SEW EURODRIVE

Manual

MOVIDRIVE® MDX60B/61B
Functional Safety

Edition 09/2010

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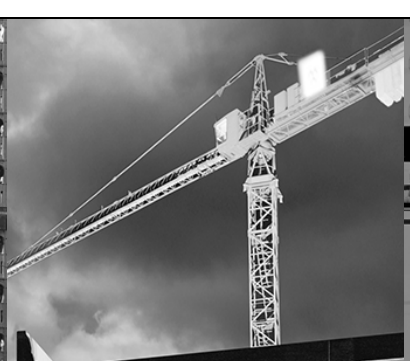


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Contents

1 Important Information

1.1 About this manual

The manual is part of the product and contains important information about installation, startup, operation and service. The manual is written for everyone installing, starting up or servicing this product.

The manual 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 manual 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

The safety notes in these operating instructions are designed as follows:

Pictogram	⚠ SIGNAL WORD
	Type and source of danger. Possible consequence(s) if disregarded. • Measure(s) to prevent the danger.

Pictogram	Signal word	Meaning	Consequences if disregarded
Example:  General danger  Specific danger, e.g. electric shock	⚠ **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.	

1.3 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 MOVIDRIVE® documentation. Therefore, read the operating instructions before you start working with the unit.

Make sure that the documentation is available to persons responsible for the system and its operation as well as to persons who work independently on the unit. You must also ensure that the documentation is legible.

1.4 Exclusion of liability

You must comply with the information contained in these operating instructions to ensure safe operation of the MOVIDRIVE® MDX60B/61B inverters and to achieve the specified product characteristics and performance requirements. SEW-EURODRIVE does not assume 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 Copyright notice

1.6 Content of this publication

This publication contains conditions and amendments related to MOVIDRIVE® MDX60B/61B in safety-related applications.

The system comprises a drive inverter with AC motor and safety-tested external disconnecting device.

1.7 Applicable documentation

This document supplements the MOVIDRIVE® MDX60B/61B operating instructions and limits the application notes according to the following information. It may only be used in conjunction with the MOVIDRIVE® MDX60B/61B operating instructions.

2 Integrated Safety Technology

The safety technology of MOVIDRIVE® MDX60B/61B described below has been developed and tested in accordance with the following safety requirements:

- Category 3 according to EN 954-1
- PL d according to EN ISO 13849-1

This was certified by TÜV Nord. Copies of the TÜV certificate and the corresponding report are available from SEW-EURODRIVE on request.

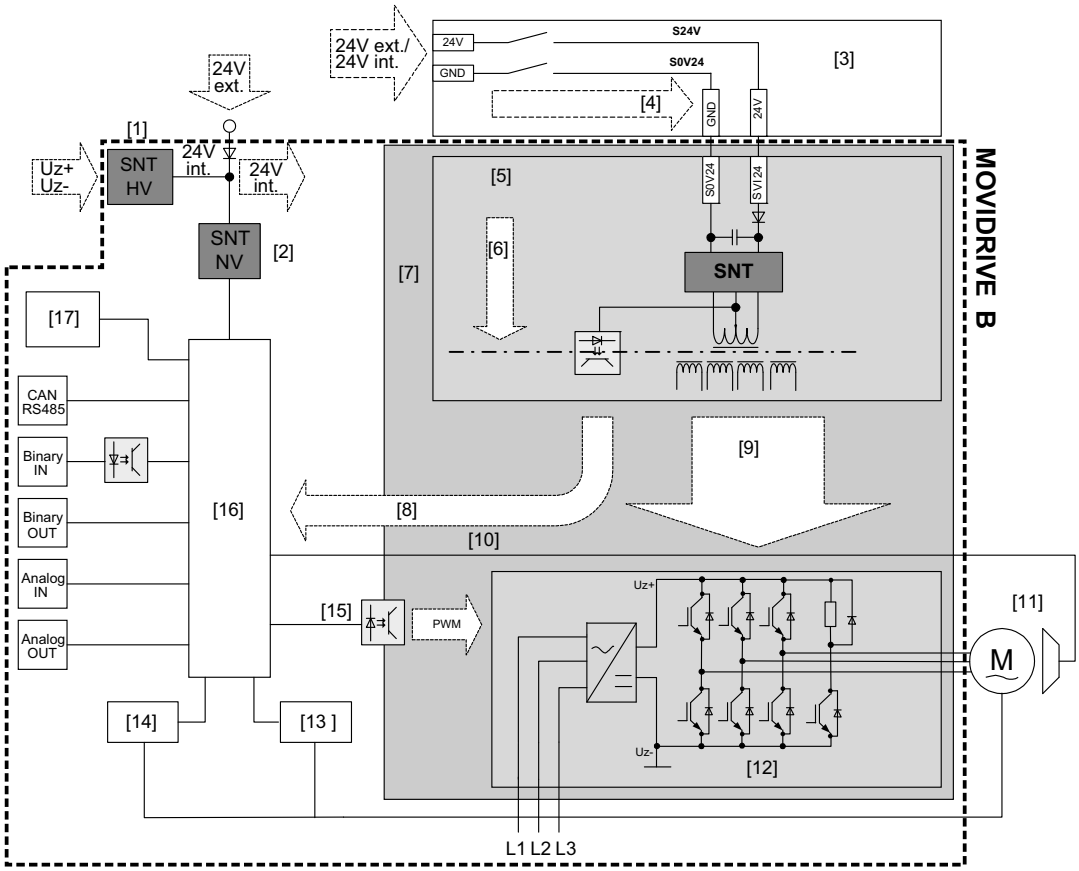
2.1 Safe condition

For safety-related operation of MOVIDRIVE® MDX60B/61B, safe torque off is defined as safe condition (see STO safety function). The safety concept is based on this.

2.2 Safety concept

- In case of danger, any potential risk related to a machine must be eliminated as quickly as possible. Standstill with restart prevention is generally the safe condition for preventing dangerous movements.
- The MOVIDRIVE® MDX60B/61B inverter is characterized by the option to connect an external safety relay. This disconnects all active elements (disconnection of the safety-related 24 V power supply of the output stage control) that generate the pulse trains to the power output stage (IGBT) when a connected control device (E-STOP button with latching function) is activated.
- Disconnecting the safety-related 24 V supply voltage ensures that the supply voltages required for operating the inverter and consequently for generating a rotating field of pulse patterns (which allow the generation of a rotating field) are safely interrupted, preventing automatic restart.
- Instead of galvanic separation of the drive from the power supply by means of relays or switches, the disconnection of the 24 V supply described here safely prevents the control of the power semiconductors in the drive inverter. This process disconnects the rotating field generation for the respective motor. The individual motor cannot develop any torque in this state even though the line voltage is still present.

2.3 Schematic representation of the "safety concept for MOVIDRIVE® B"



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[1] High voltage switched-mode power supply
[2] Low voltage switched-mode power supply
[3] Safety relay / safety controller (external)
[4] Safety-related DC 24 V voltage supply
[5] Safety switched-mode power supply (SNT)
[6] Electrical isolation
[7] Safety circuit
[8] Feedback to the processor core: Voltage supply for output stage control OK (not in safety circuit)
[9] Voltage supply for control of power transistors
[10] DC 24 V safety switched-mode power supply disconnected / brake applied (not in safety circuit)
[11] Motor
[12] Power section
[13] Temperature detection
[14] Position detection
[15] Pulse width modulated signals for the output stage
[16] Computer core
[17] Fieldbus connection

2.4 Safety functions

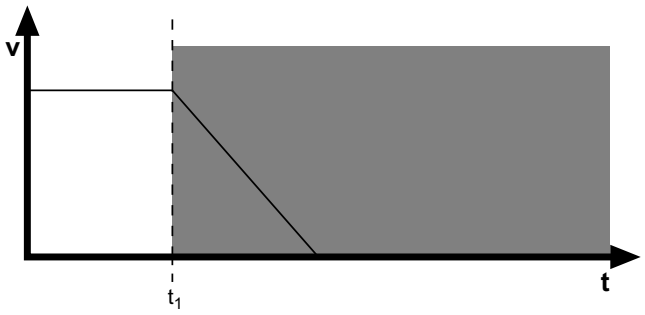
The following drive-related safety functions can be used:

- **STO** (safe torque off according to EN 61800-5-2) through disconnection of the STO input.

  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 STO input must be switched off by a suitable external safety controller or a suitable external safety relay.

  The following figure shows 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) through suitable external controller (e.g. safety relay with delayed switch-off).

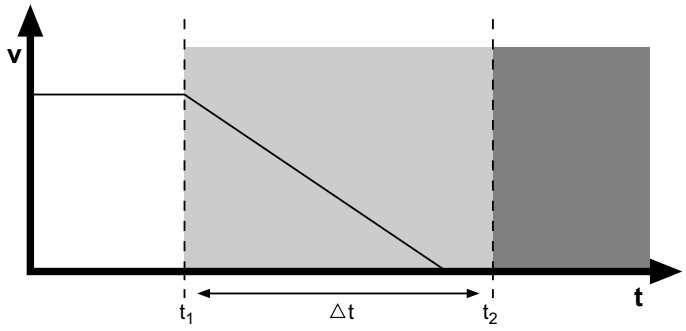
  The following sequence is mandatory:

  – Decelerate the drive using an appropriate brake ramp specified via setpoints.

  – Disconnect the STO input (= triggering the STO function) after a specified safety-related time delay.

  This safety function corresponds to a controlled stop according to EN 602041, stop category 1.

  The following figure illustrates the SS1(c) function:



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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
	Safe time delay range
	Disconnection range

2.5 Limitations

- Note that if the drive does not have a mechanical brake, or if the brake is defective, the drive may coast to a halt (depending on the friction and mass moment of inertia of the system). In case of regenerative loads, the drive can even accelerate. This must be taken into account for a risk assessment of the system/machine. Additional safety measures might have to be implemented (e.g. safety brake system).

  MOVIDRIVE® MDX60B/61B cannot be used without an additional brake system for application-specific safety functions that require active deceleration (braking) of the dangerous movement.

- When using the SS1(c) function as described in chapter "Safety functions", the brake ramp of the drive is not monitored with respect to safety. In case of a fault, the drive might not be decelerated after the delay time, or it might be accelerated in the worst case. In this case, the STO function (see chapter "Safety functions") is only activated after the set time delay has passed. The resulting danger must be taken into account for the risk assessment of the system/machine. Additional safety measures might have to be implemented.

⚠ DANGER

The safety concept is only suitable for performing mechanical work on the system/machine components.

If the STO signal is disconnected, the supply system voltage is still present at the MOVIDRIVE® MDX60B/61B DC link.

Severe or fatal injuries from electric shock.

- Before working on the electric part of the drive system, disconnect it from the supply system using an appropriate external disconnecting device and secure it against unintentional reconnection to the voltage supply.

INFORMATION

In case of safety-related switch-off of the DC 24 V supply at X17 (STO activated), the brake is **always** applied. The brake control in MOVIDRIVE® MDX60B/61B is not safety-related.

3 Safety-Relevant Conditions

A requirement for safe operation is that the safety functions of MOVIDRIVE® MDX60B/61B are properly integrated into an application-specific higher-level safety function. A system/machine-specific risk assessment must be carried out by the system/machine manufacturer and taken into account for the use of the drive system with MOVIDRIVE® MDX60B/61B.

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 MOVIDRIVE® MDX60B/61B units in safety-related applications.

The requirements are divided into:

- Permitted units
- Installation requirements
- Requirements for external safety controllers and safety relays
- Startup requirements
- Operation requirements

3.1 Permitted units

The following unit variants of MOVIDRIVE® MDX60B/61B are permitted for safety-related applications:

3.1.1 MOVIDRIVE® MDX60B/61B for 3 × AC 380...500 V supply voltage

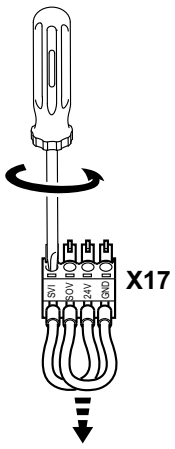
Power rating kW	Size	Number of option slots	Type
0.55	0S	0	MDX60B0005-5A3-4-XX
0.75	0S	0	MDX60B0008-5A3-4-XX
1.1	0M	0	MDX60B0011-5A3-4-XX
1.5	0M	0	MDX60B0014-5A3-4-XX
0.55	0S	2	MDX60B0011-5A3-4-XX
0.75	0S	2	MDX61B0008-5A3-4-XX
1.1	0M	2	MDX61B0011-5A3-4-XX
1.5	0M	2	MDX61B0014-5A3-4-XX
1.5	I	3	MDX61B0015-5A3-4-XX
2.2	I	3	MDX61B0022-5A3-4-XX
3	I	3	MDX61B0030-5A3-4-XX
4	I	3	MDX61B0040-5A3-4-XX
5.5	IIS	3	MDX61B0055-5A3-4-XX
7.5	IIS	3	MDX61B0075-5A3-4-XX
11	II	3	MDX61B0110-5A3-4-XX
15	III	3	MDX61B0150-503-4-XX
22	III	3	MDX61B0220-503-4-XX
30	III	3	MDX61B0300-503-4-XX
37	IV	3	MDX61B0370-503-4-XX
45	IV	3	MDX61B0450-503-4-XX
55	V	3	MDX61B0550-503-4-XX
75	V	3	MDX61B0750-503-4-XX
90	VI	3	MDX61B0900-503-4-XX
110	VI	3	MDX61B1100-503-4-XX
132	VI	3	MDX61B1320-503-4-XX
160	VII	3	MDX61B1600-503-4-XX
200	VII	3	MDX61B2000-503-4-XX
250	VII	3	MDX61B2500-503-4-XX

3.1.2 MOVIDRIVE® MDX61B for AC 230 V supply voltage

Power rating kW	Size	Number of option slots	Type
1.5	I	3	MDX61B0015-2A3-4-XX
2.2	I	3	MDX61B0022-2A3-4-XX
3,7	I	3	MDX61B0037-2A3-4-XX
5.5	II	3	MDX61B0055-2A3-4-XX
7.5	II	3	MDX61B0075-2A3-4-XX
11	III	3	MDX61B0110-203-4-XX
15	III	3	MDX61B0150-203-4-XX
22	IV	3	MDX61B0220-203-4-XX
30	IV	3	MDX61B0300-203-4-XX

3.2 Installation requirements

- The safety-related DC 24 V supply voltage 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 or other equivalent measures.
  - Individual conductors can be routed inside an electrical installation space.
  - Observe the respective regulations governing the application.
- Power lines and safety-related control lines have to be installed in separate cables.
- Make sure that parasitic voltages cannot be generated in the safety-related control lines.
- The wiring technology used must comply with EN 60204-1.
- Only use grounded voltage sources with safe isolation (PELV) according to VDE0100 and EN 60204-1. In case of a single fault, the voltage between the outputs or between any output and grounded parts may not exceed DC 60 V.
- Observe the notes in the "MOVIDRIVE® MDX60B/61B" operating instructions for information on EMC-compliant cabling. It is essential that you connect the shield of the safety-related DC 24 V supply cable to the housing at both ends.
- The cables of the safety-related DC 24 V supply voltage (terminal X17) must be clamped under the signaling electronics shield clamp.
- Remove the jumpers on X17:1 to X17:4 (see following figure) for applications with safety-related disconnection.
- When planning the installation, observe the technical data of MOVIDRIVE® MDX60B/61B.
- Observe the values specified for safety components when designing the safety circuits.
- The cable length of the safety-related DC 24 V supply may not exceed 100 m.
- The safety-related DC 24 V supply may not be used for feedback.



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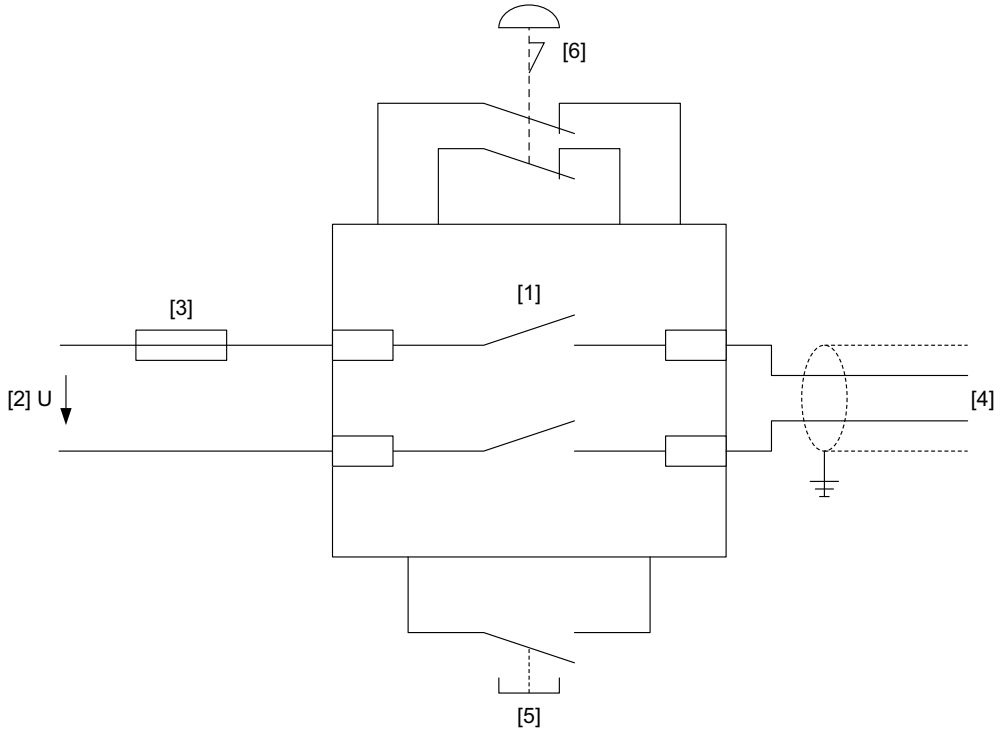
Removing jumpers

3.3 Requirements for the external safety controller



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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] EMERGENCY STOP actuating device

A safety relay can be used as an alternative to a safety controller. The following requirements apply 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	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
Category 3 according to EN 954-1	Performance level d according to EN ISO 13849-1 Category 3 according to EN 954-1 SIL 2 according to EN 61508

- The wiring of the safety controller must be suitable for the required safety class, (see manufacturer documentation).
  - If the DC 24 V supply is safely disconnected at the positive pole only, no test pulses must be applied to this pole in disconnected condition.

    If the DC 24 V supply is disconnected at both poles, the test pulses must not be applied at the same time at the plus and minus outputs. In this case, the test pulse must be applied with a time delay.
  - SEW-EURODRIVE recommends to switch off the 24 V supply at two poles.
- The values specified for the safety controller must be strictly adhered to when designing the circuit.
- The switching capacity of the safety relays or the relay outputs of the safety controller must at least correspond to the maximally permitted, limited output current of the 24 V voltage supply.

  Observe the manufacturer's instructions concerning the permitted contact loads and fusing that may be required for the safety contacts. If the manufacturer provides no specific information on this issue, 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 safe control system 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.

3.4 Startup requirements

- To validate the realized safety functions, they must be documented and checked after successful startup (validation).

  Observe the limitations for safety functions in chapter "Limitations" for the validation of the safety functions. Non-safety-related parts and components that affect the result of the validation test (e.g. motor brake) must be deactivated, if necessary.
- When you use MOVIDRIVE® MDX 60B/61B in safety-related applications, it is essential that you perform and record startup checks for the disconnecting device and correct wiring.

3.5 Operation requirements

- Operation is only allowed within the limits specified in the data sheets. This principle applies to the external safety controller as well as to MOVIDRIVE® MDX60B/61B and approved options.
- The safety functions must be checked at regular intervals to ensure proper functioning. The the test intervals should be specified in accordance with the risk assessment.

4 Connection Variants

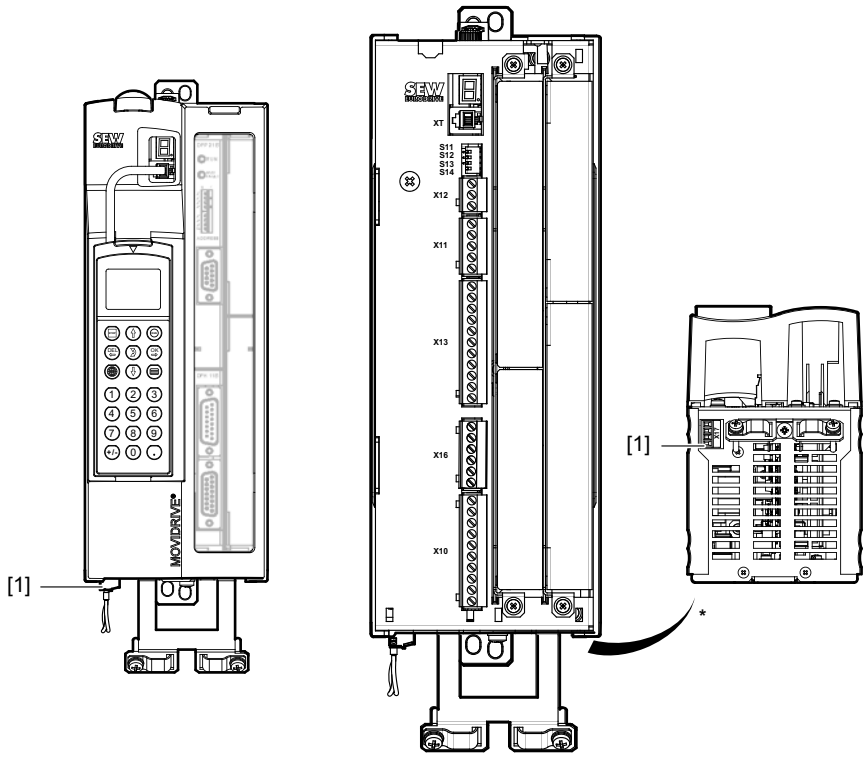
4.1 General information

Generally, all the connection variants listed in this documentation are permitted for safety-relevant applications as long as the basic safety concept is fulfilled. This means you have to make sure that the DC 24 V safety inputs are operated by an external safety relay or a safety controller, thus preventing an automatic restart.

All safety conditions mentioned in section 2, 3 and 4 of the present documentation must be met for the basic selection, installation, and application of the safety components, such as safety relay, EMERGENCY STOP switch, etc., and the approved connection variants.

4.1.1 X17 terminal on MOVIDRIVE®

The following figure shows the X17 terminal at the bottom of the control unit.



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*** View of the underside of the unit**

[1] X17: Signal terminal block for STO safety contacts

4.2 Requirements

4.2.1 Use of safety relays

The requirements of the manufacturers of safety relays (such as protecting the output contacts against welding) or other safety components must be strictly observed. For cable routing, the basic requirements as described in this publication apply.

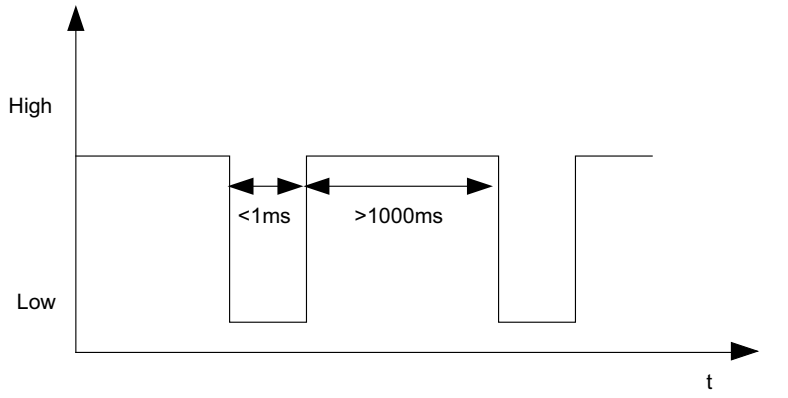
For the connection of MOVIDRIVE® with the safety relays, observe the installation requirements in chapter "Installation requirements" (page 13).

Other instructions by the manufacturer on the use of safety relays for specific applications must also be observed.

4.2.2 Use of PLC-FDOs

You must observe the ZVEI specifications for safety sensors if you use a safety PLC (SPLC).

The starting and stopping impulse of the used safe digital outputs (F-DO) must be ≤ 1 ms. The ratio must not fall below 1:1000.



	INFORMATION
	If the DC 24 V supply at X17 is switched off safely (STO activated), you must observe chapter "Requirements on the external safety controller (page 14)" with regard to the test pulses.

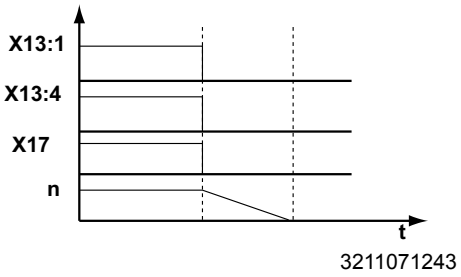
4.3 Disconnection of single drives

4.3.1 STO according to PL d (EN ISO 13849-1)

The procedure is as follows:

- Recommendation: X13:1 and X13:4 are disconnected **at the same time**, e.g. in case of an emergency stop.
- The 24 V safety input X17 is disconnected.
- The motor coasts to a halt, if no brake is installed.

STO – Safe Torque Off (EN 61800-5-2)



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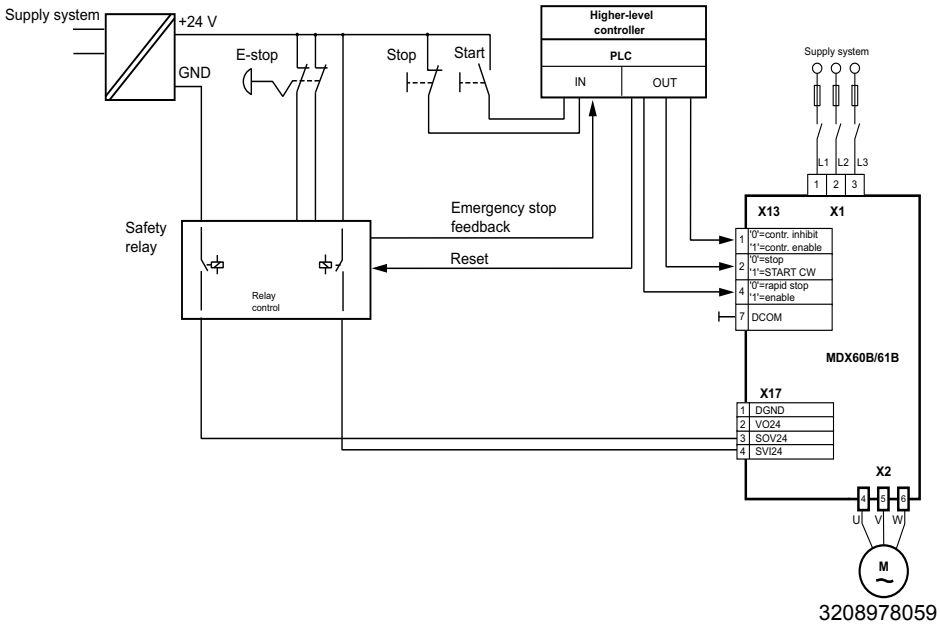
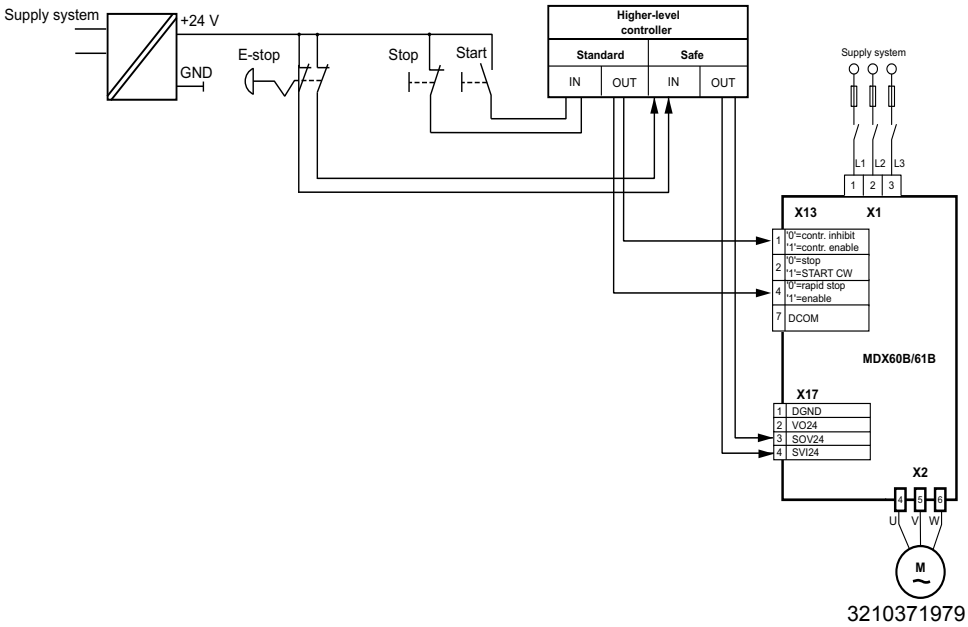
	INFORMATION
	The displayed STO disconnections can be used up to PL d according to EN ISO 13849-1.

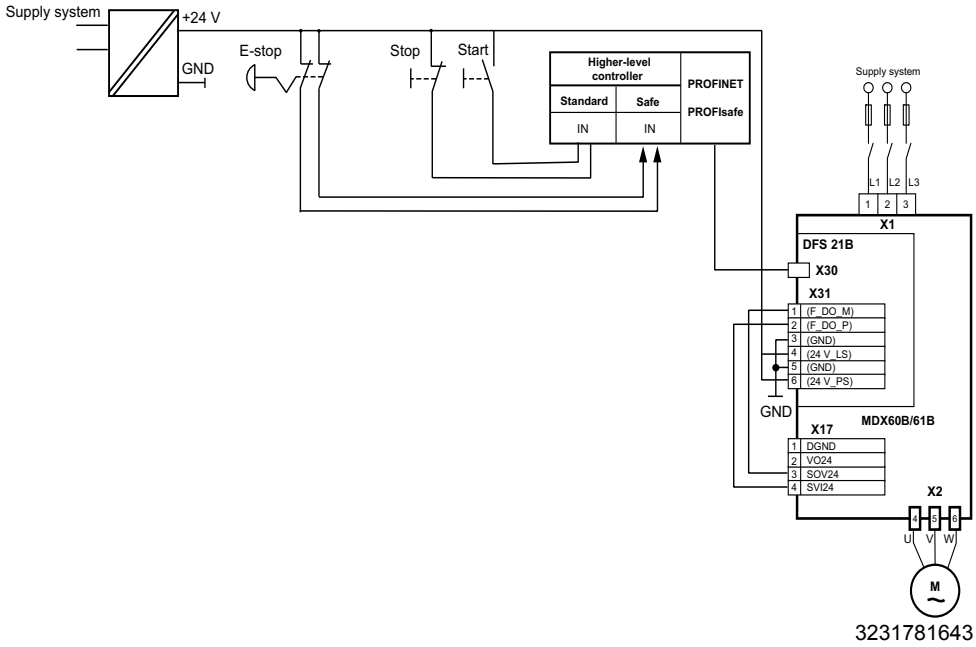
Binary control with safety relay



Binary control with safety PLC



Fieldbus control with safety PLC



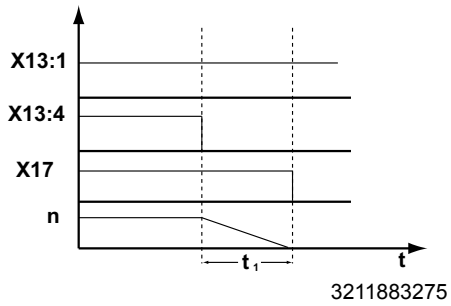
	INFORMATION
	• Controller inhibit/enable and rapid stop/enable are set via fieldbus. • Note the respective fieldbus manuals, e.g. – "DFS11B PROFIBUS DP-V1 Fieldbus Interface with PROFIsafe" manual – "DFS21B PROFINET IO Fieldbus Interface with PROFIsafe" manual

4.3.2 SS1(c) according to PL d (EN ISO 13849-1)

The procedure is as follows:

- X13:1 must not be disconnected.
- X13:4 is disconnected, e.g. in case of an emergency stop.
- During the safety time interval t_1, the motor decelerates to a complete stop along the ramp.
- After t_1 has elapsed, the safety input X17 is disconnected. The safety time interval t_1 must be sufficient for the motor to reach a complete stop.

SS1(c) – Safe Stop 1 (EN 61800-5-2)



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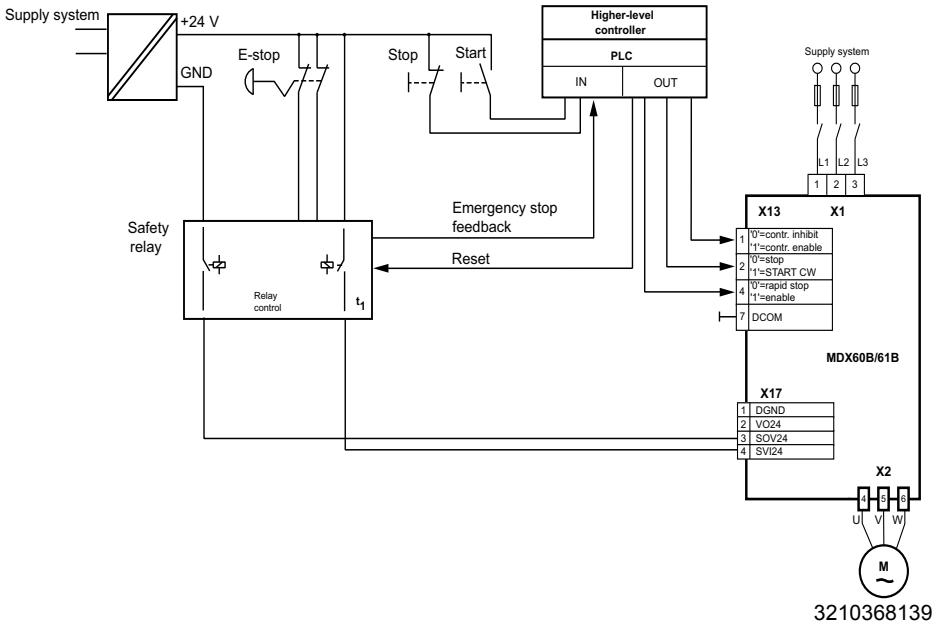
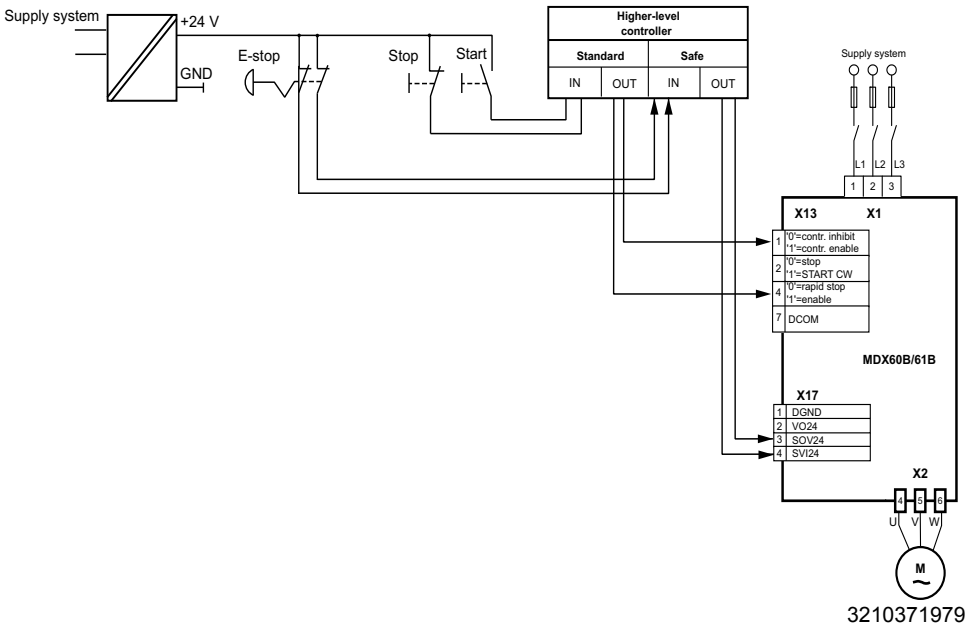
	INFORMATION
	The displayed SS1(c) disconnections can be used up to PL d according to EN ISO 13849-1.

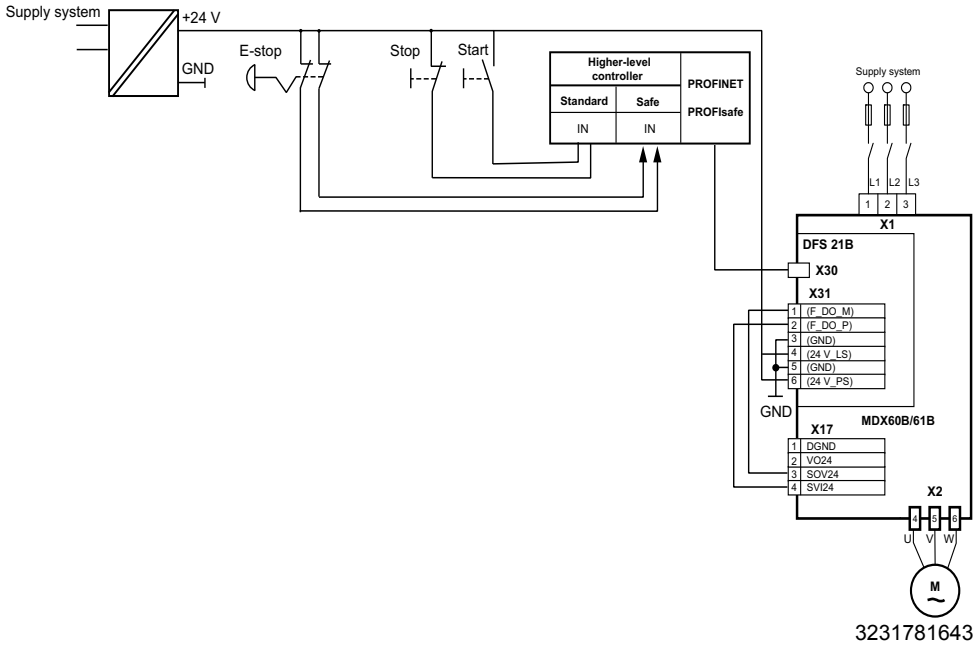
Binary control with safety relay



Binary control with safety PLC



Fieldbus control with safety PLC



	INFORMATION
	• Controller inhibit/enable and rapid stop/enable are set via fieldbus. • Note the respective fieldbus manuals, e.g. – "DFS11B PROFIBUS DP-V1 Fieldbus Interface with PROFIsafe" manual – "DFS21B PROFINET IO Fieldbus Interface with PROFIsafe" manual

4.4 Group disconnection

This chapter describes how several MOVIDRIVE® MDX60B/61B units are safely controlled.

	INFORMATION
	SEW-EURODRIVE does not recommend a group disconnection via an SPLC.

4.4.1 Requirements

With group drives, the 24 V safety inputs of several MOVIDRIVE® MDX60B/61B units can be made available via a single safety relay. The maximum number of axis modules results from the maximum permitted contact load of the safety relay or the safety controller.

Other requirements of the manufacturers of safety relays (such as protecting the output contacts against welding) or other safety components must be strictly observed. For the cable routing, observe the basic requirements stated in section "Installation requirements" (page 13).

For the connection of MOVIDRIVE® with the safety relays, observe the installation requirements in chapter "Installation requirements" (page 13).

Other instructions by the manufacturer on the use of safety relays for specific applications must also be observed.

Determining the maximum number of MOVIDRIVE® units for group disconnection

The number (n units) of MOVIDRIVE® MDX60B/61B units that can be controlled with group disconnection is limited by the following points:

1. Switching capacity of the safety relay.

   A fuse must be connected in front of the safety contacts according to the specifications of the safety relay manufacturer to prevent contact welding.

   The project planner is responsible for ensuring that the specifications for the switching capacity to EN 60947-4-1, 02/1 and EN 60947-5-1, 11/97 as well as on contact fuse protection given in the operating instructions of the safety relay manufacturer are strictly observed.

2. Maximum permitted voltage drop in the 24 V power supply cable.

   Values concerning cable lengths and permitted voltage drops must be observed during project planning for axis systems.

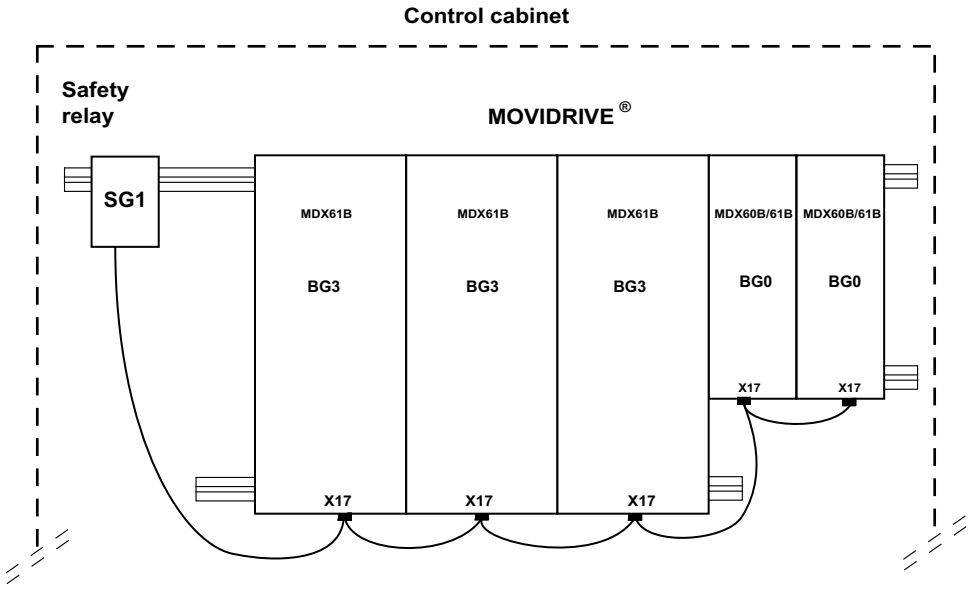
3. Maximum cable cross section of 1 × 1.5 mm^2 or 2 × 0.75 mm^2.

4. Power consumption safe disconnection X17: See chapter "Technical data" (page 28).

4.4.2 Implementation of group disconnection using a safety relay

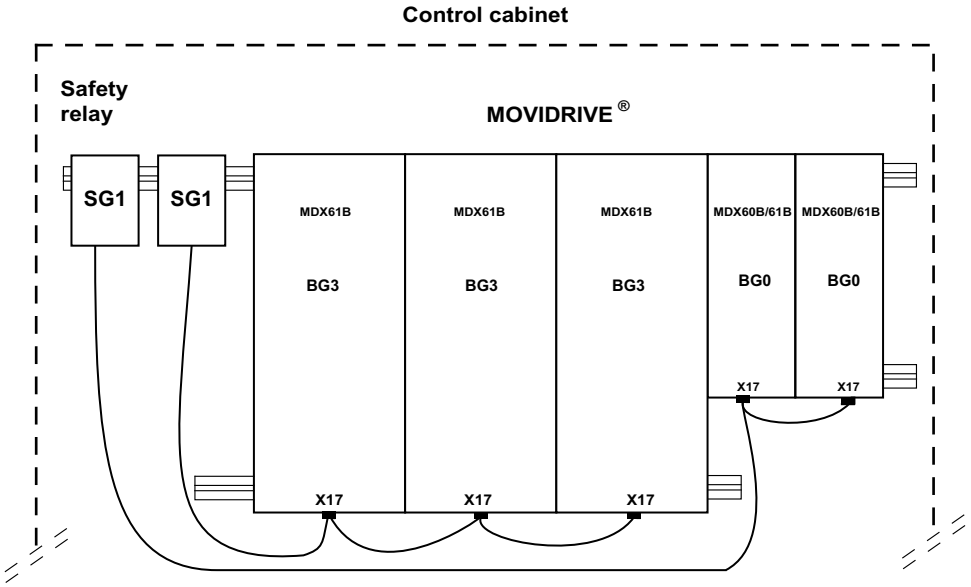
Group disconnection with one safety relay

With one safety relay, the safety inputs of all MOVIDRIVE® MDX60B/61B units can be controlled.



Group disconnection with two safety relays

With several safety relays you can control the safety inputs of the assigned MOVIDRIVE® MDX60B/61B units. In the following example, the MOVIDRIVE® MDX61B units of size 3 and the MOVIDRIVE® MDX60B/61B units of size 0 each form one group, and each group is controlled by a safety relay.

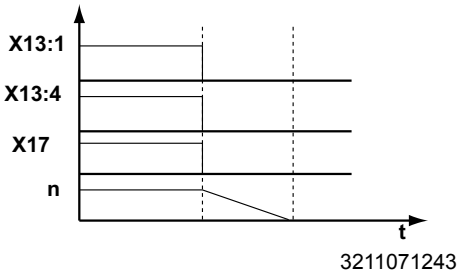


4.4.3 STO according to PL d (EN ISO 13849-1)

The procedure is as follows:

- Recommendation: X13:1 and X13:4 are disconnected **at the same time**, e.g. in case of an emergency stop.
- The 24 V safety input X17 is disconnected.
- The motor coasts to a halt, if no brake is installed.

STO – Safe Torque Off (EN 61800-5-2)



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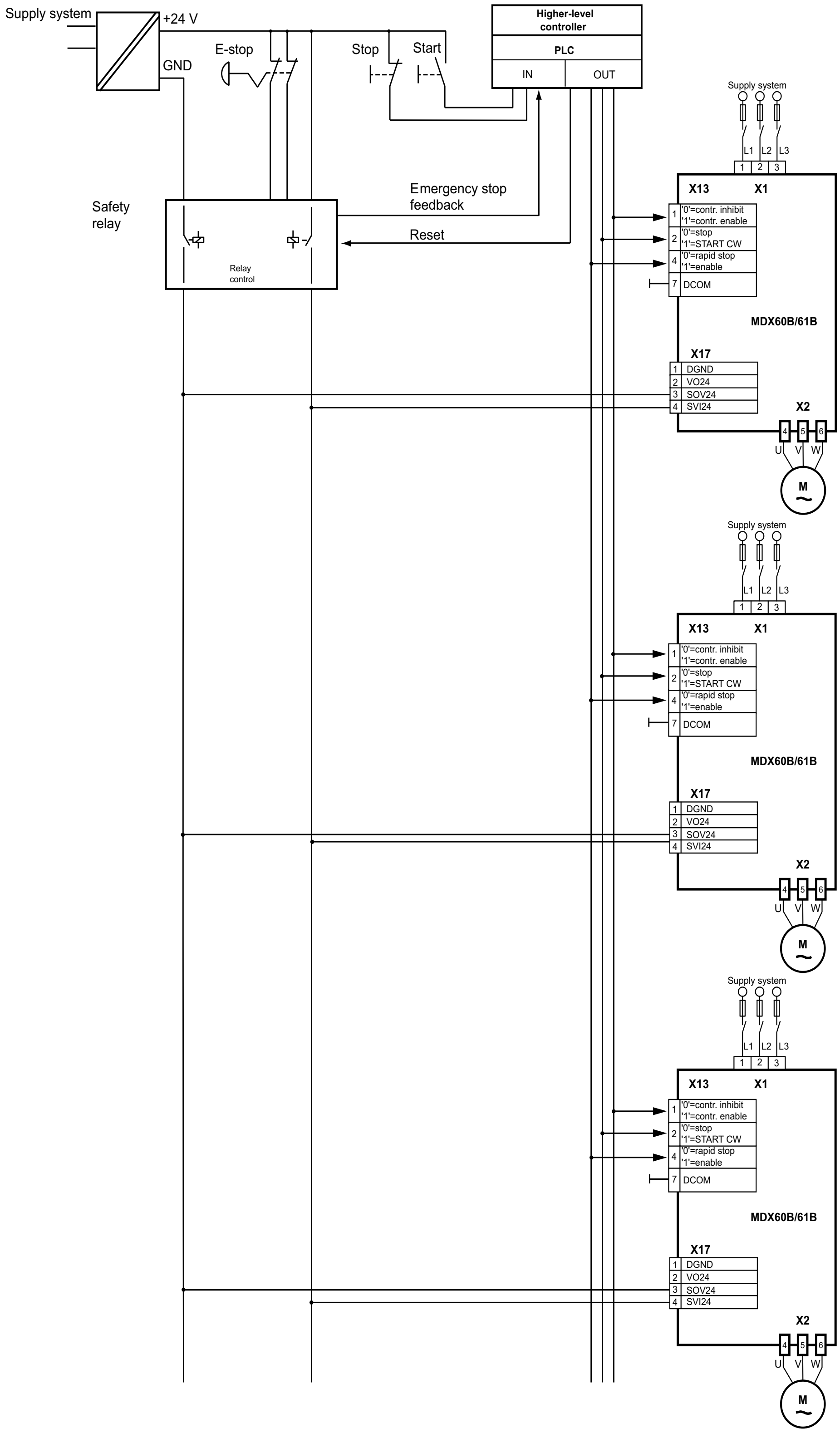
	INFORMATION
	The displayed STO disconnections can be used up to PL d according to EN ISO 13849-1.

Example: Group disconnection with three MOVIDRIVE® MDX60B/61B units



5 Technical Data

The table below provides the technical data of MOVIDRIVE® MDX60B/61B related to integrated safety technology. The technical data and approvals in the respective MOVIDRIVE® MDX60B/61B operating instructions must be observed in addition.

5.1 Characteristic safety values

Characteristic safety values	
Tested safety class / underlying standards	• Category 3 according to EN 954-1 • Performance level d according to EN ISO 13849-1
Probability of dangerous failure per hour (PFH value)	0 (fault exclusion)
Service life	20 years, after which the component must be replaced with a new one.
Safe condition	Safe torque off (STO)
Safety function	STO, SS1[1)] according to EN 61800-5-2

1) With suitable external control

5.2 Electronics data X17: Signal terminal block for STO safety contact

MOVIDRIVE® MDX60/61B	General electronics data
Safety contact X17:1	DGND: Reference potential for X17:2
X17:2	VO24: : V_{OUT} = DC 24 V, only to supply X17:4 of the same unit; **cannot be used** to supply other units.
X17:3	SOV24: Reference potential for DC +24 V "STO" input (safety contact)
X17:4	SVI24: DC+24 V "STO" input (safety contact)
Permitted cable cross section	One core per terminal: 0.08...1.5 mm^2 (AWG28...16) Two cores per terminal: 0.25 ... 1.0 mm^2 (AWG23...17)
Power consumption X17:4	Size 0: 3 W Size 1: 5 W Size 2, 2S: 6 W Size 3: 7.5 W Size 4: 8 W Size 5: 10 W Size 6: 6 W Size 7: 6 W
Input capacitance X17:4	Size 0: 27 µF Sizes 1...7: 270 µF
Time for restart Time to inhibit output stage	t_A = 200 ms t_S ≤ 100 ms

Technical data of STO input	Min.	Typical	Max.	Unit
Input voltage range	0	24	30	DC V
Input voltage for ON status (STO)	19.2			V
Input voltage for OFF status (STO)			5,0	V

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