



SEW
EURODRIVE

Manual



MOVIPRO®
Functional Safety





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1 General Information

1.1 Use of this documentation

The documentation is an integral part of the product and contains important information on operation and service. The documentation is written for all employees who assemble, install, startup, and service this product.

The documentation must be accessible and legible. Make sure that persons responsible for the system and its operation, as well as persons who work independently on the unit, have read through the documentation carefully and understood it. If you are unclear about any of the information in this documentation, or if you require further information, contact SEW-EURODRIVE.

1.2 Structure of the safety notes

1.2.1 Meaning of the signal words

The following table shows the grading and meaning of the signal words for safety notes, notes on potential risks of damage to property, and other notes.

Signal word	Meaning	Consequences if disregarded
▲ DANGER	Imminent danger	Severe or fatal injuries
▲ WARNING	Possible dangerous situation	Severe or fatal injuries
▲ CAUTION	Possible dangerous situation	Minor injuries
NOTICE	Possible damage to property	Damage to the drive system or its environment
INFORMATION	Useful information or tip: Simplifies the handling of the drive system.	

1.2.2 Structure of the section-related safety notes

Section-related safety notes do not apply to a specific action, but to several actions pertaining to one subject. The used symbols indicate either a general or a specific hazard.

This is the formal structure of a section-related safety note:



▲ SIGNAL WORD

Type and source of danger.

Possible consequence(s) if disregarded.

- Measure(s) to prevent the danger.

1.2.3 Structure of the embedded safety notes

Embedded safety notes are directly integrated in the instructions just before the description of the dangerous action.

This is the formal structure of an embedded safety note:

- **▲ SIGNAL WORD** Nature and source of hazard.
Possible consequence(s) if disregarded.
– Measure(s) to prevent the danger.

**1.3 Rights to claim under limited warranty**

A requirement of fault-free operation and fulfillment of any rights to claim under limited warranty is that you adhere to the information in the documentation. Read the documentation before you start working with the unit!

1.4 Exclusion of liability

You must comply with the information contained in this documentation to ensure safe operation and to achieve the specified product characteristics and performance features. SEW-EURODRIVE assumes no liability for injury to persons or damage to equipment or property resulting from non-observance of these operating instructions. In such cases, any liability for defects is excluded.

1.5 Product names and trademarks

All brands and product names in this documentation are trademarks or registered trademarks of their respective titleholders.

1.6 Copyright

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2 Safety Conditions

2.1 Area of application



INFORMATION

These safety conditions apply to:

- Axis module with safe torque off
- Safety-related brake module
- PROFIsafe option S11

For the safety conditions for MOVIPRO® units with safety relay, refer to chapter "Safety relay" (page 41).

2.2 Overview

A requirement for safe operation is that the safety functions of the MOVIPRO® units are properly integrated into an application-specific, higher-level safety function or safety system. The system or machine manufacturer has to make a risk analysis for this purpose. The required safety requirements and functions must be validated before startup.

The system/machine manufacturer and the operator are responsible for compliance of the system/machine with applicable safety regulations.

The following requirements are mandatory when installing and operating MOVIPRO® units in safety-related applications.

The requirements are divided into:

- Approved devices
- Installation requirements
- Requirements for external safety controllers and safety relays
- Startup requirements
- Operation requirements

2.3 Approved units

MOVIPRO® units are only permitted for applications with safe disconnection of the drive if these safety properties are documented in their operating instructions.



2.4 Installation requirements

- You may only use hybrid cables from SEW for safety-related applications with the drive controller.
- Do not shorten SEW hybrid cables. Use cables in their original lengths with prefabricated plug connectors. Ensure proper connections.
- Power lines and safety-related control lines have to be installed in separate cables. This does not apply to SEW hybrid cables.
- The length of the cable from the safety control system to the drive controller must not exceed 100 m.
- The wiring technology used must comply with EN 60204-1.
- The safety-related control lines must be routed according to EMC guidelines and as follows:
 - Outside an electrical installation space, shielded cables must be routed permanently (fixed) and protected against external damage. If this is not possible, equivalent measures must be taken.
 - Single conductors may be routed inside an electrical installation space.Observe the respective regulations governing the application.
- The safety-related DC 24 V supply may not be used for feedback.
- Make sure that parasitic voltages cannot be generated in the safety-related control lines.
- When designing the safety circuits, always observe the values specified for safety components.
- You must only use grounded voltage sources with safe disconnection (PELV) according to EN 60204-1:2006 for all DC 24 V supply voltages of the drive controller.

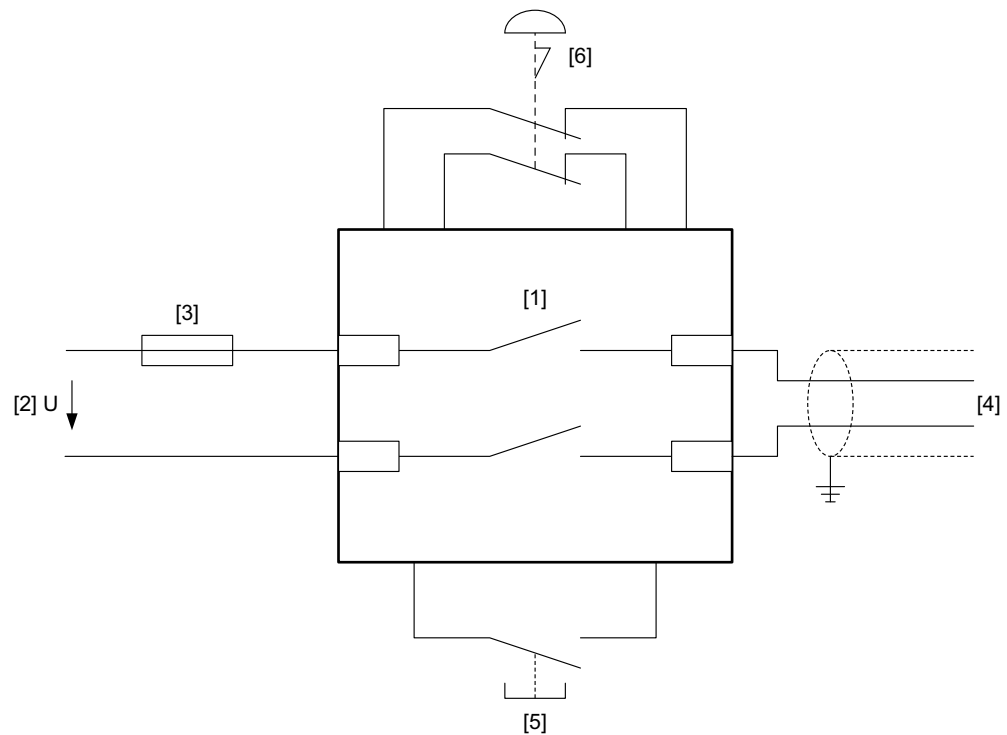
In case of a single fault, the DC voltage between 2 outputs or between an output and grounded housing parts must not exceed 60 V.



2.5 Requirements for the external safety controller

A safety relay can be used as an alternative to a safety controller.

The following figure shows a wiring example of a safety relay:



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- [1] Safety relay with approval
- [2] DC 24 V voltage supply
- [3] Fuses in accordance with the manufacturer's specifications of the safety relay
- [4] Safety-related DC 24 V voltage supply
- [5] Reset button for manual reset
- [6] Permitted emergency stop actuating device

The following requirements apply to safety controllers and safety relays analogously.

- The safety controller and all other safety-related subsystems must be approved for at least that safety class which is required in the overall system for the respective, application-related safety function.

The following table shows an example of the required safety class of the safety controller:

Application requirement	Safety controller requirements
Performance level d according to EN ISO 13849-1	Performance level d according to EN ISO 13849-1 SIL 2 according to EN 61508
SIL 2 according to EN 62061	Performance level d according to EN ISO 13849-1 SIL 2 according to EN 61508

- The wiring of the safety controller must be suitable for the required safety class, (see manufacturer documentation).
- When designing the circuits, always observe the values specified for the safety controller.

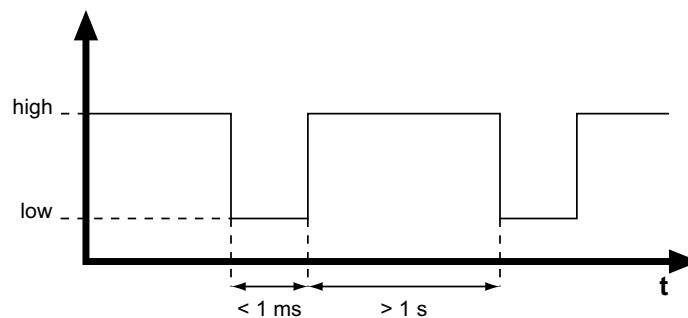


- The switching capacity of the safety relays or the relay outputs of the safety controller must correspond at least to the maximally permitted, limited output current of the DC 24 V voltage supply.

Observe the manufacturer's instructions concerning the permitted contact loads and fusing that may be required for the safety contacts. Unless specified otherwise, the contacts must be protected with 0.6 times the nominal value of the maximum contact rating specified by the manufacturer.

- To ensure protection against unintended restart in accordance with EN 1037, the safety controllers must be designed and connected in such a way that resetting the control device alone does not lead to a restart. A restart may only be carried out after a manual reset of the safety circuit.
- SEW-EURODRIVE recommends bipolar disconnection of the safety circuit.
- The input for the safety-related DC 24 V supply of the drive controller has an input capacitance. For detailed information, refer to the "Technical Data" chapter of the operating instructions of the respective unit. This must be taken into account as load when designing the switching output.

If the safety circuit is disconnected at both poles, the test pulses may not be applied at the same time. The length of a test pulse must not exceed 1 ms. The interval between 2 test pulses must be at least 1 s.



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2.6 Startup requirements

- Startup must be documented. Evidence for the safety functions must be provided. Observe the limitations for safety functions in chapter "Restrictions" (page 51) for verification of the safety functions. Non-safety-related parts and components that affect the result of the verification test (e.g. motor brake) must be deactivated, if necessary.
- For the installation of MOVIPRO® units in safety-related applications, you must perform and document startup checks for the disconnecting device and correct wiring.
- During the startup procedure/function test, the correct assignment of the respective voltage supply must be checked with a measurement.
- The function test must be carried out in succession for all potentials, i.e. separately.



2.7 Operation requirements

- Operation is only permitted within the limits defined in the respective product documentation. This applies to both the external safety relay as well as to MOVIPRO® units and approved options.
- The safety functions must be checked at regular intervals to ensure the faultless functionality. The period of time between tests must be determined in accordance with the risk analysis.



3 Axis Module with Safe Torque Off

It was developed and tested according to the following safety requirements:

- Performance level d according to EN ISO 13849-1
- Protection against restart in accordance with EN 1037

3.1 Safe condition

For safety-related operation of MOVIPRO® units, **safe torque off is defined as safe condition** (see STO safety function). The safety concept is based on this.

3.2 Safety concept

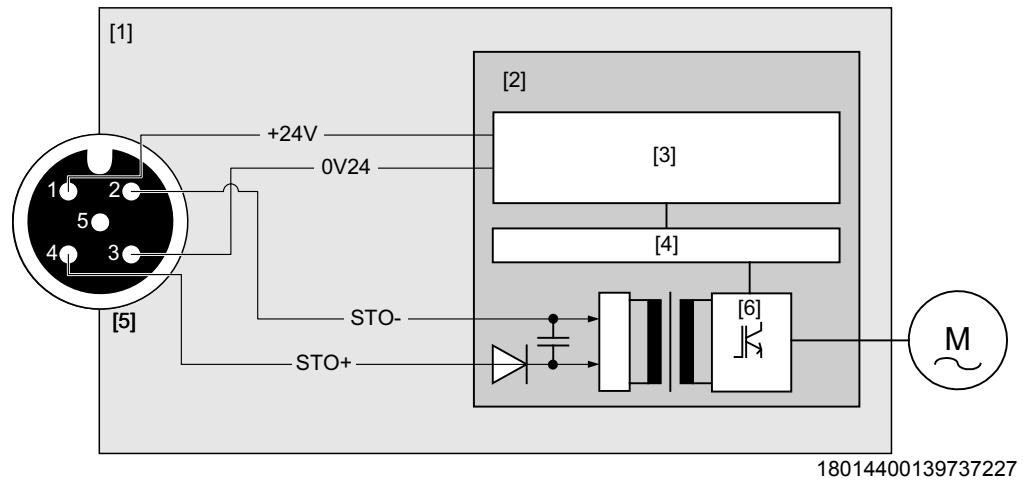
- The drive controller allows for the connection of an external safety controller or an external safety relay. They de-energize all active elements that generate the pulse trains to the power output stage (IGBT) when a connected control device (e.g. EMERGENCY OFF button with latching function) is activated. For this purpose, the safety-related DC 24 V supply is disconnected.

This ensures that the frequency inverter no longer supplies power to the motor for generating torque.

- Disconnecting the DC 24 V power supply ensures that any voltage supply required for operating the drive is safely interrupted.
- Instead of galvanic isolation of the drive from the supply system using contactors or switches, the disconnection of the DC 24 V supply described here safely prevents the gating of the power semiconductors in the frequency inverter. This means the rotary-field generation for the respective motor is deactivated even though the mains voltage is still present.



The following figure shows the safety concept:



- [1] Drive controller
- [2] Frequency inverter
- [3] DC 24 V power supply
- [4] CPU
- [5] X5502: Input for safe disconnection
- [6] Power semiconductor



INFORMATION

Observe chapter "Restrictions" (page 51).

3.3 Safety functions

The following drive-related safety functions can be used:

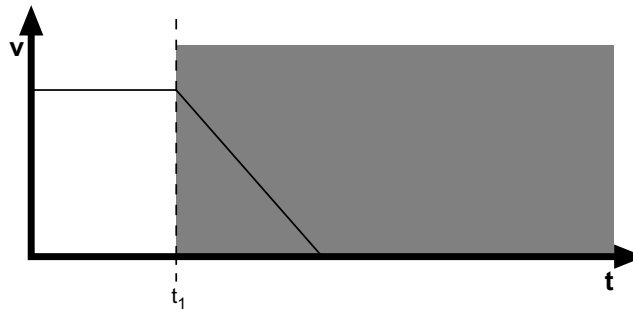
- **STO** (safe torque off according to EN 61800-5-2) by disconnecting the safety-related DC 24 V supply.

If the STO function is activated, the frequency inverter no longer supplies power to the motor for generating torque. This safety function corresponds to a non-controlled stop according to EN 60204-1, stop category 0.

The safety-related DC 24 V power supply must be disconnected by an external safety controller or safety relay.



The following figure illustrates the STO function:



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V Velocity
t Time
 t_1 Time at which STO is triggered
■ Disconnection range

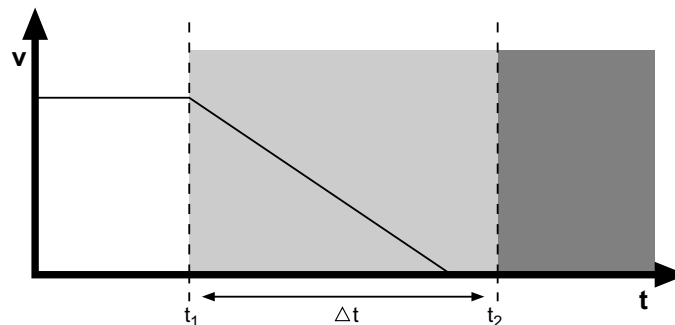
- **SS1(c)** (safe stop 1, function variant c according to EN 61800-5-2) by means of suitable external control (e.g. safety relay with delayed disconnection)

The following sequence is mandatory:

- Deceleration of the drive using an appropriate brake ramp specified via setpoints
- Disconnection of the safety-related DC 24 V power supply (= trigger the STO function) after a specified safety-related time delay.

This safety function corresponds to a controlled stop according to EN 60204-1, stop category 1.

The following figure illustrates the SS1(c) function:



2463226251

V Velocity
t Time
 t_1 Point of time when brake ramp is initiated
 t_2 Point of time when STO is triggered
 Δt Time between initiating the brake ramp and STO
■ Normal operation
■ Disconnection range



3.4 Connection variants



INFORMATION

For technical data, refer to the operating instructions of the drive controller.

3.4.1 X5502: Safe disconnection – input



⚠ WARNING

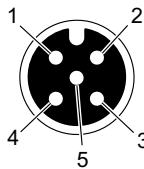
No safe disconnection of the unit if the connection is jumpered.

Severe or fatal injuries.

- Jumper this connection only if the unit will not perform any safety functions according to EN ISO 13849-1.

This connection is marked by a yellow ring.

The following table informs about this connection:

Function		
Input for safe disconnection		
Connection type		
M12, 5-pole, female, A-coded		
Wiring diagram		
		
2264816267		
Assignment		
No.	Name	Function
1	+24V	DC 24 V output
2	STO-	0V24 reference potential for safe disconnection
3	0V24	0V24 reference potential
4	STO+	DC 24 V input for safe disconnection
5	res.	Reserved



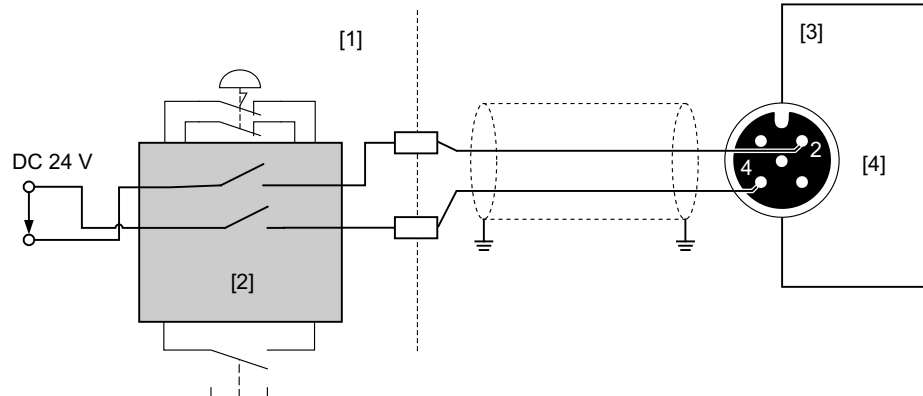
INFORMATION

Use only shielded cables for this connection.



3.4.2 Connection of an external safety relay for STO

The following figure shows a connection example with a safety relay and disconnection of all poles:



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- [1] Installation space
- [2] Safety relay
- [3] Drive controller
- [4] X5502: Input for safe disconnection



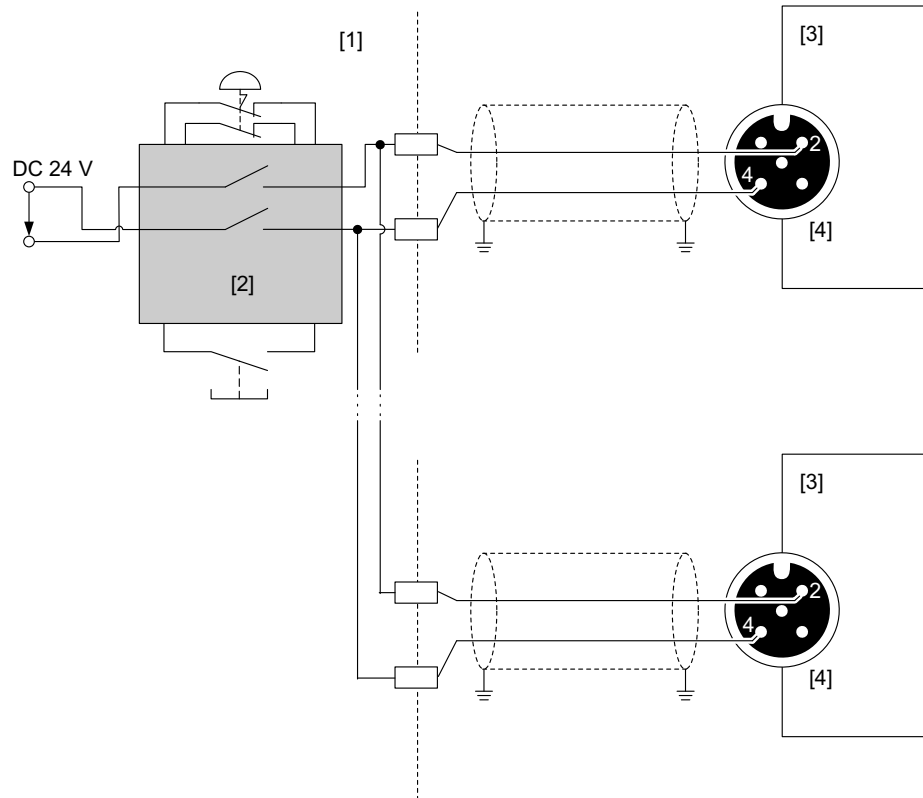
INFORMATION

When wiring the STO signals, possible faults according to EN ISO 13849-2 in plug connectors and cables/lines have to be considered and the installation has to be designed according to the required safety class. The drive controller does not detect short circuits in the supply line. SEW-EURODRIVE therefore recommends to connect only STO signals to X5502 using a two-core cable as shown in the figure.



3.4.3 Disconnection of group drives

The following figure shows a connection example for disconnection of group drives with a safety relay and disconnection of all poles:



36028799053935371

- [1] Installation space
- [2] Safety relay
- [3] Drive controller
- [4] X5502: Input for safe disconnection



INFORMATION

When wiring the STO signals, possible faults according to EN ISO 13849-2 in plug connectors and cables/lines have to be considered and the installation has to be designed according to the required safety class. The drive controller does not detect short circuits in the supply line. SEW-EURODRIVE therefore recommends to connect only STO signals to X5502 using a two-core cable as shown in the figure.



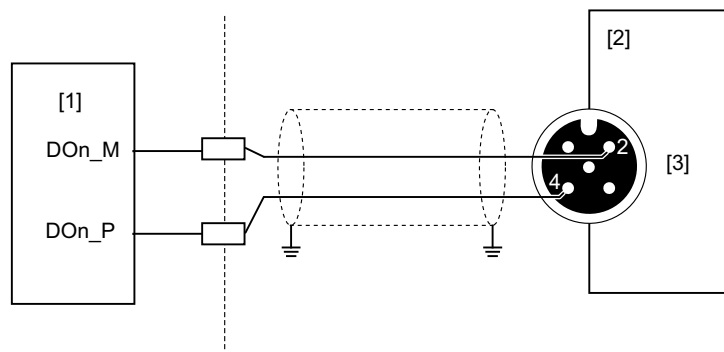
Requirements

For group drives, the STO signal for several MOVIPRO® drives can be provided by a single safety relay. The following requirements must be met:

- For EMC reasons, the maximum cable length is limited to max. 100 m. Other notes from the manufacturer on the safety relay used in a specific application must also be observed.
- The maximum output current and the maximally permitted contact load of the safety relay must be observed.
- You must comply with the permitted signal levels at the STO input and all other technical data of the drive controller. The routing of the STO control cables and the voltage drop must be considered.
- Other requirements of the safety relay manufacturer (such as protecting the output contacts against welding) must be strictly observed. You must also observe the basic cable routing requirements from chapter "Installation requirements". (page 8)
- A calculation based on the technical data of the drive controller must be performed separately for each case of group drive disconnection. For technical data, refer to the relevant operating instructions.

3.4.4 Connection of an external safety controller for STO

The following figure shows a connection example with a safety controller and disconnection of all poles for STO:



18014400187769483

- [1] F-PLC safety controller
 DOn_M: Ground output
 DOn_P: Plus output
 [2] Drive controller
 [3] X5502: Input for safe disconnection



INFORMATION

When wiring the STO signals, possible faults according to EN ISO 13849-2 in plug connectors and cables/lines have to be considered and the installation has to be designed according to the required safety class. The drive controller does not detect short circuits in the supply line. SEW-EURODRIVE therefore recommends to connect only STO signals to X5502 using a two-core cable as shown in the figure.

3.5 Diagnostics

The frequency inverter reports the unit status "Safe stop – active". Unit status 17_{dec} is reported in the high byte of status word 1.



3.6 Technical data

For technical data and approvals of the drive controller, refer to the respective operating instructions. They also contain the electrical data of the X5502 plug connector (Input for safe disconnection). The specific, safety-related data is listed below:

Safety characteristics of axis module with safe torque off STO	
Approved safety classes	Performance level d according to EN ISO 13849-1
Probability of dangerous failure per hour (PFH value)	0 (fault exclusion)
Service life	20 years
Safe condition	Safe torque off (STO)
Safety data of Input for safe disconnection	
Switch-on/switch-off threshold	Typ. DC 8 V
Input voltage for OFF status (STO)	Max. DC 5 V
Time from disconnecting the safety-related DC 24 V supply until the deactivation of the rotating field	Typ. 50 ms Max. 100 ms



4 Safety-Related Brake Module

The safety-related brake module adds the safe SBC brake control function to the axis module.

4.1 Safe condition

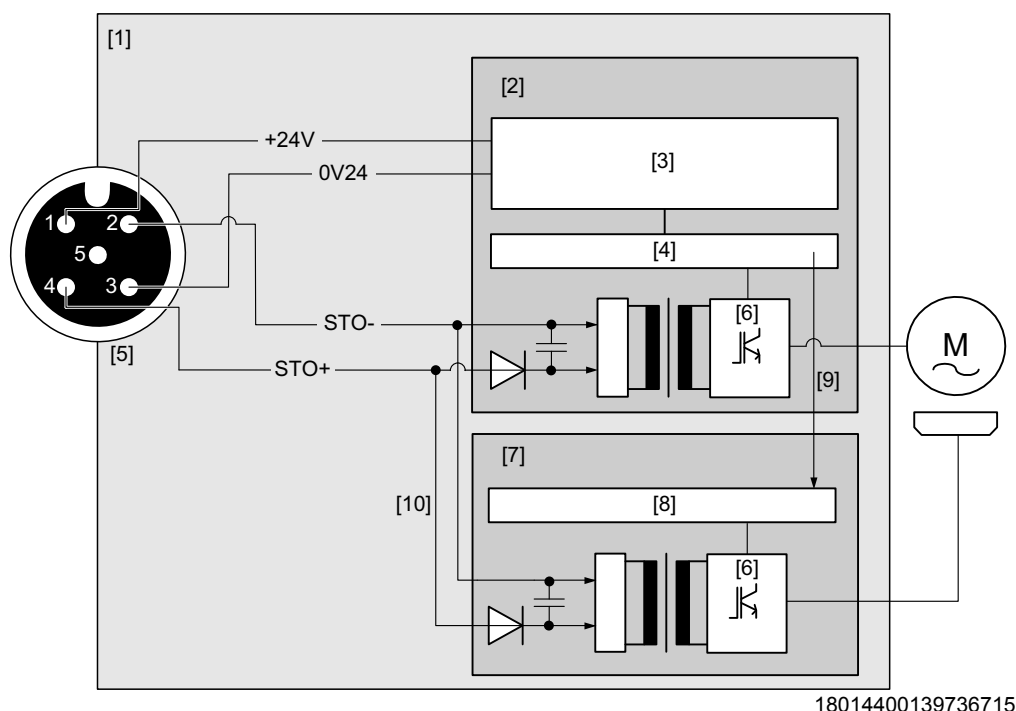
Relating to the safety-related brake module, the **de-energized condition of the connected brake is defined as safe condition**. The safety concept is based on this.

4.2 Safety concept

- Disconnecting the safety-related control voltage also means the connected brake is de-energized. The power supply required for releasing the connected brake is interrupted safely.
- Instead of separating the brake control galvanically from the power supply using contactors or switches, the disconnection procedure described here prevents the power semiconductors in the safety-related brake module from being activated, in this way ensuring safe disconnection. This means that all connected brakes are de-energized although the supply voltage is still present at the safety-related brake module.



The following figure shows the safety concept of the safety-related brake module in connection with the axis module:



18014400139736715

- [1] Drive controller
- [2] Frequency inverter
- [3] DC 24 V power supply
- [4] CPU
- [5] X5502: Input for safe disconnection
- [6] Power semiconductor
- [7] Safety-related brake module
- [8] Control
- [9] Unsafe operating control of the brake
- [10] Safety-related control of the brake

4.3 Safety function

The following drive-related safety function can be used:

- **SBC** (Safe Brake Control according to EN 61800-5-2)

The SBC function safely de-energizes the connected brake by disconnecting the safety-related control voltage. The control voltage must be disconnected by a suitable external safety relay or safety controller.

4.4 Connection variants

For connection variants, refer to "Connection variants" in section "Axis module with safe torque off" (page 15).



4.5 Technical data

For technical data and approvals of the drive controller, refer to the respective operating instructions. They also contain the electrical data of the X5502 plug connector (Input for safe disconnection). The specific, safety-related data is listed below:

Characteristic safety values of the safety-related brake module	
Safe condition	Brake de-energized
Maximum possible safety class	Performance level d according to EN ISO 13849-1 Safety category 3 according to EN 954-1
Probability of dangerous failure per hour (PFH value)	0 (fault exclusion)
Service life	Max. 20 years
Safety data of Input for safe disconnection	
Switch-on/switch-off threshold	Typ. DC 10 V
Input voltage for OFF status (brake de-energized)	Max. DC 6 V
Duration from switching off the safety-related control voltage at the safety-related brake module until switching off the brake voltage (plus the brake application time of the connected brake).	Max. 6 ms



5 PROFIsafe Option S11

The PROFIsafe option S11 supplements the drive controller with a communication connection to an external safety controller via safety-related PROFIsafe communication.

5.1 Safe condition

The safe condition for the PROFIsafe option is defined as:

- Safe outputs switched off
- Value "0" for the safety-related process data (PROFIsafe F user data)

The safety concept is based on this.

5.2 Safety concept

- The PROFIsafe option S11 is an integrated, safety-related electronics component with safe outputs.
- The strict safety requirements are met through two-channel system structure of the safety component and suitable monitoring mechanisms (see section "Technical data" (page 39)). When the system detects a fault, it reacts by reverting to a safe status.
- Inside the drive controller, the safety-related DC 24 V supply voltage of the axis module and – if applicable – of the safety-related brake module is disconnected via a safe output of the PROFIsafe option S11. This stops the drive safely. In this context, observe the safety concept of the axis module and of the brake module and all relevant conditions and installation regulations in this publication.



⚠ WARNING

With respect to disconnection, the safety class of the drive controller is decisive for the overall system.

Severe or fatal injuries.

- The drive controller may only be used in applications up to category 3/performance level d in accordance with EN ISO 13849-1.



INFORMATION

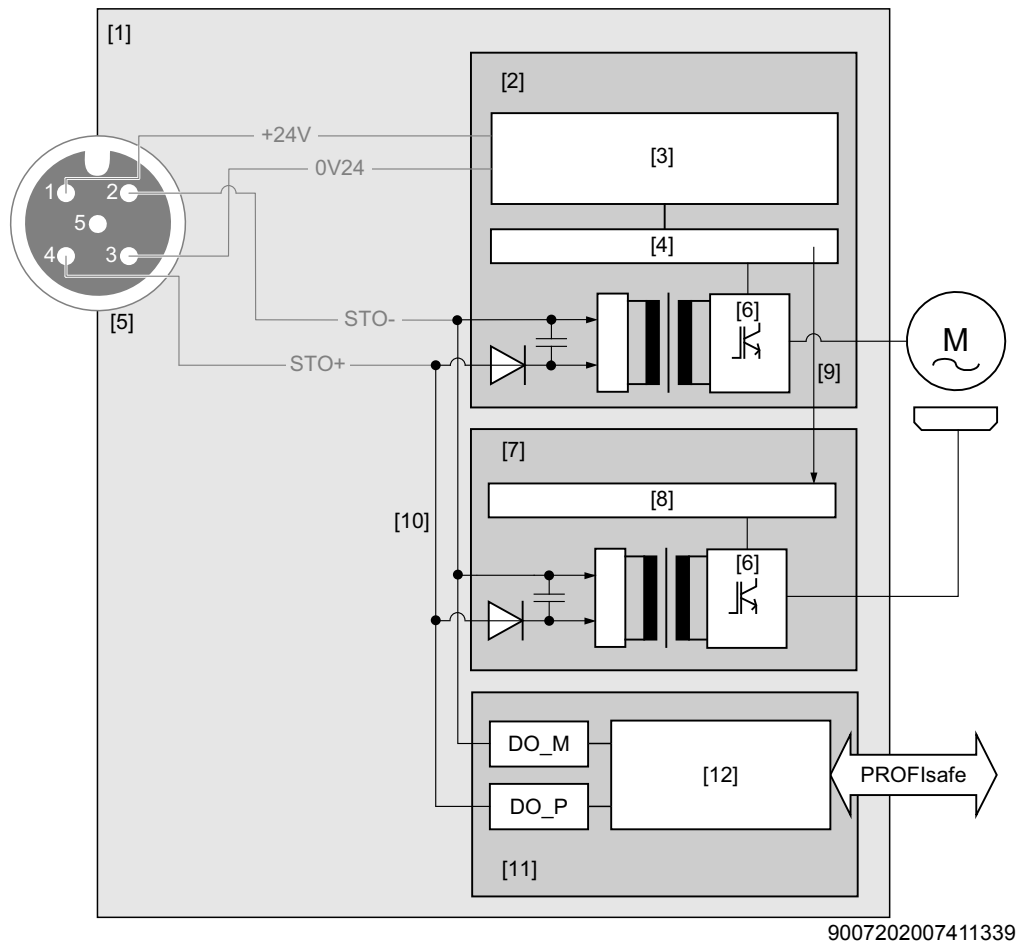
Observe chapter "Restrictions".



PROFIsafe Option S11

Safety concept

The following figure shows the PROFIsafe option S11 with an axis module and a safety-related brake module:



- [1] Drive controller
- [2] Frequency inverter
- [3] DC 24 V power supply
- [4] CPU
- [5] X5502: Input for safe disconnection (if the S11 option is not used)
- [6] Power semiconductor
- [7] Safety-related brake module
- [8] Control
- [9] Unsafe operating control of the brake
- [10] Safety-related control of safe disconnection and brake
- [11] PROFIsafe option S11
- [12] Safe S11 control electronics (dual-channel)



⚠ WARNING

Safe disconnection is not possible when the X5502 port is connected externally.

Severe or fatal injuries.

- Use the jumper plug only if the unit need not perform any safety functions according to EN ISO 13849-1.
- When using the PROFIsafe option S11, the X5502 port may not be connected externally.



5.3 Safety function

The PROFIsafe option S11 provides the safety function in the form of safe outputs, which are controlled by a higher-level controller via PROFIsafe communication.

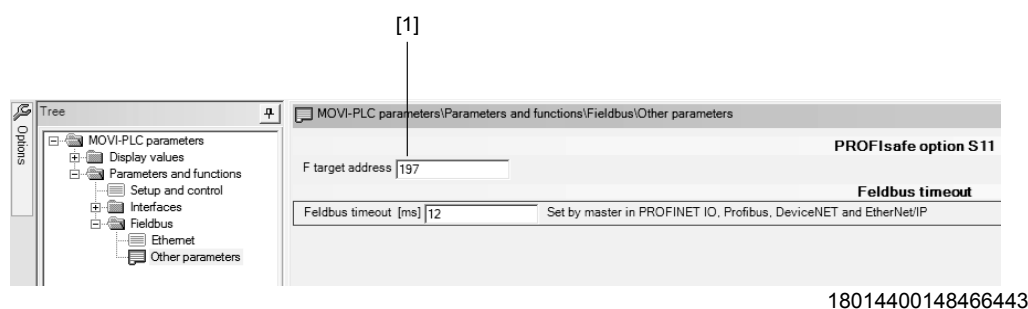
5.4 Startup

5.4.1 Setting the PROFIsafe address

Once you have connected the drive controller with PROFIsafe option S11 to a DC 24 V supply, you have to use MOVITOOLS® MotionStudio to set the PROFIsafe unit address (= F Destination Address. You may enter an address ranging from 1 to 65534.

Ensure that the entry made on the device matches the PROFIsafe address set in the project planning software of the bus master (e.g. Siemens STEP7 HW Config).

The PROFIsafe unit address is set in MOVITOOLS® MotionStudio via the parameter tree of the communication and control unit.



[1] Setting the PROFIsafe unit address (= F Destination Address)

5.4.2 Configuration in STEP7

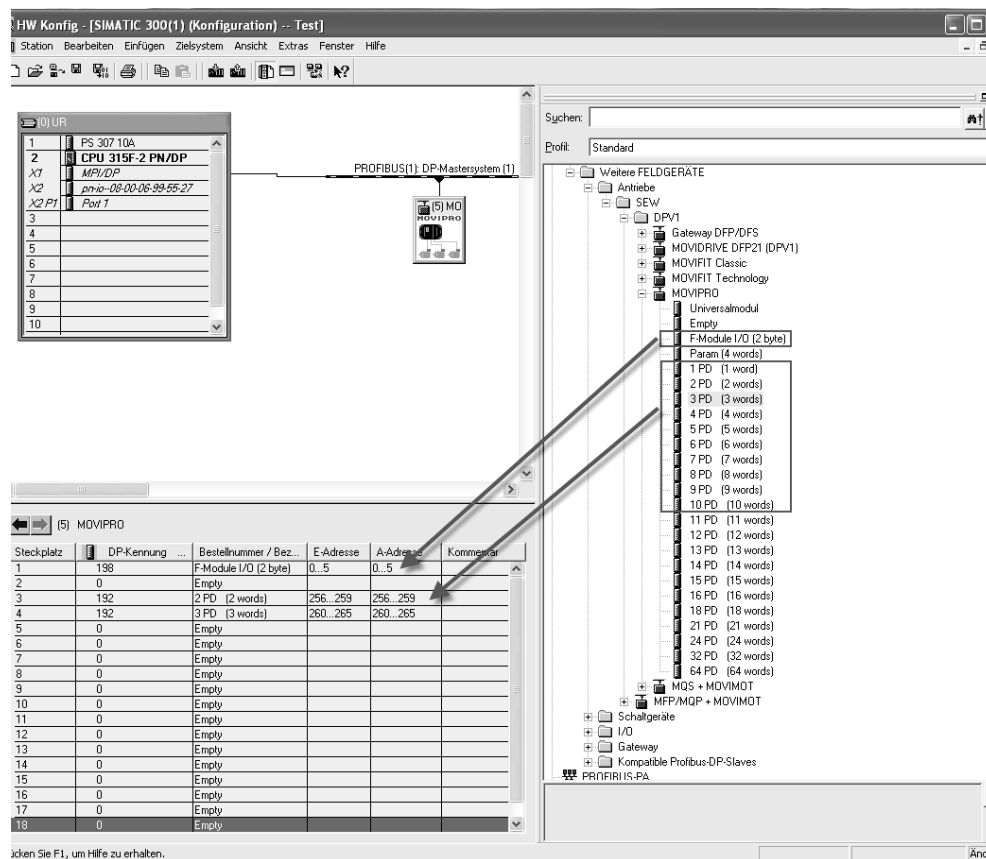
To ensure fault-free operation of the drive controller with PROFIsafe, you need the optional "Distributed Safety" package as of version V5.4 for configuration and parameterization under STEP7.

Proceed as follows for the configuration:

1. Make sure that you have installed the latest version of the appropriate GSD file.
2. In slot 1, configure the "F module I/O (2 byte)".



- Enter the corresponding I/O or peripheral addresses. The following figure shows a sample configuration of a drive controller with function level "Classic" with PROFINET.



18014400148679819

- Next, you have to parameterize the PROFIsafe option S11.

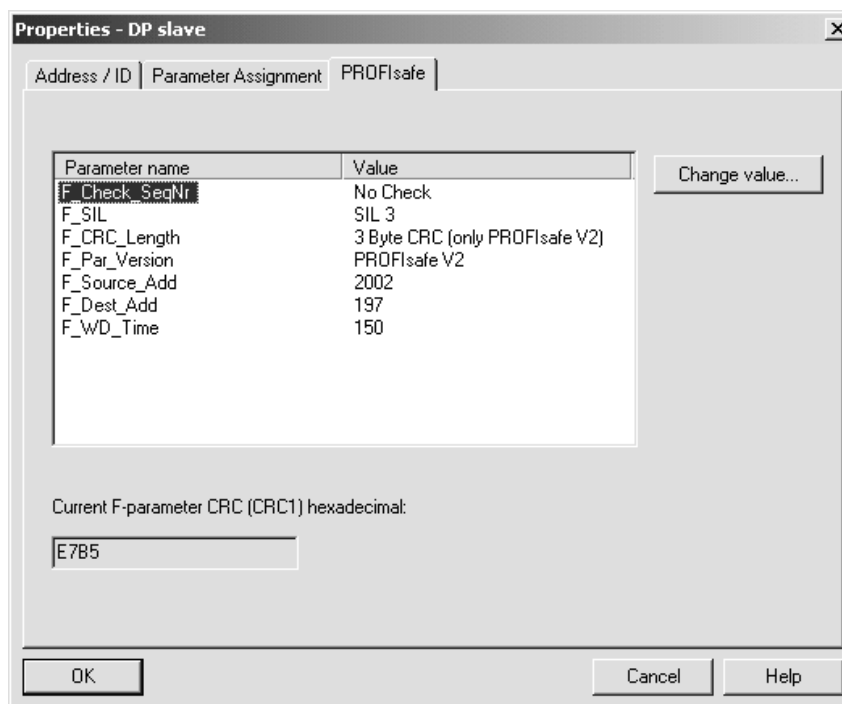
5.4.3 Parameterization

Proceed as follows for the parameterization:

- Right-click on the node "F module I/O (2 byte)". The context menu opens.
- Select the [Object properties] menu item. The "Object properties" window is displayed.
- Select the tab "PROFIsafe" or "F parameter". You will see a list of possible parameters.



The following figure shows the "Object properties" window for a PROFIBUS unit:



1639207179

Depending on the bus system being used, the following parameters are available:

PROFIsafe F parameter	Bus system	
	PROFIBUS DP	PROFINET IO
F_Check_SeqNr	Fixed	Not installed
F_SIL	Fixed	Fixed
F_CRC_Length	Variable	Fixed
F_Par_Version	Variable	Fixed
F_Source_Add	Fixed	Fixed
F_Dest_Add	Variable	Variable
F_WD_Time	Variable	Variable

When the fieldbus or network systems starts up, the bus master for PROFIsafe operation sends the safety-relevant parameters in an F parameter block to the PROFIsafe option S11 of the drive controller. The PROFIsafe option S11 checks the plausibility of the parameters. The PROFIsafe option S11 only exchanges data with bus master after positive confirmation for this F parameter block has been received. Below is a list of the safety-related parameters which are passed on to the PROFIsafe option.

Parameter
"F_Check_SeqNr"

This parameter determines whether the ready counter (consecutive number) is to be included in the consistency check (CRC calculation) of the F user data telegram.

The PROFIBUS version supports the following setting:

- F_Check_SeqNr = "No check"

Parameter "F_SIL"

This parameter allows F stations to check whether the safety category matches that of the F host. Depending on the risk, different safety circuits with different safety classes SIL 1 to SIL 3 (SIL = Safety Integrity Level) apply in these safety-related cases.



The PROFIsafe option S11 supports the following setting:

- F_SIL = SIL 3

Parameter
"F_CRC_Length"

Depending on the length of the F user data (process values) and the PROFIsafe version, the length of the required CRC check value varies. This parameter communicates the anticipated length of the CRC2 key in the safety telegram to the F component.

The PROFIsafe option S11 handles user data that is less than 12 bytes in length, so that with PROFIsafe V1, a 2 byte CRC is used and with PROFIsafe V2, a 3 byte CRC is used.

The PROFIsafe option S11 supports the following settings:

- F_CRC_Length = 2 byte CRC (only with PROFIsafe V1 combined with PROFIBUS)
- F_CRC_Length = 3 byte CRC (only with PROFIsafe V2)

Parameter
"F_Par_Version"

This parameter identifies the PROFIsafe version supported by PROFIsafe option S11. When using a drive controller with PROFIBUS, you can choose between PROFIsafe V1 and PROFIsafe V2: The PROFINET variant only supports PROFIsafe V2.

Parameter
"F_Source_Add"

The PROFIsafe addresses are used for unique identification of the source (F_Source_Add) and destination (F_Dest_Add). The combination of source and target address must be unique across the network and all stations. Depending on the master configuration, the source address F_Source_Add is automatically provided by STEP7.

Values ranging from 1 to 65534 can be entered in parameter "F_Source_Add".

You cannot directly edit this parameter in STEP7-HW Config.

Parameter
"F_Dest_Add"

This parameter is used to enter the PROFIsafe address previously set for the drive controller in MOVITOOLS® MotionStudio.

Parameter
"F_WD_Time"

This parameter defines a monitoring time in the failsafe PROFIsafe option S11.

A valid safety telegram must arrive from the F-CPU within this monitoring time. Otherwise the PROFIsafe option S11 reverts to safe status.

Select a monitoring time of a sufficient length so that communication can tolerate message delays, but also sufficiently short enough for your safety application to run without restriction.

With the PROFIsafe option S11, you can enter the "F_WD_Time" parameter in steps of 1 ms, ranging from 1 ms to 10 s.

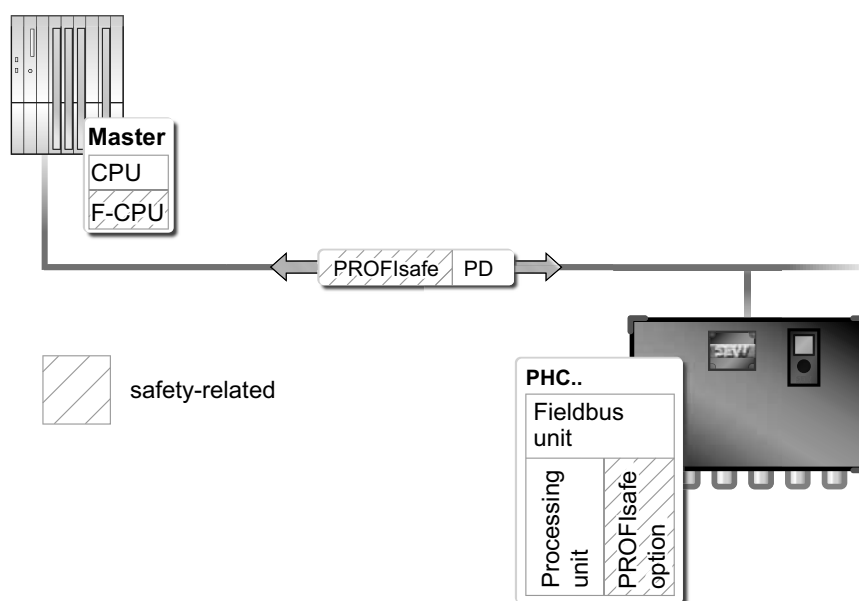


5.5 Data exchange with PROFIsafe option S11

5.5.1 General information

MOVIPRO® units with integrated PROFIsafe option S11 support parallel operation of standard and safety-relevant communication via a bus system or network. You can run safety-oriented PROFIsafe communication using PROFIBUS DP and PROFINET IO.

The data exchange between bus master and the drive controller takes place via the respective communication system that simultaneously acts as a "gray channel" for the safety-oriented application. The transmitted bus messages contain standard information for conventional drive controller operation and the PROFIsafe safety telegram. Depending on the configuration, the maximum available expansion level enables exchanges of PROFIsafe safety data, parameter and process data between the bus master and the drive controller.



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5.5.2 Access to F periphery of PROFIsafe option S11 in STEP7

For safety-related communication, the PROFIsafe option S11 requires a total of 6 bytes for the PROFIsafe telegram portion and 6 bytes for the process image. Of these, 2 bytes (= 16 bits) constitute the actual safety-related I/O data (F user data), and the remaining 4 bytes are required for storing the telegram in accordance with the PROFIsafe specifications ("PROFIsafe" header).

F periphery DB

During compilation in the HW Config tool, the system automatically generates an F periphery DB for every PROFIsafe option S11. The F periphery DB provides an interface through which you can evaluate or control variables in the safety program.

The symbolic name consists of the invariable prefix "F", the start address of the F periphery, and the name entered in the object properties during configuration for the F periphery (e.g. F00008_198).



PROFIsafe Option S11

Data exchange with PROFIsafe option S11

The following table shows the F periphery DB of the PROFIsafe option S11:

	Address	Symbol	Data type	Function	Preset
User-controllable variables	DBX0.0	"F00008_198.PASS_ON"	Boolean	1 = activate passivation	0
	DBX0.1	"F00008_198.ACK_NEC"	Boolean	1 = Acknowledgment required for reintegration with the PROFIsafe option S11	1
	DBX0.2	"F00008_198.ACK_REI"	Boolean	1 = acknowledgment for reintegration	0
	DBX0.3	"F00008_198.IPAR_EN"	Boolean	Variable for resetting parameters (not supported for PROFIsafe option S11)	0
Variables that you can evaluate	DBX2.0	"F00008_198.PASS_OUT"	Boolean	Run passivation	1
	DBX2.1	"F00008_198.QBAD"	Boolean	1 = substitute values are output	1
	DBX2.2	"F00008_198.ACK_REQ"	Boolean	1 = acknowledgment required for reintegration	0
	DBX2.3	"F00008_198.IPAR_OK "	Boolean	Variable for resetting parameters (not supported for PROFIsafe option S11)	0
	DBB3	"F00008_198.DIAG"	Byte	Service information	

PASS_ON

This variable lets you activate a passivation of the PROFIsafe option S11. Provided that *PASS_ON* = 1, the F periphery is passivated.

ACK_NEC



⚠ WARNING

The variable *ACK_NEC* = 0 may only be set if automatic reintegration is safe for the process in question.

Severe or fatal injuries.

- Check if automatic reintegration is permitted for the process in question.

After a fault has been corrected, the PROFIsafe option S11 is reintegrated, depending on *ACK_NEC*.

- *ACK_NEC*=0: Automatic reintegration
- *ACK_NEC*=1: Reintegration following acknowledgement by the user

ACK_REI

In order to reintegrate PROFIsafe option S11 after the fault has been corrected, user acknowledgement with positive edge of variable *ACK_REI* is required. Acknowledgement is only possible if variable *ACK_REQ* = 1.

PASS_OUT

Indicates whether PROFIsafe option S11 has been passivated. Substitute values are output

QBAD

Error during data exchange with PROFIsafe option S11. Indicates passivation. Substitute values are output

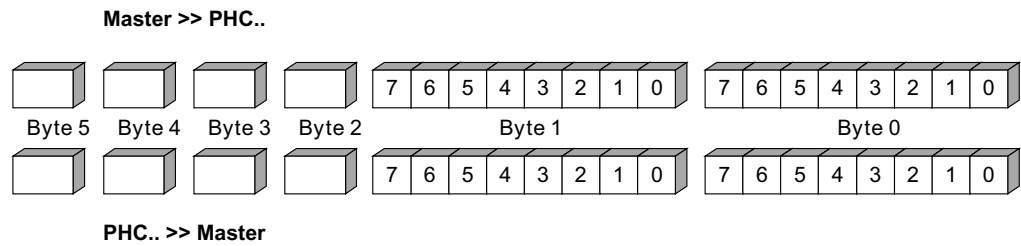


DIAG

For service information purposes, the variable DIAG supplies non-failsafe information about errors that have occurred in the F control system. For further information, refer to the relevant F control system manual.

5.5.3 F user data

F user data coding is based on the "PROFIdrive on PROFIsafe" V1.0 specifications (PNO order No. 3.272). The "PROFIdrive Safety Block 1" specified there is mapped in byte 0. Byte 1 is manufacturer-specific. With the PROFIsafe option S11, it is used for the safe inputs and outputs.



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Output data					
Byte	Bit	Name	Default	Function	Comment
0	0	STO	0	Safe torque off	0-active
	1 – 7	–	0	Reserved	Do not use!
1	0 – 7	–	0	Reserved	Do not use!
2 – 5	–	–	–	Reserved for PROFIsafe telegram backup	–

Input data					
Byte	Bit	Name	Default	Function	Comment
0	0	POWER_REMOVED	0	Response safe output F-DO_STO switched– "Power removed"	1-active
	1 – 7	–	0	Reserved	Do not use!
1	0 – 7	–	0	Reserved	Do not use!
2 – 5	–	–	–	Reserved for PROFIsafe telegram backup	–

5.5.4 Example of PROFIsafe option S11 control

The example for triggering the failsafe functions of the PROFIsafe option S11 is based on the following assumptions:

- You have already created a safety program and a process group,
- An F control program module exists.

You can activate the failsafe functions and the F periphery as well as the evaluation of the responses by the F periphery by using flags. Note that in STEP7, flags are only per-



mitted as links between the standard user program and the safety program. Flags may not be used as buffers for F data.



INFORMATION

SEW-EURODRIVE accepts no liability for the information provided in this example. This example does not represent a customer-specific solution. Its aim is simply to assist the reader.

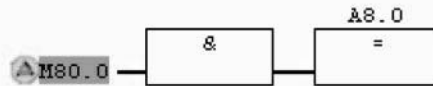
The following table shows the allocation of input/output addresses to flags.

Address	Symbol	Flag	Meaning
E 8.0	S11_PowerRemoved	M 8.0	Response: "Safe output switched"
A 8.0	S11_STO	M 80.0	Safe disconnection of the drive
DB811.DBX0.0	"F00008_198".PASS_ON	M 10.0	Activate passivation of S11
DB811.DBX0.1	"F00008_198".ACK_NEC	M 10.1	Set parameters for reintegration of S11
DB811.DBX0.2	"F00008_198".ACK_REI	M 10.2	Activate user acknowledgement of S11
DB811.DBX2.0	"F00008_198".PASS_OUT	M 10.3	Passivation of S11 has occurred
DB811.DBX2.1	"F00008_198".QBAD	M 10.4	Error in S11
DB811.DBX2.2	"F00008_198".ACK_REQ	M 10.5	Indicates whether user acknowledgement is required for reintegration of S11.



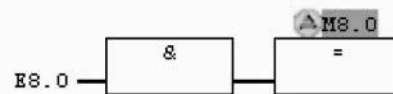
Netzwerk 1: Control STO

Kommentar:



Netzwerk 2: STO feedback

Kommentar:



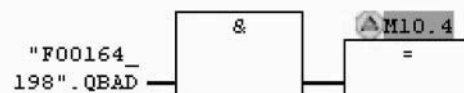
Netzwerk 3: F-feedback

l=PASSIVATION OUTPUT



Netzwerk 4: F-feedback

l=REPLACEMENT VALUES



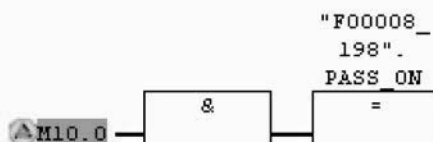
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**Netzwerk 5:** F-feedback

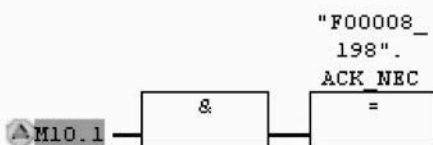
1=ACKNOWLEDGEMENT REQUEST

**Netzwerk 6:** User can activate passivation

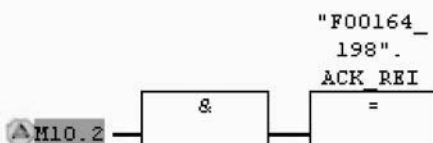
1=ACTIVATE PASSIVATION

**Netzwerk 7:** Parameterizes the reintegration

1=ACKNOWLEDGEMENT NECESSARY

**Netzwerk 8:** User must acknowledge the reintegration of S11

1=ACKNOWLEDGEMENT FOR REINTEGRATION OF S11



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5.6 Response times

Response times play a decisive role in the design and execution of safety functions of systems and machines. In order to match the response time to the requirements of a safety function, always take the entire system from sensor (or control device) to actuator into account. The following times are of particular importance in connection with the PROFIsafe option S11:

- PROFIsafe cycle time
- Processing time (cycle time) in the safety controller
- PROFIsafe monitoring time "F_WD_Time"
- Internal response time of PROFIsafe option S11
- Response and switching time of the actuators (axis module, brake module, and brake)

Establish the response sequence for each safety function in your application and determine the maximum response time for each case considering the relevant manufacturer data. Observe the information in the safety documentation of the used safety controller.

For data of the maximum response time of the PROFIsafe option S11, refer to section "Technical data" (page 39). For detailed information about response time consideration for safety-related PROFIsafe communication, refer to the respective standard: IEC 61784-3-3.

The maximum switch-off times for the safe axis and brake module are listed in the respective "Technical data" chapters.

5.7 Diagnostics



INFORMATION

Depending on the safety controller used, other terms may be used for "passivation" and "reintegration" in the safety controller documentation. For detailed information, refer to the safety controller documentation.

5.7.1 Error in the safety module

The PROFIsafe option S11 is capable of detecting errors. For information on the types of error, exact responses, and how to correct them, refer to the "PROFIsafe option S11 error table" section. If an error occurs in the safety module, the PROFIsafe option S11 usually responds by passivating the safety module and switching to substitute values instead of process values. All safety-related process values are set to "0" (→ safe condition).

After the error has been remedied, the PROFIsafe option S11 is reintegrated upon user acknowledgement.



5.7.2 PROFIsafe timeout



⚠ WARNING

Automation reintegration can also be set in the safety controller.

Severe or fatal injuries.

- Do not use this function in safety-related applications!

If safety-relevant PROFIsafe communication is interrupted or delayed, the PROFIsafe option S11 also responds with passivation after the adjustable monitoring time "F_WD_Time" (see description of F parameters) has expired, and assumes the safe status. After this time has expired, the relevant module is passivated in the safety control and the associated safety-oriented process values for the safety application are set to "0" (→ safe status).

Whenever passivation occurs, user acknowledgement is required to reintegrate the module in question.

5.7.3 Safety diagnostics via PROFIBUS DP

The state of PROFIsafe communication and error messages of the PROFIsafe option S11 are reported to the DP master using the status PDU in accordance with the PROFIBUS DPV1 standard.

Byte 11 is used for transferring diagnostics messages. These are defined in the PROFIsafe specification.

Bytes 12 and 13 send the status and error status of the PROFIsafe option S11 to the higher-level DP master.

The following overview shows the structure of the diagnostic data for the PROFIsafe communication via slot 1. In slot 1, the F module for the PROFIsafe option S11 is configured.

Status block							
Bytes 1 – 6	Byte 7	Byte 8	Byte 9	Byte 10	Byte 11	Byte 12	Byte 13
6 bytes standard diagnostics	Header	Status type	Slot number	Status specifier	Diag. user data 0	Diag. user data 1	Diag. user data 2
...	0x07	0x81	0x00	0x00	PROFIsafe	F state 1	
	↑	↑	↑	↑	↑	↑	↑
	7 bytes module-specific diagnostics	0x81 = Status block with status message	0x00 = Slot 1 (PROFIsafe option)	No DPV1 specifier	PROFIsafe diagnostics information in accordance with PROFIsafe profile V2.0	Cyclical F_State of the drive controller	



Diagnostic messages of the PROFIsafe layer

The following table shows the diagnostics messages of the PROFIsafe layer:

Byte 11	PROFIBUS diagnostic text (German)	PROFIBUS diagnostic text (English)
0 _{hex} / 0 _{dec}	Kein Fehler	–
40 _{hex} / 64 _{dec}	F_Dest_Add stimmt nicht überein	Mismatch of F_Dest_Add
41 _{hex} / 65 _{dec}	F_Dest_Add ist ungültig	F_Dest_Add not valid
42 _{hex} / 66 _{dec}	F_Source_Add ist ungültig	F_Source_Add not valid
43 _{hex} / 67 _{dec}	F_WD_Time ist 0 ms	F_WD_Time is 0 ms
44 _{hex} / 68 _{dec}	F_SIL Level größer max SIL Level	F_SIL exceeds SIL f. application
45 _{hex} / 69 _{dec}	Falsche F_CRC_Length	F_CRC_Length does not match
46 _{hex} / 70 _{dec}	Falsche F-Parameter Version	F-Parameter set incorrect
47 _{hex} / 71 _{dec}	Fehler im CRC1-Wert	CRC1 fault



INFORMATION

For more information on the meaning and remedy of error messages, refer to the manuals for the PROFIBUS DP master.

Error codes of the PROFIsafe option S11

The table below shows the error codes of the PROFIsafe option S11:

Byte 12	Byte 13	Designation (German)	Designation (English)	Meaning / error correction
00 _{hex} / 00 _{dec}	00 _{hex} / 00 _{dec}	Kein Fehler	–	See PROFIsafe option S11 error table (page 38)
	01 _{hex} / 01 _{dec}	Interner Ablauffehler	Internal sequence error	
	02 _{hex} / 02 _{dec}	Interner Systemfehler	Internal system error	
	03 _{hex} / 03 _{dec}	Fehler Kommunikation	Communication error	
	04 _{hex} / 04 _{dec}	Fehler Elektronikversorgung	Circuitry supply voltage fault	
	32 _{hex} / 50 _{dec}	Interner Fehler am sicheren Ausgang (F-DO_STO)	Internal error at failsafe output	
	33 _{hex} / 51 _{dec}	Kurzschluss am sicheren Ausgang (F-DO_STO)	Short circuit at safe output	
	34 _{hex} / 52 _{dec}	Überlast am sicheren Ausgang (F-DO_STO)	Overload at failsafe output	
	6F _{hex} / 111 _{dec}	Interner Kommunikationsfehler zur PROFIsafe-Option S11	Internal communication timeout	
	7F _{hex} / 127 _{dec}	Fehler Initialisierung PROFIsafe-Option S11	F init fault	



5.7.4 Safety diagnostics via PROFINET IO

The status of PROFIsafe communication and error messages of the PROFIsafe option S11 are reported to the PROFINET IO controller where they can then be diagnosed.

Diagnostic messages of the PROFIsafe layer

The following table shows the diagnostics messages of the PROFIsafe layer:

	PROFINET diagnostics text (German)	PROFINET diagnostics text (English)
0 _{hex} / 0 _{dec}	Kein Fehler	–
40 _{hex} / 64 _{dec}	F_Dest_Add stimmt nicht überein	Mismatch of F_Dest_Add
41 _{hex} / 65 _{dec}	F_Dest_Add ist ungültig	F_Dest_Add not valid
42 _{hex} / 66 _{dec}	F_Source_Add ist ungültig	F_Source_Add not valid
43 _{hex} / 67 _{dec}	F_WD_Time ist 0 ms	F_WD_Time is 0 ms
44 _{hex} / 68 _{dec}	F_SIL Level größer max SIL Level	F_SIL exceeds SIL f. application
45 _{hex} / 69 _{dec}	Falsche F_CRC_Length	F_CRC_Length does not match
46 _{hex} / 70 _{dec}	Falsche F-Parameter Version	F-Parameter set incorrect
47 _{hex} / 71 _{dec}	Fehler im CRC1-Wert	CRC1 fault



INFORMATION

For more information on the meaning of error messages and troubleshooting, refer to the PROFINET IO controller manuals.

Error codes of PROFIsafe option S11

The table below shows the error codes of the PROFIsafe option S11:

	Designation (German)	Designation (English)	Meaning / remedy
5F00 _{hex} / 24320 _{dec}	Kein Fehler	–	See error table of PROFIsafe option S11 (page 38)
5F01 _{hex} / 24321 _{dec}	Interner Ablauffehler	Internal sequence error	
5F02 _{hex} / 24322 _{dec}	Interner Systemfehler	Internal system error	
5F03 _{hex} / 24323 _{dec}	Fehler Kommunikation	Communication error	
5F04 _{hex} / 24324 _{dec}	Fehler Elektronikversorgung	Circuitry supply voltage fault	
5F32 _{hex} / 24370 _{dec}	Interner Fehler am sicheren Ausgang (F-DO_STO)	Internal error at failsafe output	
5F33 _{hex} / 24371 _{dec}	Kurzschluss am sicheren Ausgang (F-DO_STO)	Short circuit at failsafe output	
5F34 _{hex} / 24372 _{dec}	Überlast am sicheren Ausgang (F-DO_STO)	Overload at failsafe output	
5F7F _{hex} / 24447 _{dec}	Fehler Initialisierung PROFIsafe-Option S11	F init fault	

5.7.5 Error table for PROFIsafe option S11 error table

The PROFIsafe option S11 responds with the following measures to the errors listed in the table:

- Switching off the safe outputs (F-DO_STO = 0)
- Passivation of the PROFIsafe option S11

Error	Cause	Measure
00 / No error	–	–



Error	Cause	Measure
01 / Internal sequence error	Safety electronics faulty, possibly due to EMC influence	<ul style="list-style-type: none"> Check the installation (EMC) Switch the 24 V voltage off and on again Reintegration of the PROFIsafe option S11
02 / Internal system error		
03 / Communication error	PROFIsafe communication interrupted	<ul style="list-style-type: none"> Check the project planning (e.g. PROFIsafe monitoring time) Reintegration of the PROFIsafe option S11
04 / Electronics supply fault	Electronics supply is outside the specified limits	<ul style="list-style-type: none"> Check the installation (EMC) Switch the 24 V voltage off and on again Reintegration of the PROFIsafe option S11
50 / Internal error at safe output (F-DO_STO)	Safety electronics faulty, possibly due to EMC influence	<ul style="list-style-type: none"> Check the installation (EMC) Switch the 24 V voltage off and on again Reintegration of the PROFIsafe option S11
51 / Short circuit at safe output (F-DO_STO)	<ul style="list-style-type: none"> Short circuit to 24 V voltage supply or reference potential Short circuit between F-DO_STO_P and F-DO_STO_M 	<ul style="list-style-type: none"> Check installation / wiring and eliminate short circuit Reintegration of the PROFIsafe option S11
52 / Overload at safe output (F-DO_STO)	Overload at F-DO_STO (excessive current)	<ul style="list-style-type: none"> Check installation / wiring and eliminate overload Reintegration of the PROFIsafe option S11
111 / Internal communication error	Safety electronics faulty, possibly due to EMC influence	<ul style="list-style-type: none"> Check the installation (EMC) Switch the 24 V voltage off and on again Reintegration of the PROFIsafe option S11
127 / Initialization error	<ul style="list-style-type: none"> F_Dest_Add is set to zero The PROFIsafe option S11 is not compatible with the desired (configured) safety functions 	<ul style="list-style-type: none"> Use MOVITOOLS® MotionStudio to set F_Dest_Add to the configured value

5.8 Technical data

The technical data and approvals (CE, UL, etc.) of the respective basic MOVIPRO® unit apply to the overall MOVIPRO® system with PROFIsafe option S11. They are listed in the respective operating instructions.

The table below specifies the technical data of PROFIsafe option S11:

Safety characteristics for the PROFIsafe option S11	
Approved safety class	SIL3 to EN 61508; cat. 4/performance level e to EN ISO 13849-1
System structure	2 channels with diagnostics (1oo2D)
Operating mode selection	High demand rate according to EN 61508
Probability of dangerous failure per hour (PFH value)	$< 1 \times 10^{-9} \text{ h}^{-1}$
Service life (proof test interval in accordance with EN 61508)	20 years
Repair time	100 hours
Safe condition	Value "0" for all safety-related process values – safe outputs disabled
24 V supply (DC +24 V_IN)	$V_{IN} = \text{DC } 24 \text{ V} - 15\% / + 20\%$ according to IEC 61131-2



PROFIsafe Option S11

Technical data

Safety characteristics for the PROFIsafe option S11	
Own consumption	≤ 250 mA
F-DO_STO P-M switch	
Response time (command via PROFIsafe → the output switches)	≤ 25 ms
General technical data	
Overvoltage category	Category III according to IEC 60664-1:2003-11



6 Safety Relays

6.1 Safety technology conditions

6.1.1 Overview

A requirement for safe operation is that the safety functions of the MOVIPRO® units are properly integrated into an application-specific, higher-level safety function or safety system. The system or machine manufacturer has to make a risk analysis for this purpose. The required safety requirements and functions must be validated before startup.

The system/machine manufacturer and the operator are responsible for compliance of the system/machine with applicable safety regulations.

The following requirements are mandatory when installing and operating MOVIPRO® units in safety-related applications.

The requirements are divided into:

- Approved devices
- Installation requirements
- Requirements for external safety controllers and safety relays
- Startup requirements
- Operation requirements

6.1.2 Approved devices

For applications with safety-related disconnection of the drive, only MOVIPRO® that meet the following requirements are permitted:

- In the operating instructions, the implementation of the "safety relay" safety concept is explicitly listed as possible.
- The unit has an internal function module of the function category "safety monitor" with monitor type "safety relay". It is listed on the function module nameplate as "PFS-SR001A..".

6.1.3 Installation requirements

The installation requirements (page 8) apply.

6.1.4 Requirements for external safety devices

Independent from the controller (software), all safety devices must directly affect the safety circuit (disconnection path) so that the drives can be switched to safe state immediately.

You may only connect those safety devices that have been approved for the respective application. For example the following safety devices:

- Electro-sensitive protective equipment according to EN 61496-1 (laser scanner)
- Emergency stop devices according to EN ISO 13850

All safety-related subsystems must at least be approved for the safety class that is required for the safety function of the complete system.



6.1.5 Startup requirements

In addition to the startup requirements (page 10), the following applies:

- In order to verify the diagnostics, you have to check the diagnostics function by implementing an error.

6.1.6 Operation requirements

In addition to the operational requirements (page 11), the following applies:

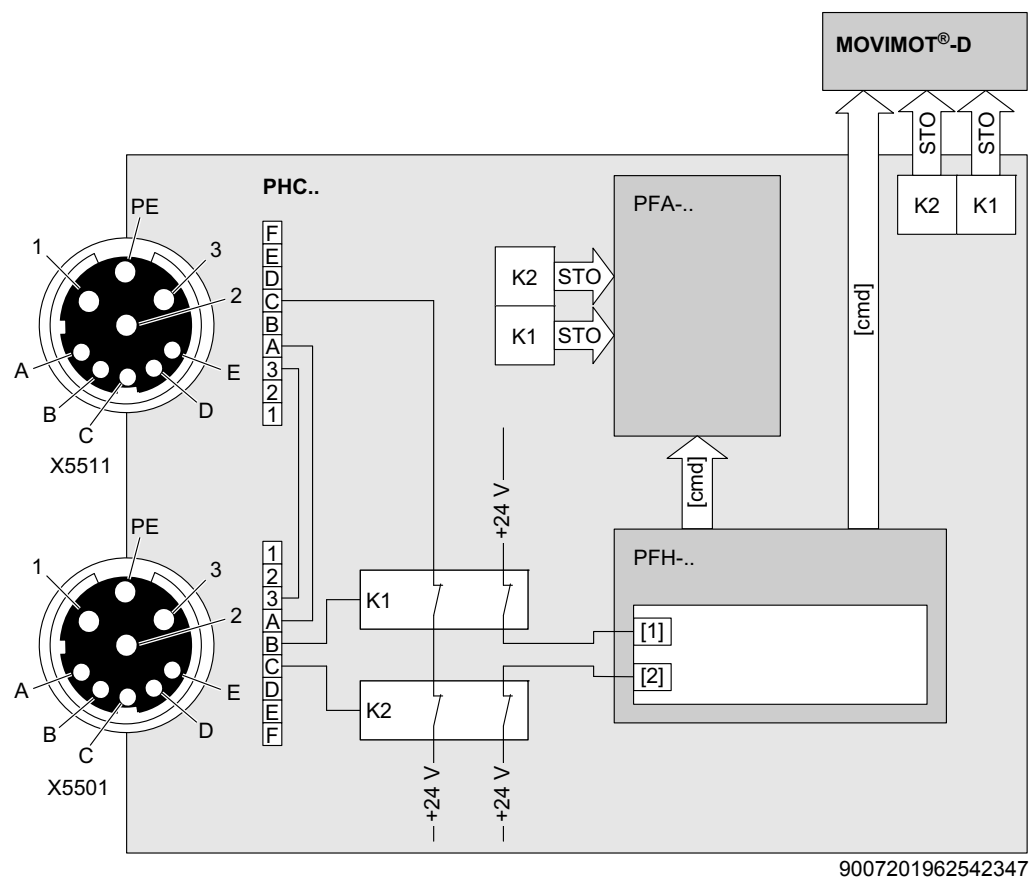
- The time between inspections must not exceed 3 months.

6.2 Safety concept

6.2.1 Basis of the safety concept

The safety concept is based on the principle of the safely disconnected torque of the connected drives when the connected emergency stop signal units or safety sensors are tripped. The safe state is the safely disconnected torque on each drive axis.

The following figure shows the safety concept:



- [1] Binary input for diagnostics K1
 [2] Binary input for diagnostics K2
 [cmd] Travel command
 PFA-.. Internal axis
 PFH-.. Communication and control unit



6.2.2 Functional description

The following sections refer to the safety concept illustration of the safety relay.

Disconnection function

If the safety function has been triggered by the connected safety sensor (e.g. laser scanner), the safety sensor disconnects control input 1 (connection X5511, terminal "OSSD1_IN") and control input 2 (connection X5511, terminal "OSSD2_IN").

The safety function can also be tripped by one of the connected emergency stop signal units (e.g. connecting block or emergency stop switch). The emergency stop signal units disconnects control input 1 (connection X5501, terminal "Control input relay 1") and control input 2 (connection X5501, terminal "Control input relay 2").

Disconnecting control input 1 de-energizes relay K1. Disconnecting control input 2 de-energizes relay K2. As a result, the safety contacts of relays K1 and K2 open. The contacts of the relays disconnect the safety-related voltage of the connected frequency inverters. By connecting the contacts in series, the safety-related voltage supply of the connected frequency inverters is disconnected via 2 channels, which triggers the STO function of the frequency inverters. This ensures that the torque of all drives is switched off safely.

Restart behavior

An automatic restart is possible or a manual reset is required prior to the restart, depending on the application and the connected safety sensors or emergency stop signal units. Observe the risk analysis and the applicable regulations and C standards for the application. The connected devices must be approved for the respective application.

The logic in the drive controller manages the restart behavior. An automatic restart is possible or a manual reset is required prior to the restart depending on the signal state of the signal input of the emergency stop circuit (connection X5501, terminal "E-Stop SC / Signal input of emergency switch-off circuit").

Manual restart

An automatic restart is not permitted with the following input signal:

Connection	Feedback input	Signal
X5501	E-Stop SC / Signal input of emergency switch-off circuit	Low (0 V)

The unit must be reset manually, e.g. via a connected button. The drives are blocked via the set points until a reset has been performed.

If the controller detects an error, the manual reset command will not be accepted until

- the error has been corrected and
- the safety function has been triggered again.

For information on the approved restart behavior and safety devices, refer to the risk analysis.

Automatic restart

An automatic restart is permitted with the following input signal:

Connection	Feedback input	Signal
X5501	E-Stop SC / Signal input of emergency switch-off circuit	High (24 V)



Once the connected safety sensors activate the two safety outputs, the drives are accelerated to the setpoint speed automatically.

If the controller detects an error, the manual reset command will not be accepted until

- the error has been corrected and
- the safety function has been triggered again.

For information on the approved restart behavior and safety devices, refer to the risk analysis.

6.2.3 Control software requirements

The functions described below have to be implemented in the control software in order to realize the diagnostics functions (page 49) and the restart control.

Checking the correct disconnection

If the control inputs 1 and 2 (X5501 pin B and C, control inputs relay 1 and 2) do not reach identical signal levels (low signal) within 500 ms after the safety function has been activated, the unit will not perform a restart. The following is ensured:

- The controller will not send any further travel commands to the frequency inverters until the error has been corrected.
- This error cannot be reset.
- An error message will be generated and displayed.
- The safety function must be triggered and checked again in order to perform a reset.

The restart conditions are met and a restart may be performed if the auxiliary relay contacts at the control inputs 1 and 2 reach an identical signal level (low signal) within 500 ms.

Checking the correct connection

If the control inputs 1 and 2 (X5501 pin B and C, control inputs relay 1 and 2) do not reach identical signal levels (high signal) within 500 ms after the safety function has been deactivated, the unit will not perform a restart. The following is ensured:

- The controller will not send any further travel commands to the frequency inverters until the error has been corrected.
- This error cannot be reset.
- An error message will be generated and displayed.
- The safety function must be triggered and checked again in order to perform a reset.

The restart conditions are met and a restart may be performed if the auxiliary relay contacts at the control inputs 1 and 2 reach an identical signal level (high signal) within 500 ms.

Controlling the restart behavior

An automatic restart can be performed if the signal input E-Stop SC (X5501 Pin D, Signal input of emergency switch-off circuit) has a high signal when the safety function has been activated and relays K1 and K2 have been disconnected correctly.

A manual reset is required prior to the restart if the signal input E-Stop SC (X5501 Pin D, Signal input of emergency switch-off circuit) has a low signal when the safety function has been activated and relays K1 and K2 have been disconnected correctly. The device must be reset via a manual command via a "High edge signal" at a binary input (X5001).



Behavior after a voltage failure or power on/off The safety function must be triggered and checked again in order to perform a reset. If control inputs 1 and 2 connect and disconnect simultaneously within 500 ms, the restart conditions are met and a restart can be performed.

Messages and displays An error message is generated and displayed in the event of an error.

6.3 Connection variants



INFORMATION

The user installation must be implemented according to EN 60204-1. As the drive controller does not detect all errors in the external wiring, the user is responsible for the error analysis.

6.3.1 With safety laser scanner

General information Note that

- both signals, "Control input relay 1" and "Control input relay 2" must not be bypassed.
- only shielded cables may be used for the installation.

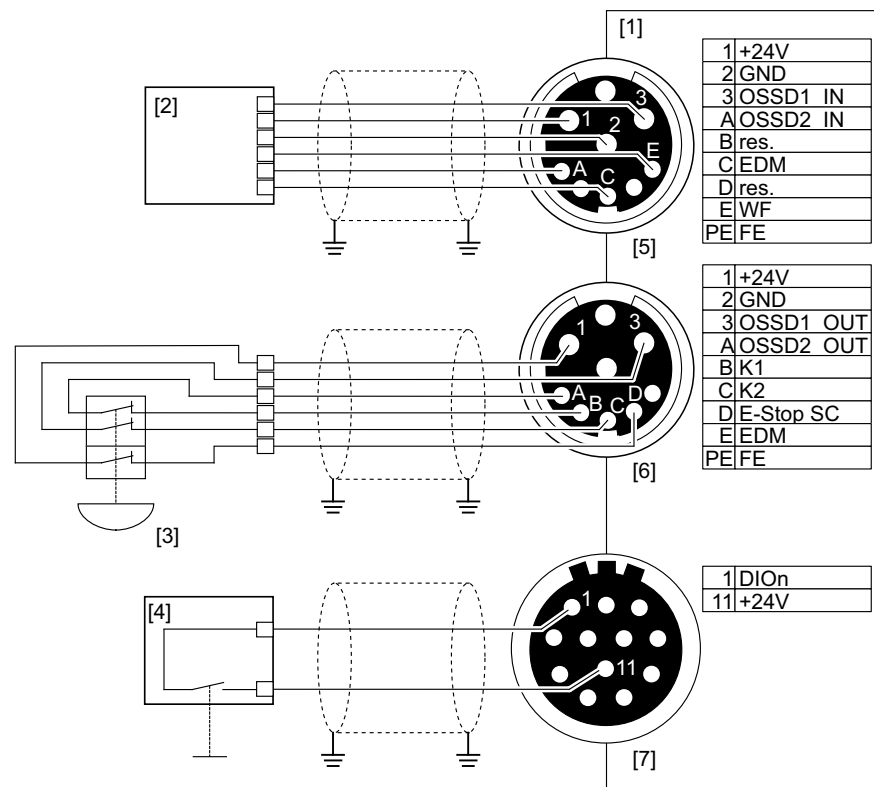


Safety Relays

Connection variants

Installation

The following figure shows the connection variant with safety laser scanner.



9007201974397451

- [1] Drive controller
- [2] Safety laser scanner
- [3] Emergency stop actuator
- [4] Reset button
- [5] X5511: Connection for electro-sensitive protective equipment
- [6] X5501: Port for safe disconnection
- [7] X5001: Digital inputs/outputs – communication and control unit

6.3.2 Without safety laser scanner

General information

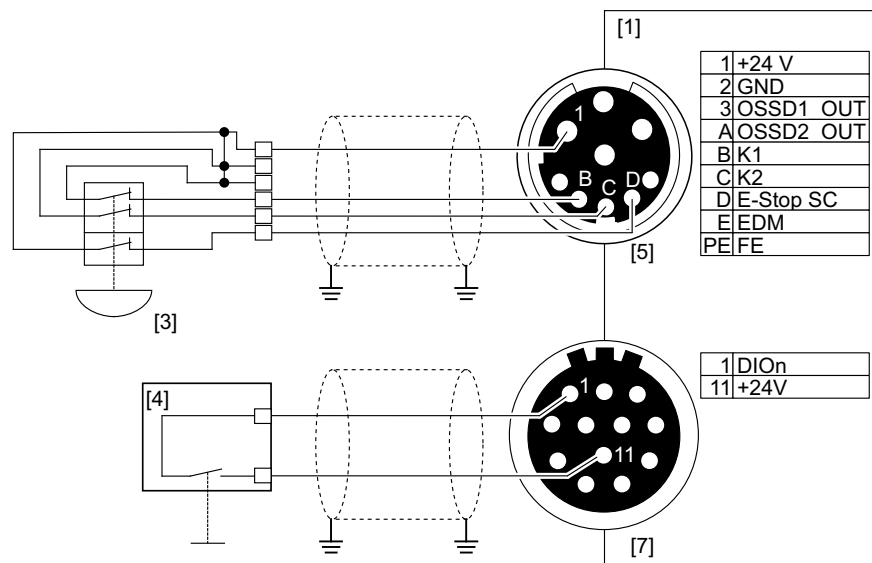
Note that

- both signals, "Control input relay 1" and "Control input relay 2" must not be bypassed.
- only shielded cables may be used for the installation.



Installation

The following figure shows the connection variant without safety laser scanner.



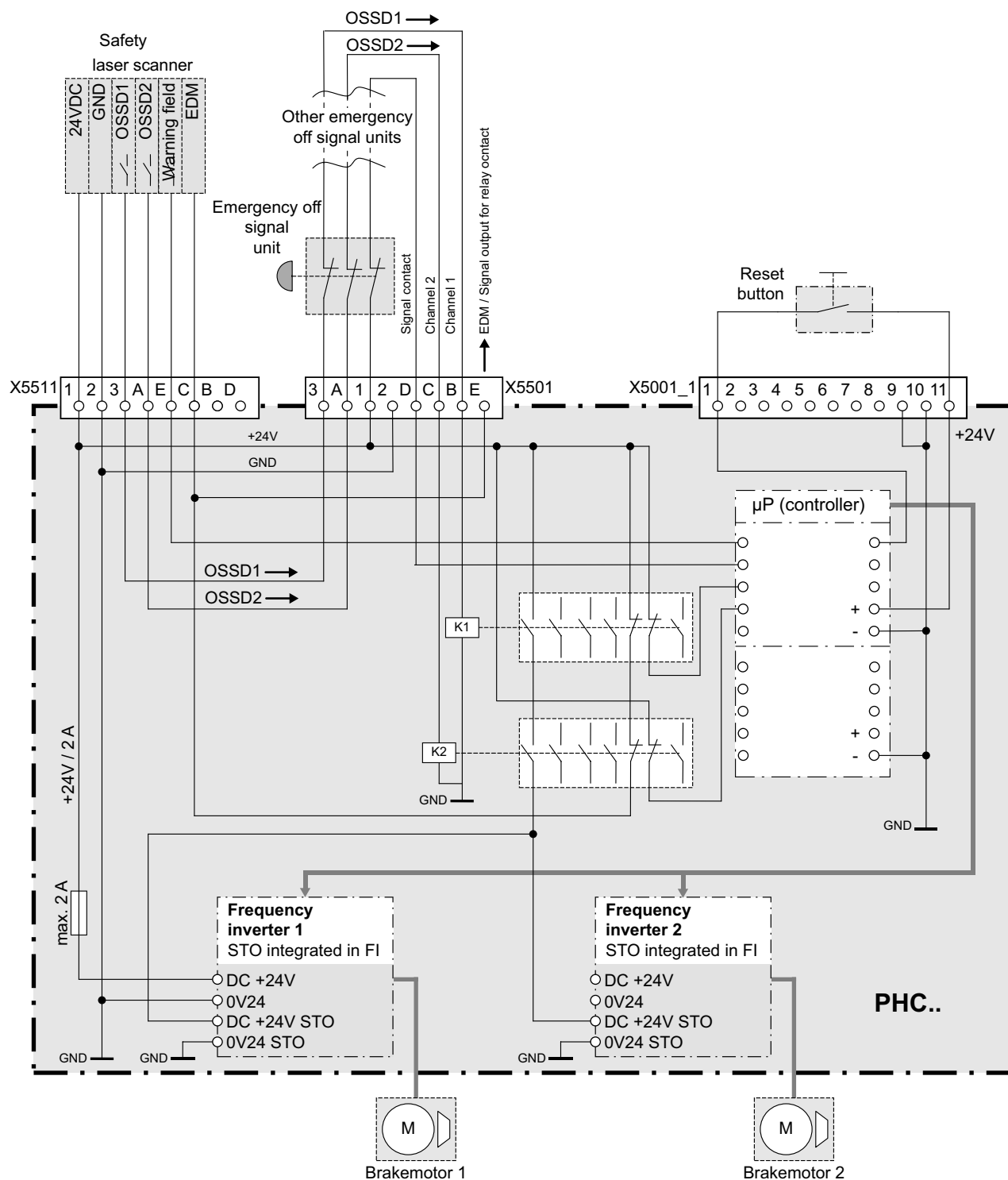
9007201974407563

- [1] Drive controller
- [3] Emergency stop actuator
- [4] Reset button
- [5] X5501: Port for safe disconnection
- [7] X5001: Digital inputs/outputs – communication and control unit



6.4 Application example

The following wiring diagram shows the installation in an automated guided vehicle (AGV).



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If the safety function is triggered via one of the connected safety sensors or an emergency stop signal device, the torque of the axis is disconnected at the frequency inverter in a safe way.



The emergency stop signal devices are designed according to EN ISO 13850 and are equipped with positive opening contacts according to EN 60947-5-1, appendix K.

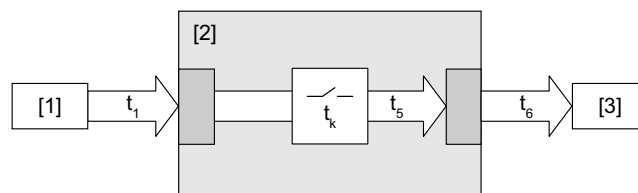
The safety laser scanner according to EN 61496-1 is used for the protection of persons and equipment with performance level d according to EN 13849 and SIL 2 according to EN 61508.

The safety-related control cables are shielded according to EN 60204-1.

According to EN 1525, the restart of the AGV may be performed automatically after 2 seconds once the safety laser scanner has tripped. The time control is performed by the safety laser scanner while the 2 safety outputs (OSSD) remain disconnected. Subsequently, the unit allows for an automatic restart. In the event of an emergency stop via an emergency stop signal device, a restart requires a manual reset via a button, for example.

6.5 Response times

The following figure shows the response sequence in conjunction with the safety relay:



2719701899

- [1] Safety relay
- [2] Drive controller
- [3] Actuator

Response time from the safety relay to the actuator		
t_1	Response time of the safety relay	According to the manufacturer
t_k	Relay release time	140 ms
t_5	Time until the output stage is switched off	100 ms
t_6	Response/switching time of the actuator	According to the manufacturer
Total		

6.6 Diagnostics

The service unit of MOVIPRO® units is equipped with a 3-digit 7-segment display. It shows the status of the drive controller.

The 7-segment display can show two different error types:

Display	Meaning
	An error has occurred (error type: "Error Pending"). The error is displayed in combination with an error number. Error type and number are displayed alternately.
	An error has occurred, the drive controller must be reset manually (error type: "Error Acknowledge"). The error is displayed in combination with an error number. Error type and number are displayed alternately.



The following status messages of the 7-segment display are safety-relevant:

Display	Meaning
	Emergency stop activated via an emergency stop device is active.
	Emergency stop activated via a contactless protection device is active.
	An error has occurred in one of the disconnection channels (channel 1 or channel 2). The disconnection channel was not triggered, or an internal safety relay has not worked correctly.

6.7 Technical data

The technical data and approvals (CE, UL, etc.) of the respective basic MOVIPRO® unit apply to the overall MOVIPRO® system with safety relay. They are listed in the respective operating instructions.

The following table lists the specific technical data of the PFS-SR001A.. function module:

Safety characteristics of PFS-SR001A.. function module.	
Approved safety class	Performance level d according to EN ISO 13849-1
System structure	2 channels with diagnostics (1oo2D)
Operating mode selection	High demand rate according to EN 61508
Probability of dangerous failure per hour (PFH value)	$25 \times 10^{-9} \text{ h}^{-1}$
Service life	20 years or 780 000 switching cycles
Repair time	100 hours
Safe condition	Safe torque off at all drive axes
DC 24 V voltage supply	The DC 24 V voltage supply for external safety devices is fused with 2 A.
Inspection interval for the safety function	Max. 3 months



7 Restrictions

- **Important:** The standard brakes of brakemotors are usually not designed to be safety-related. They are not part of the safety functions described in this documentation.

If the motor brake fails, the drive can coast for much longer depending on the application, i.e. the friction and inertia of the system. In case of regenerative loads (e.g. lifting axes, declining conveying lines), the drive can even accelerate. This must be taken into account for the risk analysis of the system/machine and prevented by safety-related additional measures (e.g. safety-rated braking system), if required.

- **Important:** When using the SS1(c) function, the brake ramp of the drive is not monitored with respect to safety.

In case of a fault, the drive might not be braked after the delay time, or it might be accelerated in the worst case. In this case, the STO function (see above) is only activated after the set time delay has elapsed. The resulting danger must be taken into account for the risk analysis of the system/machine. Additional safety measures have to be implemented if required.

- **Important:** The system/machine manufacturer must perform a system/machine-specific risk analysis. The use of the MOVIPRO[®] drive system must be considered for this purpose.
- **Important: The safety concept is only suitable for performing mechanical work on the system/machine components.**
- **Danger of fatal injury:** If the DC 24 V power supply is disconnected, the inverter DC link continues to carry voltage.
- **Important: Before carrying out work on the electrical section of the drive system, the supply voltage must be disconnected using an external maintenance switch.**



8 Address List

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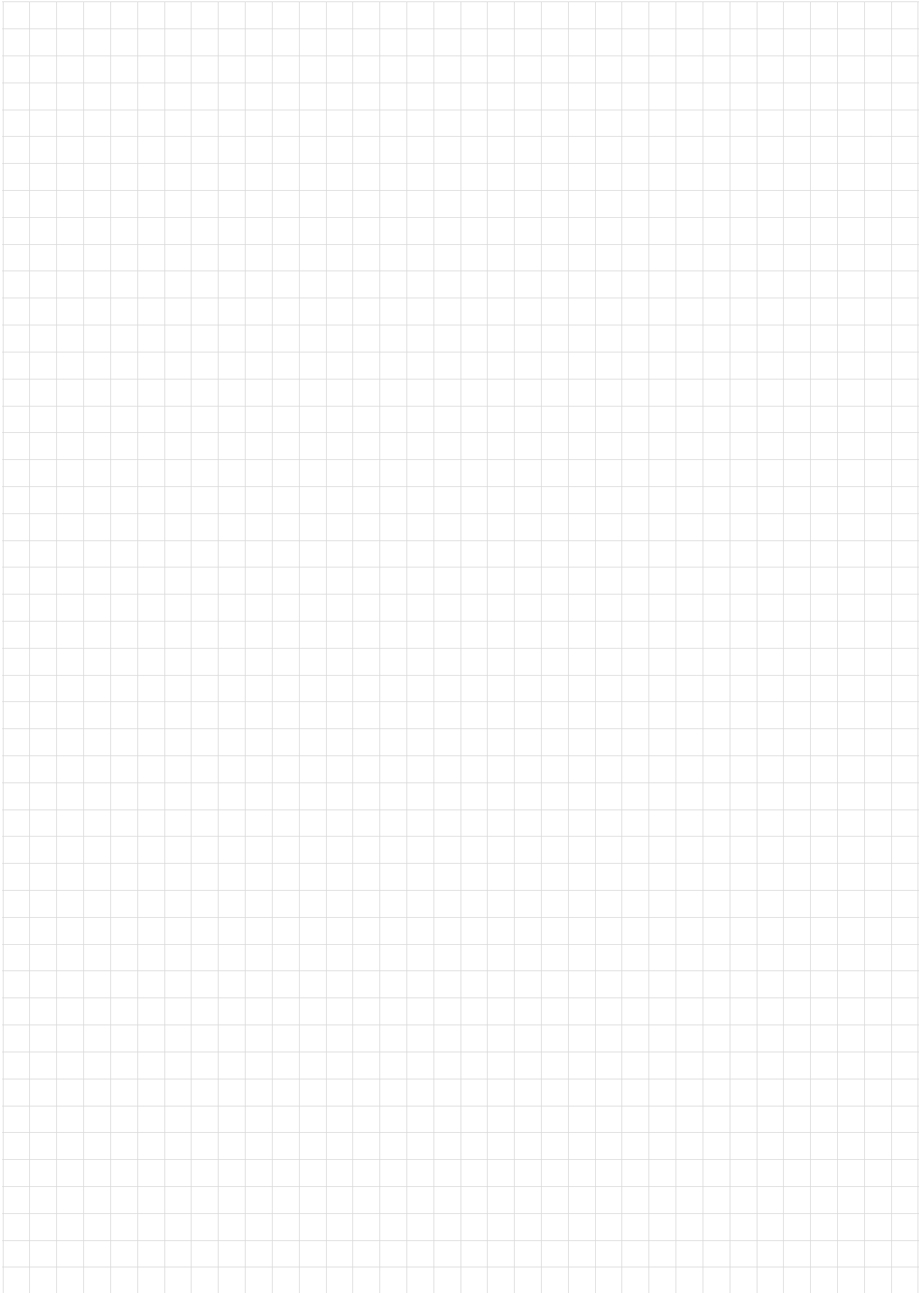
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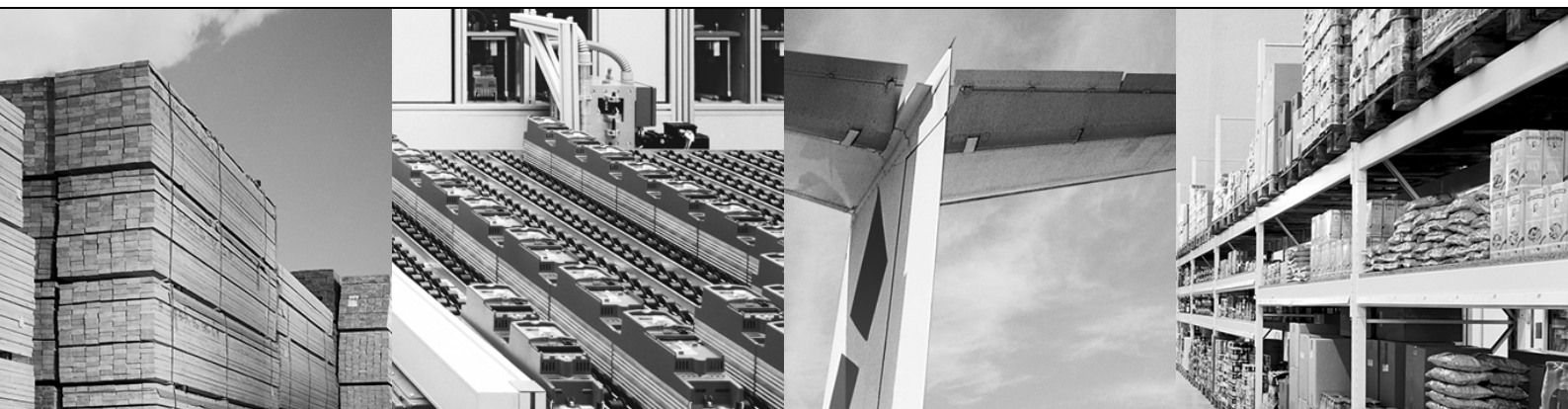
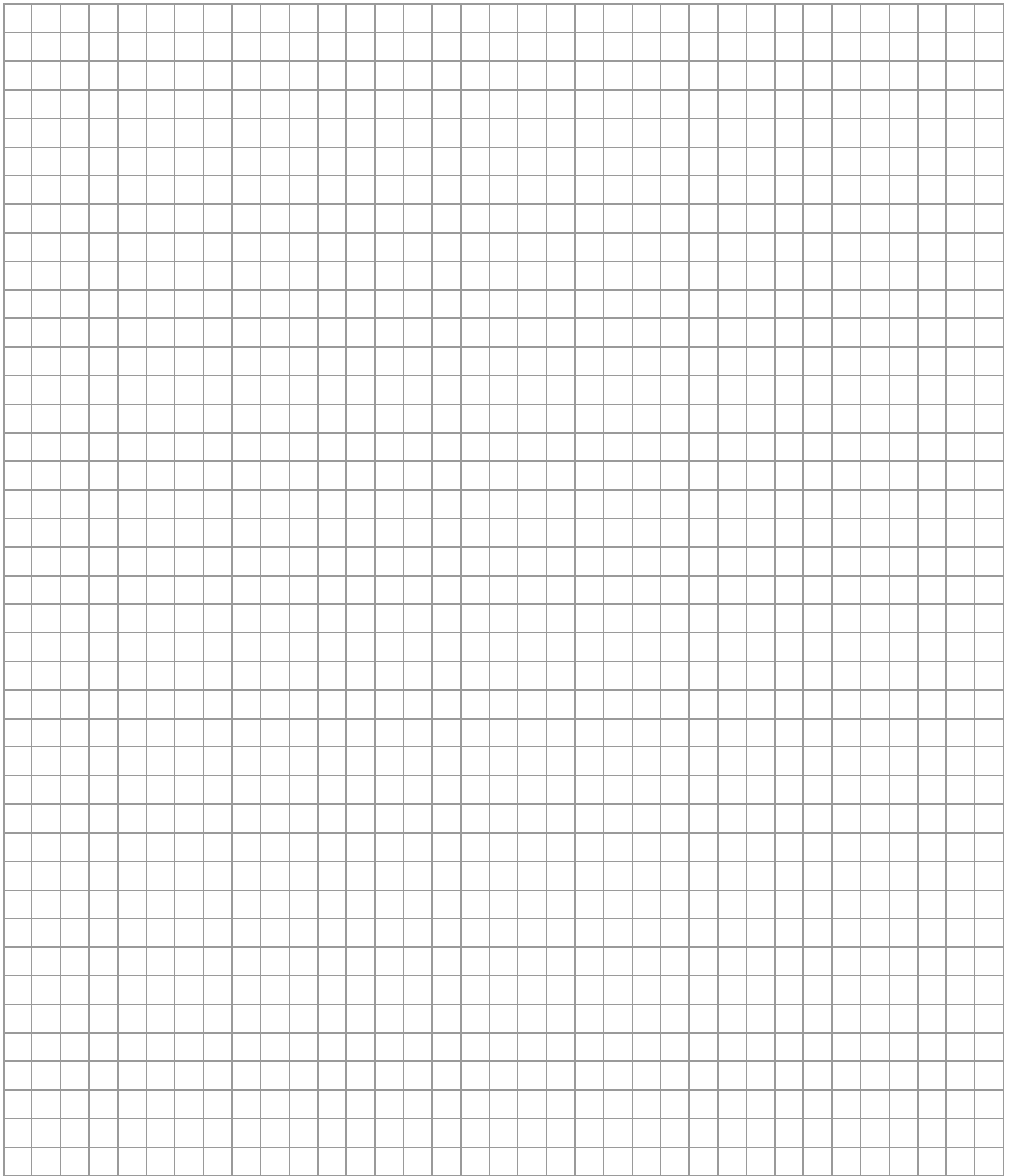


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