiver can be required between the sender and receiver.

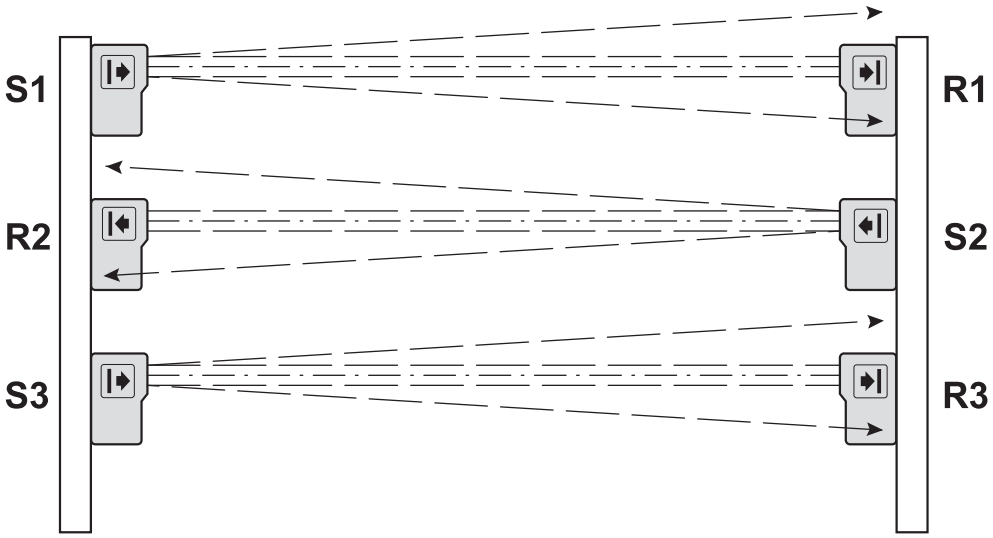


Figure 49: Mutual mounting to avoid mutual optical interference

5.4.4 Electro-sensitive protective devices

Table 72: Connection of electro-sensitive protective devices

Electrical connection: example with FX3-XTIO	
C2000, C4000, M2000, M4000, S300, S3000, V300, miniTwin	OSSD1 (receiver) at I1 OSSD2 (receiver) at I2

NOTE
You will find more information in the operating instructions for the corresponding electro-sensitive protective devices.

5.4.5 Safe outputs Q1 to Q4

WARNING
Ineffectiveness of the protective device due to unintended switching of actuators

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

- Connect the GND connections of the actuators to the outputs Q1 to Q4 in star formation with the GND connection of the voltage supply.

NOTICE
Exceeding the nominal values at the outputs

The device may be damaged if this is not observed.

- Do not connect any loads that exceed the nominal values of the outputs Q1 to Q4.

Example for the connection of an FX3-XTIO I/O module to a UE10-3OS safety relay

The following example shows how a single-channel output and protected cable laying can be used to achieve SIL3.

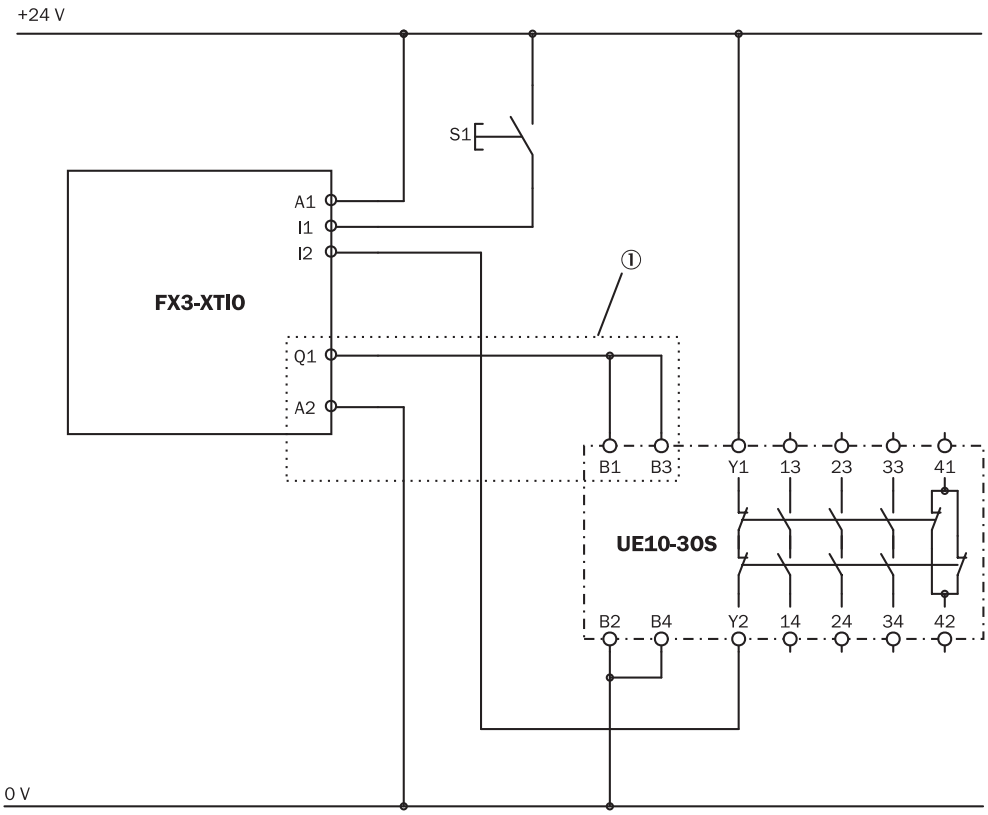


Figure 50: Example for the connection of an FX3-XTIO I/O module to a UE10-3OS safety relay

① Required for SIL3 protected cable laying

5.4.6 Connection of EFI-enabled devices

If the Flexi Soft system contains a FX3-CPU1 main module or higher, the EFI-capable devices and sensors from SICK can be connected to it.

NOTICE

Overvoltage at the EFI inputs

The device may be damaged if this is not observed.

- ▶ Connect the main module and all EFI-capable devices connected to it with the same GND connection of the voltage supply.
- ▶ Observe the maximum permissible voltage of ± 30 V (to terminal A2 = GND) at the EFI inputs.

NOTE

- If shielding is required to connect the EFI-capable devices e.g. due to EMC reasons, then an additional ground terminal must be used. Place this ground terminal in the control cabinet near the Flexi Soft main module and connect with the shielding.
- No external terminator is required for the EFI connections on the main module.

For information on connecting EFI-capable devices incl. the pin assignment, see the operating instructions of the corresponding device.

Cables

SICK offers two different EFI cables for connecting EFI-capable devices (see "Accessories", page 182). For more information, refer to the operating instructions of each EFI-capable device.

EMC measures

To increase the EMC of the EFI communication, it is important to connect the shielding of the EFI cable with the functional earth on one or both sides.

- ▶ Connect the shielding with the same DIN mounting rail that the functional earth (FE) of the Flexi Soft system is connected with to minimize faults on the EFI cable. Earthing the shielding should be done near the cable entry in the control cabinet.

NOTE

- The FE terminal of the Flexi Soft system is located on the rear of the housing. It is connected automatically when mounted on the DIN mounting rail.
- To avoid further interference, the functional earth for the SICK sensors (e.g., M4000, S3000) must also be connected to the shielding of the EFI cable.
- If further cables that may be faulty (e.g. for drives or motors) are used in the same cable channel as the EFI cable, this can lead to availability issues. For this reason, we recommend using the EFI cable in a separate cable channel.

5.4.7 Connection of a Pro-face HMI

You can connect an HMI manufactured by Pro-face to the RS-232 interface of the Flexi Soft main modules. Suitable cables: see "Accessories", page 182.

NOTE

To enable communication between the Flexi Soft system and the Pro-face-HMI, you must activate RS-232 routing for the main module (see “Flexi Soft in the Flexi Soft Designer Configuration Software” or “Flexi Soft in the Safety Designer Configuration Software” operating instructions).

Information on the configuration of data exchanged via the RS-232 interface as well as via export of tag names from the configuration software for use with a pro-face HMI can be found in the "Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions.

You will find information about replacing a suitable device, about connection, and about programming, in the “GP-Pro EX Device/PLC Connection Manual” operating instructions which are both available directly from Pro-face and can be downloaded from www.pro-face.com.

You can download the driver for the Pro-face devices for connection to the Flexi Soft main modules from www.pro-face.com.

You will find more information about communicating with the Flexi Soft system via the RS-232 interface in the “Flexi Soft RK512 Telegram Listing” online help (SICK part number 8015053).

5.4.8 Connection of encoders

The following encoder types can be connected to an FX3-MOCx:

- A/B incremental encoders HTL 24 V, HTL 12 V, TTL, max. 300 kHz
- A/B incremental encoder RS-422, max. 1 MHz [10)]
- Sine-cosine encoder 1 V_{PP}, max. 120 kHz
- SSI encoder, RS-422, max. 1 MBaud

10) Only possible for encoder 1 (ENC1).

WARNING
Ineffectiveness of the protective device due to selection of an unsuitable encoder
The target safety-related level may not be achieved in the event of non-compliance.

- ▶ Select a suitable encoder.
- ▶ Take suitable measures against the encoder's systematic errors and common causes of error.

Choosing the right encoder is crucial to achieving the desired safety integrity level (SIL) and performance level (PL). Systematic faults and common cause faults (CCF), in particular, need to be minimized in this case.

More information on selecting the encoder and on measures against common fault causes: see "Drive Monitor FX3-MOC0", page 33 and "Drive Monitor FX3-MOC1", page 36.

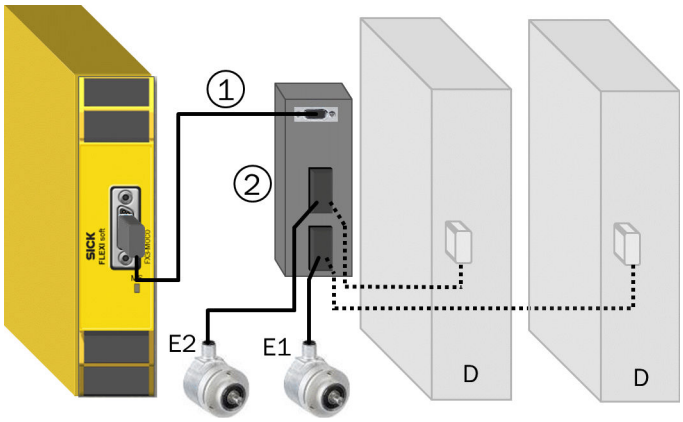
NOTE
The wiring plan for the selected configuration of the encoder is a component of the report for the configuration software.

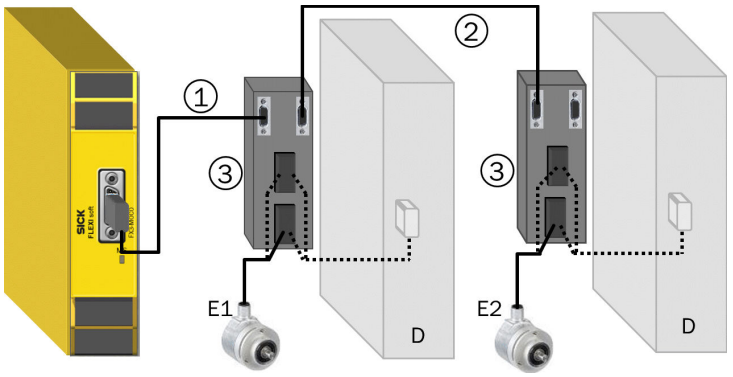
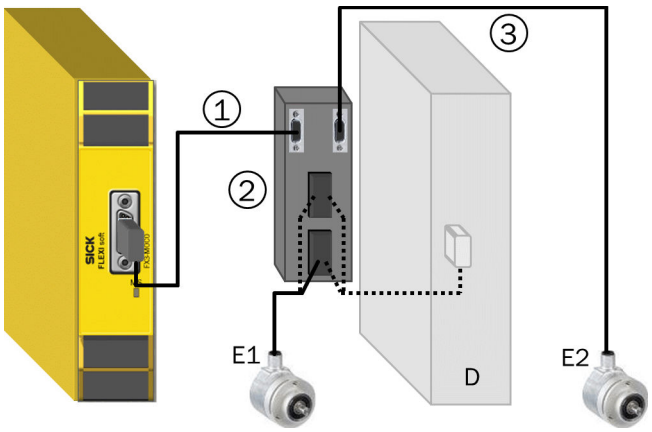
- ▶ Observe the selection options for the connection type of the encoder in the configuration software.

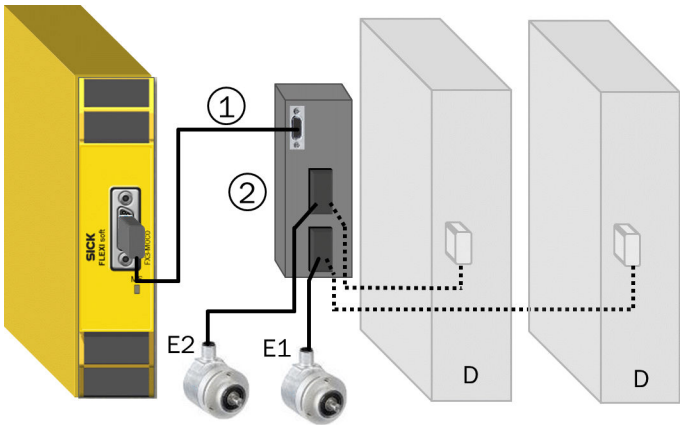
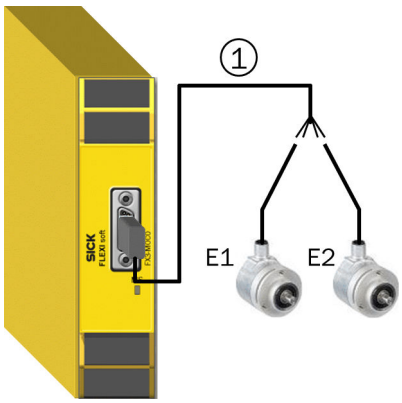
NOTE

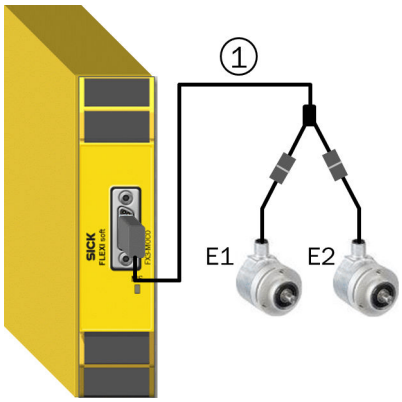
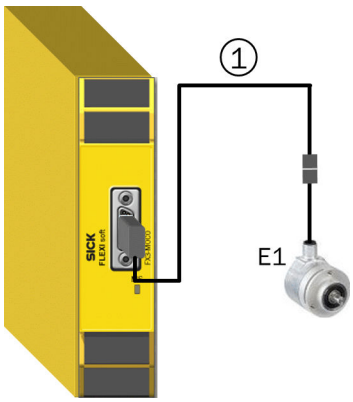
- Connection or pin assignment of the encoder:
  - "FX3-EBX1, FX3-EBX3, and FX3-EBX4 encoder/motor feedback connection boxes", page 60
  - "Encoder connection cables", page 69.
- We recommend using the connection cables and encoder/motor feedback connection boxes that are available as accessories (see "Accessories", page 182).

Table 73: Facilities for connecting encoders

Connection to an optimized dual encoder/ motor feedback connection box FX3-EBX1	 **E1** Encoder 1 **E2** Encoder 2 **D** PLC/drive controller ① Connection cable between the FX3-MOCx and an encoder/ motor feedback connection box (SICK part number 2067798, 2067799, 2077261, or 2077262) ② Optimized dual encoder/motor feedback connection box FX3-EBX1 (SICK part number 2079867)

Connection to two encoder/motor feedback connection boxes FX3-EBX3	 **E1** Encoder 1 **E2** Encoder 2 **D** PLC/drive control ① Connection cable between the FX3-MOCx and an encoder/ motor feedback connection box (SICK part number 2067798, 2067799, 2077261, or 2077262) ② Connection cable for FX3-EBX3 and FX3-EBX4 (SICK part number 2078260, 2067800, or 2067801) ③ Encoder/motor feedback connection box FX3-EBX3 (SICK part number 2068728)
Connection with an encoder/motor feedback connection box FX3-EBX3 and user-side cable for encoders	 **E1** Encoder 1 **E2** Encoder 2 **D** PLC/drive control ① Connection cable between the FX3-MOCx and an encoder/ motor feedback connection box (SICK part number 2067798, 2067799, 2077261, or 2077262) ② Encoder/motor feedback connection box FX3-EBX3 (SICK part number 2068728) ③ User-side cable for encoder

Connection to one dual encoder/motor feedback connection box FX3-EBX4	 **E1** Encoder 1 **E2** Encoder 2 **D** PLC/drive control ① Connection cable between the FX3-MOCx and an encoder/ motor feedback connection box (SICK part number 2067798, 2067799, 2077261, or 2077262) ② Dual encoder/motor feedback connection box FX3-EBX4 (SICK part number 2068729)
Connection with connection cable for direct encoder connection, open cable end	 **E1** Encoder 1 **E2** Encoder 2 ① Connection cable for direct connection of two encoders, open cable end (SICK part number 2067893 or 2077263)

Connection with connection cable for direct encoder connection, 2× M12	 **E1** Encoder 1 **E2** Encoder 2 ① Connection cable for direct connection of two encoders, 2× M12 (SICK part number 2094381)
Connection with connection cable for direct encoder connection, chosen from the following: • 1× M12, 8-pin (e.g., for DFS60S Pro) • 1× M12, 12-pin (e.g., for SSI + sine-cosine)	 **E1** Encoder 1 ① Connection cable for direct connection of one encoder, 1× M12, 8-pin (SICK part number 2094403, 2094426, 2094427, or 2094428) or 1× M12, 12-pin (SICK part number 2094372, 2094434, 2094435, or 2094436)

NOTE

Where encoders with two outputs are concerned, inputs A– and B– on the FX3-MOCx must not remain open; they must be connected to 0 V. In this case, the connection must be as close as possible to the 0 V encoder connection.

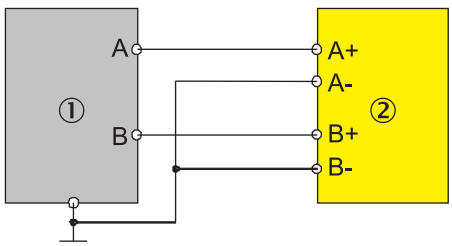


Figure 51: Connection of A/B incremental encoders with two outputs

① A/B incremental encoder with two outputs

② FX3-MOCx

24 V are available at the encoder connection of the FX3-MOC0 module for the encoder voltage supply. A selectable supply voltage is available at the encoder/motor feedback connection boxes. Details:

- see "FX3-EBX1, FX3-EBX3, and FX3-EBX4 encoder/motor feedback connection boxes", page 60
- see "Drive Monitor FX3-MOC0", page 151 (technical data)
- see "Drive Monitor FX3-MOC1", page 157 (technical data)
- see "FX3-EBX1, FX3-EBX3, and FX3-EBX4 for FX3-MOCx encoder/motor feedback connection boxes", page 163 (technical data)

5.4.9 Connecting analog sensors

Two analog sensors can be connected to the FX3-ANA0 analog input module in order to measure a joint process variable. The analog input module has two analog inputs, which are continually compared with one another.

Only sensors with a standardized current interface in accordance with EN 61131-2 5.3.1 and with a signal strength of 4 to 20 mA can be connected and evaluated.

NOTICE
Exceeding the limit values at the inputs
The device may be damaged if this is not observed.

- ▶ Observe the limit values for the inputs (30 V DC / 30 mA).
- ▶ Only use suitable sensors.

The AI1 sensor input consists of pins 1+ and 1–. The AI2 sensor input consists of pins 2+ and 2–.

NOTE
The FX3-ANA0 can detect a sensor connection with reverse polarity (I1+ switched with I1– or I2+ switched with I2–) as an error.

If only one individual sensor is used for a process variable, this sensor must be connected in series to both inputs; see figure 53.

Sensor connection cables

The FX3-ANA0 analog input module has no shielding connections. If shielding is required for connecting the sensors – for reasons of electromagnetic compatibility, for example – the shield must be connected using a ground terminal that is positioned in the control cabinet close to the Flexi Soft main module.

NOTE
Connected sensors are not supplied by the FX3-ANA0. They require an external power supply unit.

Connection examples

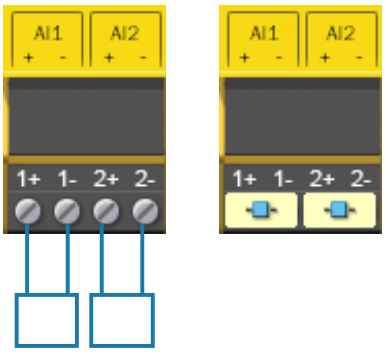


Figure 52: Connection of non-safe single-channel analog signal transmitters

Left: Connection example

Right: As illustrated in Flexi Soft Designer

WARNING

Ineffectiveness of the protective device due to improper connection

The target safety-related level may not be achieved in the event of non-compliance.

- When using a safe single-channel analog signal transmitter, install a bridge between the connections AI1– and AI2+, see figure 53.

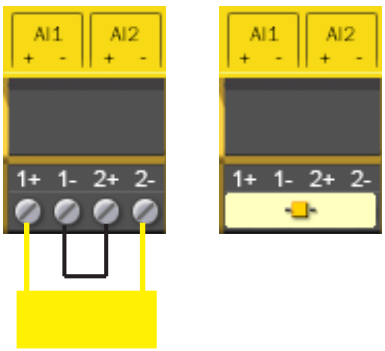


Figure 53: Connection of a safe single-channel analog signal transmitter

Left: Connection example

Right: As illustrated in Flexi Soft Designer

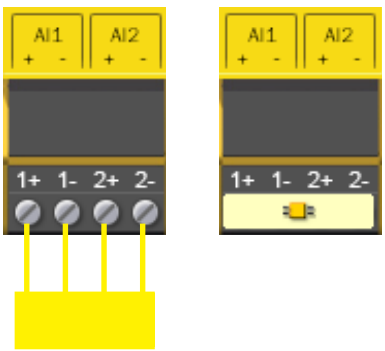


Figure 54: Connection of a safe dual-channel analog signal transmitter

Left: Connection example

Right: As illustrated in Flexi Soft Designer

Connecting the sensors to a second control

The FX3-ANA0 inputs are configured in such a way that a second control (connected in series) can use the measured values of the sensors as well.

WARNING
Influence of the signals of the FX3-ANA0 due to the memorized fault current of a second control

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

The target safety-related level may not be achieved in the event of non-compliance.

- ▶ Carry out the corresponding safety assessment and validation, taking into account this possible source of error.

5.4.10 Connection of a Flexi Link system

WARNING
Limited safety due to buffering elements

The target safety-related level may not be achieved in the event of non-compliance.

- ▶ In a Flexi Link system, do not use buffering elements such as CAN bridges, CAN repeaters or CAN-capable optical photoelectric sensors.
- ▶ Do not use any other components except for Flexi Link stations in a Flexi Link system.

NOTICE
Overvoltage at the EFI inputs

The device may be damaged if this is not observed.

- ▶ Observe the maximum permissible voltage at the EFI inputs of ± 30 V (to terminal A2 = GND).

There are two ways to connect a Flexi Link system:

- Connection via EFI1 (26 bits)
- Connection via EFI1+2 (52 bits)

In both cases, the identically named terminals must be connected (e.g., EFI1_A at station A to EFI1_B on station B, etc.).

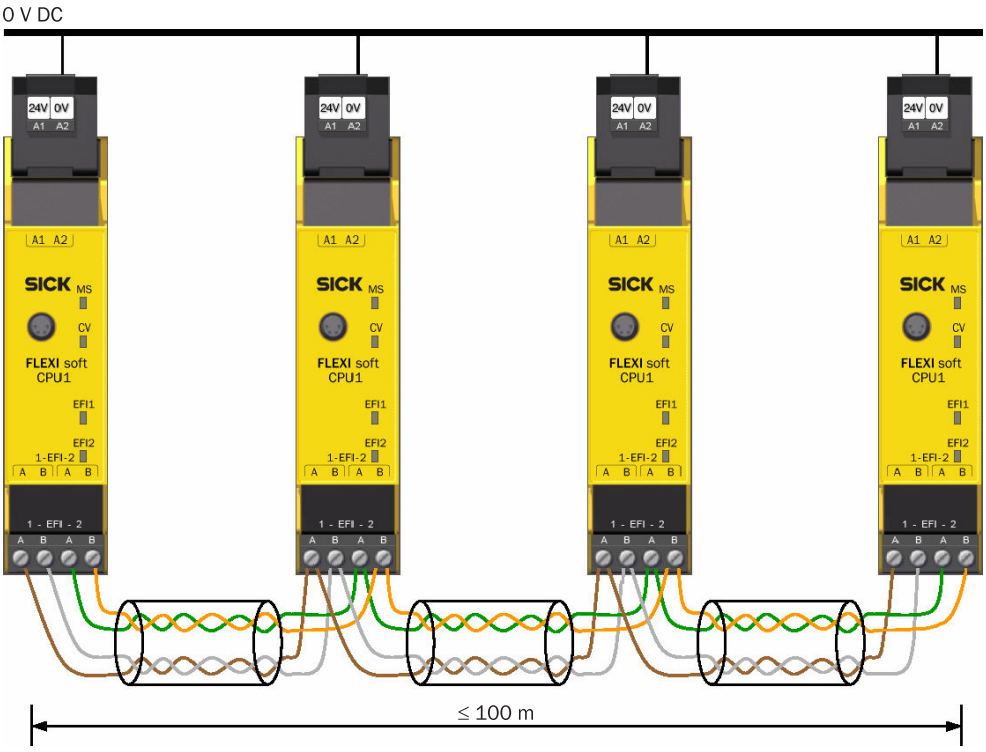


Figure 55: Connection of Flexi Link stations via EFI1+2

- No external terminator is required for the EFI connections on the main module.
- Stub cables or star-shaped wiring are not allowed.
- The maximum permissible total length of the cables for EFI1 and EFI2 (all stations) is 100 m each.

▶ Connect not used cables to the functional earth (FE) at both ends.
▶ Connect all connected Flexi Link stations with the same GND connection of the voltage supply (terminal A2 on the system plug).

Flexi Link cables

Flexi Link stations can be connected using CAN cables (shielded, twisted pair cables).

Table 74: Possible cable lengths and types for Flexi Link connections

Length of cable	Type of cable
Up to 40 m	2 × 2 × 0.25 mm² (AWG 23)
Up to 100 m	2 × 2 × 0.34 mm² (AWG 22)

SICK provides a suitable cable for connections up to 100 m in length (SICK part number 6034249, 2 × 2 × 0.34 mm², sold by the meter, see "Accessories", page 182).

EMC measures

Important notes: see "EMC measures for Flexi Link and Flexi Line", page 99.

5.4.11 Connecting a Flexi Line system

WARNING
Limited safety due to buffering elements
The target safety-related level may not be achieved in the event of non-compliance.

- ▶ Do not use any buffering elements in a Flexi Line system, such as CAN bridges, CAN repeaters or CAN-capable optical photoelectric sensors.
- ▶ Do not use any other components except Flexi Line stations in a Flexi Link system.

NOTICE
Overvoltage at the Flexi Line inputs
The device may be damaged if this is not observed.

- ▶ Observe the maximum permissible voltage at the Flexi Line inputs of ± 30 V (to terminal A2 = GND).

The stations of a Flexi Line system are connected with one another as follows:

- ▶ Connect the **NEXT** connection of every station with the **PRE** connection of the next station.
- ▶ Connect the identically named terminals with one another, i.e. **A** with **A** and **B** with **B**.

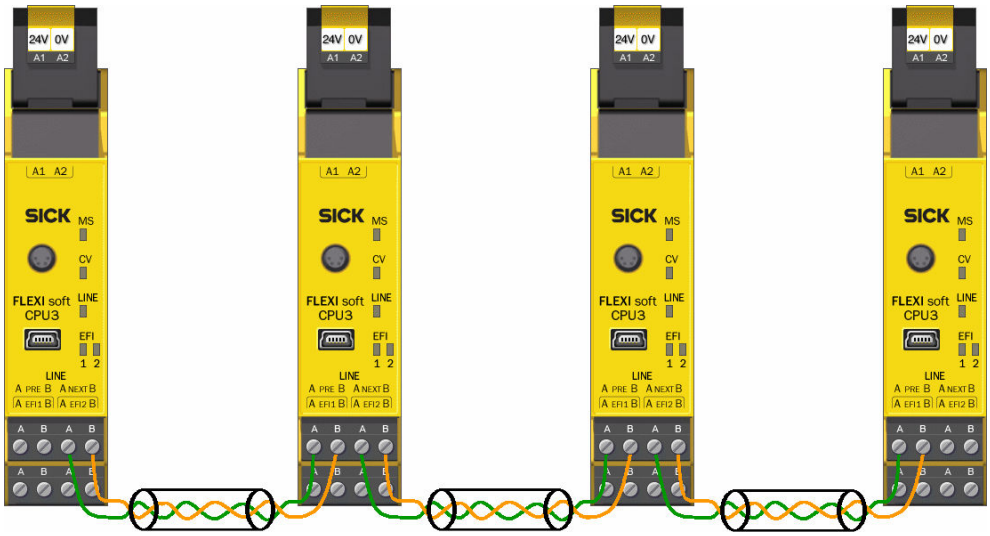


Figure 56: Connection of a Flexi Line system

- No external terminator is required for the Flexi Line connections on the main module.
- Stub cables or star-shaped wiring are not allowed.
- The maximum permissible total length of the cables for EFI1 and EFI2 (all stations) is 100 m each.

- ▶ Connect not used cables to the functional earth (FE) at both ends.

Flexi Line cables

Flexi Line stations can be connected using CAN cables (shielded, twisted pair cables).

Table 75: Possible cable lengths and types for Flexi Line connections

Length of cable	Type of cable
Up to 40 m	2 × 0.22 mm² (AWG 23)
Up to 125 m	2 × 0.34 mm² (AWG 22)

Length of cable	Type of cable
Up to 1,000 m	2 × 0.75 mm² (AWG 18)

SICK provides a suitable cable for connections up to 40 m in length (SICK part number 6029448, 2 × 0.22 mm², sold by the meter, see "Accessories", page 182).

EMC measures

Important notes: see "EMC measures for Flexi Link and Flexi Line", page 99.

5.4.12 EMC measures for Flexi Link and Flexi Line

Flexi Link and Flexi Line cables are used for the transmission of communication signals. Electromagnetic interference can disrupt signal transmission and interrupt communication. The following measures are necessary to minimize electromagnetic interference:

- Ensure sufficient equipotential bonding of the connection points for the shielding. In doing so, follow the applicable standards and directives.
- Connect all inactive metal parts (doors and housing of the control cabinet, DIN mounting rails, etc.) to the ground potential.
- Always connect the cable shielding to the ground connection across a large area at both ends.
- Use suitable cable clamps to connect the shielding of the shielded cables to the ground potential directly at the access to the system (control cabinet, frame, DIN mounting rail). The cable clamps must reach all the way around the cable shielding.
- Use suitable cable clamps to connect the cable shielding to the ground potential, **once again** as close as possible to the main module (e.g. on the DIN mounting rail). The cable clamps must reach all the way around the cable shielding.

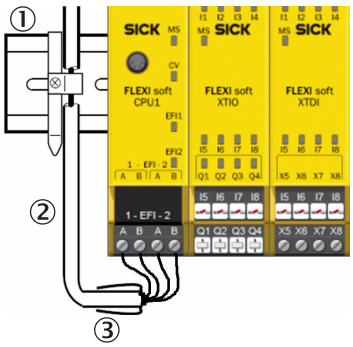


Figure 57: Connect the cable shielding to the DIN mounting rail

① DIN mounting rail
② Cable
③ Heat-shrinkable sleeve

- Keep the cable ends from which the insulation has been stripped as short as possible.
- Insulate the end of the shielding braid, for example using a suitable heat-shrinkable sleeve.

NOTE

- All connections must conduct electricity effectively with low electrical impedance. Stub cables or star-shaped wiring are not allowed.
- Load cables (e.g., for frequency inverters, electronic speed controllers, contactors, brakes, etc.) and small-signal cables (e.g., measuring cables, analog sensors, fieldbus cables, etc.) must be laid separately and with low-induction coupling.

6 Configuration

WARNING
Ineffectiveness of the protective device due to incorrect configuration

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

The target safety-related level may not be achieved in the event of non-compliance.

- ▶ Check whether the configured safety application monitors the machine or plant as intended and if the safety of the configured application is maintained at all times. This must be ensured in every operating mode and secondary application. Document the results of this thorough check.
- ▶ Check the safety function again after any change to the configuration.
- ▶ Observe the testing information in the operating instructions for the connected protective devices.

NOTE
The Flexi Soft Designer configuration software or Safety Designer configuration software as well as a FX3-MPL0 or FX3-MPL1 system plug is required for configuration.

- The system configuration for the entire Flexi Soft system (with exception of the configuration of any connected EFI-capable devices) is stored in the system plug. This has the advantage that it is not necessary to reconfigure the system if expansion modules or gateways are replaced.
- The Automatic Configuration Recovery (ACR) function can be used to detect and automatically reconfigure EFI-enabled devices of the same type following a replacement; see "Automatic configuration recovery (ACR)", page 48.
- The data saved in the system plug is retained even in the event of a power supply failure.
- Configuration information can be transmitted via the EFI interface.

NOTE
If two computers establish TCP/IP connections to the same Flexi Soft main module of a Flexi Soft Ethernet gateway in parallel (e.g., via port 9000), the Flexi Soft main module will only communicate via the most recently established connection. As a result, the second computer will establish a further connection without closing the ones already established. There comes a point when too many connections to the computers are open via the gateway and the only messages being exchanged on those computers are messages for maintaining these connections (known as keep-alive messages). This causes the Flexi Soft system to switch to the “Serious error” state.

Report

After finishing the configuration, you can use the configuration software to generate a report. Among other things, it contains the following information:

- Logic report
- Bill of materials
- Internal circuitry

Configuring connected devices

The configuration and verification of devices connected to the safety controller is generally **not** done via the configuration software of the Flexi Soft safety controller. These devices have their own configuration and verification mechanisms.

For more information, see the operating instructions for the corresponding device.

Configuration of EFI-enabled devices

NOTE

The connection of EFI-capable devices is only possible if the Flexi Soft Designer configuration software is used. The Safety Designer configuration software does not support the EFI function.

Devices connected to the Flexi Soft main module via EFI can be configured both locally on the corresponding device and via the Flexi Soft system.

The following options are available:

- Via the RS-232 interface of the Flexi Soft main module
- Via the USB interface of the Flexi Soft main module (FX3-CPU3 and higher)
- Via Ethernet (Flexi-Soft-EtherNet/IP™-Gateway required, e.g. FX0-GENT)

The SICK CDS configuration and diagnostic software is required for the configuration and verification of the EFI-capable devices.

The “Flexi Soft in Flexi Soft Designer Configuration Software” operating instructions as well as the operating instructions of the respective device contains additional information on the use of EFI-capable devices.

7 Commissioning

WARNING
Improper commissioning
The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

- Before initially commissioning a plant/machine that includes a Flexi Soft safety controller, you must have it thoroughly checked and documented by qualified safety personnel.
- Secure the hazardous area to prevent entry (e.g. by setting up warning signs, attaching barriers, and so on).
- Before carrying out commissioning, make sure that there is no one inside the hazardous area.
- Observe the relevant laws and local regulations.

7.1 Overall acceptance of the application

You are only permitted to put the system into operation if the overall acceptance process was successful. Only trained specialists are permitted to deal with overall acceptance.

Overall acceptance comprises the following steps:

- Check that all safety-related parts of the system (wiring, connected sensors and command triggers, configuration) conform to the applicable safety standards (e.g., EN 62061 or EN ISO 13849-1).
- Check the devices connected to the safety controller according to the test notes in the associated operating instructions.

NOTE
See the “Check prior to initial commissioning” section in each of the operating instructions for the electro-sensitive protective devices from SICK AG for more information.

- Clearly and unambiguously mark all connections (connecting cables and plug connectors) on the safety controller to avoid mix-ups. The Flexi Soft system features several connections of the same design. Therefore, you must make sure that no unplugged connecting cables or plug connectors are accidentally connected to the wrong connection point.
- Check the signal paths and check for correct integration into higher-level controllers.
- Check that data is transmitted correctly from and to the Flexi Soft safety controller.
- Check the logic program of the safety controller.
- Run a full validation of the safety function of the system in each operating mode and simulate at least one error. Pay particular attention to the response times of the individual applications.
- Record the entire configuration process for the system and the individual devices, as well as the result of the safety inspection, in writing.
- To make it difficult to inadvertently overwrite the configuration, you can activate write protection for the configuration of the Flexi Soft system. Changes can then only be made if write protection has first been deactivated.

7.2 Checks before initial commissioning

Check the protective device as described below and in accordance with the applicable standards and regulations.

- Check the effectiveness of the safety function on the machine in all operating modes and functions in which the machine can be set.
- Ensure that all operators have been instructed by the qualified safety personnel of the machine user before they start working on a machine protected by an safety controller. Instruction is the responsibility of the machine user.

8 Operation

8.1 Status messages on the FX3-CPUx main module

For information on the positions of the LEDs on the FX3-CPU0 main module, see figure 27, page 53.

For information on the positions of the LEDs on the FX3-CPU1 and FX3-CPU2 main modules, see figure 29, page 54.

For information on the positions of the LEDs on the FX3-CPU3 main module, see figure 30, page 55.

MS LED (all main modules)

Table 76: MS LED

MS LED	Meaning	Notes
○	Supply voltage out of range	Switch on the voltage supply of the Flexi Soft system and check at the A1 and A2 terminals of the main module.
☼ Red/ green (1 Hz)	Self-test in progress or system initializing.	Please wait ...
☼ Green (1 Hz)	System in Stop	The application can be started from within the configuration software.
☼ Green (2 Hz)	Identify (e.g., for Flexi Link)	–
● Green	System in Run	–
☼ Red (1 Hz)	Invalid configuration	Check module type and module version of main module and expansion modules on which the MS LED ☼ is flashing red/green. Modify the configuration if necessary. Use the configuration software diagnostic function.
☼ Red (2 Hz)	Serious error in the system, presumably in this module. The application was stopped. All outputs are switched off.	Switch the power supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace this module. Use the configuration software diagnostic function.
● Red	Serious error in the system, presumably in a different module. The application was stopped. All outputs are switched off.	Switch the power supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace the module showing ☼ red (2 Hz). If applicable, also use the diagnostic function in the configuration software to isolate the affected module.

CV LED (all main modules)

Table 77: CV LED

CV LED	Meaning	Note
○	Configuration in progress.	–
☼ Yellow (2 Hz)	Saving configuration data in the system plug (non-volatile memory)	Do not disconnect from power supply until save process has been completed.
☼ Yellow (1 Hz)	Unverified configuration	Verify the configuration with the configuration software.
● Yellow	Verified configuration	–

EFI LEDs (FX3-CPU1 main module and higher)

Table 78: EFI LEDs

LED EFI (EFI1 or EFI2)	Meaning	Note
○	OK	–
● Red	• Waiting for integration of EFI-enabled devices or Flexi Link station following power-up • ACR execution (FX3-CPU2 and higher)	–
☼ Red (1 Hz)	Error, e.g., • Expected EFI-enabled device or Flexi Link station not found within 3 minutes. • Integration check failed • Communication interrupted • EFI device address conflict • Flexi Link ID conflict • ACR execution error, e. g., ACR integration check failed, ACR transmission error (FX3-CPU2 and higher)	Check the wiring. Integration at a later date remains possible at all times.
☼ Red (2 Hz, EFI1 and EFI2 alternating)	Identify (e.g., for Flexi Link)	–

LINE LED (FX3-CPU3 main module and higher)

Table 79: LINE LED

LINE LED	Meaning
○	Flexi Line is not configured and not in operation.
● Green	Flexi Line in operation
☼ Green (1 Hz)	Flexi Line started, waits for neighboring station or teach possible, e.g. after system restructuring
☼ Green (2 Hz)	Teach-in required
☼ Red/green (2 Hz)	Flexi Line configuration necessary
☼ Red (1 Hz)	Error on the Flexi Line bus, e.g., communication interrupted
● Red	Serious error, Flexi Line stopped

8.2 Status messages for the FX3-XTIO I/O module

For information on the positions of the LEDs on the FX3-XTIO I/O module, see figure 31, page 56.

Table 80: MS LED on the FX3-XTIO I/O module

MS LED	Meaning	Notes
○	Supply voltage out of range	Switch on the voltage supply of the Flexi Soft system and check at the A1 and A2 terminals of the main module.
☀ Red/ green (1 Hz)	With firmware V1.xx.0: invalid configuration	
	With firmware ≥ V2.00.0: remediable external error	Check cabling of the flashing inputs and outputs. If all output LEDs are flashing, check the supply voltage of terminals A1 and A2 on this module.
☀ Green (1 Hz)	System in Stop	The application can be started from within the configuration software.
● Green	System in Run	
☀ Red (1 Hz)	With firmware V1.xx.0: remediable external error	Check cabling of the flashing inputs and outputs. If all output LEDs are flashing, check the supply voltage of terminals A1 and A2 on this module.
	With firmware ≥ V2.00.0: invalid configuration	
☀ Red (2 Hz)	Serious error in the system, presumably in this module. The application was stopped. All outputs are switched off.	Switch the power supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace this module. Use the configuration software diagnostic function.
● Red	Serious error in the system, presumably in a different module. The application was stopped. All outputs are switched off.	Switch the power supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace the module showing ☀ red (2 Hz). If applicable, also use the diagnostic function in the configuration software to isolate the affected module.

Table 81: Input and output LEDs on the FX3-XTIO I/O module

Input LEDs (I1 ... I8) Output LEDs (Q1 ... Q4)	Meaning
○	Input/output is deactivated.
● Green	Input/output is active.
☀ Green (1 Hz) synchronized with the red MS LED	Input/output is deactivated and there is a remediable error.
☀ Green (1 Hz) alternating with the red MS LED	Input/output is active and there is a remediable error.

NOTE

The LEDs indicate the state and are updated approx. every 64 ms.

8.3 Status messages for the FX3-XTDI I/O module

For information on the positions of the LEDs on the FX3-XDTI I/O module, see figure 32, page 57.

Table 82: MS LED on the FX3-XTDI I/O module

MS LED	Meaning	Notes
○	Supply voltage out of range	Switch on the voltage supply of the Flexi Soft system and check at the A1 and A2 terminals of the main module.
☼ Red/ green (1 Hz)	With firmware V1.xx.0: invalid configuration	
	With firmware ≥ V2.00.0: remediable external error	Check cabling of the flashing inputs. If all output LEDs are flashing, check the supply voltage of terminals A1 and A2 on this module.
☼ Green (1 Hz)	System in Stop	The application can be started from within the configuration software.
● Green	System in Run	
☼ Red (1 Hz)	With firmware V1.xx.0: remediable external error	Check cabling of the flashing inputs
	With firmware ≥ V2.00.0: invalid configuration	
☼ Red (2 Hz)	Serious error in the system, presumably in this module. The application was stopped.	Switch the power supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace this module. Use the configuration software diagnostic function.
● Red	Serious error in the system, presumably in a different module. The application was stopped.	Switch the power supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace the module showing ☼ red (2 Hz). If applicable, also use the diagnostic function in the configuration software to isolate the affected module.

Table 83: Input LEDs on the FX3-XTDI I/O module

Input LEDs (I1 ... I8)	Meaning
○	Input is deactivated.
● Green	Input is active.
☼ Green (1 Hz) synchronized with the red MS LED	Input is deactivated and there is a remediable error.
☼ Green (1 Hz) alternating with the red MS LED	Input is active and there is a remediable error.

NOTE
The LEDs indicate the state and are updated approx. every 64 ms.

8.4 Status messages for the FX3-XTDS I/O module

For information on the positions of the LEDs on the FX3-XTDS I/O module, see figure 33, page 58.

Table 84: MS LED on the FX3-XTDS I/O module

MS LED	Meaning	Notes
○	Supply voltage out of range	Switch on the voltage supply of the Flexi Soft system and check at the A1 and A2 terminals of the main module.
☼ Red/ green (1 Hz)	Remediable external error	Check cabling of the flashing inputs and outputs. If all output LEDs are flashing, check the supply voltage of terminals A1 and A2 on this module.
☼ Green (1 Hz)	System in Stop	The application can be started from within the configuration software.
● Green	System in Run	
☼ Red (1 Hz)	Invalid configuration	
☼ Red (2 Hz)	Serious error in the system, presumably in this module. The application was stopped. All outputs are switched off.	Switch the power supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace this module. Use the configuration software diagnostic function.
● Red	Serious error in the system, presumably in a different module. The application was stopped. All outputs are switched off.	Switch the power supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace the module showing ☼ red (2 Hz). If applicable, also use the diagnostic function in the configuration software to isolate the affected module.

Table 85: Input and output LEDs on the FX3-XTDS I/O module

Input LEDs (I1 ... I8) Output LEDs (XY1, XY2, and Y3 ... Y6)	Meaning
○	Input/output is deactivated.
● Green	Input/output is active.
☼ Green (1 Hz) synchronized with the red MS LED	Input/output is deactivated and there is a remediable error.
☼ Green (1 Hz) alternating with the red MS LED	Input/output is active and there is a remediable error.

NOTE
The LEDs indicate the state and are updated approx. every 64 ms.

8.5 Status messages for the FX0-STIO I/O module

For information on the positions of the LEDs on the FX0-STIO I/O module, see figure 34, page 59.

Table 86: MS LED on the FX0-STIO I/O module

MS LED	Meaning	Notes
○	Supply voltage out of range	Switch on the voltage supply of the Flexi Soft system and check at the A1 and A2 terminals of the main module.
☼ Red/ green (1 Hz)	Remediable external error	Check cabling of the flashing inputs and outputs. If all output LEDs are flashing, check the supply voltage of terminals A1 and A2 on this module.
☼ Green (1 Hz)	System in Stop	The application can be started from within the configuration software.
● Green	System in Run	
☼ Red (1 Hz)	Invalid configuration	
☼ Red (2 Hz)	Serious error in the system, presumably in this module. The application was stopped. All outputs are switched off.	Switch the power supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace this module. Use the configuration software diagnostic function.
● Red	Serious error in the system, presumably in a different module. The application was stopped. All outputs are switched off.	Switch the power supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace the module showing ☼ red (2 Hz). If applicable, also use the diagnostic function in the configuration software to isolate the affected module.

Table 87: Input/output LEDs on the FX0-STIO I/O module

Input LEDs (I1 ... I6) Output LEDs (Y1 ... Y6) Input/output LEDs (IY7, IY8)	Meaning
○	Input/output is deactivated.
● Green	Input/output is active.
☼ Green (1 Hz) synchronized with the red MS LED	Input/output is deactivated and there is a remediable error.
☼ Green (1 Hz) alternating with the red MS LED	Input/output is active and there is a remediable error.

NOTE

The LEDs indicate the state and are updated approx. every 64 ms.

8.6 Status signals of the FX3-ANA0 analog input module

For information on the positions of the LEDs on the FX3-ANA0, see figure 39, page 72.

Table 88: Statuses indicated by the MS LED on the FX3-ANA0 analog input module

MS LED	Meaning	Notes
○	Supply voltage out of range	Switch on the voltage supply of the Flexi Soft system and check at the A1 and A2 terminals of the main module.
☼ Red/ green (1 Hz)	Remediable external error	Check cabling of the flashing inputs
☼ Green (1 Hz)	System in Stop status	The application can be started using the configuration software.
● Green	System in Run status	
☼ Red (1 Hz)	Invalid configuration	
☼ Red (2 Hz)	Serious error in the system, probably in this module. The application was stopped. All outputs are switched off.	Switch the voltage supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace this module. Use the configuration software diagnostic function.
● Red	Serious error in the system, probably in a different module. The application was stopped. All outputs are switched off.	Switch the voltage supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace the module showing ☼ red (2 Hz). If applicable, also use the diagnostic function in the configuration software to isolate the affected module.

Table 89: Statuses indicated by the input LEDs on the FX3-ANA0 analog input module

Input LEDs AI1, AI2	Meaning
○	Input is deactivated.
● Green	Input is active.
☼ Green (1 Hz) synchronized with the ☼ red/green MS LED (1 Hz)	Input is deactivated and there is a remediable error.

8.7 Status messages of the Drive Monitor FX3-MOCx

For information on the positions of the LEDs on the Drive Monitor FX3-MOCx, see figure 35, page 59.

Table 90: Statuses indicated by the MS LED on the Drive Monitor FX3-MOCx

MS LED	Meaning	Notes
○	Supply voltage out of range	Switch on the voltage supply of the Flexi Soft system and check at the A1 and A2 terminals of the main module.
☼● Red/ green (1 Hz)	Remediable external error	Check the encoder signals. Use the configuration software diagnostic function.
☼● Green (1 Hz)	System in Stop	The application can be started from within the configuration software.
● Green	System in Run	
☼● Red (1 Hz)	Invalid configuration	
☼● Red (2 Hz)	Serious error in the system, presumably in this module. The application was stopped. All outputs are switched off.	Switch the power supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace this module. Use the configuration software diagnostic function.
● Red	Serious error in the system, presumably in a different module. The application was stopped. All outputs are switched off.	Switch the power supply off and then on again. If the problem still has not been remedied after multiple repetitions, replace the module showing ☼● red (2 Hz). If applicable, also use the diagnostic function in the configuration software to isolate the affected module.

8.8 Status messages of the UE410-2RO and UE410-4RO relay modules

For information on the positions of the LEDs on the UE410-2RO and UE410-4RO relay modules, see figure 40, page 72 and see figure 41, page 72.

Table 91: Statuses indicated by the LEDs on the UE410-2RO and UE410-4RO relay modules

LED display	Meaning
PWR (green)	Supply voltage via safety bus on.
K1/2 (green)	Relay K1/K2 – safety contacts closed
K3/4 (green)	Relay K1/K2 – safety contacts closed (on the UE410-4RO only)

9 Maintenance

This section provides information about regular checks and the replacement of Flexi Soft modules.

Do not attempt to remove, repair, or modify the Flexi Soft modules. This can lead to the loss of the safety function(s). It will also invalidate any warranty claims against SICK AG.

9.1 Regular thorough check of the safety function by qualified safety personnel

- Check the system following the inspection intervals specified in the national rules and regulations. This procedure ensures that any changes to the machine or tampering with the protective device are detected after initial commissioning.
- Every safety application must be checked at fixed intervals you define. The effectiveness of the safety function must be checked by qualified and authorized personnel.
- If alterations have been made to the machine or safety function, or if the safety controller has been changed or repaired, for example by exchanging a module, check the plant again using the checklist in the appendix.
- Carry out regular inspections in order to keep the Flexi Soft modules in perfect working order.
- Check that the implementation of the Flexi Soft modules complies with all technical data.
- Check the mounting conditions and check that the Flexi Soft module wiring is correct.
- To ensure their reliability, check at regular intervals that the safety functions are meeting the requirements of the application as well as all applicable regulations and standards (e.g., regular thorough check).

9.2 Device replacement

A serious error in one of the Flexi Soft modules impairs the entire network. Therefore devices that indicate serious errors must be quickly repaired or exchanged. It is recommended to keep replacement devices for the Flexi Soft modules ready in order to restore operation as quickly as possible.

- Follow the instructions for mounting and removing the Flexi Soft modules, see "Mounting", page 49 and see "Disassembling the modules", page 124.

Safety measures for device replacement

- Do not dismantle or repair the Flexi Soft module. In case of non-observance, not only does any warranty claim against SICK become void, but it is also dangerous as, in this case, no thorough check of the previous safety functions is possible in this case.
- Restore the device to a safe state.
- Carry out the exchange only when the voltage supply is switched off to avoid electric shock or unexpected device behavior.
- To be able to use the system configuration again, check the following points:
  - Is the new module of the same type (same part number) and are there no errors on the new module after exchange?
  - Has the new module been placed in the same position that the removed module was in?
  - Have all plug connectors been reconnected in the right location?
- Otherwise the new system will have to be completely reconfigured and commissioned, including carrying out all necessary thorough checks (see "Commissioning", page 102).

WARNING

Ineffectiveness of the protective device due to replacing the device

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

- ▶ After exchanging the device, ensure that no errors occur with the new Flexi Soft modules.
- ▶ Always carry out a function test before commissioning a replacement module.
- ▶ After exchanging a FX3-MOC1, carry out reference and/or teach-in process once again if the function block Position by Reference with Restore or SSI encoder with teach-in input is used.

NOTE

- EFI-capable devices do not need to be reconfigured after exchanging a Flexi Soft module.
- If a Flexi Soft module need to be sent in for repair, then first a report of the project including the diagnostics messages of the Flexi Soft system has to be generated using the configuration software. Send the Flexi Soft module in question together with this report, a detailed description of the problem and all other available information to SICK.
- If you send in a FX3-MPL0 or FX3-MPL1 system plug for repair or analysis, it will be returned in the state of delivery, i.e. with an empty configuration. It is therefore recommended to save your configuration as a project file using the configuration software.

10 Diagnostics

10.1 Response to errors

WARNING
Malfunction of the protective device

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

- ▶ Immediately put the plant/machine out of operation if it is not possible to clearly allocate the fault and safely remedy it.
- ▶ After remedying a fault, carry out an effects analysis and check all affected safety functions.

10.2 Error states

If certain malfunctions or a fault configuration occurs, the Flexi Soft safety controller goes into a safe state. The LEDs of the individual modules of the safety controller show the respective error state.

The error state will vary depending on the nature of the error:

Configuration error

- The system is in the Configuration required state (MS LED ☼● red (1 Hz)).
- The applications in all modules are in the Stop state.
- All safe outputs of the system are switched off.
- All safe process data is set to zero. The non-safety-related process data is typically also set to zero.

Remediable error

- The applications in all modules remain in the Run state (MS LED on the affected modules = ☼● alternate red/green (1 Hz), MS LED on modules that are not affected = ● green).
- If safe outputs of the system are affected, they are switched off as a minimum.
- If safe inputs are affected, the process data of these safe inputs is set to zero as a minimum.

Serious error

- The system is in the Serious error state (MS LED on the module that has detected the serious error = ☼● red (2 Hz). MS LED on the modules on which the cause of the error is unknown = ● red).
- The applications in all modules are in the Stop state.
- All safe outputs of the system are switched off.
- All safe process data is set to zero. The non-safety-related process data is typically also set to zero.

Recommissioning

- ▶ Remedy the cause of the error based on the MS, CV, and EFI LED displays.
- ▶ In the event of serious errors, switch the power supply to the Flexi Soft system off for at least 3 seconds and then switch it back on again.

10.3 Error displays shown by status LEDs, error messages, and troubleshooting measures

The most important error codes, possible causes, and possible troubleshooting measures are listed in this chapter. These error messages can be displayed with the diagnostics function of the configuration software if you have established a connection to the Flexi Soft system.

NOTE

- For information about how to perform diagnostics, please refer to the “Flexi Soft in the Flexi Soft Designer Configuration Software” or “Flexi Soft in the Safety Designer Configuration Software” operating instructions.
- Error displays and troubleshooting for the individual modules are described in the sections on the corresponding modules (see "Status messages on the FX3-CPUx main module", page 104 to see "Status messages of the UE410-2RO and UE410-4RO relay modules", page 111).

Table 92: Error codes and error messages in the Flexi Soft system and possible troubleshooting measures

LED display on the module		Possible error codes	Possible causes	Possible measures
Main module FX3-CPUx	**Expansion module [1)]**			
MS = red (1 Hz)	All expansion modules: MS = red (1 Hz) (firmware ≥ V2.00.0) or MS = red/green (1 Hz) (firmware V1.xx.0)	Main module: 0x000E4006, 0x00160005, 0x000F0013	The configuration in the system plug is incompatible, because it is intended for a different type of main module: • The system plug has been previously used in a system with a different type of main module (e.g., FX3-CPU0 instead of FX3-CPU1, or vice versa). • An incorrect main module has been used in the hardware installation.	• Transfer a configuration with the same type of main module as in the hardware installation. • Replace the main module in the hardware installation with a main module of the same type as in the project file.
		Main module: 0x00170005, 0x000F0013	The configuration in the system plug is incompatible, because it is intended for more recent firmware version of the main module: • The system plug has been configured for an incompatible more recent firmware version of the main module (e.g., V2.00.0 instead of V1.11.0). • An older firmware version of the main module has been used in the hardware installation.	• Transfer a configuration with the same or an older firmware version (e.g, V1.xx.0 instead of V2.xx.0). • Replace the main module in the hardware installation with a module with a more recent or identical firmware version as in the project file.
		Main module: 0x000E4013, 0x00274006	The configuration in the system plug is incompatible with at least one expansion module: • An expansion module is missing in the hardware installation.	• Transfer a configuration with a suitable number of expansion modules. • Add the missing expansion module to the hardware installation.
		Main module: 0x000E0006, 0x0005000D FX3-XTIO/-XTDI: 0x4901, 0x4904	The configuration in the system plug is invalid: • The last configuration operation was not completed successfully, e.g., because the power supply was switched off before the write operation to the system plug was completed. • Hardware error in system plug • The system plug is empty (condition on delivery).	• Transfer the configuration again and make sure that the power supply at the main module remains switched on until the transfer operation is complete. • Replace the system plug and transfer the configuration again.

LED display on the module		Possible error codes	Possible causes	Possible measures
Main module FX3-CPUx	Expansion module [1]			
MS = red (1 Hz) EFI = red (1 Hz)	One or more expansion modules: MS = red (1 Hz) (firmware ≥ V2.00.0) or MS = red/green (1 Hz) (firmware V1.xx.0)	Main module: 0x0014000A	If FX3-CPU1: EFI device address conflict: • At least 2 main modules with the same EFI address are connected.	• Change the EFI address of the main module or the connected device in the configuration software.
		Main module: 0x0015000A	If FX3-CPU1 and Flexi Link: incorrect Flexi Link ID: • EFI1 and EFI2 were mixed up during wiring. • At least 1 main module with an incorrect Flexi Link ID is connected.	• Check the wiring between the Flexi Link stations: EFI1 must be connected to EFI1 and, if applicable, EFI2 to EFI2. • Connect Flexi Link stations with correct IDs. • Transfer the configuration to all Flexi Link stations with the same Flexi Link IDs.
		Main module: 0x001F0006, 0x00230006, 0x00234006, 0x001F4006	The configuration in the system plug is incompatible with at least one expansion module: • Incorrect module type or incorrect module version (MS LED on module is flashing red or red/green). • Too many expansion modules are connected. (MS LED on module is flashing red or red/green.) • Expansion modules are missing. (MS LEDs on all other modules are flashing red or red/green.)	• Transfer a configuration with the same module type and the same or an older firmware version of all expansion modules. • Replace the expansion module affected in the hardware installation with a module of the same type and a firmware version that is older than or identical to the one in the project file.
MS = green (1 Hz) CV = yellow (1 Hz)	MS = green (1 Hz)	–	The system is in the Stop state (ready for operation).	The application can be started from within the configuration software. For automatic starting following power-up, the project must be verified with the configuration software.
MS = green (1 Hz) CV = yellow	MS = green (1 Hz)	–	The system is in the Stop state (ready for operation).	The application can be started from within the configuration software.
MS = green	MS = green	–	The system is in operation. No errors detected.	–
MS = green	One or more expansion modules: MS = red/green (1 Hz) (firmware ≥ V2.00.0) or MS = red (1 Hz) (firmware V1.xx.0) and Q1 + Q2 + Q3 + Q4 = green (1 Hz)	FX3-XTIO: 0x4804, 0x4806, 0x4807	The supply voltage of an FX3-XTIO module is too low or is missing.	Check the power supply at terminals A1 (24 V) and A2 (GND) on the FX3-XTIO module, including under worst-case conditions. The error is reset automatically after approx. 8 seconds if its cause is no longer present.

LED display on the module		Possible error codes	Possible causes	Possible measures
Main module FX3-CPUx	Expansion module [1]			
MS = ● green	One or more expansion modules: MS = ☼ red/green (1 Hz) (firmware ≥ V2.00.0) or MS = ☼ red (1 Hz) (firmware V1.xx.0) and Q1 or Q2 or Q3 or Q4 = ☼ green (1 Hz)	FX3-XTIO: 0x4701, 0x4702, 0x4704. 0x4705	• Short-circuit to 24 V or cross-circuit in the wiring of the safe output Q1 to Q4 (associated LED is flashing) • Capacitive load exceeds permissible maximum value (e.g., due to spark quenching capacitor). • Inductive load exceeds permissible maximum value. • Internal hardware in FX3-XTIO module • Short-circuit to GND in the wiring of the safe output Q1 to Q4 (associated LED is flashing) • Power supply at FX3-XTIO module interrupted briefly	• Check the wiring of the affected output. • Check the capacitive load. • Check the inductive load. • Replace the FX3-XTIO module. To reset the error, all outputs of the affected module must be switched off by the logic of the main module by switching off the associated input signals (e.g., emergency stop). It can take up to 8 seconds to reset the error. Alternatively, reset the voltage at the main module.
MS = ● green	One or more expansion modules: MS = ☼ red/green (1 Hz) (firmware ≥ V2.00.0) or MS = ☼ red (1 Hz) (firmware V1.xx.0) and I1 or I2 or I3 or I4 or I5 or I6 or I7 or I8 = ☼ green (1 Hz)	FX3-XTIO/-XTDI: 0x4601	Inputs connected to a test output: • Short-circuit to 24 V or cross-circuit in the wiring of tested sensors: o a) Short-circuit to 24 V or cross-circuit in the wiring of X1, X2, ... or X8 to a tactile switch or to a test input of a testable input o b) Short-circuit to 24 V or cross-circuit in the wiring of a tactile switch or an output of a testable sensor to I1, I2, ... or I8 • Defective testable sensor • Cable break in the wiring of a pressure-sensitive safety mat: o a) Cable break in the wiring of X1, X2, ... or X8 to the pressure-sensitive safety mat o b) Cable break in the wiring from the pressure-sensitive safety mat to I1, I2, ... or I8 • Defective pressure-sensitive safety mat	• Check the wiring of the affected input. • Replace the testable sensor. To reset the error, switch off the affected input (input state Low/Low for equivalent dual-channel inputs, Low/High for complementary dual-channel inputs) or reset the voltage at the main module.

LED display on the module		Possible error codes	Possible causes	Possible measures
Main module FX3-CPUx	Expansion module [1]			
MS = ● green	One or more expansion modules: MS = ☼ red/green (1 Hz) (firmware ≥ V2.00.0) or MS = ☼ red (1 Hz) (firmware V1.xx.0) and I1 + I2 or I3 + I4 or I5 + I6 or I7 + I8 = ☼ green (1 Hz)	FX3-XTIO/-XTDI: 0x4429 or 0x442A	Discrepancy error or sequence error at dual-channel inputs (associated LEDs flashing green): • Cable break or short-circuit to GND at one of the two input signals of the input pair • Sensor hardware error (e.g., is one of the two contacts/outputs permanently closed (High) or open (Low)). • Defective sensor (one of the two signals is not switching to a state corresponding to the other input within the configured discrepancy time). • The safety door opened or closed too slowly; as a result, both contact switches (e.g., reed contacts) did not switch within the configured discrepancy time. • Only one of the two inputs triggered the switch-off condition and then switched back to the ON state, while the value of the other input did not change at all (sequence error).	• Check the wiring of the affected input and check the switching capacity of the two contacts/outputs of the connected sensor. • Check the mechanical dependence of the two switches. • Replace the switch/sensor in the hardware installation. To reset the error, the affected input pair must be Low/Low in the case of equivalent dual-channel inputs and Low/High in the case of complementary dual-channel inputs.
MS = ● red	MS = ● red	Main module: 0xXXXCXXXX Expansion modules: 0xCXXX (X = random value)	• Power supply GND at the FX3-XTIO module is missing (only with firmware V1.xx.0). • Internal error in the expansion module • Internal error in the main module	• Check the connection from terminal A2 on the FX3-XTIO modules to the power supply GND. • Check the system for electromagnetic interference (grounding of the DIN mounting rail, etc.). • To reset the error, reset the voltage at the main module. • If the error persists, replace the modules.
MS = ● red	MS = ☼ red (2 Hz) (firmware ≥ V2.00.0)	Main module: 0xXXXCXXXX Expansion modules: 0xCXXX (X = random value)	Internal error in the expansion module (associated MS LED flashing)	• Check the system for electromagnetic interference (grounding of the DIN mounting rail, etc.). • To reset the error, reset the voltage at the main module. • If the error persists, replace the module on which the MS LED is flashing.
MS = ☼ red (2 Hz) (firmware ≥ V2.00.0)	MS = ● red	Main module: 0xXXXCXXXX Expansion modules: 0xCXXX (X = random value)	Internal error in the main module or in the system	• Check the system for electromagnetic interference (grounding of the DIN mounting rail, etc.). • To reset the error, reset the voltage at the main module. • If the error persists, replace the main module followed by the expansion modules.

LED display on the module		Possible error codes	Possible causes	Possible measures
Main module FX3-CPUx	Expansion module [1]			
MS = ● red or ☼ red (2 Hz)	MS = ● red or ☼ red (2 Hz)	Main module: 0x0006C002, 0x0007C002, 0x0001C005, 0x0003C006, 0x0005C006, 0x0029C006, 0x0003C013	• Consequential error further to another serious error • Fault affecting the internal signals of the main module caused by significant electromagnetic interference • Hardware error in the main module or in an expansion module	• Check the other diagnostic messages for serious errors with a very similar time stamp. • To reset the error, reset the voltage at the main module. • If the error persists, replace the main module followed by the expansion modules.
		Main module: 0x0001C013, 0x0004C013, 0x0005C013, 0x000CC013	• FLEXBUS+ communication (backplane bus communication with I/O modules and gateways) faulty due to electromagnetic interference • FLEXBUS+ communication (backplane bus communication with I/O modules and gateways) faulty due to a serious error in I/O modules. This is a consequential error and there are other messages relating to serious errors with a very similar time stamp (±1 s) in the diagnostic history.	• To reset the error, reset the voltage at the main module. • Check the system with regard to electromagnetic interference (FE connection for DIN mounting rail and control cabinet, star wiring of the 24 V power supply, local isolation of load and control elements, etc.). • Check the other diagnostic messages with a very similar time stamp.
		Main module: 0x002AC006	Incompatible input data from the expansion module: • A dual-channel input at an FX3-XTIO or FX3-XTDI module has two signal dips (High to Low) within 2 s (e.g., test gaps of an OSSD output or bouncing relay contacts). • A signal input at an FX3-XTIO or FX3-XTDI module changes its state in 4 ms intervals during a period of 40 ms or more (e.g., proximity switch at a gear wheel).	• To reset the error, reset the voltage at the main module. • Change the configuration by activating the on-off filter and the on-off filter for the inputs of the FX3-XTIO or FX3-XTDI module concerned. Please note that this extends the response time for this signal by at least 8 ms.

LED display on the module		Possible error codes	Possible causes	Possible measures
Main module FX3-CPUx	Expansion module [1]			
MS = ● red or ☼ red (2 Hz) (continued)	MS = ● red or ☼ red (2 Hz) (continued)	FX3-XTIO/-XTDI: 0xC306 Main module: 0x0029C006	• Internal hardware in FX3-XTIO or FX3-XTDI module • Consequential error on main module: 0x0029C006	• To reset the error, reset the voltage at the main module. • Replace the FX3-XTIO or FX3-XTDI module in the hardware installation.
		FX3-XTIO/-XTDI: 0xC307 Main module: 0x0029C006	• Power supply at terminal A2 (GND) of the FX3-XTIO module interrupted • Internal hardware in FX3-XTIO or FX3-XTDI module • Consequential error on main module: 0x0029C006	• Check the supply voltage at terminals A1 (24 V) and A2 (GND) on the FX3-XTIO module, including under worst-case conditions. • To reset the error, reset the voltage at the main module. • If the error persists, replace the FX3-XTIO or FX3-XTDI module in the hardware installation.
		FX3-XTIO/-XTDI: 0xC307 Main module: 0x0029C006	• Short-circuit to 24 V or cross-circuit in the wiring of the safe output Q1 to Q4 (associated LED is flashing) • Capacitive load exceeds permissible maximum value (e.g., due to spark quenching capacitor). • Inductive load exceeds permissible maximum value. • Internal hardware in FX3-XTIO module • Consequential error on main module: 0x0029C006	• Check the wiring of the affected output. • Check the capacitive load. • Check the inductive load. • To reset the error, reset the voltage at the main module. • If the error persists, replace the FX3-XTIO module in the hardware installation.

LED display on the module		Possible error codes	Possible causes	Possible measures
Main module FX3-CPUx	Expansion module [1]			
MS = ● green	All expansion modules: MS = ● green	Main module: 0x000A0011	• Function block error during dual-channel input evaluation (e.g., emergency stop, solenoid switch): discrepancy error at input pair 1 of the function block • Cable break or short-circuit to GND at one of the two input signals of the input pair • Sensor hardware error (e.g., is one of the two contacts/outputs permanently closed (High) or open (Low)). • Defective sensor (one of the two signals is not switching to a state corresponding to the other input within the configured discrepancy time). • The safety door opened or closed too slowly; as a result, both contact switches (e.g., reed contacts) did not switch within the configured discrepancy time.	• Check the wiring of the affected input and check the switching capacity of the two contacts/outputs of the connected sensor. • Check the mechanical dependence of the two switches. • Replace the switch/sensor in the hardware installation. To reset the error, the affected input pair must switch from Low/Low to High/High in the case of equivalent dual-channel inputs and from Low/High to High/Low in the case of complementary dual-channel inputs within the configured discrepancy time.
		Main module 0x00100011	• Function block error (external device monitoring or valve monitoring): The feedback signal was not sent in response to the control signal within the maximum feedback delay time. • Hardware error affecting the connected relay/valve or error in the wiring • The relay/valve used has a longer switching delay at the monitoring contact.	• Increase the maximum feedback delay time for the function block if this is compatible with your application. • Replace the relay/valve in the hardware installation.

LED display on the module		Possible error codes	Possible causes	Possible measures
Main module FX3-CPUx	Expansion module [1]			
All LEDs briefly off, then LED test sequence	All LEDs briefly off, then LED test sequence	Main module: 0x002D4006	• The power supply to the main module was affected by a brief voltage dip (almost to 0 V). • The voltage of the voltage supply to the main module dropped (to between approx. 6 V and 16 V) and then rose back into the operating range.	• Ensure that the power supply unit is able to jumper an interruption in the power supply lasting up to 20 ms. • Ensure that the power supply unit is able to operate the load so that load switching cannot cause the voltage to drop. • Check the wiring of the power supply to the main module. Use separate cables to other heavy loads in order to avoid a voltage dip on the supply cable caused by other load currents.
		Main module: 0x003E4006	The system has performed a restart due to faults occurring on the FLEXBUS+: • FLEXBUS+ communication (backplane bus communication with I/O modules and gateways) faulty due to electromagnetic interference • FLEXBUS+ communication (backplane bus communication with I/O modules and gateways) faulty due to a serious error in an expansion module (I/O module or gateway). This is a consequential error and there are other messages relating to serious errors with a very similar time stamp (±1 s) in the diagnostic history.	• Check the system with regard to electromagnetic interference (FE connection for DIN mounting rail and control cabinet, star wiring of the power supply (24 V and GND), local isolation of load and control elements, etc.). • Check the other diagnostic messages with a very similar time stamp.

1) FX3-XTIO, FX3-XTDI, FX3-XTDS, FX0-STIO, FX3-ANA0, and FX3-MOCx.

10.4 Error history

The diagnostic function of the configuration software allows you to read out the fault history from the Flexi Soft system and to print or store this in the report as a PDF file. For detailed information, see the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions.

10.5 SICK support

If you cannot remedy an error with the help of the information in the relevant Flexi Soft operating instructions, please contact your SICK subsidiary.

11 Decommissioning

11.1 Disassembling the modules

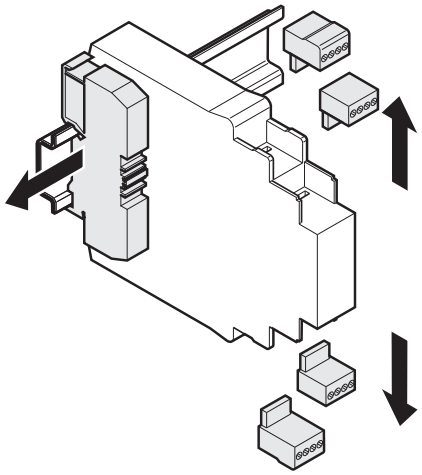


Figure 58: Detaching the plug-in terminals

- ▶ Remove the plug-in terminals along with the wiring and the end pieces.

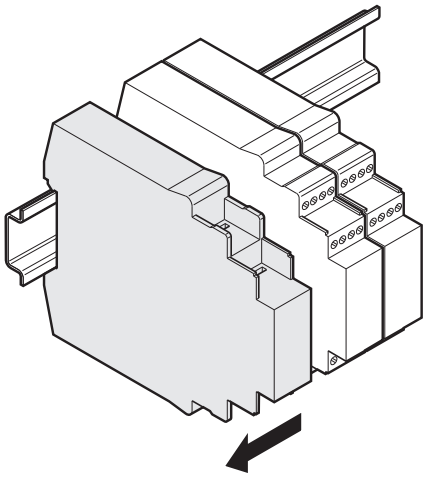


Figure 59: Disconnecting the plug connector

- ▶ Slide the modules apart one by one in the direction of the arrow until the side-mounted plug connector is disconnected.

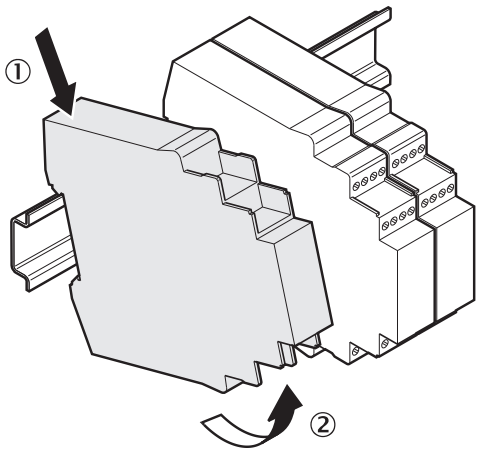


Figure 60: Removing the modules from the DIN mounting rail

- Push the module down at the back (①). With the module still pushed down, move it in the direction of the arrow to remove it from the DIN mounting rail (②).

NOTE
To mount and remove the encoder/motor feedback connection boxes, see the mounting instructions for the encoder/motor feedback connection boxes at www.sick.com.

11.2 Disposal

Always dispose of unusable or irreparable devices in accordance with the applicable waste disposal regulations specific to your country (e.g., European waste disposal code 16 02 14).

NOTE
We will be glad to help you dispose of these devices on request.

11.3 Separation of materials

CAUTION
Improper handling
There is a risk of injury in the event of improper material separation.

- Ensure that the materials are only be separated by qualified safety personnel.
- Care must be taken when separating materials.

Before disposing of the devices via an environmentally friendly recycling process, the different materials in the Flexi Soft safety controller must be separated from each other.

- Separate the housing from the remaining components (particularly from the PCB).
- Add the separated components to the respective recycling section.

Table 93: Overview of component disposal

Components	Disposal
Housing	Plastics recycling
Printed circuit boards, cables, male connectors, and electrical connectors	Electronics recycling
Packaging	Paper/cardboard recycling

12 Technical data

12.1 Minimum switch-off time

The minimum switch-off this (e.g. of the connected sensors) is the minimum time during which a switch-off condition must be present to be recognized by the Flexi Soft system.

The minimum switch-off time must correspond to the following requirements:

- It must be greater than the logic execution time +1 ms.
  And:
- When connected to the device via a Flexi Soft test output, it must be greater than the test gap + the maximum OFF-ON delay, when the test gap is > 1 ms.
  And:
- It must be greater than the test period (i.e. the higher value of the two test outputs used) + the maximum OFF-ON delay if safety mats or bumpers are used. [11)]

The minimum switch-off time of the sensors is usually listed in the technical data for the sensors.

12.2 Maximum response time of the Flexi Soft system

All paths must be taken into account when calculating the response times in a Flexi Soft system.

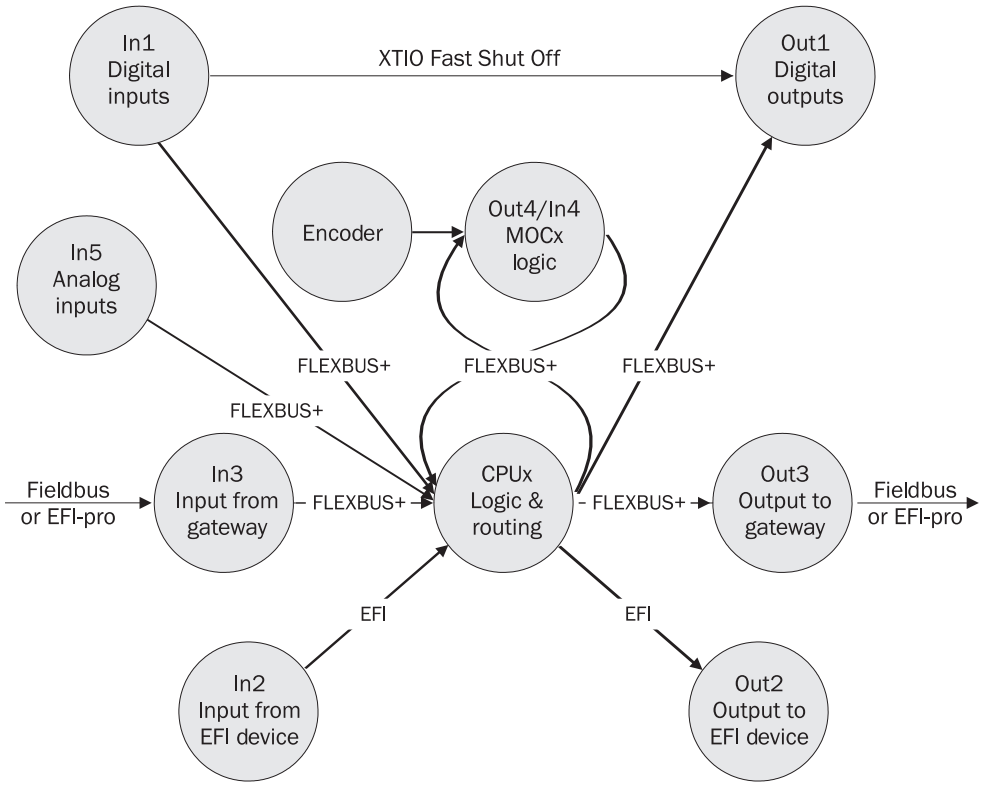


Figure 61: Response times within a Flexi Soft system

Fast shut-off

The fast shut-off function is supported on FX3-XTIO I/O modules. This function enables a response time of 8 ms to be achieved.

11) Take the values from the report in the configuration software.

NOTE
The Fast Shut Off function only has an effect on the inputs and outputs of the same FX3-XTIO I/O module.

Flexi Link

In a Flexi Link system, the response time is extended for a remote input when compared to a local input by **4.5 ms +2 × logic execution time** of the Flexi Link system on which the remote input is located.

Flexi Line

If the input is to a far-away station, the response time in a Flexi Line system is extended by

- the input time of the remote station (see table 95, page 128 to see table 102, page 131),
- the logic response time of the station that processes this input (see table 94, page 128: point 2.a)

and

- N × (10 ms + 2 × send cycle time)
  where N = the number of connection paths between the stations.

Using the Flexi Line solution within a station increases the response time by one logic execution time of this station.

Optimization of logic execution time

Flexi Soft main modules with firmware ≥ V4.00.0 have firmware optimizations which can affect the logic execution time. For compatibility with older models, these optimizations can be activated and/or deactivated by the user.

To benefit from the improved performance of this firmware, select **Logic execution time optimization** option in Flexi Soft Designer and deactivate any functions that are not being used (Flexi Line, Flexi Loop, EFI including Flexi Link).

NOTE
The **Optimization of the logic execution time** is always activated in the Safety Designer. Flexi Soft main modules with firmware < V4.00.0 are not supported by Safety Designer.

When optimization is activated, the logic program is executed more quickly in the main module. This can reduce the logic execution time. In complex applications in particular, this reduces the processing time and thus also the response time.

NOTE
The minimum logic execution time of a Flexi Soft system is always 4 ms. It cannot be reduced further by means of optimization.

Changes to the logic execution time can mean that changes have to be made to the configuration of the function blocks that are based on the logic execution time.

In order to be able to use the optimization of the logic execution time, you need an FX3-CPUx main module with firmware ≥ V4.00.0 (Step 4.xx) and the Flexi Soft Designer version ≥ V1.7.1.

More information on optimizing the logic execution time can be found in the “Flexi Soft in the Flexi Soft Designer Configuration Software” operating instructions.

12.2.1 Calculation of the response time

The following table can be used to calculate the response time of associated paths within the Flexi Soft system.

Table 94: Calculation of the maximum response time of the Flexi Soft system in milliseconds

1. Inputs	Response time of the input under consideration on the signal path	E1 or E2 or E3 or E4 or E5 (see corresponding table)	
2. Logic	a) Response time of the logic of the main module (FX3-CPUx logic)	2 × logic execution time [1]	
		Delay with logic application [2] (e.g., switch-on delay or switch-off delay function block)	
	b) Response time for routing (only affects A3 output to gateway)	No delay	0 ms
	c) Response time of the fast shut-off logic (only applicable for FX3-XTIO modules)	No delay	0 ms
3. Outputs	Response time of the output under consideration on the signal path	A1 or A2 or A3 or A4 (see corresponding table)	
Total response time			

1) Take values from the configuration software report.
2) Time values have a tolerance of 10 ms in addition to the logic execution time; i.e., 10 ms must be added to each selected value in order to calculate the response time. For example, in the case of a switch-off delay of 10 ms and a logic execution time of 12 ms, 32 ms must be used for the calculation.

Digital inputs (E1)

Table 95: Calculation of the response time for the digital inputs (E1) in milliseconds

General information	Sensor response time [1]	
General information	Input processing time	6.5 ms
If on/off filter active	+ min. filter time [2]	
If I1 … I8 connected to test input X1 … X8	+ max. OFF-ON delay [3] of the test output used	
a) Pressure-sensitive safety mats and bumpers	+ test period [3] of the test output; use higher value of the two test outputs	
b) Type 4 testable sensors (e.g., L41)	+ test period [3] of the test output	
c) All other sensors	+ test gap [3] of the test output (if test gap [3] > 1 ms)	
Total E1		

1) Take value from the corresponding operating instructions.
2) Switching off is delayed until the signal has been at Low for at least the selected filter time. For FX3-XTIO and FX3-XTDI firmware version < V3.00.0, the filter time is set to a fixed value of 8 ms.
3) Take values from the configuration software report.

Digital outputs (A1)

Table 96: Calculation of the response time for the digital outputs (A1) in milliseconds

General information	Response time of the actuator [1]	
General information	Output processing time a) From the logic (via FLEXBUS+): + 4.5 ms b) From fast shut-off: + 1.5 ms	
If you are using single-channel outputs	Potential switch-off delay in the event of an internal error, depending on whether an extended error detection time has been configured for the switching of capacitive loads: +10 ms or +50 ms [2]	
Total A1		

1) Take value from the corresponding operating instructions.
2) see "Extended error detection time for cross-circuits at outputs Q1 to Q4 on the FX3-XTIO for the switching of increased capacitive loads", page 26 and see "Fault detection time and fault response time when using single-channel outputs on the FX3-XTIO", page 27.

Input from an EFI-enabled device (E2)

Table 97: Calculation of the response time for the input from an EFI-capable device (E2) in milliseconds

If EFI functions are used via EFI-enabled devices	Response time of the EFI data source (usually a sensor) for external OSSDs via EFI [1] or remote Flexi Link station	
Constant:		
a) Scanner (e.g., S3000)	+ 3.5 ms	
b) Light curtain (e.g., C4000)	+ 1.5 ms	
c) Flexi Link	+ 0.5 ms	
Total E2		

1) Take value from the corresponding operating instructions.

Output to an EFI-enabled device (A2)

Table 98: Calculation of the response time for the output to an EFI-capable device (A2) in milliseconds

If EFI functions are used via EFI-enabled devices	Response time of the EFI data recipient (e.g., scanner with protective field switching via EFI) [1]	
Constant:	EFI cycle time of the EFI data receiver[1]	
a) Scanner (e.g., S3000)	+ 24 ms	
b) Light curtain (e.g., C4000)	+ 4 ms	
c) Flexi Link	+ 4 ms	
Total A2		

1) Take value from the corresponding operating instructions.

Input from a gateway (E3)

Table 99: Calculation of the response time for the input from a gateway (E3) in milliseconds

General information	Fieldbus response time for data to gateway (e.g., from PLC) [1]	
General information	2 × internal update interval for data from the gateway to the main module [2]	
a) EtherCAT gateway	– 3 ms	
b) Other gateway	+ 5 ms	
Deduction when using a second gateway	– 4 ms	
Total E3		

1) Take value from the corresponding operating instructions.
2) The update interval between the main module and a Flexi Soft gateway depends on the quantity of the data to be transmitted and the number of gateways in the system. Take the values from the report in the configuration software.
The update interval is a multiple of 4 ms for every 10 bytes to be transmitted in or out of the gateway if the system only contains one gateway. When two gateways are used, the update interval is a multiple of 8 ms.

Output to a gateway (A3)

Table 100: Calculation of the response time for the output to gateway (A3) in milliseconds

General information	Fieldbus response time for data from the gateway (e.g., to the PLC) [1]	
General information	2 × internal update interval for data from the main module to the gateway [2]	
a) EtherCAT gateway	0 ms	
b) Other gateway	+ 8 ms	
Deduction when using a second gateway	– 4 ms	
Total A3		

1) Take value from the corresponding operating instructions.
2) The update interval between the main module and a Flexi Soft gateway depends on the quantity of the data to be transmitted and the number of gateways in the system. Take the values from the report in the configuration software.
The update interval is a multiple of 4 ms for every 10 bytes to be transmitted in or out of the gateway if the system only contains one gateway. When two gateways are used, the update interval is a multiple of 8 ms.

Input from an FX3-MOCx (E4)

Table 101: Calculation of the response time for the input from an FX3-MOCx (E4) in milliseconds

General information	FX3-MOCx logic to FX3-CPUx logic	0 ms
Encoder to FX3-MOCx logic		
a) A/B incremental encoder, sine-cosine encoder (speed value and direction status) [1]	8 ms	
b) A/B incremental encoder, sine-cosine encoder (position value)	6 ms	
c) SSI master (speed value and direction status)	Max. 4 ms + 1.5 × max. data reception interval [1] [2]	
d) SSI master (position value)	Max. 4 ms + max. data reception interval [2]	

e) SSI listener (speed value and direction status)	Max. 9 ms + 1.5 × max. data reception interval [1] [2]	
f) SSI listener (position value)	Max. 9 ms + max. data reception interval [2]	
Error detection times		
a) Sine-cosine analog voltage monitoring, vector length monitoring	22 ms	
b) Sine-cosine analog voltage monitoring, signal deviation monitoring	6 ms + 1 sine-cosine period, but min. 10 ms	
c) Error detection time for ID code monitoring with FX3-EBX1, FX3-EBX3, or FX3-EBX4 encoder/motor feedback connection box [3]	10 ms	
Total E4		

1 Since the speed is calculated from the position difference between two detected position values, the speed value is an average of the actual speed within the time interval for position detection. In the case of an assumed linear speed change, the response time for the speed value is therefore greater than the response time for the position value by ½ the time interval for position detection. In the case of A/B incremental encoders and sine-cosine encoders, the time interval for position detection is 4 ms; for SSI encoders it is the selected maximum data reception interval, in a worst-case scenario.

2 This is the selected value in the dialog box for the SSI encoder. Take the value from the configuration software report.

3 See “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions, “Encoder connection type and monitoring of ID identifier” section.

Output to an FX3-MOCx (A4)

Table 102: Calculation of the response time for the output to an FX3-MOCx (A4) in milliseconds

General information	FX3-CPUx logic to FX3-MOCx logic	4 ms
Total A4		**4 ms**

Analog inputs (E5)

Table 103: Calculation of the response time for the analog inputs (E5) in milliseconds

Generally	Sensor response time [1)]	
Generally	Processing time	20 ms
Generally	Measurement cycle	4 ms
If more than 1 cycle with average value filter	(Number of cycles – 1) × measurement cycle	
If sensor AI1 delayed	+ delay for sensor AI1	
E5 total		

1) Take value from the corresponding operating instructions.

12.2.1.1 Example 1: Calculation of the response time for a Flexi Soft system consisting of an FX3-CPU1 and an FX3-XTIO

Digital inputs (E1):	C4000 safety light curtain at FX3-XTIO (e.g., at I5/I6)
Digital outputs (A1):	Robot, dual-channel, at FX3-XTIO (e.g., at Q3/Q4)
Input of EFI-enabled device (E2):	C4000 receiver (stand-alone) at FX3-CPU1 (e.g., at EFI1_A)

Two paths must be considered and calculated separately:

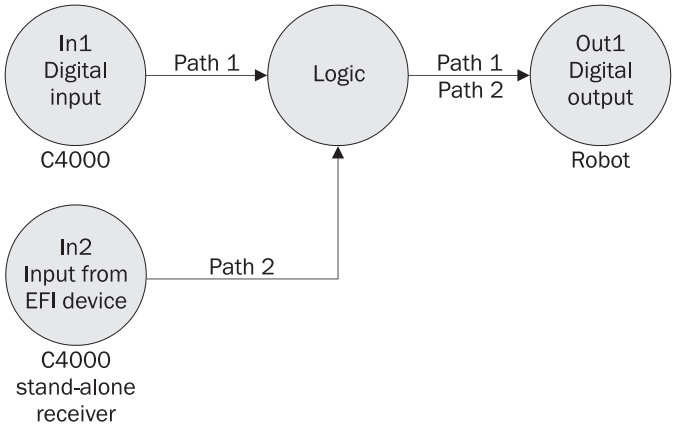


Figure 62: Response times within a Flexi Soft system

Digital inputs (E1)

Table 104: Example for the calculation of the response time for the digital inputs (E1)

General information	C4000 response time	14.0 ms
General information	Input processing time	6.5 ms
If on-off filter active	+ min. filter time [1]	–
If I1 ... I8 connected to test input X1 ... X8	+ max. OFF-ON delay [2] of the test input used	–
a) Pressure-sensitive safety mats and bumpers	+ test period [2] of the test output, higher value of the two test outputs	–
b) Type 4 testable sensors (e.g., L41)	+ test period [2] of the test output	–
c) All other sensors	+ test gap [2] of the test output (if test gap [2] > 1 ms)	–
If you are using single-channel outputs		–
Total E1		**20.5 ms**

1) Switching off is delayed until the signal has been at Low for at least the selected filter time. For FX3-XTIO and FX3-XTDI firmware version < V3.00.0, the filter time is set to a fixed value of 8 ms.
2) Take the values from the report in the configuration software.

Digital outputs (A1) on path 1

Table 105: Example for the calculation of the response time for the digital outputs (A1) on path 1

General information	Robot response time	40.0 ms
General information	Output processing time	4.5 ms
If you are using single-channel outputs	Potential switch-off delay in the event of an internal error, depending on whether an extended error detection time has been configured for the switching of capacitive loads: +10 ms or +50 ms [1]	–
Total A1		**44.5 ms**

1) see "Extended error detection time for cross-circuits at outputs Q1 to Q4 on the FX3-XTIO for the switching of increased capacitive loads", page 26 and see "Fault detection time and fault response time when using single-channel outputs on the FX3-XTIO", page 27.

Response time of path 1

Table 106: Example for the calculation of the response time of path 1 of a Flexi Soft system

1. Inputs	Response time of the input under consideration on path 1	E1	20.5 ms
2. Logic	Logic response time	2 × logic execution time	8.0 ms
		Delay due to logic application	–
3. Outputs	Response time of the output under consideration on path 1	A1	44.5 ms
Total response time of path 1			**73.0 ms**

Input from an EFI-enabled device (E2)

Table 107: Example for the calculation of the response time for the input from an EFI-enabled device (E2)

If EFI functions are used via EFI-enabled devices	Response time of the EFI data source (C4000 receiver (stand-alone))	12.0 ms
	Constant (C4000)	1.5 ms
Total E2		**13.5 ms**

Digital outputs (A1) on path 2

Table 108: Example for the calculation of the response time for the digital outputs (A1) on path 2

General information	Robot response time	40.0 ms
General information	Output processing time	4.5 ms
Total A1		**44.5 ms**

Response time of path 2

Table 109: Example for the calculation of the response time of path 2 of a Flexi Soft system

1. Inputs	Response time of the input under consideration on path 2	E2	13.5 ms
2. Logic	Logic response time	2 × logic execution time	8.0 ms
		Delay due to logic application	–
3. Outputs	Response time of the output under consideration on path 2	A1	44.5 ms
Total response time of path 2			**66.0 ms**

12.2.1.2 Example 2: Calculation of the response time for a Flexi Link system

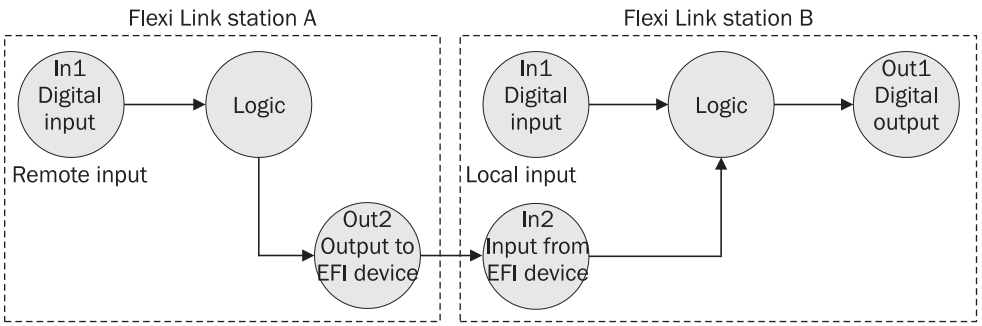


Figure 63: Response times within a Flexi Link system

Flexi Link station A

Logic execution time = 4 ms

Flexi Link station B

Logic execution time = 8 ms

Digital inputs (E1) from station A

Table 110: Example for the calculation of the response time for the digital inputs (E1) from station A

General information	Tactile sensor	0 ms
General information	Input processing time	6.5 ms
If on-off filter active	+ min. filter time [1]	–
If I1 ... I8 connected to test input X1 ... X8		–
Total E1		**6.5 ms**

1) Switching off is delayed until the signal has been at Low for at least the selected filter time. For FX3-XTIO and FX3-XTDI firmware version < V3.00.0, the filter time is set to a fixed value of 8 ms.

Output to an EFI-enabled device (A2) from station A

Table 111: Example for the calculation of the response time for the output to an EFI-enabled device (A2) from station A

If EFI functions are used via EFI-enabled devices	Response time of the EFI data recipient (see corresponding table for Flexi Link station B)	–
	Constant (Flexi Link)	4 ms
Total A2		**4 ms**

1) Switching off is delayed until the signal has been at Low for at least the selected filter time. For FX3-XTIO and FX3-XTDI firmware version < V3.00.0, the filter time is set to a fixed value of 8 ms.

Total response time of station A

Table 112: Example for the calculation of the total response time of station A (from remote input to EFI) in a Flexi Link system

1. Inputs	Response time of the input under consideration on the signal path	E1	6.5 ms
2. Logic	Logic response time	2 × logic execution time	8.0 ms
		Delay due to logic application	–
3. Outputs	Response time of the output under consideration on the signal path	A2	4.0 ms
Total response time (from remote input to EFI) of station A			**18.5 ms**

Input from an EFI-enabled device (E2) from station B

Table 113: Example for the calculation of the response time for the input from an EFI-enabled device (E2) from station B

If EFI functions are used via EFI-enabled devices	Response time of the EFI data source (see corresponding table for Flexi Link station A)	18.5 ms
	Constant (Flexi Link)	0.5 ms
Total E2		**19.0 ms**

Digital outputs (A1) from station B

Table 114: Example for the calculation of the response time for the digital inputs (E1) from station B

General information	Response time of the actuator	40.0 ms
General information	Output processing time	4.5 ms
Total A1		**44.5 ms**

Total response time of station B

Table 115: Example for the calculation of the total response time of station B (remote input to local output) in a Flexi Link system

1. Inputs	Response time of the input under consideration on the signal path	E2	19.0 ms
2. Logic	Logic response time	2 × logic execution time	16.0 ms
		Delay due to logic application	–
3. Outputs	Response time of the output under consideration on the signal path	A1	44.5 ms
Total response time (remote input to local output) of station B			**79.5 ms**

12.3 Data sheet

12.3.1 Main modules FX3-CPU0, FX3-CPU1, FX3-CPU2, and FX3-CPU3

Safety technology parameters FX3-CPUx

NOTE
The data for the safety technology parameters is based on an ambient temperature of +40 °C (the temperature usually used for the static calculation of the values).

Table 116: Safety technology parameters FX3-CPU0, FX3-CPU1, FX3-CPU2, and FX3-CPU3

	FX3-CPU0	FX3-CPU1/2/3
Safety integrity level	SIL3 (IEC 61508)	
SIL claim limit	SILCL3 (EN 62061)	
Category	Category 4 (EN ISO 13849-1)	
Performance level	PL e (EN ISO 13849-1)	
PFH_D	1.07×10^{-9}	1.69×10^{-9}
PFH_D for Flexi Line station	–	0.40×10^{-9}
PFD_{avg}	5×10^{-5}	
PFD_{avg} for Flexi Line station [1]	–	5×10^{-5}
T_M (mission time)	20 years (EN ISO 13849-1)	

1) Valid for a FX3-CPU3 main module which is only used for the transfer of information via Flexi Line.

General data FX3-CPUx

Table 117: General data FX3-CPU0, FX3-CPU1, FX3-CPU2, and FX3-CPU3

	FX3-CPU0	FX3-CPU1/2/3
Conformity/approvals	CE, cULus, CCC, EAC	
Protection class	III (EN 61140)	

	FX3-CPU0	FX3-CPU1/2/3
Enclosure rating	IP 20 (EN 60529)	
Ambient operating temperature (UL/CSA: surrounding air temperature)	–25 ... +55 °C	
Storage temperature	–25 ... +70 °C	
Air humidity	10 ... 95%, non-condensing	
Operating altitude	Max. 2,000 m above sea level (80 kPa)	
Vibration resistance	5–150 Hz/1 G (EN 60068-2-6) 10–500 Hz/3 G_{rms} (EN 60068-2-64)	
Shock resistance		
Continuous shock	15 g, 11 ms (EN 60068-2-27)	
Single shock	30 g, 11 ms (EN 60068-2-27)	
Interference immunity	EN 61000-6-2	
Radiated emission	EN 61000-6-4	
Number of EFI interfaces	0	2
Number of Flexi Line interfaces	0	FX3-CPU1/2: 0 FX3-CPU3: 1
Data interface	Internal bus (FLEXBUS+)	
Configuration interface	RS-232	FX3-CPU1/2: RS-232 FX3-CPU3: RS-232, USB
RS-232 connectivity	M8, 4-pin	
USB connectivity	–	FX3-CPU1/2: – FX3-CPU3: USB Mini-B, 5-pin
EFI and Flexi Line connectivity	–	Dual level spring terminals
EFI and Flexi Line wire cross-section	–	Single-wire or fine-wire: 0.2 ... 1.5 mm^2 Stranded wire with ferrule: a) With plastic ferrule max. 0.75 mm^2 b) With plastic ferrule max. 1.5 mm^2 AWG to UL/CUL: 24 ... 16
Dimensions (W × H × D)	22.5 × 96.5 × 120.6 mm	
Weight	111 g (±5%)	FX3-CPU1/2: 119 g (±5%) FX3-CPU3: 133 g (±5%)

Power supply unit (A1, A2) for FX3-CPUx via system plug

Table 118: Power supply unit (A1, A2) for FX3-CPU0, FX3-CPU1, FX3-CPU2, and FX3-CPU3 (via FX3-MPL0 or FX3-MPL1 system plug)

	FX3-CPU0/1/2/3
Supply voltage	24 V DC (16.8 ... 24 ... 30 V DC)
Supply voltage UL/CSA applications	24 V DC
Type of supply voltage	PELV or SELV The supply current for the module must be limited externally to max. 4 A – either by the power supply unit used or using a fuse.
Short-circuit protection	4 A gG (with tripping characteristics B or C)
Overvoltage category	II (EN 61131-2)
Power consumption	Max. 2.5 W
Power-up delay	Max. 18 s
Connectivity	Screw terminals
Wire cross-section	Single-wire or stranded: 0.14 ... 2.5 mm^2 AWG to UL/CUL: 26 ... 14

12.3.2 FX3-XTIO I/O module

Safety technology parameters FX3-XTIO

NOTE

The data for the safety technology parameters is based on an ambient temperature of +40 °C (the temperature usually used for the static calculation of the values).

Table 119: Safety technology parameters FX3-XTIO

	FX3-XTIO
Safety integrity level	SIL3 (IEC 61508)
SIL claim limit	SILCL3 (EN 62061)
Category	
For single-channel outputs with activated test signals at all safe outputs (Q1 ... Q4)	Category 4 (EN ISO 13849-1)
For single-channel outputs with deactivated test signals at this or any other safe output (Q1 ... Q4)	Category 3 (EN ISO 13849-1)
For dual-channel outputs with or without deactivated test signals at this or any other safe output (Q1 ... Q4)	Category 4 (EN ISO 13849-1)
Performance level	PL e (EN ISO 13849-1)
PFH_D	
For single-channel outputs	4.8×10^{-9}
For dual-channel outputs	0.9×10^{-9}
PFD_{avg} [1]	
For single-channel outputs	4.2×10^{-4}
For dual-channel outputs	5×10^{-5}
T_M (mission time)	20 years (EN ISO 13849-1)

1) Valid for single-channel and dual-channel inputs.
2) If single-channel outputs are being used: Use protected or separate cabling for these safe outputs, because although a short-circuit to 24 V can be detected, no other option is available for switching off.
3) If safe outputs without test signals are being used, at least once a year either all safe outputs with test signals must be switched off at the same time for at least one second or the Flexi Soft system must be restarted by switching off the voltage supply.
4) If safe outputs without test signals are being used: Use protected or separate cabling for the safe outputs whose test signals are deactivated, because a short-circuit to 24 V cannot be detected if the safe output is High. In the event of an internal hardware error being detected, the ability of the other safe outputs to shut down could be impaired by reverse current.

General data for the FX3-XTIO

Table 120: General data for the FX3-XTIO

	FX3-XTIO
Conformity/approvals	CE, cULus, CCC, EAC
Protection class	III (EN 61140)
Enclosure rating	IP 20 (EN 60529)
Ambient operating temperature (UL/CSA: surrounding air temperature)	–25 ... +55 °C
Storage temperature	–25 ... +70 °C
Air humidity	10 ... 95%, non-condensing
Operating altitude	Max. 2,000 m above sea level (80 kPa)
Vibration resistance	5–150 Hz/1 G (EN 60068-2-6) 10–500 Hz/3 G_{rms} (EN 60068-2-64)
Shock resistance	
Continuous shock	15 g, 11 ms (EN 60068-2-27)
Single shock	30 g, 11 ms (EN 60068-2-27)
Interference immunity	EN 61000-6-2
Radiated emission	EN 61000-6-4
Connectivity	Dual level spring terminals
Wire cross-section	Single-wire or stranded: 0.2 ... 1.5 mm^2 Stranded wire with ferrule: a) With plastic ferrule max. 0.75 mm^2 b) With plastic ferrule max. 1.5 mm^2 AWG to UL/CUL: 24 ... 16
Data interface	Internal bus (FLEXBUS+)
Power consumption via FLEXBUS+, no current at X1, X2	Max. 2.2 W
Dimensions (W × H × D)	22.5 × 96.5 × 120.6 mm
Weight	164 g (±5%)

Power supply unit (A1, A2) for FX3-XTIO

Table 121: Power supply unit (A1, A2) for FX3-XTIO

	FX3-XTIO
Supply voltage	24 V DC (16.8 ... 24 ... 30 V DC)
Supply voltage UL/CSA applications	24 V DC
Type of supply voltage	PELV or SELV The supply current for the module must be limited externally to max. 4 A – either by the power supply unit used or using a fuse.
Short-circuit protection	4 A gG (with tripping characteristics B or C)
Power consumption	Maximum 120 W (30 V x 4 A) determined by the load at outputs Q1 to Q4, plus maximum 1 W power consumption through the internal circuit
Power-up delay	Max. 18 s

Safe inputs (I1 ... I8) of the FX3-XTIO

Table 122: Safe inputs (I1 ... I8) of the FX3-XTIO

	FX3-XTIO
Number of inputs	8
Input voltage High	13 ... 30 V DC
Input voltage Low	–5 ... +5 V DC
Input current High	2.4 ... 3.8 mA
Input current Low	–2.5 ... +2.1 mA
Reverse current at input in the event of the loss of a ground connection [1]	
Hardware version < V1.10 (FX3-XTIO Step 1.xx) [2]	Max. 20 mA 1.5 kΩ effective resistance of the power supply to the input
Hardware version ≥ V1.10 (FX3-XTIO Step 2.xx) [2]	Max. 2 mA
Switching current (for the connection of mechanical contacts)	14.4 mA at 5 V 3 mA at 24 V
Input pulse filter (pulses within these limits do not have any effect)	
Pulse width	Max. 0.9 ms
Pulse period	Min. 4 ms
Input capacity	Max. 10 nF + 10%
Discrepancy time	4 ms ... 30 s, configurable

1) Do not connect any other safe inputs in parallel if the reverse current could lead to a high state on the other input.

2) The hardware version of the Flexi Soft module can be found in the configuration software in the online state or in the report if the system was previously online.

Test outputs (X1, X2) of the FX3-XTIO

Table 123: Test outputs (X1, X2) of the FX3-XTIO

	FX3-XTIO
Number of outputs	2 (with 2 test signal generators)
Type of output	PNP semiconductor, short-circuit protected, cross-circuit monitored
Output voltage High	15 ... 30 V DC (max. 1.8 V dip to terminal A1 of the main module)
Output resistance Low	≤ 33 Ω + 10%, current limited at approx. 10 mA
Output current	Max. 120 mA at every test output (X1 or X2). A maximum of 8 testable sensor cascades are thus possible per module, each with up to 30 mA, maximum. The total current of the Flexi Soft system for all outputs (X1 ... X8 and XY1 ... XY2) must not exceed 1.28 A. This corresponds, for example, to a maximum of 32 testable sensor cascades each with 30 mA plus 64 tactile sensors at inputs of expansion modules, each with 5 mA.
Test signal rate (test period)	40 ... 1,000 ms, configurable
Test pulse duration (test gap)	1 ... 100 ms, configurable
Load capacity	1 µF for test gap ≥ 4 ms 0.5 µF for test gap 1 ms
Cable resistance	< 100 Ω

Safe outputs (Q1 ... Q4) of the FX3-XTIO

Table 124: Safe outputs (Q1 ... Q4) of the FX3-XTIO

	FX3-XTIO
Number of outputs	4
Type of output	PNP semiconductors, short-circuit protected
Output voltage High	16 ... 30 V DC (max. 0.8 V dip to terminal A1 of the main module)
Leakage current Low	
Normal operation	Max. 0.1 mA
Error [1], hardware version < V1.10 (FX3-XTIO Step 1.xx)	Max. 1.6 mA
Error [1], hardware version ≥ V1.10 (FX3-XTIO Step 2.xx)	Max. 2.0 mA
Output current	Max. 2.0 A
Sum current I_{sum}	
T_U ≤ 45 °C	Max. 4.0 A
T_U ≤ 55 °C	Max. 3.2 A
UL/CSA applications	Max. 3.2 A
Test pulse duration (test gap) [2]	< 650 µs or deactivated
Test signal rate (test period)	Min. 200 ms
Load capacity	≤ 0.5 µF
Cable resistance [3]	Max. 5 Ω (e.g., 100 m × 1.5 mm^2 = 1.2 Ω)
Maximum permitted coil energy without external protection elements [4]	
Hardware version V1.00	0.22 J
Hardware version ≥ V1.01	0.37 J
Response time	Dependent on logic configuration, details: see table 94, page 128
Synchronicity of outputs Qx within a Flexi Soft station (time delay)[5]	Max. 1 ms
Possible switching to High in the event of an internal hardware error	10 ms or 50 ms Details: see "Fault detection time and fault response time when using single-channel outputs on the FX3-XTIO", page 27

1) In the event of an error (interruption of the GND cable) with a minimum load resistance of 2.5 kΩ, the leakage current will flow as a maximum at the safe output. With lower load resistances, the leakage current may be higher, but in this case the output voltage is < 5 V. A downstream device such as a relay or an FPLC (fail-safe programmable logic controller), for example, must detect this state as Low.

2) When activated, the outputs are tested regularly (brief Low switching). When selecting the downstream controllers, make sure that the test pulses with the listed parameters do not result in switching off, or deactivate the test pulses at the outputs.

3) Limit the resistance of the individual cables to the downstream controller to this value to ensure that a short-circuit between the outputs is safely detected. (See also EN 60204 Electrical equipment of machines, Part 1: General requirements.)

4) Examples for the resulting maximum coil induction based on the coil current:
   - Hardware version V1.00: 1760 mH @ 0.5 A, 440 mH @ 1 A, 110 mH @ 2 A
   - Hardware version V1.01: 2960 mH @ 0.5 A, 740 mH @ 1 A, 185 mH @ 2 A

   External controllers are not required for inductive loads (e.g., contactors, relays, and valves) if this maximum coil energy is not exceeded.

RC elements parallel to the inductive load should not be used, because they form an oscillating circuit which can cause an overshoot in the positive voltage range after the induction voltage has died down, leading to a cross-circuit error. The tolerated time for the overshoot (> 3.5 V) must be observed:

- Firmware version ≤ V2.10.0: < 1 ms
- Firmware version V2.11.0: < 3 ms
- • Firmware version ≥ V3.00.0: < 3 ms or < 43 ms, if an extended error detection time has been configured for the switching of capacitive loads

An external parallel resistor can be used to reduce the overshoot if necessary.

5) This includes switching off in the event of an error: In the case of a dual-channel output, both channels switch off within this time in the event of an error.

12.3.3 FX3-XTDI I/O module

Safety technology parameters FX3-XTDI

NOTE

The data for the safety technology parameters is based on an ambient temperature of +40 °C (the temperature usually used for the static calculation of the values).

Table 125: Safety technology parameters FX3-XTDI

	FX3-XTDI
Safety integrity level	SIL3 (IEC 61508)
SIL claim limit	SILCL3 (EN 62061)
Category	Category 4 (EN ISO 13849-1)
Performance level	PL e (EN ISO 13849-1)
PFH_D	0.4×10^{-9}
PFD_{avg}	3×10^{-5}
T_M (mission time)	20 years (EN ISO 13849-1)

General data for the FX3-XTDI

Table 126: General data for the FX3-XTDI

	FX3-XTDI
Conformity/approvals	CE, cULus, CCC, EAC
Protection class	III (EN 61140)
Enclosure rating	IP 20 (EN 60529)
Ambient operating temperature (UL/CSA: surrounding air temperature)	–25 ... +55 °C
Storage temperature	–25 ... +70 °C
Air humidity	10 ... 95%, non-condensing
Operating altitude	Max. 2,000 m above sea level (80 kPa)
Vibration resistance	5–150 Hz/1 G (EN 60068-2-6) 10–500 Hz/3 G_{rms} (EN 60068-2-64)
Shock resistance	
Continuous shock	15 g, 11 ms (EN 60068-2-27)
Single shock	30 g, 11 ms (EN 60068-2-27)
Interference immunity	EN 61000-6-2
Radiated emission	EN 61000-6-4
Connectivity	Dual level spring terminals
Wire cross-section	Single-wire or stranded: 0.2 ... 1.5 mm^2 Stranded wire with ferrule: a) With plastic ferrule max. 0.75 mm^2 b) With plastic ferrule max. 1.5 mm^2 AWG to UL/CUL: 24 ... 16
Data interface	Internal bus (FLEXBUS+)
Power consumption via FLEXBUS+, no current at X1 ... X8	Max. 2 W
Dimensions (W × H × D)	22.5 × 96.5 × 120.6 mm
Weight	139 g (±5%)

Safe inputs (I1 ... I8) of the FX3-XTDI

Table 127: Safe inputs (I1 ... I8) of the FX3-XTDI

	FX3-XTDI
Number of inputs	8
Input voltage High	13 ... 30 V DC
Input voltage Low	–5 ... +5 V DC
Input current High	2.4 ... 3.8 mA
Input current Low	–2.5 ... +2.1 mA
Reverse current at input in the event of the loss of a ground connection [1]	
Hardware version < V1.10 (FX3-XTDI Step 1.xx) [2]	Max. 20 mA 1.5 kΩ effective resistance of the power supply to the input
Hardware version ≥ V1.10 (FX3-XTDI Step 2.xx) [2]	Max. 2 mA
Switching current (for the connection of mechanical contacts)	14.4 mA at 5 V 3 mA at 24 V
Input capacity	Max. 10 nF + 10%
Discrepancy time	4 ms ... 30 s, configurable

1) Do not connect any other safe inputs in parallel if the reverse current could lead to a high state on the other input.

2) The hardware version of the Flexi Soft module can be found in the configuration software in the online state or in the report if the system was previously online.

Test outputs (X1, X2) of the FX3-XTDI

Table 128: Test outputs (X1, X2) of the FX3-XTDI

	FX3-XTDI
Number of outputs	8 (with 2 test signal generators)
Type of output	PNP semiconductors, short-circuit protected, cross-circuit monitored
Output voltage High	15 ... 30 V DC (max. 1.8 V dip to terminal A1 of the main module)
Output resistance Low	≤ 33 Ω + 10%, current limited at approx. 10 mA
Output current	Max. 120 mA at each of the two test signal generators (X1/X3/X5/X7 or X2/X4/X6/X8). A maximum of 8 testable sensor cascades are thus possible per module, each with up to 30 mA, maximum. The total current of the Flexi Soft system for all outputs (X1 ... X8 and XY1 ... XY2) must not exceed 1.28 A. This corresponds, for example, to a maximum of 32 testable sensor cascades each with 30 mA plus 64 tactile sensors at inputs of expansion modules, each with 5 mA.
Test signal rate (test period)	40 ... 1,000 ms, configurable
Test pulse duration (test gap)	1 ... 100 ms, configurable
Load capacity	1 µF for test gap ≥ 4 ms 0.5 µF for test gap 1 ms
Cable resistance	< 100 Ω

12.3.4 FX3-XTDS I/O module

Safety technology parameters FX3-XTDS

NOTE

The data for the safety technology parameters is based on an ambient temperature of +40 °C (the temperature usually used for the static calculation of the values).

The safety technology parameters do not apply for outputs XY1, XY2, and Y3–Y6.

Table 129: Safety technology parameters FX3-XTDS

	FX3-XTDS
Safety integrity level	SIL3 (IEC 61508)
SIL claim limit	SILCL3 (EN 62061)
Category	Category 4 (EN ISO 13849-1)
Performance level	PL e (EN ISO 13849-1)
PFH_D	0.4×10^{-9}
PFD_{avg}	3×10^{-5}
T_M (mission time)	20 years (EN ISO 13849-1)

General data for the FX3-XTDS

Table 130: General data for the FX3-XTDS

	FX3-XTDS
Conformity/approvals	CE, cULus, CCC, EAC
Protection class	III (EN 61140)
Enclosure rating	IP 20 (EN 60529)
Ambient operating temperature (UL/CSA: surrounding air temperature)	–25 ... +55 °C
Storage temperature	–25 ... +70 °C
Air humidity	10 ... 95%, non-condensing
Operating altitude	Max. 2,000 m above sea level (80 kPa)
Vibration resistance	5–150 Hz/1 G (EN 60068-2-6) 10–500 Hz/3 G_{rms} (EN 60068-2-64)
Shock resistance	
Continuous shock	15 g, 11 ms (EN 60068-2-27)
Single shock	30 g, 11 ms (EN 60068-2-27)
Interference immunity	EN 61000-6-2
Radiated emission	EN 61000-6-4
Connectivity	Dual level spring terminals
Wire cross-section	Single-wire or stranded: 0.2 ... 1.5 mm^2 Stranded wire with ferrule: a) With plastic ferrule max. 0.75 mm^2 b) With plastic ferrule max. 1.5 mm^2 AWG to UL/CUL: 24 ... 16
Data interface	Internal bus (FLEXBUS+)
Power consumption via FLEXBUS+, no current at XY1 and XY2	Max. 1.5 W
Dimensions (W × H × D)	22.5 × 96.5 × 120.6 mm
Weight	139 g (±5%)

Power supply unit (A1, A2) for FX3-XTDS

Table 131: Power supply unit (A1, A2) for FX3-XTDS

	FX3-XTDS
Supply voltage	24 V DC (16.8 ... 24 ... 30 V DC)
Supply voltage UL/CSA applications	24 V DC
Type of supply voltage	PELV or SELV The supply current for the module must be limited externally to max. 4 A – either by the power supply unit used or using a fuse.
Short-circuit protection	4 A gG (with tripping characteristics B or C)
Power consumption	Max. 60 W (30 V × 2 A), determined by the load at outputs Y3 to Y6
Power-up delay	Max. 18 s

Safe inputs of the FX3-XTDS

Table 132: Safe inputs (I1 ... I8) of the FX3-XTDS

	FX3-XTDS
Number of inputs	8
Input voltage High	13 ... 30 V DC
Input voltage Low	–5 ... +5 V DC
Input current high	2.4 ... 3.8 mA
Input current Low	–2.5 ... +2.1 mA
Reverse current at input in the event of the loss of a ground connection [1)]	Max. 2 mA
Switching current (for the connection of mechanical contacts)	14.4 mA at 5 V 3 mA at 24 V
Input capacity	Max. 15 nF + 10%
Discrepancy time	4 ms ... 30 s, configurable

1) Do not connect any other safe inputs in parallel if the reverse current could lead to a High state at the other input.

Outputs of the FX3-XTDS as test outputs

Table 133: Outputs XY1 ... XY2 of the FX3-XTDS when used as test outputs

	FX3-XTDS
Number of outputs	2 (with 2 test signal generators)
Type of output	PNP semiconductors, short-circuit protected
Output voltage High	15 ... 30 V DC (max. 1.8 V dip to terminal A1 of the main module)
Output resistance Low	≤ 33 Ω + 10%, current limited at approx. 10 mA
Output current	Max. 120 mA at each of the two test signal generators (XY1 or XY2). A maximum of 8 testable sensor cascades are thus possible per module, each with up to 30 mA, maximum. The total current of the Flexi Soft system for all outputs (X1 ... X8 and XY1 ... XY2) must not exceed 1.28 A. This corresponds, for example, to a maximum of 32 testable sensor cascades each with 30 mA plus 64 tactile sensors at inputs of expansion modules, each with 5 mA.
Test signal rate (test period)	40 ... 1,000 ms, configurable
Test pulse duration (test gap)	1 ... 100 ms, configurable
Load capacity	1 µF for test gap ≥ 4 ms 0.5 µF for test gap 1 ms
Cable resistance	< 100 Ω

Non-safe outputs of the FX3-XTDS

Table 134: Non-safe outputs (Y3 ... Y6 plus XY1 and XY2 when used as non-safe outputs) of the FX3-XTDS

	FX3-XTDS
Number of non-safe outputs	4 (6)
Type of output	PNP semiconductors, short-circuit protected
Output voltage High	16 ... 30 V DC (max. 0.8 V dip to terminal A1 of the main module)
Leakage current Low	
Normal operation	Max. 0.1 mA
Error [1]	Max. 1.0 mA
Output current	
XY1, XY2	Max. 120 mA
Y3 ... Y6	Max. 0.5 A
Maximum permitted coil energy without external protection elements [2]	0.37 J
Response time	Dependent on logic configuration, details: see table 94, page 128

1) In the event of an error (interruption of the GND cable) with a minimum load resistance of 2.5 kΩ, the leakage current will flow as a maximum at the output. With lower load resistances, the leakage current may be higher, but in this case the output voltage is < 5 V. A downstream device such as a relay or an FPLC (fail-safe programmable logic controller), for example, must detect this state as Low.

2) Examples for the resulting maximum coil induction: 2960 mH @ 0.5 A.

12.3.5 FX0-STIO I/O module

General data for the FX0-STIO

Table 135: General data for the FX0-STIO

	FX0-STIO
Conformity/approvals	CE, cULus, CCC, EAC
Protection class	III (EN 61140)
Enclosure rating	IP 20 (EN 60529)
Ambient operating temperature (UL/CSA: surrounding air temperature)	–25 ... +55 °C
Storage temperature	–25 ... +70 °C
Air humidity	10 ... 95%, non-condensing
Operating altitude	Max. 2,000 m above sea level (80 kPa)
Vibration resistance	5–150 Hz/1 G (EN 60068-2-6) 10–500 Hz/3 G_{rms} (EN 60068-2-64)
Shock resistance	
Continuous shock	15 g, 11 ms (EN 60068-2-27)
Single shock	30 g, 11 ms (EN 60068-2-27)
Interference immunity	EN 61000-6-2
Radiated emission	EN 61000-6-4
Connectivity	Dual level spring terminals
Wire cross-section	Single-wire or stranded: 0.2 ... 1.5 mm^2 Stranded wire with ferrule: a) With plastic ferrule max. 0.75 mm^2 b) With plastic ferrule max. 1.5 mm^2 AWG to UL/CUL: 24 ... 16
Data interface	Internal bus (FLEXBUS+)
Power consumption via FLEXBUS+	Max. 1.5 W
Dimensions (W × H × D)	22.5 × 96.5 × 120.6 mm
Weight	139 g (±5%)

Power supply unit (A1, A2) for FX0-STIO

Table 136: Power supply unit (A1, A2) for FX0-STIO

	FX0-STIO
Supply voltage	24 V DC (16.8 ... 24 ... 30 V DC)
Supply voltage UL/CSA applications	24 V DC
Type of supply voltage	PELV or SELV The supply current for the module must be limited externally to max. 4 A – either by the power supply unit used or using a fuse.
Short-circuit protection	4 A gG (with tripping characteristics B or C)
Power consumption	Max. 120 W (30 V × 4 A), determined by the load at outputs Y1 to IY8
Power-up delay	Max. 18 s

Input circuit of the FX0-STIO

Table 137: Input circuit (I1 ... IY8) of the FX0-STIO

	FX0-STIO
Number of non-safe inputs	6 (8)
Input voltage High	13 ... 30 V DC
Input voltage Low	–5 ... +5 V DC
Input current High	2.4 ... 3.8 mA
Input current Low	–2.5 ... +2.1 mA
Switching current (for the connection of mechanical contacts)	14.4 mA at 5 V 3 mA at 24 V
Input capacity	Max. 15 nF + 10%
Discrepancy time	4 ms ... 30 s, configurable

Non-safe outputs of the FX0-STIO

Table 138: Non-safe outputs (Y1 ... Y6 plus IY7 and IY8) of the FX0-STIO

	FX0-STIO
Number of non-safe outputs	6 (8)
Type of output	PNP semiconductors, short-circuit protected
Output voltage High	16 ... 30 V DC (max. 0.8 V dip to terminal A1 of the main module)
Leakage current Low	
Normal operation	Max. 0.1 mA
Error [1]	Max. 1.0 mA
Output current	Max. 0.5 A
Maximum permitted coil energy without external protection elements [2]	0.37 J
Response time	Dependent on logic configuration, details: see table 94, page 128

1) In the event of an error (interruption of the GND cable) with a minimum load resistance of 2.5 kΩ, the leakage current will flow as a maximum at the output. With lower load resistances, the leakage current may be higher, but in this case the output voltage is < 5 V. A downstream device such as a relay or an FPLC (fail-safe programmable logic controller), for example, must detect this state as Low.

2) Examples for the resulting maximum coil induction: 2960 mH @ 0.5 A.

12.3.6 FX3-ANA0 analog input module

FX3-ANA0 safety-related parameters

NOTE

This data on the safety-related parameters relates to an ambient temperature of +40 °C, which is the temperature usually assumed for statistical calculation of the values.

Table 139: FX3-ANA0 safety-related parameters

	FX3-ANA0
Safety integrity level	SIL3 (IEC 61508)
SIL claim limit	SILCL3 (EN 62061)
Category	Category 4 (EN ISO 13849-1)
Performance level	PL e (EN ISO 13849-1)
PFH_D	0.166×10^{-9}
PFD_{avg}	2.5×10^{-5}
T_M (mission time)	20 years (EN ISO 13849-1)

General data for FX3-ANA0

Table 140: General data for FX3-ANA0

	FX3-ANA0
Conformity/approvals	CE, cULus, CCC, EAC
Protection class	III (EN 61140)
Enclosure rating	IP 20 (EN 60529)
Ambient operating temperature (UL/CSA: surrounding air temperature)	–25 ... +55 °C
Storage temperature	–25 ... +70 °C
Air humidity	10 ... 95%, non-condensing
Operating altitude	Max. 2,000 m above sea level (80 kPa)
Vibration resistance	5–150 Hz/1 G (EN 60068-2-6)
Shock resistance	
Single shock	15 g, 11 ms (EN 60068-2-27)
Immunity to interference	EN 61000-6-2
Emitted interference	EN 61000-6-4
Connectivity	Dual-level spring terminals
Wire cross-section	Single-wire or stranded: 0.2 ... 1.5 mm^2 Stranded wire with ferrule: a) With plastic ferrule max. 0.75 mm^2 b) Without plastic ferrule max. 1.5 mm^2 AWG to UL/CUL: 24 ... 16
Data interface	Internal bus (FLEXBUS+)
Power consumption via FLEXBUS+ without currents at AI1 and AI2	Max. 2 W
Dimensions (W × H × D)	22.5 × 96.5 × 120.6 mm
Weight	117 g (± 5%)

Analog inputs (AI1, AI2) of the FX3-ANA0

Table 141: Analog inputs (AI1, AI2) of the FX3-ANA0

	FX3-ANA0
Number of inputs	2
Type of inputs	Current
Max. input voltage	30 V DC
Max. current	30 mA
Current measuring range	4.0 ... 20.0 mA
Scan repetition time	4.0 ms [1]
Min. input range	3.5 mA [2]
Max. input range	20.5 mA [3]
Measurement resistance R_{SHUNT}	
Between 1+ and 1–	50 Ω
Between 2+ and 2–	50 Ω
Measurement accuracy	1% of the scale value (20 mA)
Insulation voltage between AI1 and AI2	0.5 kV
Transmission frequency	10.6 kHz
Digital resolution	16 bits
Value of the lowest bit	0.4 µA

1) Update rate (module cycle time) visible at the output; shorter signal pulses at the inputs may not be detected. A maximum of 32 samples are evaluated per cycle.
2) Threshold below which a sensor error is assumed. With maximum deviation of 1% (scale end value), a tolerance range of 3.3 mA to 3.7 mA applies.
3) Threshold above which a sensor error is assumed. With a maximum deviation of 1% (scale end value), a tolerance range of 20.3 mA to 20.7 mA applies.

NOTICE

Exceeding the limit values at the inputs

The device may be damaged if this is not observed.

- ▶ Observe the limit values for the inputs (30 V DC / 30 mA).
- ▶ Only use suitable sensors.

12.3.7 Drive Monitor FX3-MOC0

Safety technology parameters FX3-MOC0

NOTE

The data for the safety technology parameters is based on an ambient temperature of +40 °C (the temperature usually used for the static calculation of the values).

Table 142: Safety technology parameters FX3-MOC0

	FX3-MOC0
Safety-related parameters for axes with two encoders (any combination of sine-cosine, TTL, HTL 24 V, HTL 12 V, RS-422, SSI, same or different types)	
Safety integrity level	SIL3 (IEC 61508)
SIL claim limit	SILCL3 (EN 62061)
Category	Category 4 (EN ISO 13849-1)
Performance level	PL e (EN ISO 13849-1)
PFH_D	5×10^{-9}
PFD_{avg}	1.5×10^{-4}
Minimum movement for error detection	≥ Selected tolerance limit of the function block used for the cross-comparison; e.g., speed comparison, at least 1 × within 24 h
Safety-related parameters for axes with one sine-cosine encoder and sine-cosine analog voltage monitoring activated	
Safety integrity level	SIL2 (IEC 61508)
SIL claim limit	SILCL2 (EN 62061)
Category	Category 3 (EN ISO 13849-1)
Performance level	PL d (EN ISO 13849-1)
PFH_D	6×10^{-9}
PFD_{avg}	4×10^{-4}
Minimum movement for error detection	≥ 1 sine-cosine period, at least 1 × within 24 h
Supplementary troubleshooting measures	
For encoders with Sin/Sin_Ref and Cos/Cos_Ref	Required, see the “Limits of sine-cosine analog voltage monitoring” section of the “Flexi Soft in the Flexi Soft Designer Configuration Software” operating instructions
For encoders with Sin+/Sin– and Cos+/Cos–	Not required
General safety technology parameters	
T_M (mission time)	20 years (EN ISO 13849-1)

1) Typically, in accordance with generally accepted test principles set out by testing authorities, the requirement here is that provision must be made in the application to ensure that the unit to be monitored executes a movement at least once within 24 hours. This movement must trigger a signal change at the encoder system on the basis of which the errors to be considered are detected.
2) Sin_Ref and Cos_Ref are DC voltage, typically 2.5 V DC.
3) E.g., joint use of the encoder signals for the electronic switching of the drive system.
4) Sin– and Cos– are the inverted voltage of Sin+ and Cos+ respectively.

General data for the FX3-MOC0

Table 143: General data for the FX3-MOC0

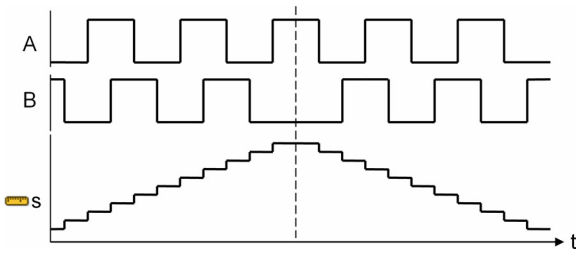
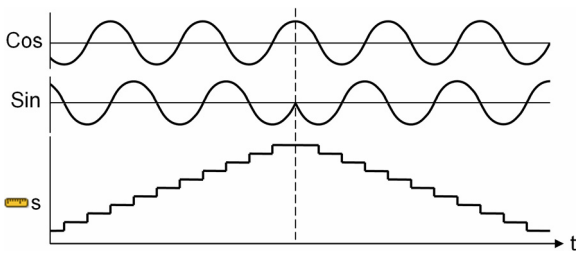
	FX3-MOC0
Conformity/approvals	CE, cULus, CCC, EAC
Protection class	III (EN 61140)
Enclosure rating	IP 20 (EN 60529)
Ambient operating temperature (UL/CSA: surrounding air temperature)	–25 ... +55 °C
Storage temperature	–25 ... +70 °C
Air humidity	10 ... 95%, non-condensing
Operating altitude	Max. 2,000 m above sea level (80 kPa)
Vibration resistance	5–150 Hz/1 G (EN 60068-2-6) 10–500 Hz/3 G_{rms} (EN 60068-2-64)
Shock resistance	
Continuous shock	15 g, 11 ms (EN 60068-2-27)
Single shock	30 g, 11 ms (EN 60068-2-27)
Interference immunity	EN 61000-6-2
Radiated emission	EN 61000-6-4
Connectivity	Micro-D-Sub male connector, 15-pin
Data interface	Internal bus (FLEXBUS+)
Power consumption via FLEXBUS+, no encoder power supply (ENC1_24V, ENC2_24V, ENC_0V)	Max. 2.5 W
Dimensions (W × H × D)	22.5 × 96.5 × 126.2 mm
Weight	120 g

Encoder connection at the FX3-MOC0

Table 144: Encoder connection at the FX3-MOC0

	Minimum	Typical	Maximum
General values (ENCx_A+, ENCx_B+, ENCx_C+, ENCx_A–, ENCx_B–, ENCx_C–, ENC_0V)			
Input resistance in the case of configuration for SSI encoders or A/B incremental encoders [1]	35 kΩ	–	–
Input resistance in the case of configuration for sine-cosine encoders [2]	0.9 kΩ	1 kΩ	1.1 kΩ
Differential resistance in the case of configuration for SSI encoders or RS-422 A/B incremental encoders [3]	100 Ω	120 Ω	150 Ω
Encoder power supply (ENC1_24V, ENC2_24V, ENC_0V)			
Voltage drop Output voltage [4]	–	–	1.8 V
Output current ENC1_24V	–	–	0.2 A sum current
Output current ENC2_24V	–	–	
Current limitation ENC1_24V	–	0.7 A	< 1 s: 1.2 A ≥ 1 s: 1.0 A
Current limitation ENC2_24V	–		
TTL, 2 outputs (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–)			

	Minimum	Typical	Maximum
Input voltage difference High [6]	2 V	5 V	5.3 V
Input voltage difference Low [6]	–0.3 V	0 V	0.8 V
Input voltage [7]	–5 V	–	10 V
TTL, 2 output pairs (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–, ENC_0V)			
Input voltage difference High [6]	1.2 V	5 V	5.6 V
Input voltage difference Low [6]	–5.6 V	–5 V	–1.2 V
Input voltage [7]	–5 V	–	10 V
HTL 24 V, 2 outputs (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–)			
Input voltage difference High [6]	13 V	24 V	30 V
Input voltage difference Low [6]	–3 V	0 V	5 V
Input voltage [7]	–10 V	–	40 V
HTL 24 V, 2 output pairs (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–, ENC_0V)			
Input voltage difference High [6]	8 V	24 V	30 V
Input voltage difference Low [6]	–30 V	–24 V	–8 V
Input voltage [7]	–10 V	–	40 V
HTL 12 V, 2 outputs (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–)			
Input voltage difference High [6]	6.5 V	12 V	15 V
Input voltage difference Low [6]	–1 V	0 V	2.5 V
Input voltage [7]	–5 V	–	20 V
HTL 12 V, 2 pairs of outputs (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–, ENC_0V)			
Input voltage difference High [6]	4 V	12 V	15 V
Input voltage difference Low [6]	–15 V	–12 V	–4 V
Input voltage [7]	–5 V	–	20 V
SSI encoders (ENCx_A+, ENCx_A–, ENCx_C+, ENCx_C–, ENC_0V)			
Input voltage difference High for Clock, if SSI listener, and Data [6]	0.2 V	–	5 V
Input voltage difference Low for Clock, if SSI listener, and Data [6]	–5 V	–	–0.2 V
Input voltage [7]	–7 V	–	7 V
Output voltage difference High for Clock, if SSI master [8]	2 V	–	–
Output voltage difference Low for Clock, if SSI master [8]	–	–	–2 V
A/B incremental encoder with HTL 24 V, HTL 12 V, TTL (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–, ENC_0V)			
Input frequency	–	–	300 kHz
Pulse duration High	1.5 µs	–	–
Pulse duration Low	1.5 µs	–	–
Edge distance A/B (phase shift)	70°	90°	110°
Accuracy error affecting speed detection [9]	Max. 5% incl. the internal resolution of the speed information		
Accuracy error affecting position detection [10]	Max. 1 increment of the internal resolution of the position information		

	Minimum	Typical	Maximum
Counting direction	 S = position information		
A/B incremental encoder with RS-422 (ENC1_A+, ENC1_A–, ENC1_C+, ENC1_C–, ENC_0V)			
Input voltage difference High [6]	0.2 V	–	5 V
Input voltage difference Low [6]	–5 V	–	–0.2 V
Input voltage [7]	–7 V	–	7 V
Output voltage difference High [8]	2 V	–	–
Output voltage difference Low [8]	–	–	–2 V
Input frequency	–	–	1 MHz
Pulse duration High	0.4 µs	–	–
Pulse duration Low	0.4 µs	–	–
Edge distance A/B (phase shift)	70°	90°	110°
Accuracy error affecting speed detection [9]	Max. 5% incl. the internal resolution of the speed information		
Accuracy error affecting position detection [10]	Max. 1 increment of the internal resolution of the position information		
Sine-cosine encoder (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–, ENC_0V)			
Input voltage difference [17]	0.8 V_{PP}	1 V_{PP}	1.2 V_{PP}
Input voltage [18]	0 V	–	5 V
Input frequency	0 Hz	–	120 kHz
Phase shift	80°	90°	100°
Sine-cosine analog voltage monitoring [19], lower limit for vector length monitoring [17]	0.5 V_{PP}	0.55 V_{PP}	–
Sine-cosine analog voltage monitoring [19], upper limit for vector length monitoring [17]	–	1.26 V_{PP}	1.5 V_{PP}
Accuracy error affecting speed detection [20]	Max. 5% incl. the internal resolution of the speed information		
Accuracy error affecting position detection [21]	Max. 1 increment of the internal resolution of the position information		
Counting direction	 S = position information		
SSI encoder (ENCx_A+, ENCx_A–, ENCx_C+, ENCx_C–, ENC_0V)			

	Minimum	Typical	Maximum
Baud rate [11] [14]	100 kHz	–	1 MHz
Clock gap between data packages (mono flop time) [12]	100 µs	–	–
Synchronization SSI Clock for SSI master between encoder 1 and encoder 2	–1 ms	–	1 ms
“Max. data reception interval” parameter tolerance [14]	–0.5 ms	–	0.5 ms
Number of position data bits [14] [13] [22]	8	–	32
Number of bits of the complete SSI protocol frame [14] [13] [23]	8	–	62
Changing the position information (speed) per max. data reception interval [14] [24]			
≤ 16 position data bits [14]	Max. ½ value range of position data bits – 1 increment		
≥ 17 position data bits [14]	Max. 65,535 increments		
Accuracy error affecting speed detection [15]	Max. 5% incl. the internal resolution of the speed information		
Accuracy error affecting position detection [16]	Max. 1 increment of the internal resolution of the position information		

WARNING

Incorrect data is output if the maximum speed is exceeded

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

The target safety-related level may not be achieved in the event of non-compliance.

- ▶ Observe maximum speed.
- ▶ Only use suitable encoders for the application.

1 Resistance between ENCx_y+/– and ENC_0V.
2 Resistance between ENCx_y+/– and ENC_0V. An input voltage of 30 V between ENCx_y+/– and ENC_0V will not damage the module, e.g., in the event of voltage limiting, if the voltage exceeds 5 V.
3 Resistance between between ENCx_y+ and ENCx_y– with series capacitor to block direct current load. An input voltage of 30 V will not damage the module.
4 Voltage between A1 of the main module and ENCx_24V at 0.2 A sum load current.
6 Voltage between ENCx_y+ and ENCx_y–.
7 Voltage between ENCx_y+ and ENC_0V as well as between ENCx_y– and ENC_0V.
8 Voltage between ENCx_y+ and ENCx_y– with a terminator of ≥ 60 Ω.
9 Plus the resolution of the speed information based on the resolution of the encoder system:
a) Rotational movement in rpm = 15,000/(4 × number of A/B periods per revolution)
b) Linear movement in mm/s = 250/(4 × number of A/B periods per revolution)
10 Plus the resolution of the position information based on the resolution of the encoder system:
1 rev./(4 × number of A/B periods per revolution).
11 Master and listener mode.
12 Time between the falling edges of the clock.
13 Without start bit. If repeat transmission is used (clock continues without clock gap so that the same data can be transmitted again), the entire stream is viewed as a frame.
14 These are parameters of the SSI encoder that can be set in Flexi Soft Designer.
15 Plus the resolution of the speed information based on the resolution of the encoder system:
a) Rotational movement in rpm = 15,000/(increments per revolution)
b) Linear movement in mm/s = 250/(increments per revolution)
16 Plus the resolution of the position information based on the resolution of the encoder system:
1 rev./(increments per revolution).
17 Peak-to-peak voltage between ENCx_y+ and ENCx_y–.
18 Voltage between ENCx_y+ and ENC_0V as well as between ENCx_y– and ENC_0V.
19 For a description of this function, refer to the “Sine-cosine analog voltage monitoring” section in the “Flexi Soft in the Flexi Soft Designer Configuration Software” operating instructions.
20 Plus the resolution of the speed information based on the resolution of the encoder system:
a) Rotational movement in rpm = 15,000/(4 x number of sine-cosine periods per revolution)
b) Linear movement in mm/s = 250/(4 × number of sine-cosine periods per revolution)
21 Plus the resolution of the position information based on the resolution of the encoder system:
1 rev./(4 x number of sine-cosine periods per revolution).

22 Firmware version ≥ V1.10.0. With earlier firmware versions 16 ... 32 bits.
23 Firmware version ≥ V1.10.0. With earlier firmware versions 16 ... 62 bits.
24 If the maximum permissible change to the position information (speed) is exceeded, then this can lead to the output of an inverted rotation direction and to a lower speed, since it results in non-recognized overflowing of the position data bits.

12.3.8 Drive Monitor FX3-MOC1

FX3-MOC1 safety-related parameters

NOTE
The data for the safety-related parameters relates to an ambient temperature of +40 °C, which is the temperature usually assumed for statistical calculation of the values.

Table 145: FX3-MOC1 safety-related parameters

	FX3-MOC1
Safety-related parameters for axes with two encoders (any combination of sine-cosine, TTL, HTL 24 V, HTL 12 V, RS-422, SSI, same or different types)	
Safety integrity level	SIL3 (IEC 61508)
SIL claim limit	SILCL3 (EN 62061)
Category	Category 4 (EN ISO 13849-1)
Performance level	PL e (EN ISO 13849-1)
PFH_D	5×10^{-9}
PFD_{avg}	1.5×10^{-4}
Minimum movement for error detection	≥ Selected tolerance limit of the function block used for the cross-comparison; e.g., position comparison, at least 1 × within 24 h
Safety-related parameters for axes with one sine-cosine encoder and sine-cosine analog voltage monitoring activated	
Safety integrity level	SIL2 (IEC 61508)
SIL claim limit	SILCL2 (EN 62061)
Category	Category 3 (EN ISO 13849-1)
Performance level	PL d (EN ISO 13849-1)
PFH_D	6×10^{-9}
PFD_{avg}	4×10^{-4}
Minimum movement for error detection	≥ 1 sine-cosine period, at least 1 × within 24 h
Supplementary error control measures	
For encoders with Sin/Sin_Ref and Cos/Cos_Ref	Required, see section “Limits of sine-cosine analog voltage monitoring” in the “Flexi Soft in the Flexi Soft Designer Configuration Software” and “Flexi Soft in the Safety Designer Configuration Software” operating instructions [1)]
For encoders with Sin+/Sin– and Cos+/Cos–	Not required
General safety-related parameters	
T_M (mission time)	20 years (EN ISO 13849-1)

1) In accordance with generally recognized testing principles, test authorities typically stipulate that the application must ensure the monitored unit performs a movement at least once within the space of 24 hours. This movement must generate a signal change on the encoder system, which can be used as a basis for detecting the relevant errors.

1) E.g., shared use of encoder signals for electronic commutation of the drive system.

2) Sin_Ref and Cos_Ref are DC voltages, typically 2.5 V DC.

4) Sin– and Cos– are the inverted voltages of Sin+ and Cos+ respectively.

General data for FX3-MOC1

Table 146: General data for FX3-MOC1

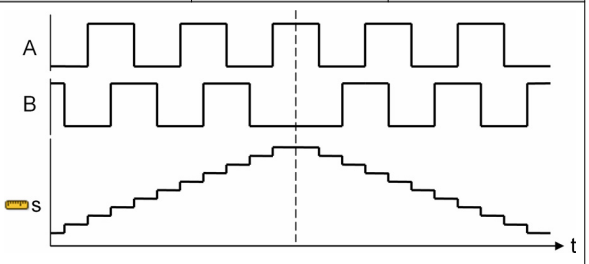
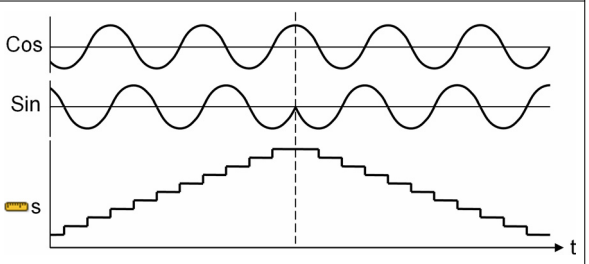
	FX3-MOC1
Conformity/approvals	CE, CCC, EAC
Protection class	III (EN 61140)
Enclosure rating	IP 20 (EN 60529)
Ambient operating temperature (UL/CSA: surrounding air temperature)	–25 ... +55 °C
Storage temperature	–25 ... +70 °C
Air humidity	10 ... 95%, non-condensing
Operating altitude	Max. 2,000 m above sea level (80 kPa)
Vibration resistance	5–150 Hz/1 G (EN 60068-2-6) 10–500 Hz/3 G_{rms} (EN 60068-2-64)
Shock resistance	
Continuous shock	15 g, 11 ms (EN 60068-2-27)
Single shock	30 g, 11 ms (EN 60068-2-27)
Immunity to interference	EN 61000-6-2
Emitted interference	EN 61000-6-4
Connectivity	Micro D-Sub male connector, 15-pin
Data interface	Internal bus (FLEXBUS+)
Power consumption via FLEXBUS+ without encoder voltage supply (ENC1_24V, ENC2_24V, ENC_0V)	Max. 2.5 W
Dimensions (W × H × D)	22.5 × 96.5 × 126.2 mm
Weight	120 g

Encoder connection at the FX3-MOC1

Table 147: Encoder connection at the FX3-MOC1

	Minimum	Typical	Maximum
General values (ENCx_A+, ENCx_B+, ENCx_C+, ENCx_A–, ENCx_B–, ENCx_C–, ENC_0V)			
Input resistance in the case of configuration for SSI encoders or A/B incremental encoders [1]	35 kΩ	–	–
Input resistance in the case of configuration for sine-cosine encoders [2]	0.9 kΩ	1 kΩ	1.1 kΩ
Differential resistance in the case of configuration for SSI encoders or RS-422 A/B incremental encoders [3]	100 Ω	120 Ω	150 Ω
Encoder voltage supply (ENC1_24V, ENC2_24V, ENC_0V)			
Voltage drop Output voltage [4]	–	–	1.8 V
Output current ENC1_24V	–	–	0.2 A sum current
Output current ENC2_24V	–	–	
Current limitation ENC1_24V	–	0.7 A	< 1 s: 1.2 A ≥ 1 s: 1.0 A
Current limitation ENC2_24V			
TTL, 2 outputs (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–)			

	Minimum	Typical	Maximum
Input voltage difference High [5]	2 V	5 V	5.3 V
Input voltage difference Low [5]	–0.3 V	0 V	0.8 V
Input voltage [6]	–5 V	–	10 V
TTL, 2 pairs of outputs (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–, ENC_0V)			
Input voltage difference High [5]	1.2 V	5 V	5.6 V
Input voltage difference Low [5]	–5.6 V	–5 V	–1.2 V
Input voltage [6]	–5 V	–	10 V
HTL 24 V, 2 outputs (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–)			
Input voltage difference High [5]	13 V	24 V	30 V
Input voltage difference Low [5]	–3 V	0 V	5 V
Input voltage [6]	–10 V	–	40 V
HTL 24 V, 2 pairs of outputs (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–, ENC_0V)			
Input voltage difference High [5]	8 V	24 V	30 V
Input voltage difference Low [5]	–30 V	–24 V	–8 V
Input voltage [6]	–10 V	–	40 V
HTL 12 V, 2 outputs (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–)			
Input voltage difference High [5]	6.5 V	12 V	15 V
Input voltage difference Low [5]	–1 V	0 V	2.5 V
Input voltage [6]	–5 V	–	20 V
HTL 12 V, 2 pairs of outputs (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–, ENC_0V)			
Input voltage difference High [5]	4 V	12 V	15 V
Input voltage difference Low [5]	–15 V	–12 V	–4 V
Input voltage [6]	–5 V	–	20 V
SSI encoder (ENCx_A+, ENCx_A–, ENCx_C+, ENCx_C–, ENC_0V)			
Input voltage difference High for Clock, if SSI listener, and Data [5]	0.2 V	–	5 V
Input voltage difference Low for Clock, if SSI listener, and Data [5]	–5 V	–	–0.2 V
Input voltage [6]	–7 V	–	7 V
Output voltage difference High for Clock, if SSI master [7]	2 V	–	–
Output voltage difference Low for Clock, if SSI master [7]	–	–	–2 V
A/B incremental encoder with HTL 24 V, HTL 12 V, TTL (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–, ENC_0V)			
Input frequency	–	–	300 kHz
Pulse duration High	1.5 µs	–	–
Pulse duration Low	1.5 µs	–	–
Edge distance A/B (phase shift)	70°	90°	110°
Accuracy error affecting speed detection [8]	Max. 5% incl. the internal resolution of the speed information		
Accuracy error affecting position detection [9]	Max. 1 increment of the internal resolution of the position information		

	Minimum	Typical	Maximum
Counting direction	 S = position information		
A/B incremental encoder with RS-422 (ENC1_A+, ENC1_A–, ENC1_C+, ENC1_C–, ENC_0V)			
Input voltage difference High [5]	0.2 V	–	5 V
Input voltage difference Low [5]	–5 V	–	–0.2 V
Input voltage [6]	–7 V	–	7 V
Output voltage difference High [7]	2 V	–	–
Output voltage difference Low [7]	–	–	–2 V
Input frequency	–	–	1 MHz
Pulse duration High	0.4 µs	–	–
Pulse duration Low	0.4 µs	–	–
Edge distance A/B (phase shift)	70°	90°	110°
Accuracy error affecting speed detection [8]	Max. 5% incl. the internal resolution of the speed information		
Accuracy error affecting position detection [9]	Max. 1 increment of the internal resolution of the position information		
Sine-cosine encoder (ENCx_A+, ENCx_A–, ENCx_B+, ENCx_B–, ENC_0V)			
Input voltage difference [10]	0.8 V_{PP}	1 V_{PP}	1.2 V_{PP}
Input voltage [11]	0 V	–	5 V
Input frequency	0 Hz	–	120 kHz
Phase shift	80°	90°	100°
Sine-cosine analog voltage monitoring [12], lower limit for vector length monitoring [10]	0.5 V_{PP}	0.55 V_{PP}	–
Sine-cosine analog voltage monitoring [12], upper limit for vector length monitoring [10]	–	1.26 V_{PP}	1.5 V_{PP}
Accuracy error affecting speed detection [13]	Max. 5% incl. the internal resolution of the speed information		
Accuracy error affecting position detection [14]	Max. 1 increment of the internal resolution of the position information		
Counting direction	 S = position information		
SSI encoder (ENCx_A+, ENCx_A–, ENCx_C+, ENCx_C–, ENC_0V)			

	Minimum	Typical	Maximum
Baud rate [15) 16)]	100 kHz	–	1 MHz
Clock gap between data packages (mono flop time) [17)]	100 µs	–	–
Synchronization SSI Clock for SSI master between encoder 1 and encoder 2	–1 ms	–	1 ms
“Max. data reception interval” parameter tolerance [16)]	–0.5 ms	–	0.5 ms
Number of position data bits [16) 18)]	8	–	32
Number of bits of the complete SSI protocol frame [16) 18)]	8	–	62
Changing the position information (speed) per max. data reception interval [16) 19)]			
≤ 16 position data bits [16)]	Max. ½ value range of position data bits – 1 increment		
≥ 17 position data bits [16)]	Max. 65,535 increments		
Accuracy error affecting speed detection [20)]	Max. 5% incl. the internal resolution of the speed information		
Accuracy error affecting position detection [21)]	Max. 1 increment of the internal resolution of the position information		

WARNING

Incorrect data is output if the maximum speed is exceeded

The dangerous state may not be stopped or not be stopped in a timely manner in the event of non-compliance.

The target safety-related level may not be achieved in the event of non-compliance.

- ▶ Observe maximum speed.
- ▶ Only use suitable encoders for the application.

1) Resistance between ENCx_y+/– and ENC_0V.
2) Resistance between ENCx_y+/– and ENC_0V. An input voltage of 30 V between ENCx_y+/– and ENC_0V will not damage the module; e.g., if the voltage exceeds 5 V in the event of voltage limiting.
3) Resistance between ENCx_y+ and ENCx_y– with series capacitor to block direct current load. An input voltage of 30 V will not damage the module.
4) Voltage between A1 of the main module and ENCx_24V at 0.2 A sum load current.
5) Voltage between ENCx_y+ and ENCx_y–.
6) Voltage between ENCx_y+ and ENC_0V and between ENCx_y– and ENC_0V.
7) Voltage between ENCx_y+ and ENCx_y– with a terminating resistance of ≥ 60 Ω.
8) Plus the resolution of the speed information based on the resolution of the encoder system:
   a) Rotational movement in rpm = 15,000/(4 × number of A/B periods per revolution)
   b) Linear movement in mm/s = 250/(4 × number of A/B periods per revolution)
9) Plus the resolution of the position information based on the resolution of the encoder system:
   1 rev./(4 × number of A/B periods per revolution).
10) Peak to peak voltage between ENCx_y+ and ENCx_y–.
11) Voltage between ENCx_y+ and ENC_0V and between ENCx_y– and ENC_0V.
12) You can find a description of this function in the “Flexi Soft in the Flexi Soft Designer Configuration Software” or “Flexi Soft in the Safety Designer Configuration Software” operating instructions in the “Sine-cosine analog voltage monitoring” section.
13) Plus the resolution of the speed information based on the resolution of the encoder system:
   a) Rotational movement in rpm = 15,000/(4 × number of sine-cosine periods per revolution)
   b) Linear movement in mm/s = 250/(4 × number of sine-cosine periods per revolution)
14) Plus the resolution of the position information based on the resolution of the encoder system:
   1 rev./(4 × number of sine-cosine periods per revolution).
15) Master mode and listener mode.
16) These are parameters of the SSI encoder that can be set using the configuration software.
17) Time between the falling edges of the clock.
18) Without start bit. If repeat transmission is being used (clock continues without gap in order to transmit the same data again), the entire stream is considered as one frame.
19) If the maximum permissible change to the position information (speed) is exceeded, then this can lead to the output of an inverted rotation direction and to a lower speed, since it results in non-recognized overflowing of the position data bits.

20) Plus the resolution of the speed information based on the resolution of the encoder system:
a) Rotational movement in rpm = 15,000/(increments per revolution)
b) Linear movement in mm/s = 250/(increments per revolution)

21) Plus the resolution of the position information based on the resolution of the encoder system:
1 rev./(increments per revolution).

12.3.9 FX3-EBX1, FX3-EBX3, and FX3-EBX4 for FX3-MOCx encoder/motor feedback connection boxes

General data for FX3-EBX1, FX3-EBX3, and FX3-EBX4 for FX3-MOCx encoder/motor feedback connection boxes

Table 148: General data for FX3-EBX1, FX3-EBX3, and FX3-EBX4 for FX3-MOCx encoder/motor feedback connection boxes

	FX3-EBX1, FX3-EBX3, and FX3-EBX4
Protection class	III (EN 61140)
Enclosure rating	IP 20 (EN 60529)
Ambient operating temperature (UL/CSA: surrounding air temperature)	–25 ... +55 °C
Storage temperature	–25 ... +70 °C
Air humidity	10 ... 95%, non-condensing
Operating altitude	Max. 2,000 m above sea level (80 kPa)
Vibration resistance	5–150 Hz/1 G (EN 60068-2-6) 10–500 Hz/3 G_{rms} (EN 60068-2-64)
Shock resistance	
Continuous shock	15 g, 11 ms (EN 60068-2-27)
Single shock	30 g, 11 ms (EN 60068-2-27)
Interference immunity	EN 61000-6-2
Radiated emission	EN 61000-6-4
Wire cross-section	Single-wire or stranded: 0.2 ... 1.5 mm^2 Stranded wire with ferrule: a) With plastic ferrule max. 0.75 mm^2 b) With plastic ferrule max. 1.5 mm^2 AWG to UL/CUL: 24 ... 16
Dimensions (W × H × D)	45 × 142.3 × 73.1 mm
Weight	
Optimized dual encoder/motor feedback connection box FX3-EBX1	119 g
Encoder/motor feedback connection box FX3-EBX3	170 g
Dual encoder/motor feedback connection box FX3-EBX4	163 g

Voltage supply for encoders from FX3-MOCx (FX3-EBX1)

The technical data in this section only applies to the following device:

- Optimized dual encoder/motor feedback connection box FX3-EBX1

Table 149: Voltage supply for encoders ENC1_24V and ENC2_24V (from FX3-MOCx)

	Minimum	Typical	Maximum
Supply voltage	24 V DC (16.8 ... 24 ... 30 V DC)		
Supply voltage UL/CSA applications	24 V DC		
Type of supply voltage	PELV or SELV The supply current for the encoder/motor feedback connection box must be limited externally to max. 1 A – either by the connection to the voltage supply at the encoder connection of the FX3-MOCx, or by the power supply unit being used, or by means of a fuse.		
Encoder voltage supply (ENC1_24V, ENC2_24V, ENC_0V)			
Voltage drop, output voltage [1]	–	–	2.5 V
Output current ENC1_24V	–	–	0.19 A sum current
Output current ENC2_24V	–	–	
Current limitation ENC1_24V	–	1.4 A	< 1 s: 2.4 A [2] ≥ 1 s: 2.0 A [2]
Current limitation ENC2_24V			

1 Voltage between A1 of the main module and ENCx_24V with 0.19 A sum load current.
2 Sum current of ENC1_24V and ENC2_24V, therefore resulting in a doubled value.

On-board voltage supply from FX3-MOCx (FX3-EBX3, FX3-EBX4)

The technical data in this section only applies to the following devices:
- Encoder/motor feedback connection box FX3-EBX3
- Dual encoder/motor feedback connection box FX3-EBX4

Table 150: On-board voltage supply U_{out} (from FX3-MOCx)

	Minimum	Typical	Maximum
Supply voltage	24 V DC (16.8 ... 24 ... 30 V DC)		
Supply voltage for UL/CSA applications	24 V DC		
Type of supply voltage	PELV or SELV The supply current for the encoder/motor feedback connection box must be limited externally to max. 1 A – either by the connection to the voltage supply at the encoder connection of the FX3-MOCx, or by the power supply unit being used, or by means of a fuse.		
Output voltage at U_{out}			
Rotary switch U_{out} = 0	4.75 V	5 V	5.25 V
Rotary switch U_{out} = 1	6.65 V	7 V	7.35 V
Rotary switch U_{out} = 2	11.4 V	12 V	12.6 V
Rotary switch U_{out} = 3	–	24 V [1]	–
Permissible output current at U_{out}			
Rotary switch U_{out} = 0	–	650 mA [2]	430 mA [3] [4]
Rotary switch U_{out} = 1	–	470 mA [2]	310 mA [3] [4]
Rotary switch U_{out} = 2	–	270 mA [2]	180 mA [3] [4]
Rotary switch U_{out} = 3	–	180 mA [2]	180 mA [3] [4]
Current limitation U_{out}	–	1.4 A	< 1 s: 2.4 A [5] ≥ 1 s: 2.0 A [5]

1) The supply voltage for the encoder can be up to 2.8 V below the supply voltage at the system plug (terminal A1).
2) With 24 V at the FX3-MPLx Flexi Soft system plug.
3) With 16.8 V at the FX3-MPLx Flexi Soft system plug.
4) Sum current for all encoders supplied via this encoder/motor feedback connection box; i.e., including the encoders that are connected at FX3-EBX3 via D4, e.g., via an additional FX3-EBX3.
5) Sum current of ENC1_24V and ENC2_24V, therefore resulting in a doubled value.

12.3.10 UE410-2RO/UE410-4RO relay modules

Safety-related parameters for UE410-2RO/UE410-4RO

NOTE

The data for the safety technology parameters is based on an ambient temperature of +40 °C (the temperature usually used for the static calculation of the values).

Table 151: Safety-related parameters for UE410-2RO/UE410-4RO

	UE410-2RO/UE410-4RO
Safety integrity level	SIL3 (IEC 61508)
SIL claim limit	SILCL3 (EN 62061)
Category	Category 4 (EN ISO 13849-1)
Performance level	PL e (EN ISO 13849-1)
PFH_D at I = 0.75 A, switching frequency = h^{-1} (see table 158, page 170)	1.2×10^{-9}
PFD_{avg} at I = 0.75 A, switching frequency = h^{-1}	1.2×10^{-5}
B_{10D} value	0.75 A (AC-15)/4,150,000 (see table 158, page 170)
Safe Failure Fraction (SFF)	99.6%
Diagnostic coverage (DC)	99%
T_M (mission time)	Depending on PFH_d value, ambient temperature, load case, and switching operations (see table 158, page 170)
Number of mechanical switching operations	Min. 200,000

General data for UE410-2RO/UE410-4RO

Table 152: General data for UE410-2RO/UE410-4RO

	UE410-2RO/UE410-4RO
Conformity/approvals	CE, cULus, CCC, EAC
Enclosure rating	IP 20 (EN 60529)
Ambient operating temperature (UL/CSA: surrounding air temperature)	–25 °C ... +55 °C
Storage temperature	–25 °C ... +70 °C
Air humidity	10 ... 95%, non-condensing
Operating altitude	Max. 2,000 m above sea level (80 kPa)
Vibration resistance	5–150 Hz/1 G (EN 60068-2-6) 10–500 Hz/3 G_{rms} (EN 60068-2-64)
Shock resistance	
Continuous shock	15 g, 11 ms (EN 60068-2-27)
Single shock	30 g, 11 ms (EN 60068-2-27)
Interference immunity	EN 61000-6-2
Radiated emission	EN 61000-6-4
Rated impulse voltage (U_{imp})	4 kV
Overvoltage category	II (EN 61131-2)
Contamination rating	2 inside, 3 outside
Rated voltage	300 V AC
Galvanic separation	
Supply circuit–input circuit	No
Supply circuit–output circuit	Yes
Input circuit–output circuit	Yes
Dimensions (W × H × D)	22.5 × 96.5 × 120.8 mm
Weight (without packaging)	
UE410-2RO	160 g (±5%)
UE410-4RO	186 g (±5%)

Supply circuit of the UE410-2RO/UE410-4RO (via FX3-CPUx)

Table 153: Supply circuit of the UE410-2RO/UE410-4RO (via FX3-CPUx)

	Minimum	Typical	Maximum
Power consumption			
UE410-2RO	–	–	1.6 W
UE410-4RO	–	–	3.2 W

Input circuit (B1, B2) of the UE410-2RO/UE410-4RO

Table 154: Input circuit (B1, B2) of the UE410-2RO/UE410-4RO

	Minimum	Typical	Maximum
Input voltage ON	18 V DC	–	30 V DC

Output circuit (13-14, 23-24, 33-34, 43-44) of the UE410-2RO/UE410-4RO

Table 155: Output circuit (13-14, 23-24, 33-34, 43-44) of the UE410-2RO/UE410-4RO

	Minimum	Typical	Maximum
No. of normally open			
UE410-2RO	2		
UE410-4RO	4		
No. of normally closed			
UE410-2RO	1		
UE410-4RO	2		
AC switching voltage	5 V AC	230 V AC [1]	253 V AC
DC switching voltage	5 V DC	230 V DC [1]	253 V DC
Switching current	10 mA	–	6 A
Mechanical service life	Min. 10×10^6		
Electrical endurance	see figure 65, page 169		
Minimum contact load at U_n = 24 V DC	50 mW	–	–
Sum current	–	–	8 A
Response time [2]	–	–	30 ms
Type of output	Volt-free N/O contacts, positively guided		
Contact material	$AgSnO_2$		
Output circuit fuse	6 A gG, each current path		
Usage category	AC-15: U_e 250 V, I_e 3 A		
	DC-13: U_e 24 V, I_e 3 A		

1) see figure 64, page 168 or see figure 65, page 169.
2) Time from Low at B1/B2 until relay drops out.

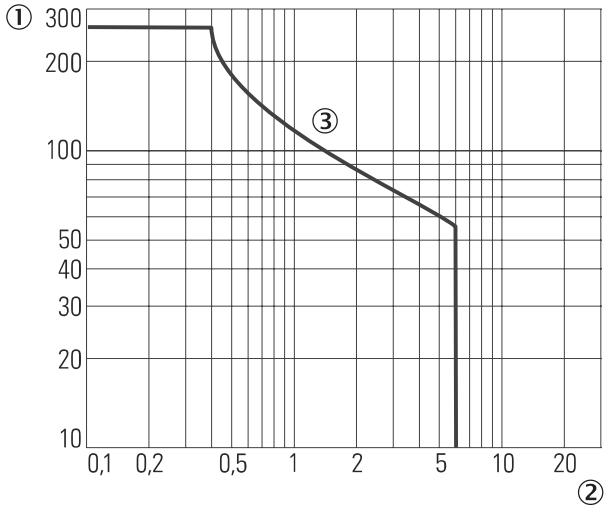


Figure 64: Maximum switching voltage for direct current, UE410-2RO/UE410-4RO relay modules

① DC voltage [V DC]
② Direct current [A]
③ Resistive load

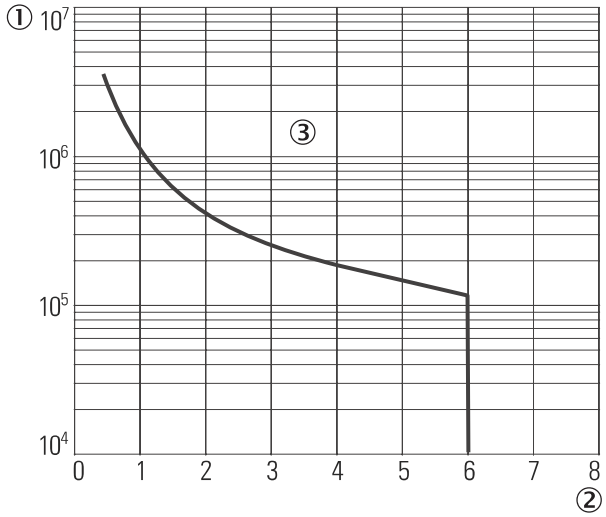


Figure 65: Electrical endurance of UE410-2RO/UE410-4RO relay modules

① Switching operations

② Switching current [A]

③ 250 V AC resistive load with 1 N/O contact

Output circuit (Y14, Y24) of the UE410-2RO/UE410-4RO

Table 156: Output circuit (Y14, Y24) of the UE410-2RO/UE410-4RO

	Minimum	Typical	Maximum
Type of output	N/O contact at internal 24 V DC, positively guided, current-limited		
No. of normally open Y14/24			
UE410-2RO	1		
UE410-4RO	2		
Output voltage	16 V DC	24 V DC	30 V DC
Output current [1]	–	–	75 mA
Load capacity	–	–	200 nF

1) The entire output current is limited. Maximum sum current of all relay modules at Y14 or Y24 is < 80 mA.

Terminal and connection data for UE410-2RO/UE410-4RO

Table 157: Terminal and connection data for UE410-2RO/UE410-4RO

	Minimum	Typical	Maximum
Wire cross-section	Single-wire or stranded: 0.2 … 1.5 mm^2 Stranded wire with ferrule: a) With plastic ferrule max. 0.75 mm^2 b) With plastic ferrule max. 1.5 mm^2 AWG to UL/CUL: 24 … 16		
Stripping length	–	–	8 mm
Maximum tightening torque	–	–	0.6 Nm
For UL-508 and CSA applications			
UE410-xx**3**..., UE410-xxx**3**...			
Connection cross-section	AWG 30–12 (use 60/75 °C copper strands only)		
Tightening torque	5–7 lb·in		
UE410-xx**4**..., UE410-xxx**4**...			
Connection cross-section	AWG 30–12 (use 60/75 °C copper strands only)		

PFH_D values for UE410-2RO/UE410-4RO

Table 158: PFH_D values for UE410-2RO/UE410-4RO

Utilization category	I [A]	Switching frequency	Switching operations per year	B_{10D}	PFH_D
AC-15	0.1	1/h	8760	10,000,000	5×10^{-10}
	0.75	**1/h**	**8760**	**4,150,000**	**1.2×10^{-9}**
	3	1/h	8760	400,000	1.2×10^{-8}
	5	1/h	8760	70,000	7.2×10^{-8}
DC-13	1	1/h	8760	2,000,000	2.5×10^{-9}
	3	1/h	8760	450,000	1.1×10^{-8}
AC-1	2	1/h	8760	1,000,000	5×10^{-9}
	4	1/h	8760	600,000	8.4×10^{-9}

WARNING

Impaired safety due to exceeding the prescribed test interval

The safety-related Level SILCL3 as per EN 62061 (see "Technical data", page 126) is not achieved in case of non-compliance.

- At least every 365 days, check the correct switching function for each safety-relevant output circuit of the relay modules UE410-2RO/UE410-4RO, e.g. by switching the machine or plant off and on again, monitored by the EDM function.
- Document the thorough check.

12.3.11 Diode module DM8-A4K

General system data for the DM8-A4K diode module

Table 159: General system data for the DM8-A4K diode module

	Diode module DM8-A4K
Dimensions (W × H × D)	32 × 87 × 72 mm
Weight	59 g
Ambient operating temperature (UL/CSA: surrounding air temperature)	–25 … +55 °C
Storage temperature	–25 … +70 °C
Stripping length	7 mm
Wire cross-section	0.2 … 2.5 mm^2
Screw connection	AWG 22–14
Enclosure rating	IP 00
Protection class	III
Contamination rating	2

Input data for diode module DM8-A4K

Table 160: Input data for diode module DM8-A4K

	Diode module DM8-A4K
Input voltage (max.)	25 V AC/60 V DC
Reverse voltage	1,000 V
Reverse current	5 µA
Forward voltage	0.8 V
Input current per channel (1/2)	400 mA

12.4 Dimensioned drawings

12.4.1 FX3-CPUx main modules with system plug

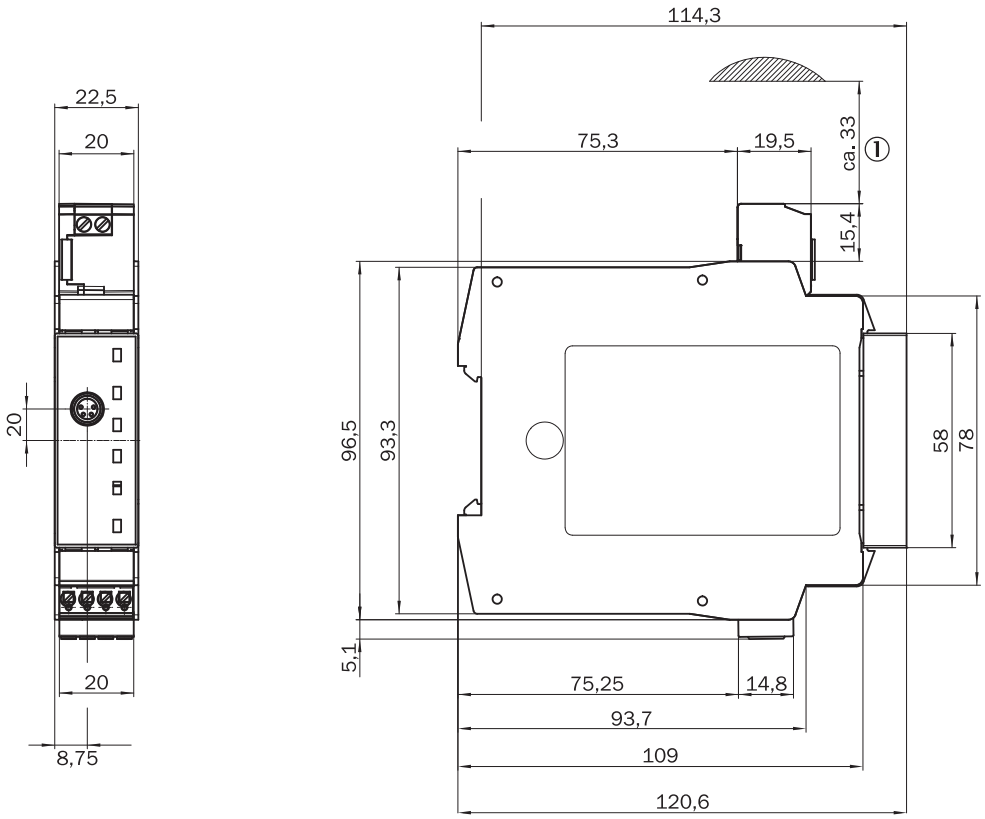


Figure 66: Dimensioned drawing FX3-CPUx (mm)

① Connector range

12.4.2 FX3-XTIO, FX3-XTDI, FX3-XTDS, and FX0-STIO I/O modules, UE410-2RO and UE410-4RO relay modules

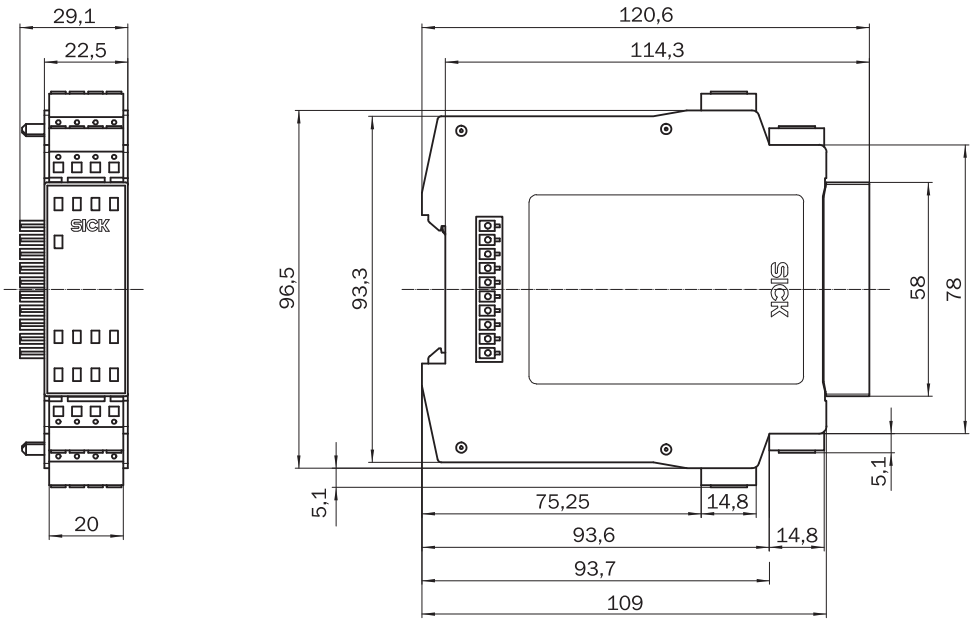


Figure 67: Dimensioned drawing FX3-XTIO, FX3-XTDS, FX0-STIO, FX3-XTDI, UE410-2RO, and UE410-4RO (mm)

12.4.3 FX3-ANA0 analog input module

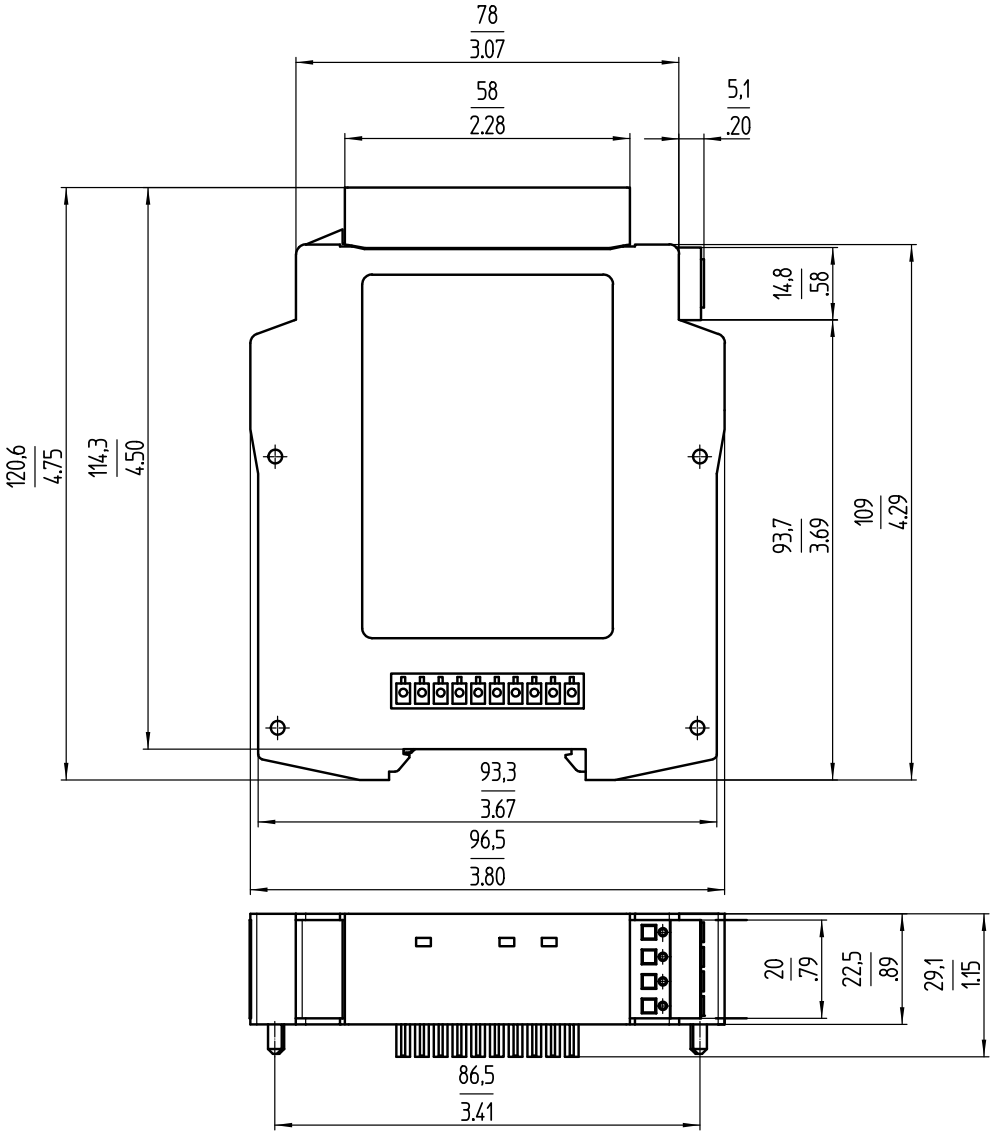


Figure 68: Dimensional drawing for the FX3-ANA0 (mm/in)

12.4.4 Drive Monitor FX3-MOCx

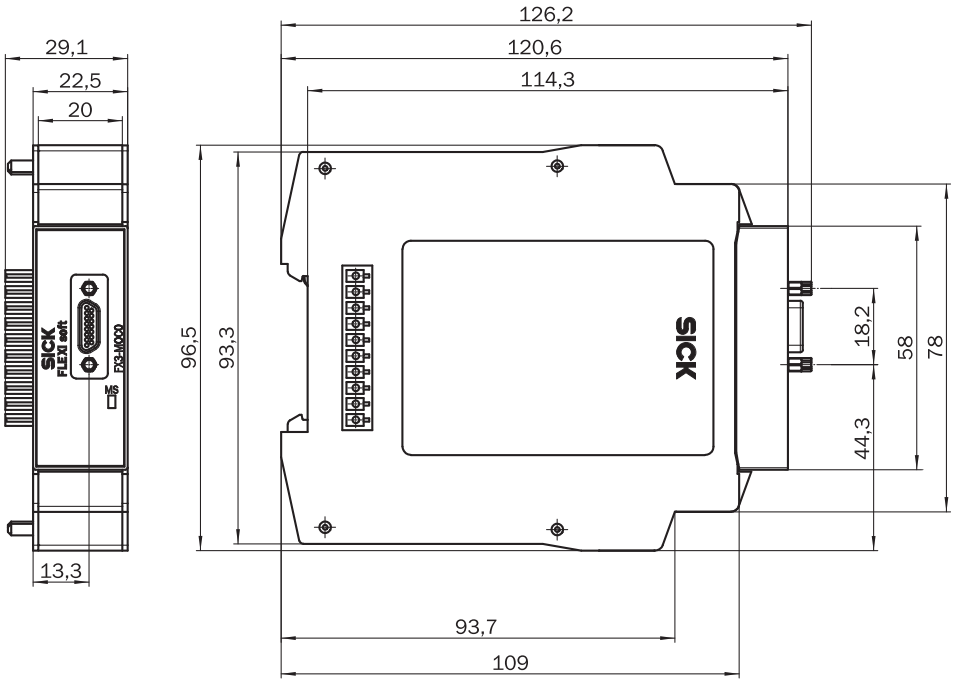


Figure 69: Dimensional drawing for the FX3-MOC0 (mm) [12)]

12) *Drive Monitor FX3-MOC1 is identical.*

12.4.5 FX3-EBX1, FX3-EBX3, and FX3-EBX4 encoder/motor feedback connection boxes

FX3-EBX1 optimized dual encoder/motor feedback connection box

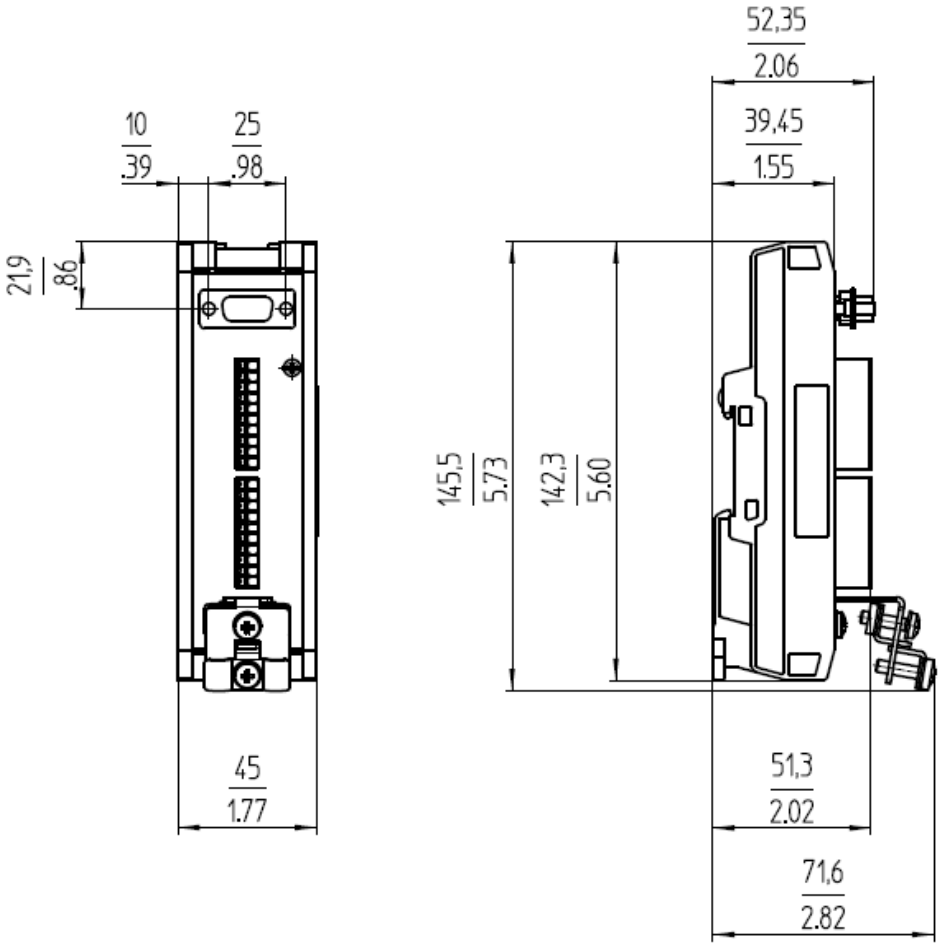


Figure 70: Dimensional drawing for the optimized dual encoder/motor feedback connection box FX3-EBX1 (mm/in)

FX3-EBX3 encoder/motor feedback connection box

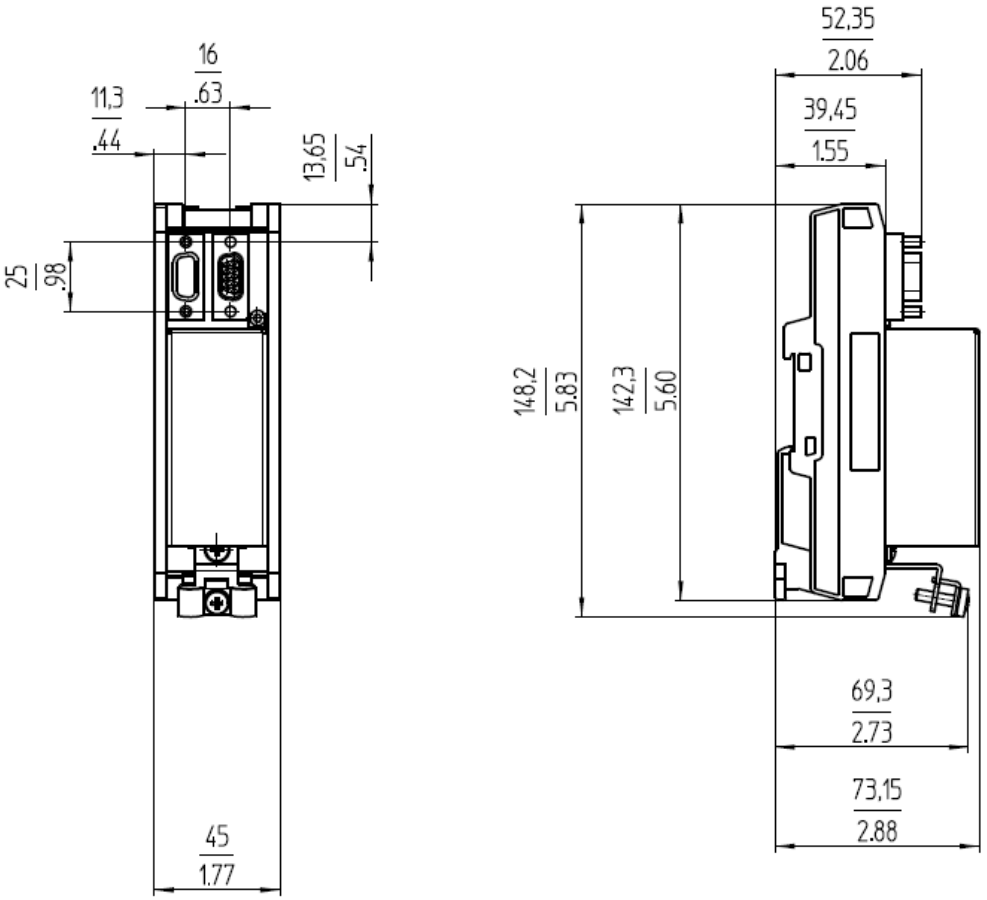


Figure 71: Dimensional drawing for the FX3-EBX3 encoder/motor feedback connection box (mm/in)

FX3-EBX4 dual encoder/motor feedback connection box

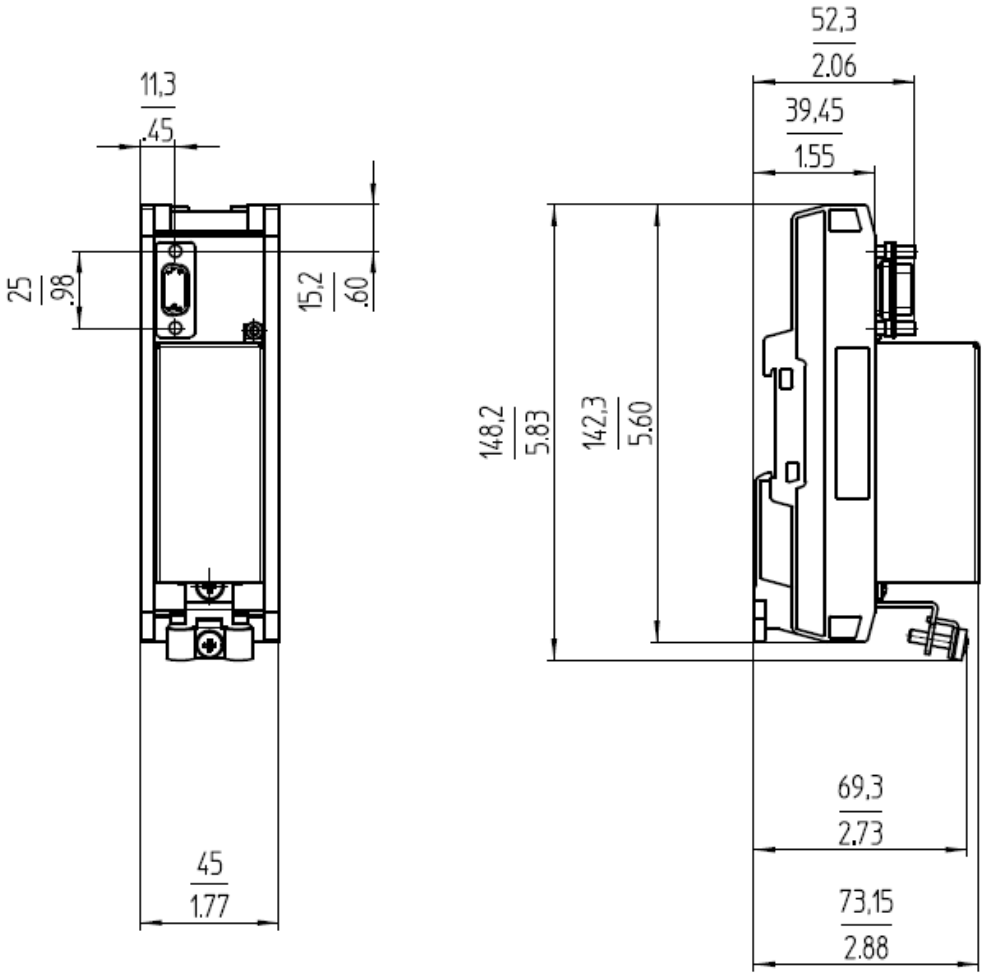


Figure 72: Dimensional drawing for the FX3-EBX4 dual encoder/motor feedback connection box (mm/in)

12.4.6 Diode module DM8-A4K

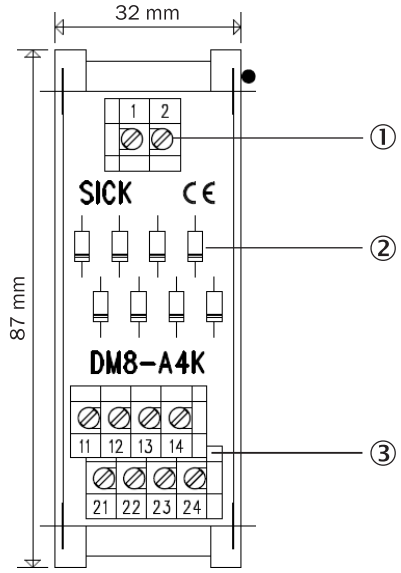


Figure 73: Dimensioned drawing diode module DM8-A4K

① Inputs
② 8 × 1N4007
③ Outputs

13 Ordering information

13.1 System plugs and modules

Table 161: Part numbers for the system plug and modules of the Flexi Soft safety controller

Part	Description	Part number
System plug		
FX3-MPL000001	System plug for FX3-CPU0 or FX3-CPU1 Screw terminals	1043700
FX3-MPL000011	System plug for FX3-CPU0 or FX3-CPU1 Screw terminals, protective coating [1]	1050619
FX3-MPL100001	System plug for FX3-CPU2 or FX3-CPU3 Screw terminals	1047162
Main modules		
FX3-CPU000000	Main module	1043783
FX3-CPU000010	Main module, protective coating [1]	1050615
FX3-CPU130002	Main module 2 EFI connections, plug-in dual level spring terminals	1043784
FX3-CPU130012	Main module 2 EFI connections, plug-in dual level spring terminals, protective coating [1]	1050616
FX3-CPU230002	Main module 2 EFI connections, plug-in dual level spring terminals	1058999
FX3-CPU320002	Main module 2 EFI connections, 1 Flexi Line connection, plug-in dual level spring terminals	1059305
Gateways		
FX0-GENT00000	EtherNet/IP™ gateway	1044072
FX0-GMOD00000	Modbus TCP gateway	1044073
FX0-GPNT00000	PROFINET IO gateway	1044074
FX0-GETC00000	EtherCAT gateway	1051432
FX0-GPR000000	PROFIBUS DP gateway	1044075
FX0-GCAN00000	CANopen gateway	1044076
FX0-GDEV00000	DeviceNet gateway	1044077
FX0-GCC100200	CC-Link gateway	1085195
FX3-GEPR00000	EFI-pro gateway	1069070
Expansion modules		
FX3-XTIO84002	I/O module 8 safe inputs, 4 safe outputs, plug-in dual level spring terminals	1044125
FX3-XTIO84012	I/O module 8 safe inputs, 4 safe outputs, plug-in dual level spring terminals, protective coating [1]	1050618
FX3-XTDI80002	I/O module 8 safe inputs, plug-in dual level spring terminals	1044124
FX3-XTDI80012	I/O module 8 safe inputs, plug-in dual level spring terminals, protective coating [1]	1050617

Part	Description	Part number
FX3-XTDS84002	I/O module 8 safe inputs, 4 or 6 non-safe outputs, plug-in dual level spring terminals	1061777
FX0-STIO68002	I/O module 6 or 8 non-safe inputs, 8 or 6 non-safe outputs, plug-in dual level spring terminals	1061778
FX3-MOC000000	Drive Monitor Connection of two encoders	1062344
FX3-MOC100000	Drive Monitor For connecting two encoders	1057833
FX3-ANA020002	Analog input module For connecting two analog sensors	1051134
Relay modules		
UE410-2RO4	Relay module 2 normally open contacts and 1 24 V DC signal output, plug-in spring terminals	6032677
UE410-4RO4	Relay module 4 normally open contacts and 2 24 V DC signal outputs, plug-in spring terminals	6032676
UE410-4RO401	Relay module 4 normally open contacts and 2 24 V DC signal outputs, plug-in spring terminals, protective coating [1]	6053182
RLY3-OSSD1	Safety relay Output expansion module for OSSDs	1085343
UE10-2FG3D0	Safety relay Plug-in screw terminals	1043916
UE12-2FG3D0	Cascadable safety relay Plug-in screw terminals	1043918

1) For stricter environmental requirements (e.g., resistance to sulfur).

13.2 Accessories

Table 162: Part numbers of accessories for the Flexi Soft safety controller

Part	Description	Part number
–	Plug-in spring terminals	2045890
–	Plug-in screw terminals	2045891
–	EFI cable thick, 12.2 mm, PVC, sold by the meter	6030756
–	EFI cable thin, 6.9 mm, PVC, sold by the meter	6030921
–	Flexi Line cable, shielded, twisted pair, PVC, 2 × 0.22 mm^2 (AWG 23), sold by the meter	6029448
–	Flexi Line cable, shielded, twisted pair, 2 × 2 × 0.34 mm^2 (AWG 22), sold by the meter	6034249
–	Configuration cable 2 m, M8, D-Sub	6021195
–	Configuration cable 3 m, USB-A, USB Mini-B	6042517
–	Configuration cable 3 m, M8, angled, open end	6036342
DSL-8U04G02M025KM1	Configuration cable, M8 on USB-A, 2 m	6034574
DSL-8U04G10M025KM1	Configuration cable, M8 on USB-A, 10 m	6034575

Table 163: Part numbers for Drive Monitor FX3-MOCx accessories

Part	Description	Part number
FX3-EBX1	Optimized dual encoder/motor feedback connection box: facility for connecting two encoder/motor feedback systems Connection to Drive Monitor FX3-MOCx: D-Sub, female connector, 15-pin	2079867
FX3-EBX3	Encoder/motor feedback connection box: facility for connecting an encoder/motor feedback system Connection to Drive Monitor FX3-MOCx: D-Sub, female connector, 15-pin Connection for an additional encoder/motor feedback connection box: D-Sub, female connector, 9-pin	2068728
FX3-EBX4	Dual encoder/motor feedback connection box: facility for connecting two encoder/motor feedback systems Connection to Drive Monitor FX3-MOCx: D-Sub, female connector, 15-pin, and HD D-Sub, female connector, 15-pin	2068729
–	Connection cable between Drive Monitor FX3-MOCx and an encoder/motor feedback connection box • Shielded, twisted pair • 1 × Micro D-Sub, male connector, 15-pin, straight • 1 × D-Sub, male connector, 15-pin, straight	
–	• 2 m	2067798
–	• 10 m	2067799

Part	Description	Part number
–	Connection cable between Drive Monitor FX3-MOCx and an encoder/motor feedback connection box • Shielded, twisted pair • 1 × Micro D-Sub, male connector, 15-pin, angled • 1 × D-Sub, male connector, 15-pin, straight	
–	• 2 m	2077261
–	• 10 m	2077262
–	Connection cable for FX3-EBX3 and FX3-EBX4 • Shielded, twisted pair • 1 × D-Sub, male connector, 9-pin, straight • 1 × D-Sub, male connector, 15-pin, straight	
–	• 0.3 m	2078260
–	• 2 m	2067800
–	• 10 m	2067801
–	Connection cable for direct encoder connection (sine-cosine encoder, e.g., DFS60S Pro) • Shielded, twisted pair • 1 × Micro D-Sub, male connector, 15-pin, angled • 1 × M12, female connector, 8-pin, straight	
–	• 1 m	2094403
–	• 3 m	2094426
–	• 5 m	2094427
–	• 10 m	2094428
–	Connection cable for direct encoder connection (SSI + sine-cosine encoder) • Shielded, twisted pair • 1 × Micro D-Sub, male connector, 15-pin, angled • 1× M12, female connector, 12-pin, straight	
–	• 1 m	2094372
–	• 3 m	2094434
–	• 5 m	2094435
–	• 10 m	2094436
–	Connection cable for direct connection of two encoders • Shielded, twisted pair • 1 × Micro D-Sub, male connector, 15-pin, straight • Open cable end • 2 m	2067893
–	Connection cable for direct connection of two encoders • Shielded, twisted pair • 1 × Micro D-Sub, male connector, 15-pin, angled • Open cable end • 2 m	2077263

Part	Description	Part number
–	Y connection cable for direct connection of two encoders • Shielded, twisted pair • 1 × Micro D-Sub, male connector, 15-pin, angled • 2 × M12, female connector, 8-pin, straight • 0.6 m	2094381

Table 164: Part numbers for DM8-A4K diode module

Part	Description	Part number
DM8-A4K	Diode module for the connection of multiple pressure-sensitive safety mats that trigger short-circuits	6026142

Table 165: Part numbers for muting lamp and cable

Part	Description	Part number
–	Muting lamp with mounting kit	2020743
–	LED muting lamp with cable 2 m	2019909
–	LED muting lamp with cable 10 m	2019910

14 List of abbreviations

ACR

Automated configuration recovery = a function that allows automated recovery or duplication of the configuration for connected EFI-enabled safety sensors such as laser scanners or light curtains

ESPE

Electro-sensitive protective device (e.g., C4000)

CDS

SICK Configuration & Diagnostic Software = software for configuration and diagnostics

EDM

External device monitoring

EFI

Enhanced function interface = safe SICK device communication

FPLC

Fail-safe programmable logic controller

HMI

Human machine interface

OSSD

Output signal switching device = switching output that is responsible for controlling the safety circuit

PFH_D

Probability of dangerous failure per hour

SIL

Safety integrity level

SILCL

Safety integrity level claim limit

PLC

Programmable logic controller

15 Appendix

15.1 Compliance with EU directives

EU declaration of conformity (extract)

The undersigned, representing the manufacturer, herewith declares that the product is in conformity with the provisions of the following EU directive(s) (including all applicable amendments), and that the standards and/or technical specifications stated in the EU declaration of conformity have been used as a basis for this.

Complete EU declaration of conformity for download

You can call up the EU declaration of conformity and the current operating instructions for the protective device by entering the part number in the search field at www.sick.com (part number: see the type label entry in the “Ident. no.” field).

15.2 Checklist for the manufacturer

Checklist for manufacturers / installers for the installation of the Flexi Soft safety controller

The details on the items listed below must be available at the latest when the system is commissioned for the first time. However, they are dependent upon the application, the requirement of which must be reviewed by the manufacturer/installer.

This checklist should be retained and kept with the machine documentation to serve as reference during recurring tests.

This checklist does not replace the initial commissioning, nor the regular inspection by qualified safety personnel.

Have the safety rules and regulations been observed in compliance with the directives/standards applicable to the machine?	Yes ☐ No ☐
Are the applied directives and standards listed in the declaration of conformity?	Yes ☐ No ☐
Does the protective device correspond to the required category?	Yes ☐ No ☐
Are the required protective measures against electric shock in effect (protection class)?	Yes ☐ No ☐
Has the safety function been checked in compliance with the test notes of this documentation? In particular: Function test on the control switches, sensors and actuator connected to the safety controller Check of all cut-off paths	Yes ☐ No ☐
Is it ensured that a complete test of the safety functions is done after any configuration change of the safety controller?	Yes ☐ No ☐

16 List of figures

17 List of tables

8012478/10NF/2019-04-30/en

Australia
Phone +61 (3) 9457 0600
1800 33 48 02 – tollfree
E-Mail sales@sick.com.au

Austria
Phone +43 (0) 2236 62288-0
E-Mail office@sick.at

Belgium/Luxembourg
Phone +32 (0) 2 466 55 66
E-Mail info@sick.be

Brazil
Phone +55 11 3215-4900
E-Mail comercial@sick.com.br

Canada
Phone +1 905.771.1444
E-Mail cs.canada@sick.com

Czech Republic
Phone +420 2 57 91 18 50
E-Mail sick@sick.cz

Chile
Phone +56 (2) 2274 7430
E-Mail chile@sick.com

China
Phone +86 20 2882 3600
E-Mail info.china@sick.net.cn

Denmark
Phone +45 45 82 64 00
E-Mail sick@sick.dk

Finland
Phone +358-9-25 15 800
E-Mail sick@sick.fi

France
Phone +33 1 64 62 35 00
E-Mail info@sick.fr

Germany
Phone +49 (0) 2 11 53 01
E-Mail info@sick.de

Hong Kong
Phone +852 2153 6300
E-Mail ghk@sick.com.hk

Hungary
Phone +36 1 371 2680
E-Mail ertekesites@sick.hu

India
Phone +91-22-6119 8900
E-Mail info@sick-india.com

Israel
Phone +972-4-6881000
E-Mail info@sick-sensors.com

Italy
Phone +39 02 27 43 41
E-Mail info@sick.it

Japan
Phone +81 3 5309 2112
E-Mail support@sick.jp

Malaysia
Phone +603-8080 7425
E-Mail enquiry.my@sick.com

Mexico
Phone +52 (472) 748 9451
E-Mail mario.garcia@sick.com

Netherlands
Phone +31 (0) 30 229 25 44
E-Mail info@sick.nl

New Zealand
Phone +64 9 415 0459
0800 222 278 – tollfree
E-Mail sales@sick.co.nz

Norway
Phone +47 67 81 50 00
E-Mail sick@sick.no

Poland
Phone +48 22 539 41 00
E-Mail info@sick.pl

Romania
Phone +40 356-17 11 20
E-Mail office@sick.ro

Russia
Phone +7 495 283 09 90
E-Mail info@sick.ru

Singapore
Phone +65 6744 3732
E-Mail sales.gsg@sick.com

Slovakia
Phone +421 482 901 201
E-Mail mail@sick-sk.sk

Slovenia
Phone +386 591 78849
E-Mail office@sick.si

South Africa
Phone +27 (0)11 472 3733
E-Mail info@sickautomation.co.za

South Korea
Phone +82 2 786 6321
E-Mail info@sickkorea.net

Spain
Phone +34 93 480 31 00
E-Mail info@sick.es

Sweden
Phone +46 10 110 10 00
E-Mail info@sick.se

Switzerland
Phone +41 41 619 29 39
E-Mail contact@sick.ch

Taiwan
Phone +886-2-2375-6288
E-Mail sales@sick.com.tw

Thailand
Phone +66 2 645 0009
E-Mail marcom.th@sick.com

Turkey
Phone +90 (216) 528 50 00
E-Mail info@sick.com.tr

United Arab Emirates
Phone +971 (0) 4 88 65 878
E-Mail info@sick.ae

United Kingdom
Phone +44 (0)17278 31121
E-Mail info@sick.co.uk

USA
Phone +1 800.325.7425
E-Mail info@sick.com

Vietnam
Phone +65 6744 3732
E-Mail sales.gsg@sick.com

Further locations at **www.sick.com**

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