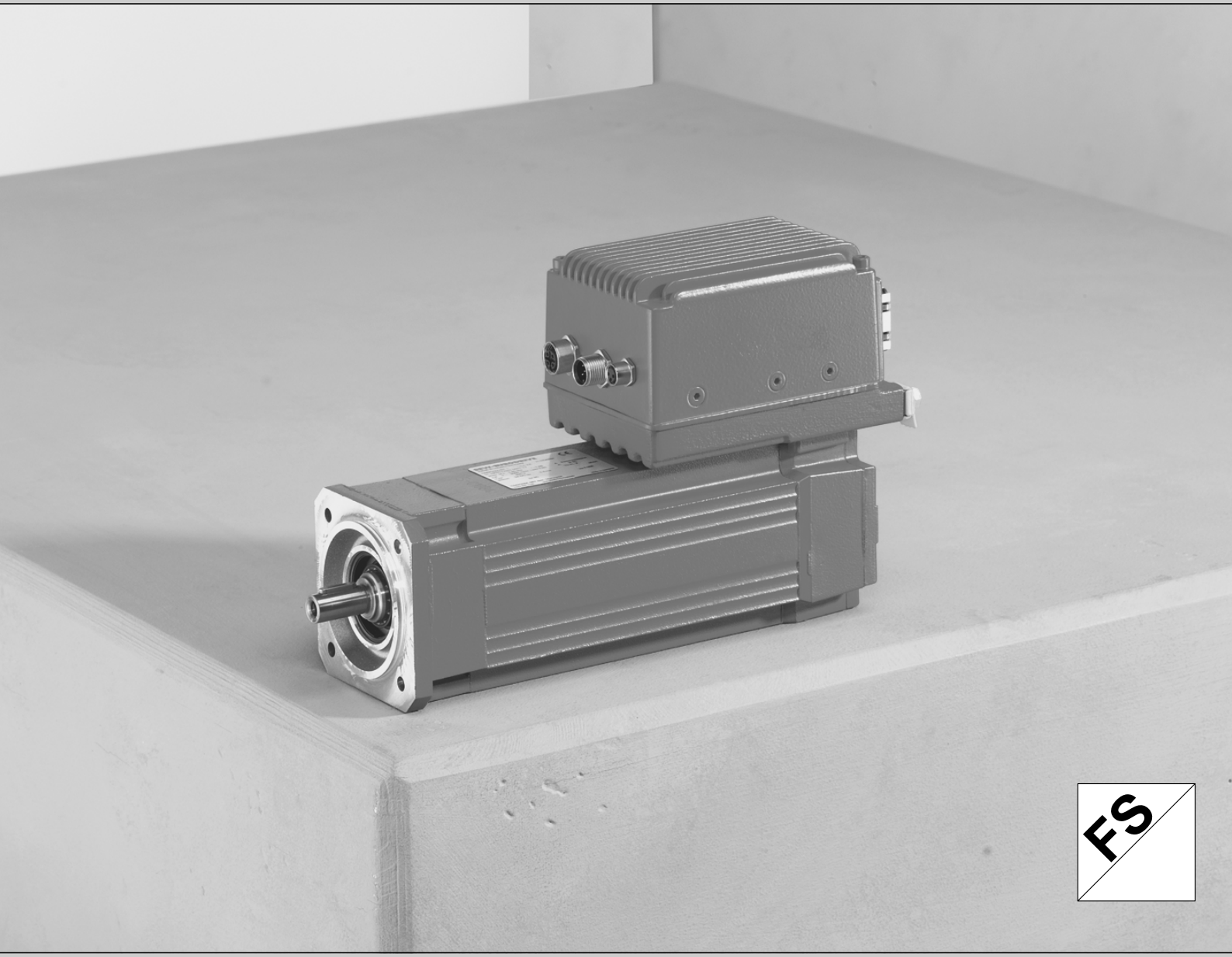
SEW EURODRIVE

Manual



FS

Decentralized Extra-Low Voltage Servo Drive
CMP ELVCD – Functional Safety

Edition 07/2017

23494050/EN

Contents

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1 General information

1.1 About this documentation

The current version of the documentation is the original.

This documentation is an integral part of the product. The documentation is written for all employees who assemble, install, start up, and service this product.

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

1.2 Content of the documentation

This documentation contains additional safety-related information and conditions for operation in safety-related applications.

1.3 Other applicable documentation

This documentation supplements the operating instructions of the product. Use this document only in connection with the operating instructions.

Always use the latest edition of documentations and software.

The SEW-EURODRIVE website (www.sew-eurodrive.com) provides a wide selection of documents for download in various languages. If required, you can also order printed and bound copies of the documentation from SEW-EURODRIVE.

1.4 Structure of the safety notes

1.4.1 Meaning of signal words

The following table shows the grading and meaning of the signal words for safety notes.

Signal word	Meaning	Consequences if disregarded
⚠ **DANGER**	Imminent hazard	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 product or its environment
INFORMATION	Useful information or tip: Simplifies handling of the product.	

1.4.2 Structure of section-related safety notes

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

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This is the formal structure of a safety note for a specific section:

SIGNAL WORD

Type and source of hazard.

Possible consequence(s) if disregarded.

- Measure(s) to prevent the hazard.

Meaning of the hazard symbols

The hazard symbols in the safety notes have the following meaning:

Hazard symbol	Meaning
	General hazard
	Warning of dangerous electrical voltage
	Warning of hot surfaces
	Warning of risk of crushing
	Warning of suspended load
	Warning of automatic restart

1.4.3 Structure of embedded safety notes

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

This is the formal structure of an embedded safety note:

⚠ **SIGNAL WORD** Type and source of hazard. Possible consequence(s) if disregarded. Measure(s) to prevent the hazard.

1.5 Rights to claim under limited warranty

Read the information in this documentation. This is essential for fault-free operation and fulfillment of any rights to claim under limited warranty. Read the documentation before you start working with the product.

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1.6 Exclusion of liability

Read the information in this documentation, otherwise safe operation is impossible. You must comply with the information contained in this documentation 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, SEW-EURODRIVE assumes no liability for defects.

1.7 Product names and trademarks

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

1.8 Copyright notice

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2 Safety requirements

2.1 Conditions

The safety functions of the ELVCD drive may only be used for safe operation of the system or machine if they are integrated correctly in an application-specific, higher-level safety function or safety system.

We recommend that the system/machine manufacturer performs a risk analysis.

The system/machine manufacturer should perform a functional test after successful startup. The system/machine manufacturer and the operator are responsible for compliance of the system or machine with applicable safety regulations.

The following requirements are mandatory when installing and operating ELVCD drives in safety-relevant applications.

2.2 Requirements for electrical installation

INFORMATION

A bag containing the safety notes and wiring diagrams is attached to the device.

Observe the enclosed notes.

- Observe the information and explanations about correct wiring in the corresponding operating instructions.
- The line length between the safety controller and the ELVCD drive must not exceed 100 m.
- Wiring must comply with the EN 60204-1 standard.
- Route the safety-related control cables in compliance with EMC requirements.

  Outside an electrical installation space, shielded cables must be routed permanently and protected against external damage, or other equivalent measures must be taken.
- Make sure that no parasitic voltages can be generated in safety-related control cables.
- Adhere to the values specified for safety components when designing the safety circuits.
- For all 24 V supply voltages of the ELVCD drive and all stations of the fieldbus, only voltage sources with safe disconnection (SELV/PELV) according to EN 60204-1 and EN 61131-2 are permitted.
- The ELVCD inverter is not equipped with integrated crossfault monitoring. Use a safety relay with crossfault detection or use a connection that is not subject to crossfaults.

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2.3 Requirements for the external safety controller

A safety relay can be used as an alternative to a safety controller. Observe the following requirements.

- For safety-relevant applications up to performance level d to EN ISO 13849-1, the safety controller and all other safety-relevant subsystems must be approved for at least performance level d to EN ISO 138491-1 or SIL 2 to EN 61508. For determining the performance level of the overall application, you can use the method described in EN ISO 13849-1 for combining several safety-relevant subsystems without PFH value calculation. But SEW-EURODRIVE recommends to determine the PFH value for the overall application. For the PFHd value for the ELVCD drive, see chapter "Technical data" (→ 🗎 19).
- For safety-related applications up to SIL 2 according to EN 62061, the safety controller and all other safety-relevant subsystems must be approved for at least SIL 2 to EN 61508 or performance level d to EN ISO 13849-1. The probability of a dangerous failure per hour (PFHd value) must also be determined. The PHF value of the ELVCD drive is to be used to determine the PFHd value for the overall application.

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
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). Safety circuits with ELVCD drives require 2-pole disconnection.
- 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 correspond at least 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, 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.

2.4 Requirements for startup

- Startup of the system/machine must be documented. The safety functions of the system/machine must be checked and verified. Observe the information in chapter "Requirements in the event of a safety-relevant fault" (→ 🗎 9).

  Observe the limitations for the safety functions of the device provided in chapter "Restrictions" (→ 🗎 14) when verifying safety functions. If necessary, deactivate non-safety-related parts and components, such as the motor brake, that affect the result of the verification.

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- For operating the device in safety-related applications, the disconnecting device and correct wiring must always be verified and documented during startup. A disconnecting device is, for example, a safety relay or a safety controller.
- It is important that the discrepancy time is set to a value that does not exceed the time used for checking the disconnection paths. The discrepancy time is set to 150 ms by default. You find more information on parameters in the "Parameter description" chapter of the operating instructions.

2.5 Acceptance of safety functions

In order to determine the safety of a machine, the manufacturer must perform an overall evaluation of the safety functions.

The effectiveness of risk minimization is checked. This includes checking whether the required safety integrity is achieved for each implemented control-related safety function.

2.6 Requirements for operation

- Operation is only allowed within the limits specified in the data sheets. This applies both to the external safety relay and the ELVCD drive.
- To achieve performance level d, the STO function must be checked at least once a year. Depending on the process, the performance level can also be checked each time the machine/system is switched on.

2.7 Requirements in the event of a safety-relevant fault

When the servo inverter detects a safety-related fault, it enters safe state and prevents a restart. A safety-related fault can be an internal plausibility check that indicates a faulty STO1 signal.

In this respect, observe the following points:

- Do not ignore the error message.
- Do not acknowledge the error message without eliminating its cause.
- Do not cancel controller enable because a negative edge will acknowledge pending error messages.
- Do not interrupt the control voltage of the servo inverter.

INFORMATION

After a safety-relevant fault, do not take the machine/system into operation until you have checked the safety functions for proper functioning.

The following error messages are safety-relevant:

- Code 9 "Error 5 V electronics supply"
- Code 10 "Error 12 V electronics supply"
- Code 22 "STO – PWM power driver plausibility error"
- Code 23 "STO – Driver supply plausibility error"
- Code 24 "STO – Plausibility STO 1 & 2"

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3 Integrated safety technology

The STO safety function described below has been checked according to the safety requirements for performance level d to EN ISO 13849-1:2008.

This was certified by the employer's liability insurance association. Copies of the employer's liability insurance association certificate and the corresponding report are available from SEW-EURODRIVE on request.

3.1 Safe condition

INFORMATION

There is no galvanic isolation when the STO safety function is activated. This means it is not protected against electrical shock. This is the reason why the STO safety function cannot be used to implement an emergency off device in terms of normative requirements. For this purpose, the entire system must be switched off by means of a line disconnector.

For safety-related operation of the device, safe torque off is defined as safe condition, see "STO – Safe Torque Off" (→ 🗎 12). The safety concept is based on this definition.

When the STO safety function is active, the power supply to the drive is interrupted safely. This means the drive cannot generate torque and consequently no hazardous movement. In the event of suspended loads or other external forces, take additional measures to safely prevent the load from sagging. Such additional measures can be mechanical holding brakes, for example. The standstill position is not monitored.

You have to ensure that the machine is stopped in a safety-related manner, for example by using a safety relay. This is in particular important when using vertical axes that are not equipped with self-locking mechanism, arresting device or counter weight.

If multiple faults occur, the drive might start with jerks. If the output stage fails during safe state, a limited detent movement of the rotor of a maximum of 60° might occur. A failure is possible, for example caused by the simultaneous short circuit of 2 power semiconductors with different phases.

3.2 Safety concept

- The device allows for connecting 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 command device (e.g. emergency stop 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 safety-related DC 24 V supply voltage ensures that the voltage supplies required for operating the drive are safely interrupted.
- Instead of galvanic isolation of the drive from the supply system using contactors or switches, the disconnection of the safety-related 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 line voltage is still present.

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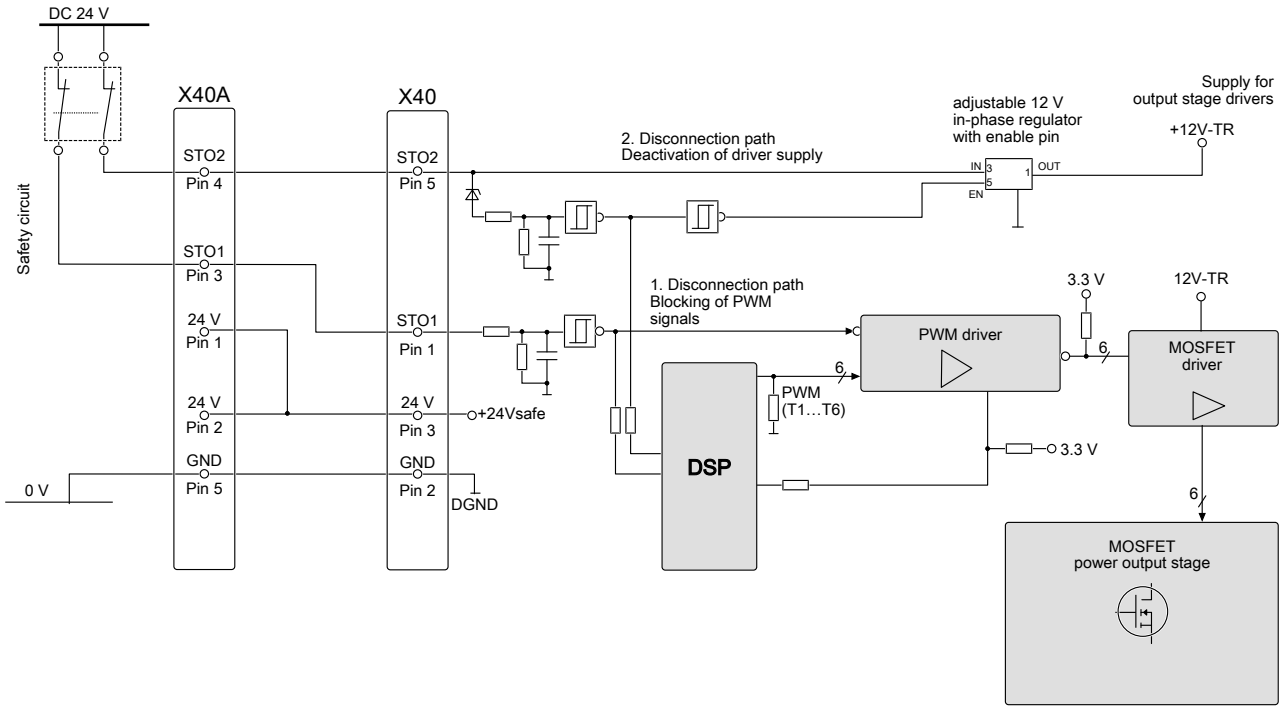
The following figure shows the safety concept:



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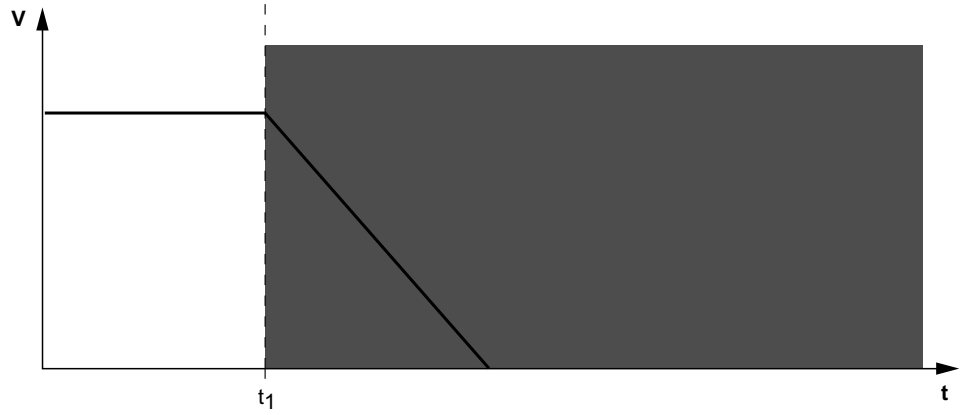
INFORMATION

Observe chapter "Restrictions" (→ 🗎 14).

3.3 Drive safety functions

3.3.1 STO – Safe Torque Off

If the STO function is activated, the drive inverter no longer supplies power to the motor. As a result, the drive cannot generate torque. This drive safety function corresponds to a non-controlled stop according to EN 60204-1, stop category 0.



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■ = Drive safety function trips
v = Speed
t = Time
t_1 = Point of time when STO is triggered.

INFORMATION

The motor coasts to a halt or is stopped mechanically.

Controlled standstill is preferred, if possible.

3.3.2 SS1(c) – Safe Stop 1

When the SS1(c) function is active, the drive inverter brings the motor to a standstill electrically. The drive safety function STO is triggered after a specified, safety-related time.

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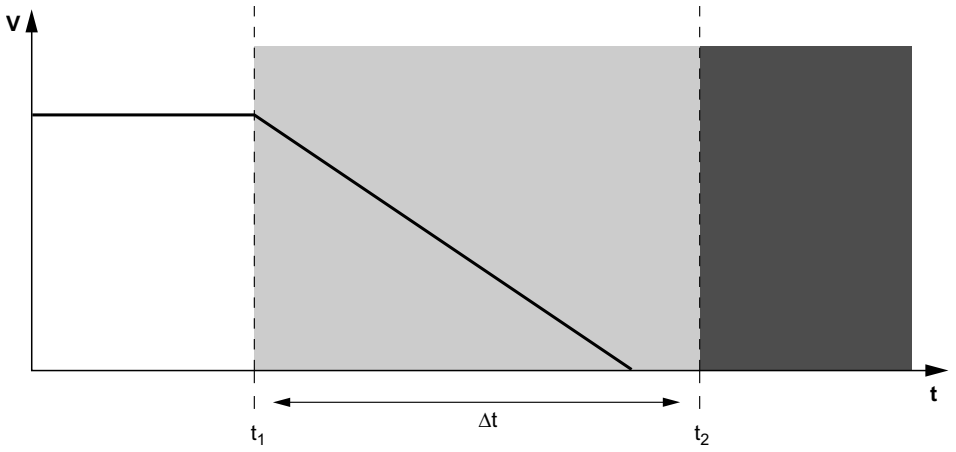
This drive safety function corresponds to a controlled stop of the drive according to EN 60204-1, stop category 1.



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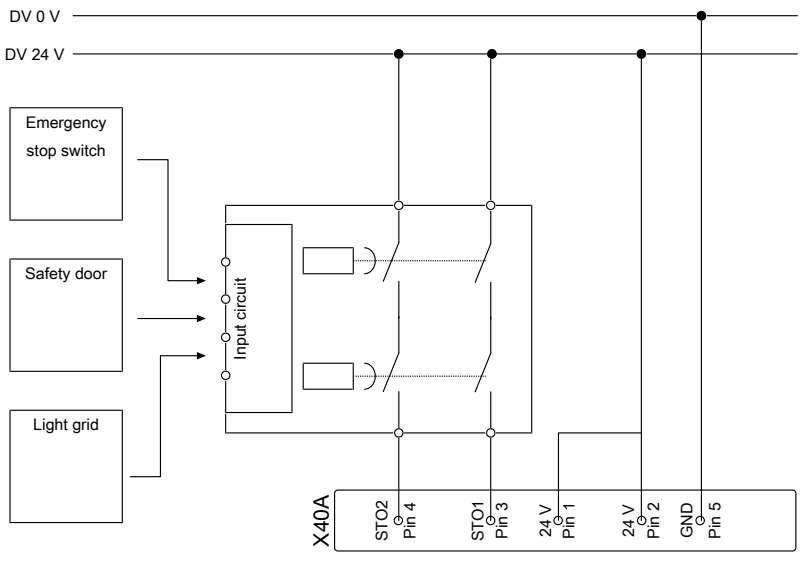
= Drive safety function monitored
= Drive safety function trips
v = Speed
t = Time
t_1 = Point of time when SS1(c) is activated and motor deceleration is triggered.
t_2 = Point of time when STO is triggered.
Δt = Safety-relevant period of time

INFORMATION

- The SS1(c) function does not monitor the stopping of the drive.
- The safety-relevant period of time Δt allows the drive to come to a stop. In the event of a fault, the drive does not come to a stop and becomes de-energized at the time t_2 (STO).

3.4 Sample circuit



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3.5 Restrictions

The brake controller integrated in this device and the standard brake integrated in brakemotors is not safety-related and therefore not part of the safety functions mentioned above. If the brake controller and/or 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 a risk analysis of the system/machine. Additional safety measures might have to be implemented (e.g. safety brake system). The device must not 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 above, 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" (→ 🗎 12) 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 might have to be implemented.

The system/machine manufacturer must perform a system/machine-specific risk analysis. The use of the device must be taken into account for this purpose.

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

INFORMATION

There is no galvanic isolation when the STO safety function is activated. This means it is not protected against electrical shock. This is the reason why the STO safety function cannot be used to implement an emergency off device in terms of normative requirements. For this purpose, the entire system must be switched off by means of a line disconnector.

If the 24 V supply voltage is disconnected, the supply voltage is still present at the frequency inverter DC link.

To perform work on the electrical section of the drive system, the supply voltage must be disconnected using an external maintenance switch.

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4 Service

4.1 Fault list

The following table helps you with troubleshooting. The fault codes are available in MultiMotion from version V180.100.

Code	CANopen code	Error	Possible cause	Measure
3	17168	Motor overtemperature	• The KTY motor temperature sensor indicates that the motor temperature has exceeded the permitted limit.	• Check if the drive is unable to move freely. • Contact SEW-EURODRIVE Service.
4	16912	Undertemperature/overtemperature of the power electronics	• The temperature of the power electronics is beyond the permitted range of −40 °C to +85°C.	• Check the ambient temperature. • Observe derating characteristic curve. • Contact SEW-EURODRIVE Service.
5	29586	Faulty sine-cosine supply	• The angular encoder is defective or an incorrect angular encoder was selected.	• Contact SEW-EURODRIVE Service.
6	29585	Sine-cosine R2485 communication error	• The angular encoder is defective or an incorrect angular encoder was selected.	• Contact SEW-EURODRIVE Service.
7	29584	Sine-cosine encoder track signal error or offset error	• The angular encoder is defective or an incorrect angular encoder was selected.	• Contact SEW-EURODRIVE Service.
8	29568	Faulty resolver signals/encoder supply	• The angular encoder is defective or an incorrect angular encoder was selected.	• Contact SEW-EURODRIVE Service.
9	20755	Error 5 V electronics supply	• Internal fault	• Contact SEW-EURODRIVE Service.
10	20756	Error 12 V electronics supply	• 24 V voltage supply failed.	• Check and remedy the 24 V supply.
			• Internal fault	• Contact SEW-EURODRIVE Service.
11	20754	24 V supply fault	• The 24 V voltage supply is outside the permitted range of 16 – 32 V.	• Check and remedy the 24 V supply.
12		Conflict between hardware and firmware	• Firmware does not match hardware.	• Contact SEW-EURODRIVE Service.
13	21008	Current measurement offset error	• Internal fault	• Contact SEW-EURODRIVE Service.

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Code	CANopen code	Error	Possible cause	Measure
14	8992	DC link/output stage overcurrent	• The motor is defective, e.g. winding overloaded, short circuit between winding and housing, output stage defective.	• Contact SEW-EURODRIVE Service.
15	12832	DC link under-voltage	• The 48 V voltage supply has failed or does not have sufficient capacity, e.g. during acceleration.	• Ensure DC 48 V voltage supply. • Check if there is a link between failure and the acceleration process.
16	12816	DC link over-voltage	• 48 V voltage supply too high (> DC 70 V).	• Reduce 48 V voltage supply.
17	29573	HALL track signal error	• Internal fault	• Contact SEW-EURODRIVE Service.
18	29574	PWM encoder fault	• Internal fault	• Contact SEW-EURODRIVE Service.
19	8978	I²t error motor (I²t at 100%). I²t monitoring has tripped.	• Incorrect nominal current setting	• Check and correct the nominal motor current setting.
20	8977	I²t error controller (I²t at 100%). I²t monitoring has tripped.	• Incorrect nominal current setting	• Check and correct the nominal motor current setting.
21	29575	PWM encoder initialization error	• Internal fault • PWM frequency could not be correctly determined.	• Contact SEW-EURODRIVE Service.
22	20610	STO – PWM power driver plausibility error: Feedback ≠ PWM power driver	• Internal fault	• Contact SEW-EURODRIVE Service.
23	20609	STO – Driver supply plausibility error: Feedback ≠ driver supply	• Internal fault	• Contact SEW-EURODRIVE Service.
24	32903	STO – Plausibility STO 1 & 2 (STO 1 ≠ STO 2)	• The STO plausibility check signals an error: Control inputs STO 1 & STO 2 are not activated at the same time.	• Contact SEW-EURODRIVE Service.
26	9088	I²t at 80%	• The load threshold of 80% is reached.	• Remove motor blockage.

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Code	CANopen code	Error	Possible cause	Measure
27	17280	Motor temperature 5 °C below maximum limit	• The motor temperature is reaching its critical limit.	• Check and correct the configuration of the drive.
28	17024	Output stage temperature 5 °C below maximum limit	• The thermal load of the drive is reaching its critical limit.	• Check and correct the configuration of the drive.
29	34320	Lag error monitoring	• The actual position of the motor has left the lag error window. The difference between actual value and setpoint is too large.	• Check the maximum current. • Check the motor for blockage. • Check the controller settings, particularly the internal closed loop systems for current and speed. • Check the acceleration parameters. • Check that the lag error window is sufficiently large.
31	34322	Limit switch fault Both limit switches are active simultaneously.	• Limit switch signals are not plausible.	• Check the configuration of the limit switches. • If there are no limit switches connected, set the limit switch type to NO contact. • Check the wiring.
35	24985	Rapid stop timeout	• The rapid stop ramp was not executed correctly.	• Check and correct the acceleration value for rapid stop.
36	35456	Reference travel error	• An error has occurred during reference travel.	• Check the reference travel configuration. • Check the controller setting.
40	24983	Motor identification and angular encoder fault	• Error identifying the motor encoder	• Contact SEW-EURODRIVE Service.
43	24979	Faulty travel program, unknown command	• Internal fault • Unknown travel program extension found.	• Contact SEW-EURODRIVE Service.
44	24978	Fault travel program, jump destination	• Internal fault • Jump to a line outside the valid range.	• Contact SEW-EURODRIVE Service.
46	33056	Node guarding timeout error	• No new NMT message was received within the parameterized node guarding time.	• Check CAN cable. • Provide for EMC measures. • Check MOVI-PLC® for proper functioning.
55	33024	CAN communication error	• A CAN communication error (SBus) has occurred.	• Check the CAN cable. • Check the shielding. • Switch the drive off and on again.

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Code	CANopen code	Error	Possible cause	Measure
56	29968	RS232 communication error	• Communication is interrupted.	• Provide for EMC measures. • Check the cable connection.
57	21889	Positioning data set error	• The set acceleration value is too small for V_{max}.	• Contact SEW-EURODRIVE Service.
58	25472	Operating mode change error	• The operating mode was switched with enabled output stage.	• Contact SEW-EURODRIVE Service.
60	24976	Position precalculation error	• Internal fault • The motor can no longer be braked up to the target position.	• Contact SEW-EURODRIVE Service.
61	34690	SYNC_TIMEOUT	• SYNC signal failure.	• Check MOVI-PLC® status. • Contact SEW-EURODRIVE Service.
62	24960	Stack overflow	• Internal fault	• Contact SEW-EURODRIVE Service.
63	21889	Checksum error	• Internal fault	• Contact SEW-EURODRIVE Service.
64	24967	Fault during initialization	• Internal fault	• Contact SEW-EURODRIVE Service.

4.2 Resetting fault messages

⚠ WARNING

Eliminating the cause of the fault or performing a reset can result in the unit restarting automatically.

Severe or fatal injuries.

- Program the application program such that the unit is not enabled when a fault occurs.

An error message can be acknowledged by sending a reset command of the controller or the PLC.

INFORMATION

After a safety-relevant fault, do not take the machine/system into operation until you have checked the safety functions for proper functioning.

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5 Technical data

5.1 General

Basic device	
Nominal voltage	DC 24 V, with reference to GND
Voltage range	DC 19.2 – 28.8 V
Permitted residual ripple	2%, with reference to DC 24 V nominal voltage
Input current STO 1	Typically DC 0.5 mA, maximally DC 1 mA
Input current STO 2	Typically DC 25 mA, maximally DC 30 mA
Input voltage threshold	
Switch on device	approx. DC 17 V
Switch off device	approx. DC 15.5 V
Switch-on time STO 1 from low to high	Typically 5 ms, maximally 10 ms
Switch-on time STO 2 from low to high	Typically 10 ms, maximally 15 ms
Switch-off time STO 1 from high to low	Typically 5 ms, maximally 10 ms
Switch-off time STO 2 from high to low	Typically 70 ms, maximally 75 ms

5.2 Safety technology

Safety characteristics	
Classification	• Performance level d according to EN ISO 13849-1 • SIL 2 according to EN 61800-5-2
Probability of dangerous failure per hour (PFHd value)	$< 4.29 \times 10^{-7}$ 1/h
Service life	20 years
Safe state	Safe Torque Off
Safety functions	• STO • SS1 according to EN 61800-5-2 with suitable external control

INFORMATION

To achieve the specified values, adhere to the information in chapter "Requirements for startup" (→ 🗎 8). Additionally, you have to check the STO function of the higher-level controller at regular intervals at least once a year. This is not necessary if the STO function is checked as part of the process or if it is checked regularly each time the machine/system is switched on.

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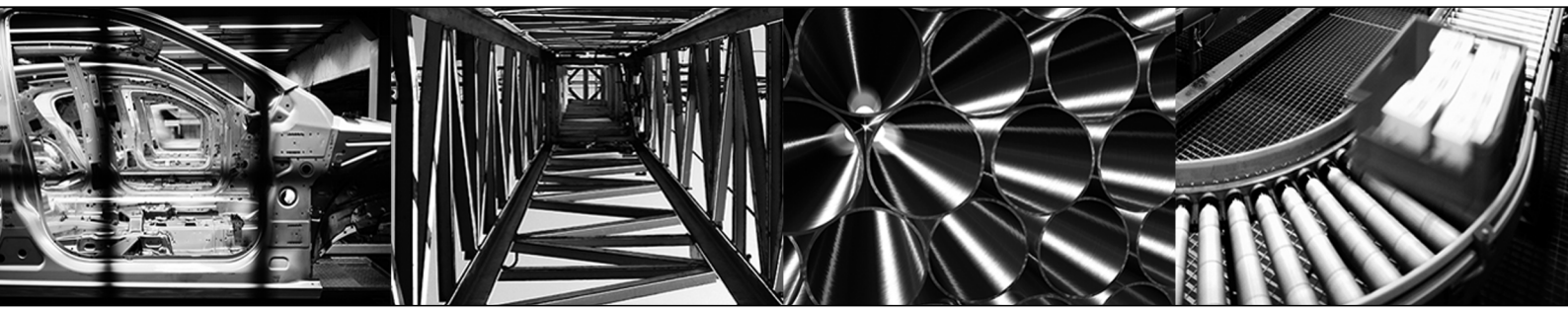

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