Product Manual

STO (Safe Torque Off) for the servo drives ARS 2000 SE

Metronix Meßgeräte und Elektronik GmbH
Kocherstraße 3
38120 Braunschweig
Germany

Phone: +49-(0)531-8668-0
Telefax: +49-(0)531-8668-555
E-Mail: vertrieb@metronix.de
http://www.metronix.de

Translation of the original instructions

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Identification of hazards and instructions on how to prevent them:

Danger

Immediate hazards which will result in death or severe personal injury.

Warning

Hazards that can cause death or serious injury.

Caution

Hazards that can cause minor injury or serious property damage.

Other symbols:

Note

Property damage or loss of functionality.

Recommendations, tips, references to other documentation

Essential or useful accessories

Information on environmentally sound usage

Electrostatic sensitive devices ESD

Text designations:

Activities that may be carried out in any order.

1. Activities that may be carried out in the order stated.

– General lists

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Instructions on this product manual

This product manual is to ensure work with the safety function STO - “Safe Torque Off” in accordance with EN 61800-5-2 is performed safely by using an ARS 2000 SE (Standard Edition) series servo drive, hereinafter referred to as "ARS 2000 SE”.

❖ In addition, always observe the “Safety notes for electrical drives and controllers” on the servo drives ARS 2000 SE.

You will find the “Safety notes for electrical drives and controllers” on the servo drives ARS 2000 SE in the product manuals according to Table 1.
Observe the information regarding safety and on the requirements for product use in Section 1.2.

Product identification

This product manual refers to the following versions:

- Servo drives ARS 2000 SE with STO function, from revision 1.0
- Servo drives ARS 2000 SE-firmware version 4.0.0.1.1 and higher.
- Parameterisation program Metronix ServoCommander™ from version 4.0 KM Release 1.5.

Support

For technical questions please contact your reseller.

Documentation

You will find additional information on the servo drives in the following documentation:

User documentation on the servo drives ARS 2000 SE	
Name, type	**Contents**
Product Manual “Servo drives ARS 2100 SE”	Description of the technical data and the device functionality plus notes concerning the installation and operation of the ARS 2102 SE, ARS 2105 SE and ARS 2108 SE servo drives.
Product Manual “Servo drives ARS 2300 SE”	Description of the technical data and the device functionality plus notes concerning the installation and operation of the ARS 2302 SE, ARS 2305 SE and ARS 2310 SE.
Product Manual “STO (Safe Torque Off) for the servo drives ARS 2000 SE“	Description of the functional safety technology for the servo drives ARS 2000 SE with the safety function STO (this product manual).
Mounting Instructions ”Servo drives ARS 2100 SE”	Instructions on the installation of the ARS 2102 SE, 2105 SE and 2108 SE servo drives.
Mounting Instructions “Servo drives ARS 2300 SE”	Instructions on the installation of the ARS 2302 SE, ARS 2305 SE and ARS 2310 SE servo drives.

Table 1: Documentation on the servo drives ARS 2000 SE

You can find all these documents on our homepage at the download area http://www.metronix.de.

1 Safety and requirements for product use

1.1 Safety

1.1.1 General safety information

❖ In addition, always observe the “Safety notes for electrical drives and controllers“ on the servo drives ARS 2000 SE.

You will find the “Safety notes for electrical drives and controllers“ on the servo drives ARS 2000 SE in the product manuals according to Table 1.

Note

Danger of loss of the safety function.

Non-compliance with environmental and connection conditions can lead to loss of the safety function.

Observe the specified environmental and connection conditions, in particular the input voltage tolerances ➔ Technical data, Appendix 7.1.

Note

Incorrect handling can damage the servo drive.

Before mounting and installation work, switch off the supply voltage. Switch on the supply voltage only when the mounting and installation work is complete.

Observe the handling specifications for electrostatically-sensitive devices.

1.1.2 Intended use

The servo drive ARS 2000 SE has the following safety function firmly integrated:

- Safely switched-off torque – “Safe Torque Off” (STO) with SIL3 according to EN 61800-5-2 / EN 62061 / IEC 61508 or category 4 / PL e according to EN ISO 13849-1.

The servo drive ARS 2000 SE with integrated STO function is a product with safety-relevant functions and is intended for installation in machines or automation systems and for use as follows:

- in a faultless technical condition,
- in its original condition, without any modifications by the user,
- within the product’s limits as defined by the technical data (➔ Appendix 7.1),
- in an industrial environment.

➔ **Note**

In the event of damage caused by unauthorised manipulation or use other than intended, the guarantee is invalidated and the manufacturer is not liable for damages.

1.1.3 Possible incorrect application

Improper use includes the following possible cases of incorrect application:

- use outdoors,
- use in a non-industrial area (residential area),
- use in applications where switching off can result in hazardous movements or conditions.

➔ **Note**

- The STO function is insufficient as the sole safety function for drives subject to permanent torque (e.g. suspended loads).
- Bypassing of safety equipment is impermissible.
- Repairs on the device are impermissible!

The STO (Safe Torque Off) function does **not** provide protection against electric shock, only against hazardous movements!

➔ Product Manual „Servo drives ARS 2100 SE“

➔ Product Manual „Servo drives ARS 2300 SE“

1.1.4 Achievable safety level, Safety function according to EN ISO 13849-1 / EN 61800-5-2

The servo drive ARS 2000 SE with integrated STO function fulfils the basic test requirements

- Category 4 / PL e according to EN ISO 13849-1,
- SIL CL 3 according to EN 61800-5-2 / EN 62061 / IEC 61508,

and can be used in applications up to cat. 4 / PL e according to EN ISO 13849-1 and SIL 3 according to EN 62061 / IEC 61508.

The achievable safety level depends on the other components used to achieve a safety function.

1.2 Requirements for product use

- ❖ Make this documentation available to the design engineer and installer or person responsible for commissioning the machine or system in which this product will be used.
- ❖ Ensure compliance with specifications in the documentation at all times. Also take into account the documentation for the other components (e.g. servo drive, lines, etc.).
- ❖ Take into account the legal regulations applicable to the destination, as well as:
  - regulations and standards,
  - regulations of the testing organisations and insurers,
  - national specifications.
- ❖ For emergency stop applications, protection against automatic restart must be provided according to the required safety category. This can be achieved through an external safety switching device, for example.

1.2.1 Technical requirements

General conditions for the correct and safe use of the product, which must be observed at all times:

- ❖ Comply with the connection and environmental conditions of the servo drive (➔ Appendix 7) and all connected components.
  The product can be operated in accordance with the relevant safety guidelines only if the limit values or load limits are observed.
- ❖ Observe the warnings and instructions in this documentation.

1.2.2 Qualification of the specialist personnel (requirements for personnel)

The device may only be placed in operation by a qualified electrical engineer who is familiar with:

- installation and operation of electrical control systems,
- the applicable regulations for operating safety-engineered systems,
- the applicable regulations for accident protection and occupational safety, and
- product documentation.

1.2.3 Diagnostic coverage (DC)

Diagnostic coverage depends on the connection between the servo drive with integrated safety function and the control loop system as well as the implemented diagnostic measures.

If a potentially hazardous disturbance is recognised during diagnosis, appropriate measures for maintaining the safety level must be implemented.

Note

Check whether cross-circuit detection of the input circuit and the connection wiring is required in your application.

If needed, use a safety switching device with horizontal cross-circuit detection to activate the safety function.

1.2.4 Range of applications and certification

The servo drive with integrated safety function is a safety component in accordance with the machinery directive and bears the CE mark.

Standards and test values which the product must comply with and fulfils can be found in the section “Technical appendix” (➔ Appendix 7.1).The product-relevant EU directives can be found in the declaration of conformity.

Certificates and the declarations of conformity for this product can be found at http://www.metronix.de.

2 Product description ARS 2000 SE with integrated STO function

2.1 Product overview

2.1.1 Purpose

As processes become increasingly automated, protecting people from potentially hazardous movements is gaining in importance. Functional safety describes the measures offered by electrical or electronic devices that are required to reduce or eliminate malfunction-induced hazards. In normal operation, safety devices prevent human intervention in hazardous areas. In certain operating modes, during set-up for example, people also need to be in hazardous areas. In such situations, the machine operator must be protected by drive and internal control measures.

Integrated functional safety technology provides the conditions required by controller and drive for the optimised realisation of safety functions. Planning and installation complexity is reduced. The use of integrated functional safety technology increases machine functionality and availability over the levels achieved by conventional safety technology.

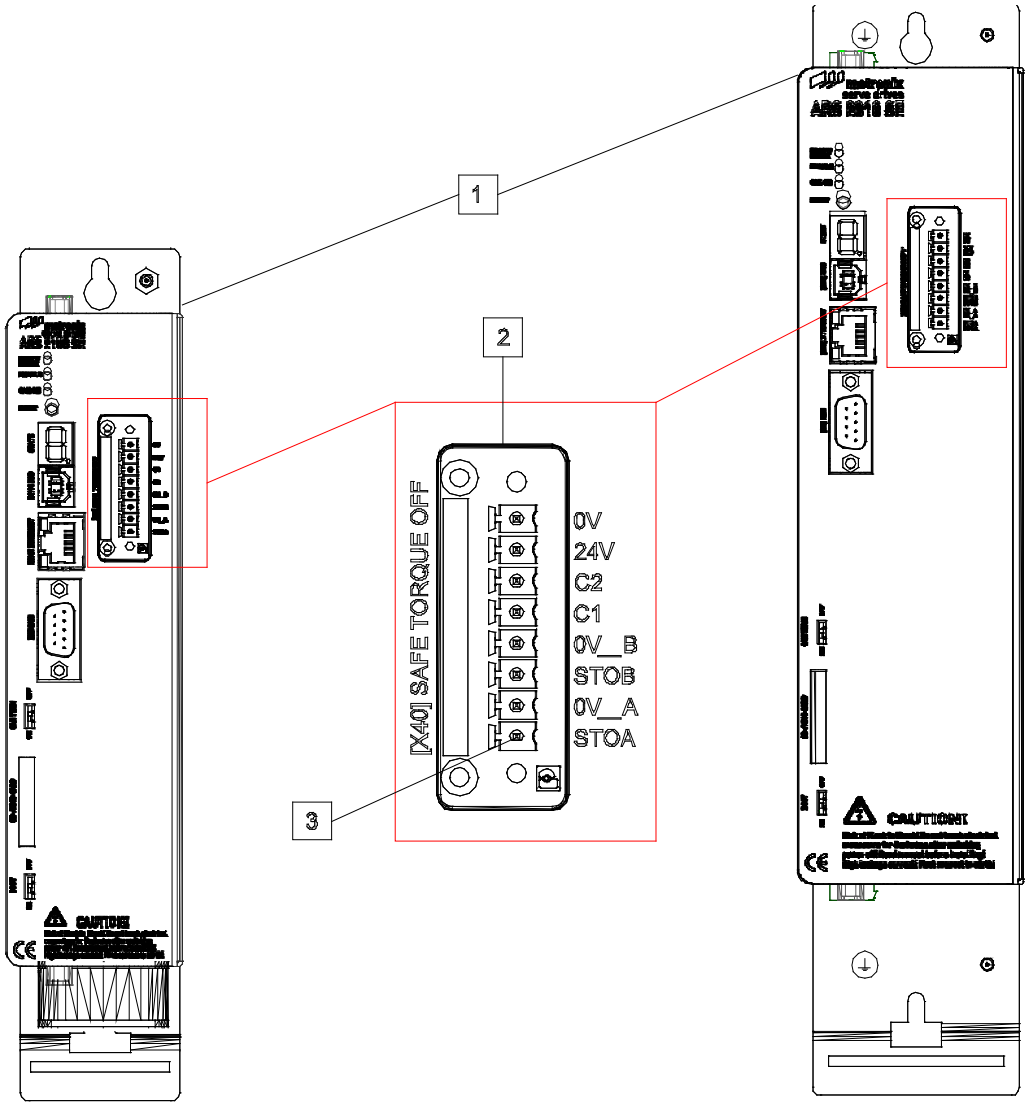
2.1.2 Supported devices

Type	Description
ARS 2102 SE	Servo drive single-phase, 2,5 A output current
ARS 2105 SE	Servo drive single-phase, 5 A output current
ARS 2108 SE	Servo drive single-phase, 8 A output current
ARS 2302 SE	Servo drive three-phase, 2,5 A output current
ARS 2305 SE	Servo drive three-phase, 5 A output current
ARS 2310 SE	Servo drive three-phase, 10 A output current

Table 2: Overview ARS 2000 SE series of devices with integrated STO function

2.1.3 Connections

The servo drive ARS 2000 SE has a digital I/O-interface for control of the STO function.



1 Servo drives ARS 2105 SE and ARS 2310 SE

2 Digital I/O-interface [X40] for control of the STO function

3 Pin 1 of the interface [X40]

Figure 1: Connections of the ARS 2000 SE for the STO function

2.2 Function and application

The servo drive ARS 2000 SE has the following performance characteristics:

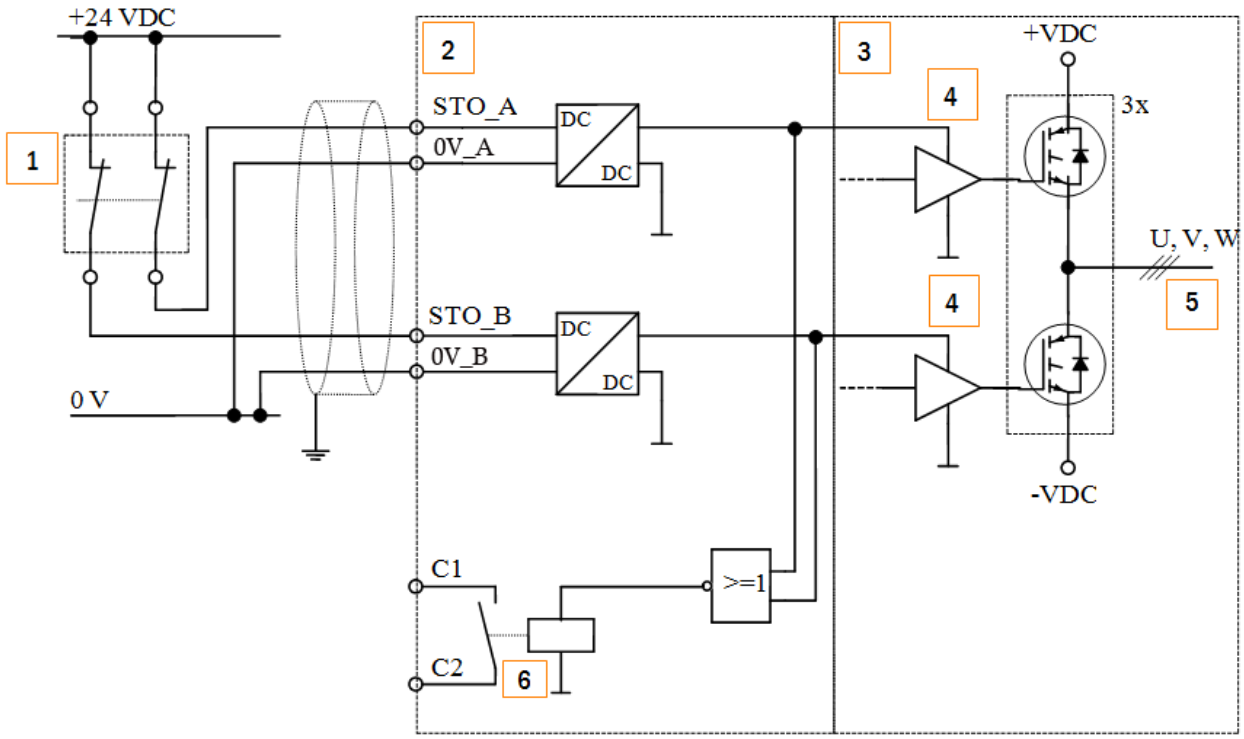
- “Safe Torque Off” (STO) function,
- Potential-free feedback contact for the operating status.

The “Safe Stop 1” (SS1) function can be realised by employing a suitable external safety switching device and appropriate servo drive circuitry.

2.2.1 Description of the safety function STO

Use the function “Safe Torque Off” (STO) whenever you have to reliably disconnect the energy supply to the motor in your particular application.

The function “Safe Torque Off” switches off the driver supply for the power semiconductor. This makes sure that the power stage does not feed any significant current into the motor and thus that the motor does not start moving unexpectedly, see Figure 2.



1 Safety circuit (switch, relay, safety switching device)

2 Integrated STO function

3 Power end stage in the ARS 2000 SE (only one phase illustrated)

4 Driver supply

5 Motor connection

6 Feedback contact

Figure 2: “Safe Torque Off” – Operating principle for the ARS 2000 SE

The power supply to the drive is reliably disconnected via the active safety function STO “Safe Torque Off”. The drive cannot generate torque and so cannot perform any hazardous movements. With suspended loads or other external forces, additional measures must be taken to reliably prevent sagging (e.g. mechanical holding brake). In the STO “Safe Torque Off” state, the standstill position is not monitored.

The machine must be stopped in a safe manner, e.g. via a safety switching device. This applies specifically to vertical axes without self-locking mechanism, clamping unit or counterbalance.

➔ **Note**

There is a risk that the drive will advance in case of multiple errors in the ARS 2000 SE.

If the output stage of the servo drive fails while in the STO status (simultaneous short circuit of 2 power semiconductors in different phases), a limited dwell movement of the rotor may result. The rotation angle / path corresponds to a pole pitch. Examples:

- Rotary axis, synchronous machine, 8-pin ➔ movement < 45° at the motor shaft.
- Linear motor, pole pitch 20 mm ➔ movement < 20 mm at the moving part.

2.2.2 Overview of interface [X40]

On its front, the servo drive ARS 2000 SE provides an 8-pin connection [X40] for control ports, feedback contact and a 24 V auxiliary supply for external sensors ➔ Section 3.2.

The safety function STO is requested solely via the two digital control ports STO-A and STO-B. A safety circuit for additional interfaces at the ARS 2000 SE servo drive is neither required nor intended.

i Cross-circuit detection in the input circuit is not carried out by the servo drive.

The status of the servo drive is reported back to an external safety switching device through a potential-free acknowledgment contact (normally open). This enables a downwards-compatible activation in a mixed configuration, comprising an ARS 2000 (previous series with the “Safe Stop” function to be realised via the connection [X3]) and the ARS 2000 SE ➔ Section 6.2.

The interface [X40] permits the direct connection of active and passive sensors, since a 24 V supply voltage (auxiliary supply) with corresponding reference potential is lead out.

Connections		Description
STO-A 0V-A	(Pin 1) (Pin 2)	Control port A for the STO function with corresponding reference potential. 1) – Request for “Safe Torque Off” (STO) at Low (0 signal), together with STO-B.
STO-B 0V-B	(Pin 3) (Pin 4)	Control port B for the STO function with corresponding reference potential. 1) – Request for “Safe Torque Off” (STO) at Low (0 signal), together with STO-A.
C1 C2	(Pin 5) (Pin 6)	Feedback contact for the “Safe Torque Off” (STO) status, e.g. to an external controller. – Feedback contact opened: “Safe Torque Off” (STO) not active – Feedback contact closed: “Safe Torque Off” (STO) active
24 V 0 V	(Pin 7) (Pin 8)	Auxiliary supply, e.g. for safety peripherals (24 V DC logic supply of the servo drive).
1) Control inputs 24 V, high active, based on EN 61131-2, deviating signal level, see Section 7, Table 18.		

Table 3: Function of the servo drive connections

The connections are electrically isolated from each other in groups and from the 24 V supply to the servo drive ➔ Section 7, Table 22.

2.2.3 Control ports STO-A, 0V-A / STO-B, 0V-B [X40]

The safety function STO (Safe Torque Off) is requested via the two control ports STO-A and STO-B. They permit the direct connection of safe semiconductor outputs (electronic safety switching devices, active safety sensors, e.g. light curtains with OSSD signals) and of switch contacts (safety switching device with relay outputs, passive safety sensors, e.g. forcibly-guided position switches)
➔ e.g. Section 3.2.3, Figure 6.

To request the safety function STO (Safe Torque Off), the 24 V control voltage at both control ports STO-A and STO-B is switched off (0 V).
If the two control ports are switched off simultaneously or within a defined discrepancy time, the STO function is active.

For control ports STO-A and STO-B, an undervoltage monitoring mechanism is integrated to eliminate the possibility of invalid voltage ranges for the downstream electronics, as well as an overvoltage monitoring mechanism to protect against overvoltage.

Table 18 in Section 7.1.4 describes the technical data for the control ports within the specified operating range of the logic voltages.

Tolerance ranges are defined for the input voltage range of control ports STO-A and STO-B. The amount of energy stored in the components of the STO circuit (e.g. capacitors) depends on the input voltage level. During switching operations, these energies must be charged or discharged. Consequently, switch-off time values for the transition to the safe state (STO) and the tolerance time vis-a-vis OSSD signals (buffer time) depend on the input level.

The time response requirements are contained in the technical specifications in Section 7.1.4. The time response itself is described in Section 2.4.

2.2.3.1 Discrepancy time

The transition between the safe and the unsafe state is initiated via level changes at the control ports STO-A and STO-B of the servo drive ARS 2000 SE. According to the safety function specification, the two levels must be identical otherwise an error message will be generated. The finite state machine in the servo drive internally monitors the driver supply voltage after the control ports have been activated. Due to component tolerances or bouncing safety controller ports, for example, these level changes do not normally occur precisely at the same time. The firmware tolerates this for as long as the second input occurs within a defined time, the so-called discrepancy time. If this time is exceeded, the servo drive generates an error message.

The default discrepancy time is 100 ms.
Recommendation: Always switch STO-A and STO-B simultaneously.

2.2.3.2 Test pulse

Temporary test pulses from safety controllers are tolerated and thus do not trigger the STO function.

The tolerance to test pulses from sensors with OSSD signals is rated for the operating range specified in accordance with Appendix 7.1.4, Table 19. The permissible test pulse length is dependent upon the control voltage level at inputs STO-A and STO-B.

Example: Input voltage for STO-A and STO-B = 24 V
➔ OSSD signals with a test pulse length of 3.5 ms are tolerated.

2.2.4 Feedback contact C1, C2 [X40]

If the **STO function is inactive**, the feedback contact opens. This is the case, for example, when only one of the two control voltages STO-A or STO-B is present, if the 24 V logic power supply is switched off or if the supply voltage fails.
When the **STO function is active**, the relay contact is closed.

The feedback contact has a single channel and may be used for diagnostic purposes, but not in the safety circuit.

Table 20 in Section 7.1.4 describes the electrical data, and the time response of the feedback contact.

When the 24 V supply to the servo drive is turned on and off, the switching status of the relay may – due to the internal supply voltages powering up at a different speed – deviate briefly (approx. 100 ms) from the state of the control ports STO-A and STO-B.

2.2.5 Auxiliary supply 24V, 0V [X40]

The servo drive ARS 2000 SE with integrated STO function provides a 24 V auxiliary supply to [X40]. This can be employed when using the feedback contact C1/C2 or to supply external, active sensors.

Table 21 in Section 7.1.4 describes the electrical data for the auxiliary supply.

2.3 Functionalities in the servo drive ARS 2000 SE

The following functions in the servo drive ARS 2000 SE are not certified according to EN 61800-5-2. They are functional supplements and offer additional diagnostics options.

Error messages generated by the integrated STO circuit, such as exceeding the discrepancy time, are detected and analysed by the non-safety finite state machine of the servo drive. If conditions for an error status are detected, an error message is generated. In this case, it cannot always be guaranteed that power end stage has been safely switched off.

The integrated STO circuit in the ARS 2000 SE controls only the provisioning of the driver supply for the device. Although input voltage levels are monitored area by area, the integrated STO circuit does not have its own error analysis function and is unable to display errors.

Note

When error messages are acknowledged, all acknowledgeable errors regarding functional safety are also always acknowledged ➔ Section 5.4.2.

The servo drive ARS 2000 SE monitors the status of the control ports STO-A and STO-B.

Consequently, the servo drive firmware detects the request for the safety function STO (Safe Torque Off) and various non-safety functions are then performed:

- Detection of deactivated driver supply for the power semiconductor via the integrated STO circuit,
- Deactivation of the drive controller and activation of the power semiconductor (PWM),
- The holding brake controller is deactivated (if configured),
- Finite state machine on the servo drive with activation analysis (discrepancy time),
- Detection of application-related error messages,
- Hardware diagnostics,
- Status and error display via display, digital outputs, fieldbuses etc.

Note

The brake is activated by the servo drive's non-safety firmware.

Note

If one of the control ports STO-A or STO-B is deactivated with an active output, the drive coasts unbraked if no holding brake is connected.

This can cause damage to the machine. It is therefore recommended that a holding brake is connected to the servo drive.

Please check whether the motors with holding brake you use is designed to decelerate and bring the motor to a standstill via the holding brake if a malfunction occurs.

The safe state can be requested when the power semiconductor (PWM) is activated, but results in an acknowledgeable error message. The two driver supply voltage states are detected and analysed in 10 ms cycles. If they are unequal over a prolonged period, an error message is generated ➔ Section 5.4.2. The safety function presupposes that the two signals have the same status. Unequal signals are tolerated only during a transition period, the so-called "discrepancy time" ➔ Section 2.2.3.

The finite state machine in the servo drive ARS 2000 SE has its own status in parallel to the integrated STO circuit. Due to the discrepancy time analysis, this finite state machine may reach the "Safe status" only with a considerable delay. Accordingly, this state can also be signalled via digital outputs or a fieldbus only with a considerable delay. The power end stage itself is then, however, "safely switched off". This finite state machine is processed within the 10 ms cycle.

This generally results in a graded response speed as per Table 4:

Function	Response time	Reaction
Switching time from high to low	T_STO-A/B_OFF	➔ Section 7.1.4, Table 18
Switching time from low to high	T_STO-A/B_ON	➔ Section 7.1.4, Table 18
Detection of driver supply failure	$t_{Reaction} \leq 125$ µs	Activation of the power semiconductor (PWM) is switched off
Activation of holding brake	$t_{Reaction} \leq 10$ ms	Activation of the holding brake after detection of the driver supply failure
Signal analysis and status display	$t_{Reaction} \leq 10$ ms	Status transitions in the internal finite state machine, triggering an error message and showing the status on the display if necessary

Table 4: Detection and response times of the driver supply voltage

2.4 Time behaviour

Functionally, the STO-A and STO-B inputs are identical. The switch sequence of STO-A/STO-B is interchangeable across all diagrams.

2.4.1 Basic time behaviour STO

Figure 3 displays the basic time behaviour of the safety circuit STO. The time specifications can be found in Table 5:

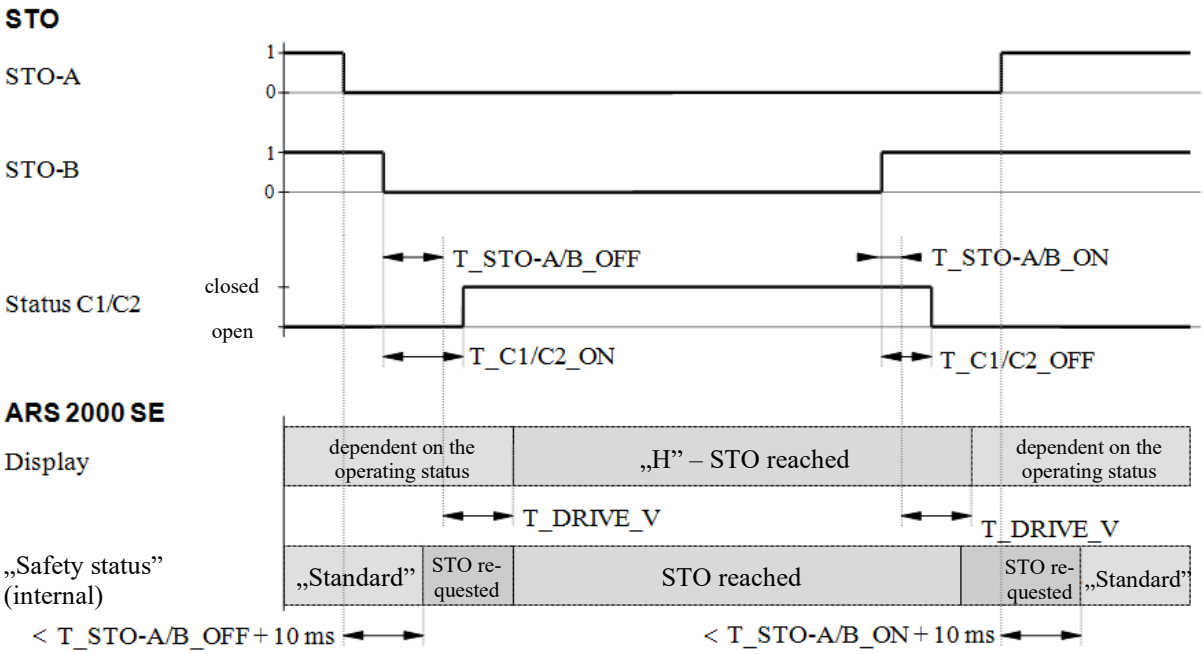


Figure 3: Basic time behaviour when activating and deactivating the safety function STO

Time	Description	Value
T_STO-A/B_OFF	STO-A/B – Switching time from High to Low	➔ Section 7.1.4, Table 18
T_STO-A/B_ON	STO-A/B – Switching time from Low to High	➔ Section 7.1.4, Table 18
T_C1/C2_ON	C1/2 – Switching time closing	➔ Section 7.1.4, Table 20
T_C1/C2_OFF	C1/2 – Switching time opening	➔ Section 7.1.4, Table 20
T_DRIVE_V	Delay of the ARS 2000 SE	0 … 10 ms

Table 5: Time data concerning Figure 3

2.4.2 Time behaviour for activating STO during operation with restart

Figure 4 displays the time behaviour starting from interruption of the control voltage to STO-A/B, as well as the sequence required to allow the servo drive to restart. The time specifications can be found in Table 6. Notes:

- The holding brake is activated via the servo drive, not a safety function.
- The coasting of the motor, irrespective of brake activation/deactivation, is displayed.
- The setpoint value is only activated when the holding brake delay T_BRAKE_V has expired.
- An error is triggered because the STO inputs are deactivated while the output stage is active.

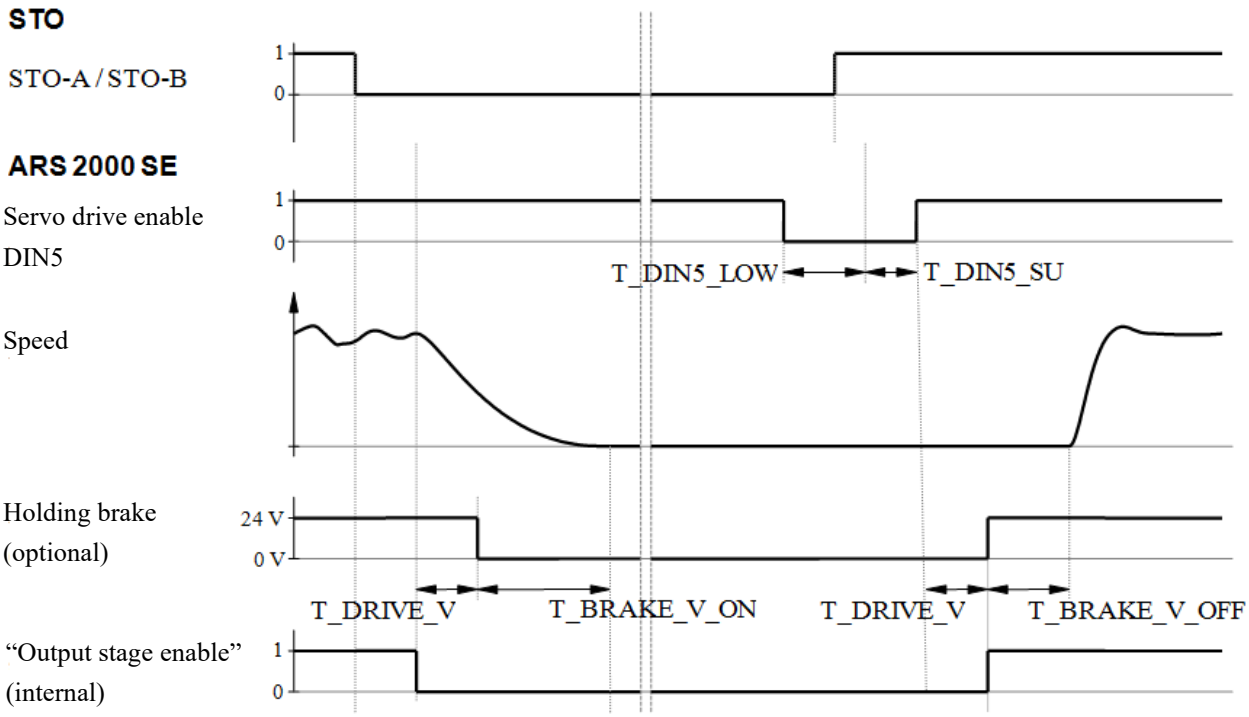


Figure 4: Time behaviour when activating the safety function STO with restart

Time	Description	Value
T_STO-A/B_OFF	STO-A/B – Switching time from High to Low	➔ Section 7.1.4, Table 18
T_STO-A/B_ON	STO-A/B – Switching time from Low to High	➔ Section 7.1.4, Table 18
T_DIN5_LOW	Time for which the DIN5 must be Low before STO-A/B is switched on again	0 ms
T_DIN5_SU	Time for which the DIN5 must be Low after switching on STO-A/B again and status change of the STO circuit	> 20 ms
T_DRIVE_V	Delay of the ARS 2000 SE	0 … 10 ms
T_BRAKE_V_ON	Switch off delay of the holding brake	Dependent on the brake [1)]
T_BRAKE_V_OFF	Switch on delay of the holding brake	Dependent on the brake [2)]

1) Physical delay until the brake closes.

2) Minimum time: Physical delay until the brake opens. This time can be parameterised in the servo drive via a large value.

Table 6: Time data concerning Figure 4

2.4.3 Time behaviour for activating SS1 during operation with restart

The time behaviour in Figure 5 is based on the typical circuit for SS1 in Section 3.3.2, starting from control signal S1 for K1. The time specifications can be found in Table 8.

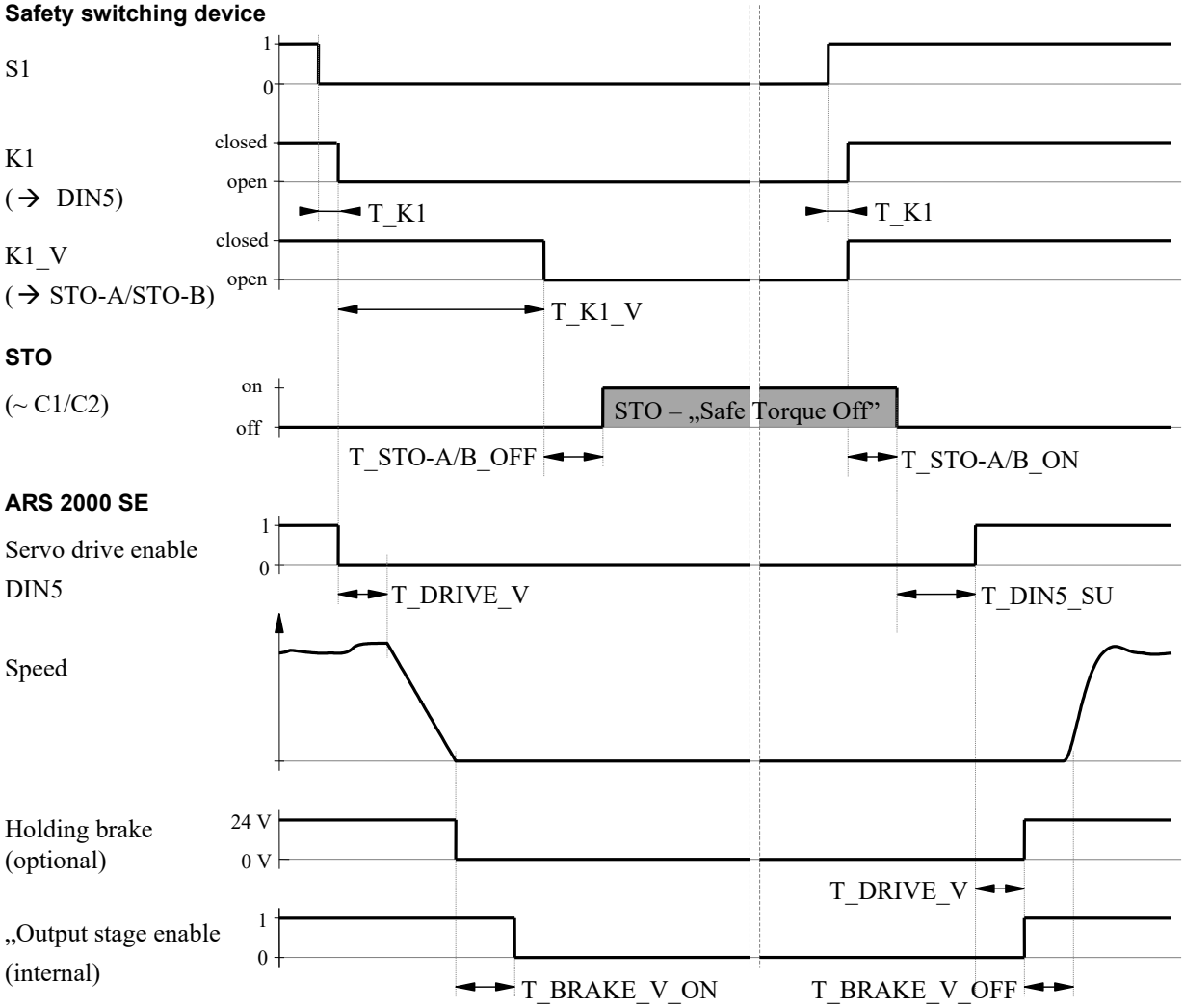


Figure 5: Time behaviour when activating the safety function SS1 (external switching) with restart

Time	Description	Value
T_K1	Delay between the switching of S1 and the closing of the undelayed contact K1	➔ Data sheet for the safety switching device
T_K1_V	Delay between S1 and the opening of the relapse delayed contact K1	Can be set on the safety switching device
T_STO-A/B_OFF	STO-A/B – Switching time from High to Low	➔ Section 7.1.4, Table 18
T_STO-A/B_ON	STO-A/B – Switching time from Low to High	➔ Section 7.1.4, Table 18
T_DRIVE_V	Delay of the ARS 2000 SE	0 … 10 ms
T_DIN5_SU	Time for which the DIN5 must be Low after switching on STO-A/B again and status change of the STO circuit	> 20 ms
T_BRAKE_V_ON	Switch off delay of the holding brake	Dependent on the brake 1)
T_BRAKE_V_OFF	Switch on delay of the holding brake	Dependent on the brake 2)

1) Physical delay until the brake closes.

2) Minimum time: Physical delay until the brake opens. This time can be parameterised in the servo drive via a large value.

Table 7: Time data concerning Figure 5

3 Assembly and Installation

3.1 Mounting / Dismounting

The STO circuit integrated in the ARS 2000 SE servo drive is not intended to be mounted/dismounted by the customer.

For general information on mounting the ARS 2000 SE please refer to the product manual “Servo drives ARS 2000 SE“.

3.2 Electrical installation

3.2.1 Safety instructions

During installation, the requirements of EN 60204-1 must be fulfilled.

Warning

Danger of electric shock in case of voltage sources without safety measures.

Use only PELV (protective extra-low voltage) circuits according to EN 60204-1 for the electric logic supply.
Also observe the general requirements for PELV power circuits according to EN 60204-1.

Only use power sources which guarantee reliable electrical isolation of the operating voltage according to EN 60204-1.

Protection against electric shock (protection against direct and indirect contact) is guaranteed in accordance with EN 60204-1 by using PELV circuits (electrical equipment of machines, general requirements). The 24 V power supply unit used in the system must satisfy the requirements of EN 60204-1 for DC power supply (behaviour during power interruptions, etc.).

Make sure that no jumpers or the like can be inserted parallel to the safety wiring, e.g. through the use of the maximum wire cross section of 1.5 mm² or suitable wire end sleeves with insulating collars.

Use twin wire end sleeves for looping through lines between neighbouring devices.

3.2.2 ESD protection

With non-assigned plug connectors, there is a danger of the device that other parts of the system may be damaged as a result of ESD (electrostatic discharge). Earth the system parts prior to installation and use suitable ESD equipment (e.g. shoes, earthing straps, etc.).

3.2.3 Connection [X40]

The servo drive ARS 2000 SE with integrated STO function has a combined interface for control and acknowledgment via the plug connector [X40].

- Type on device: PHOENIX MINICOMBICON MC 1,5/8-GF-3,81 BK
- Plug (supplied as standard): PHOENIX MINICOMBICON MC 1,5/8-STF-3,81 BK, connection corresponds to Section 7.1.4, Table 23.

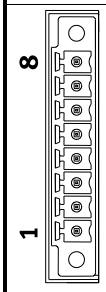
Plug	Pin	Designation	Value	Description
	8	0V	0 V	Reference potential for auxiliary power supply.
	7	24V	+24 V DC	Auxiliary power supply (24 V DC logic supply of the servo drive carried out).
	6	C2	–	Feedback contact for the status “STO” on an external controller.
	5	C1		
	4	0V-B	0 V	Reference potential for STO-B.
	3	STO-B	0 V / 24 V	Control port B for the function STO.
	2	0V-A	0 V	Reference potential for STO-A.
	1	STO-A	0 V / 24 V	Control port A for the function STO.

Table 8: Pin assignment [X40]

In order to ensure the STO “Safe Torque Off” functions correctly, the control ports STO-A and STO-B are to be connected in two channels with parallel wiring, see Section 3.3, Figure 6.
This interface can be part of an emergency stop circuit or a protective door arrangement, for example.

3.2.4 Minimum wiring for commissioning [X40]

For the initial start-up of the servo drive without safety equipment, the servo drive ARS 2000 SE can be equipped with an emergency stop switch (2) with minimum wiring as per Figure 6.

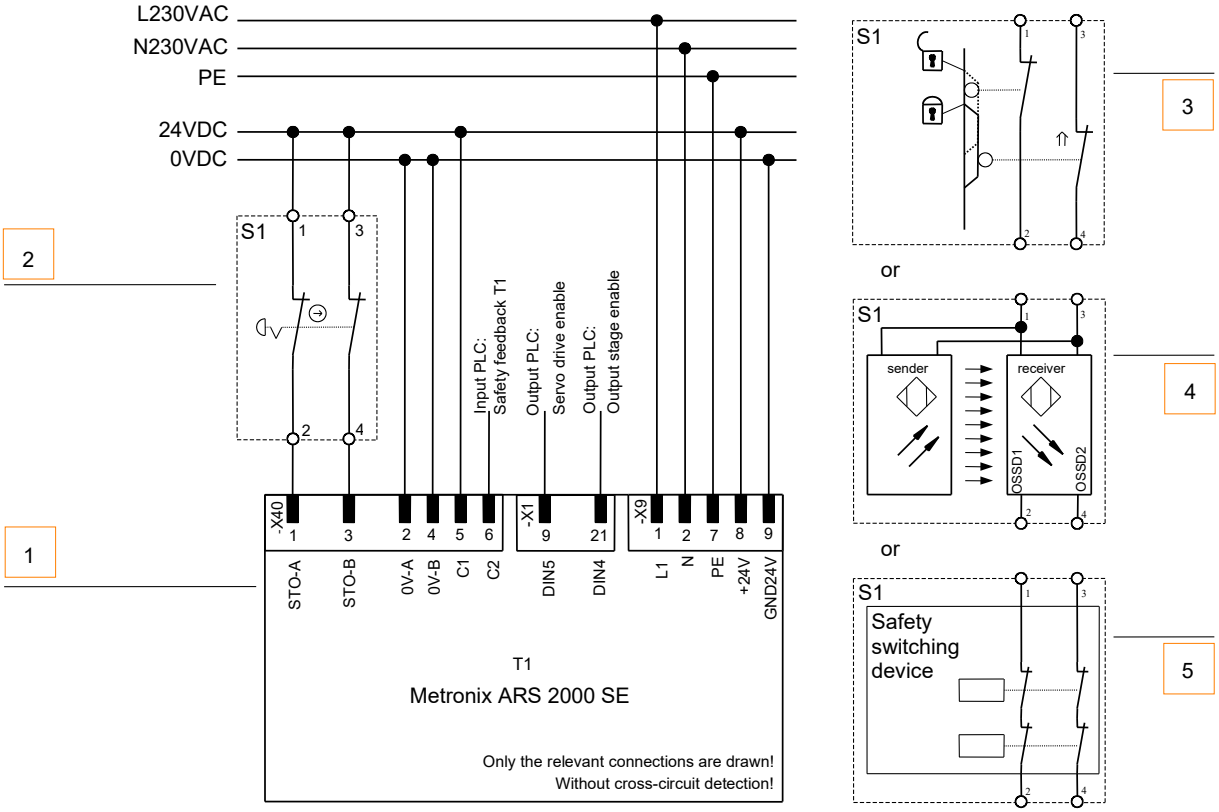
➔ **Note**

Safety functions must never be bypassed.

Carry out the minimum wiring of the inputs STO-A/STO-B and 0V-A/0V-B for the initial start-up so that it will be forcibly removed when the final protection wiring is executed.

3.3 Typical circuits

3.3.1 Safe Torque Off (STO)



1 Servo drive ARS 2000 SE with integrated STO function
(only relevant connections illustrated)

2 Emergency stop switch

3 Protective door

4 Light curtain

5 Safety switching device

Figure 6: Connection of the integrated STO function, example of single-phase servo drive ARS 2000 SE

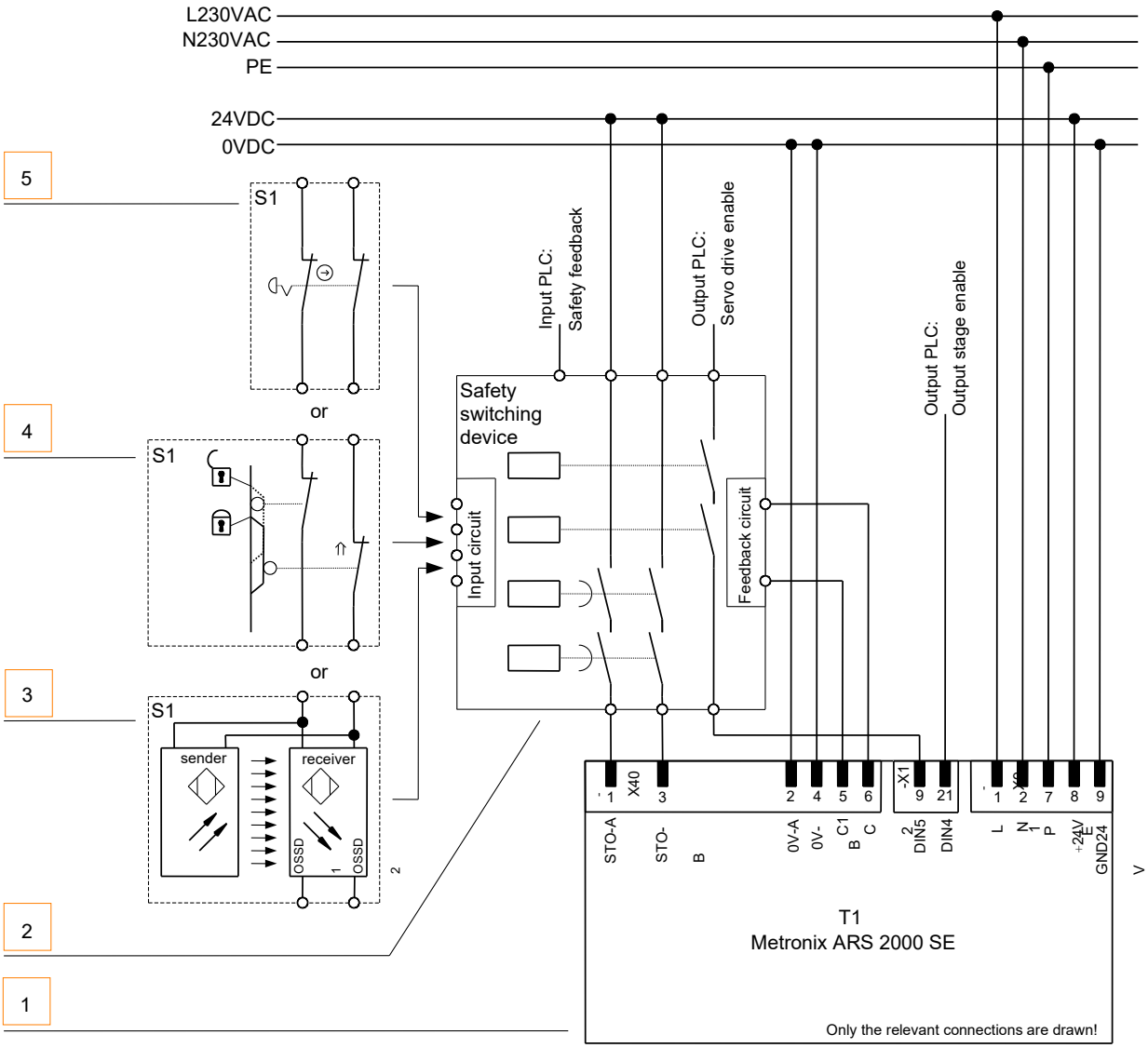
The safety function “Safe Torque Off” (STO) can be requested via various devices. The switch S1 can be, for example, an emergency stop switch, a safety door switch, a light barrier or a safety switching device. The safety request is made in 2 channels via switch S1 and routes to the 2-channel switch-off of the output stage. Once the output stage has been switched off, it is output by the floating contact C1/C2.

Notes with regard to a typical circuit:

– The servo drive with integrated STO function does not have integrated cross-circuit detection. With direct light barrier wiring, the light barrier detects cross-circuits if designed to do so.

- When using safety switching devices, the contacts C1, C2 can be integrated in the feedback circuit of the safety switching device.
- The typical circuit shows a 2-channel structure, which is suitable for categories 3 and 4 with additional measures.
- Which additional measures are required depends on the range of applications and the safety concept of the machine.

3.3.2 Delays and safe torque switch off (SS1, “Safe Stop 1”)



1 Servo drive ARS 2000 SE with integrated STO function (only relevant connections illustrated)

2 Safety switching device

3 Light curtain

4 Protective door

5 Emergency stop switch

Figure 7: Typical circuit “Decelerate and safe torque off” (SS1, “Safe Stop 1”), example single-phase servo drive ARS 2000 SE

The safety function “Safe Stop 1” (SS1, type C) can be requested via various devices ➔Figure 7. The switch S1 in Figure 7can be, for example, an emergency stop switch, a safety door switch or a light barrier. The safety request is made in 2-channels via switch S1 and to the safety switching device. The safety switching device switches off the servo drive enable. If the servo drive enable switched off, the movement is automatically delayed and, if the brake is configured, brake activation is expected before the control circuit is switched off. After a time set in the safety switching device, the 2-channel output stage is switched off via STO-A/B. Once the output stage has been switched off, it is output by the floating contact C1-C2.

Notes with regard to a typical circuit:

- The safety switching device used must switch off the servo drive enable (X1-9, DIN5) without a delay and the inputs STO-A and STO-B (X40-1, -3) with a delay.
- The required delay is application-dependent and must be defined specific to the application concerned. The delay must be designed so that the drive is decelerated to zero, even at maximum speed, via the quick stop ramp in the ARS 2000 SE, before STO-A/B are switched off.
- The electrical installation is executed in accordance with the requirements of EN 60204-1.
  For example, the safety switching device and the servo drive are located in the same control cabinet, so that faults can be excluded for a cross-circuit or earth fault between the cables (acceptance test on the control cabinet for faultless wiring).
- The typical circuit exhibits a 2-channel structure, which is suitable for categories 3 and 4 with additional measures.
- Which additional measures are required depends on the range of applications and the safety concept of the machine.

4 Commissioning

➔ **Note**

Measures against the loss of the safety function!

Lack of the safety function can result in serious, irreversible injuries, e.g. due to uncontrolled movements of the connected actuators.

- ❖ Operate the integrated safety function STO only when all safety measures have been implemented.
- ❖ Validate the safety function to complete commissioning ➔ Section 4.3.

Incorrect wiring or the use of external components that were not selected according to the safety category, result in loss of the safety function.

- ❖ Carry out a risk evaluation for your application and select the circuitry and components accordingly.
- ❖ Note the examples ➔ Section 3.3.

4.1 Before commissioning

Perform the following steps to prepare for commissioning:

1. Ensure that the servo drive is correctly mounted (see Section 3.1).
2. Check the electrical installation (connecting cable, pin allocation see Section 3.2). Are all protective earth conductors connected?

4.2 Parameterisation with Metronix ServoCommander™

The Metronix ServoCommander™ (MSC) parameterisation software has been expanded for the use of the ARS 2000 SE series of servo drives with integrated safety function STO.

The main additions are:

- ❖ Indication of the presence of the integrated safety function STO
- ❖ Status indication for the safety state machine in the ARS 2000 SE
- ❖ Support of the specified warnings and error messages
- ❖ Display of the state data of the integrated safety function STO

The window **Safety module (integrated)** of the Metronix ServoCommander™ shows the status data of the integrated safety function STO, see Section 4.2.3 Window “Safety module (integrated)”

The safety function STO integrated in the servo drive does not have to be parameterised.

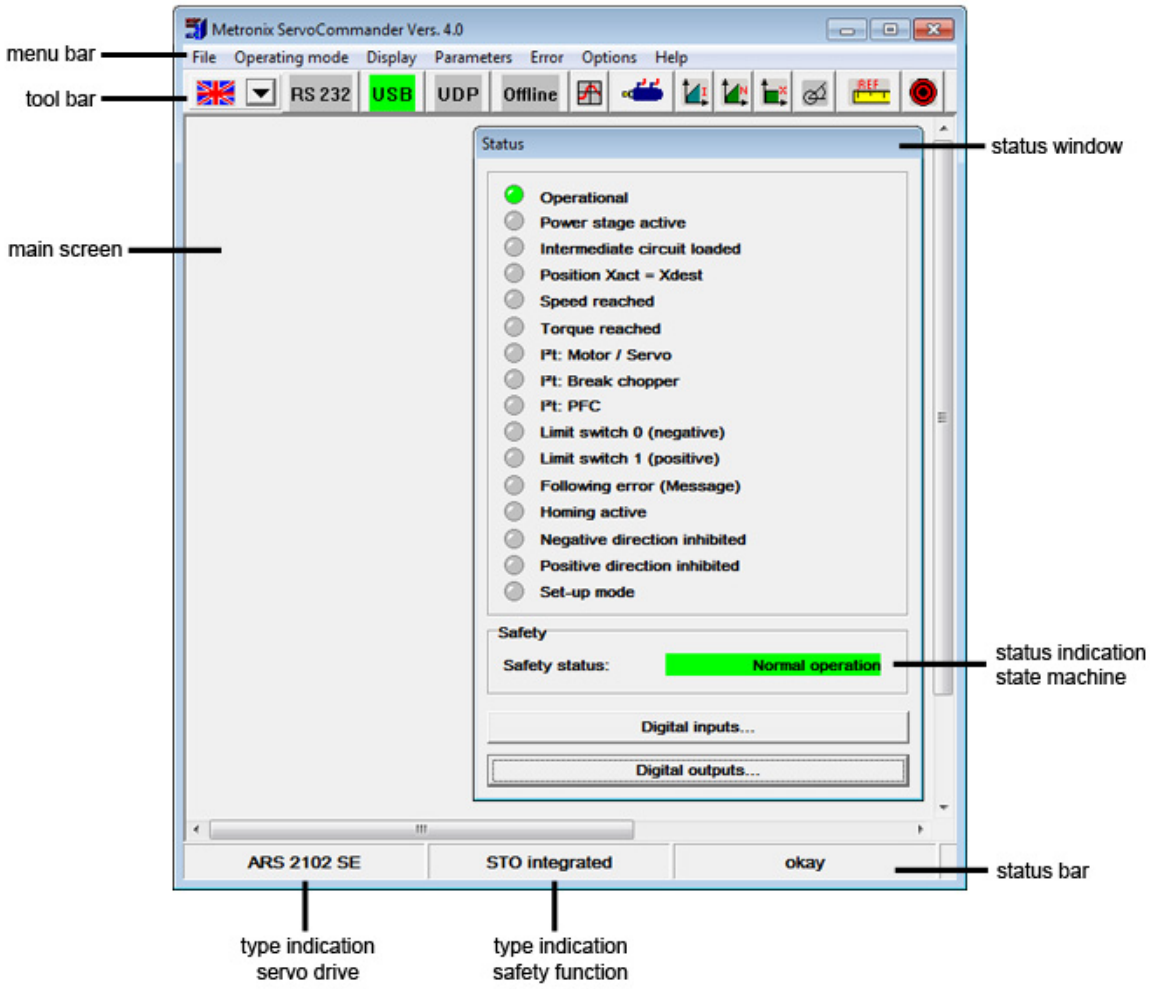


Figure 8: Type indication of the safety function and extended status window

4.2.1 Type indication servo drive and safety function

At the lower edge of the MSC main screen, there is a **status bar**. It shows the type of the servo drive and the type of the integrated safety function (for the ARS 2000 SE always “STO integrated”), see Figure 8.

Additionally, information on the built-in circuit of the integrated safety function STO are indicated in the window **Safety module (integrated)**, see Section 4.2.3 Window “Safety module (integrated)”.

4.2.2 Status indication of the state machine

The **Status window** (i.e. the window that is permanently displayed in the online mode) has been extended by the **status indication of the state machine**. It shows the status of the functional safety in the firmware of the ARS 2000 SE, see Figure 8.

This is not the indication of the electrical status of the two STO inputs. Here, the status of the state machine within the ARS 2000 SE resulting from the evaluation of the driver supply voltages by the integrated safety function STO is displayed. Independently of the display the power end stage of the ARS 2000 SE may be already safely switched off by the integrated safety function STO.

In addition, the status of the internal state machine is indicated in the window **Safety module (integrated)**, see Section 4.2.3 Window “Safety module (integrated)” and Section 4.2.3.2 Status-LEDs of the state machine.

4.2.3 Window “Safety module (integrated)”

In order to use the ARS 2000 SE servo drives with integrated safety function STO, the window **Safety module (integrated)** has been added to the MSC parameterisation software.

This window can be opened either via the menu **Parameters – Functional safety – Safety module** or via the **Safety** button in the quick-access toolbar below the menu bar, see Figure 9.

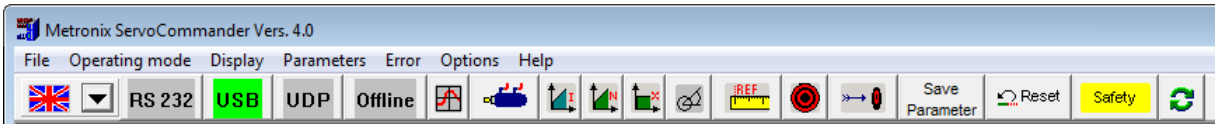


Figure 9: Quick-Access Toolbar with the button “Safety”

In order to emphasise its importance in view of the functional safety, the **Safety** button is yellow.

The window **Safety module (integrated)** displays the status data of the firmly integrated safety function STO.

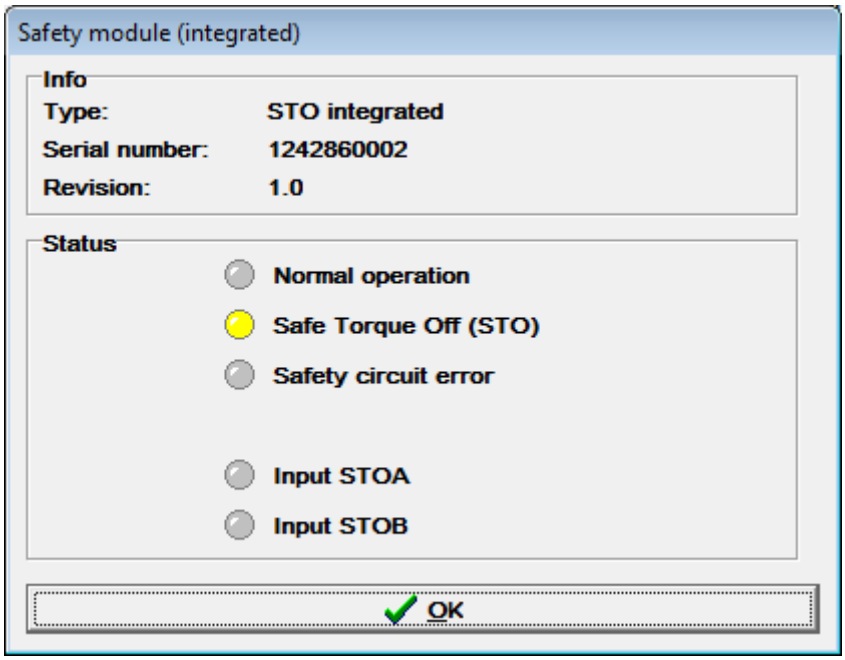


Figure 10: Window “Safety module (integrated)”

The window “Safety module (integrated)” is divided into different fields:

4.2.3.1 Info

This field displays the device data that have been stored in the hardware of the firmly integrated safety function during factory commissioning:

- **Type:**

  Exact type designation, for the ARS 2000 SE always “STO integrated”

- **Serial number:**

  The serial number is assigned during production and is stored in the hardware of the firmly integrated safety function. The serial number is unique for a product of the applicable type.

- **Revision:**

  Revision number of the hardware of the firmly integrated safety function STO.

4.2.3.2 Status-LEDs of the state machine

The lower two LEDs display the status of the driver supply voltage.

The upper three LEDs show the state of the state machine within the servo drive ARS 2000 SE, see Figure 9. The state is read out from the ARS 2000 SE via communication objects and then displayed.

Status display	Meaning	State
○ Normal operation ○ Safe Torque Off (STO) ○ Safety circuit error	All LEDs Off: The integrated safety function STO is not initialized / not operational.	--
○ Normal operation ○ Safe Torque Off (STO) ○ Safety circuit error	Normal operation, that is "non-safe state". The integrated safety function STO is initialized error-free and operational.	Z2, Z3
○ Normal operation ○ Safe Torque Off (STO) ○ Safety circuit error	"Safe state" SAFE TORQUE OFF, this means that the power output stage of the ARS 2000 SE is reliably switched off.	Z1
○ Normal operation ○ Safe Torque Off (STO) ○ Safety circuit error	The safety conditions are violated. The detected state of the two driver supply voltages does not comply with any of the defined valid states. The PWM has been deactivated, the power output stage is not reliable switched of, that means that the system is in a "non-safe state".	Z4

Table 9: Meaning of the LEDs for the status display in the window “Safety module (integrated)”

4.3 Function test, validation

Note

The STO function must be validated after the installation and after changes to the installation.

This validation must be documented by the person performing commissioning. To assist you with the commissioning, questions for risk minimisation are summarised below in the form of sample checklists.

The checklists below are no substitute for safety training.
No guarantee can be provided for the completeness of the checklists.

No.	Questions	Correct	Completed
1.	Were all operating conditions and interventions taken into account?	Yes ☐ No ☐	☐
2.	Has the “3-step method” for risk minimisation been applied, i. e. 1. Inherently safe design, 2. Technical and possibly additional safety measures, 3. User information on the residual risk?	Yes ☐ No ☐	☐
3.	Were the hazards eliminated or the hazard risk reduced as far as practically possible?	Yes ☐ No ☐	☐
4.	Can it be guaranteed that the implemented measures will not pose new hazards?	Yes ☐ No ☐	☐
5.	Have the users been adequately informed and warned about the residual risks?	Yes ☐ No ☐	☐
6.	Can it be guaranteed that the operators’ working conditions have not deteriorated due to the safety measures taken?	Yes ☐ No ☐	☐
7.	Are the safety measures taken mutually compatible?	Yes ☐ No ☐	☐
8.	Was adequate consideration given to the potential consequences of using a machine designed for commercial/industrial purposes in a non-commercial/industrial area?	Yes ☐ No ☐	☐
9.	Can it be guaranteed that the implemented measures will not severely impair the machine’s ability to perform its function?	Yes ☐ No ☐	☐

Table 10: Questions for validation in accordance with EN ISO 12100-1:2010 (example)

No.	Questions	Correct	Completed
1.	Has a risk assessment been conducted?	Yes ☐ No ☐	☐
2.	Have an error list and a validation plan been drawn up?	Yes ☐ No ☐	☐
3.	Was the validation plan, including analysis and inspection, processed and a validation report compiled? The validation procedure must include the following inspections as a minimum:	Yes ☐ No ☐	☐
	a) Component check: Is an ARS 2000 SE used (inspection using the rating plates)?	Yes ☐ No ☐	☐
	b) Is the wiring correct (check against the wiring diagram)?	Yes ☐ No ☐	☐
	– Have any short-circuit bypasses been removed?	Yes ☐ No ☐	☐
	– Has a safety switching device been wired to X40?	Yes ☐ No ☐	☐
	– Is the safety switching device certified and wired in accordance with the application's requirements?	Yes ☐ No ☐	☐
	c) Functional inspections:	Yes ☐ No ☐	☐
	– Pressing the emergency stop button on the unit. Is the drive shut down?	Yes ☐ No ☐	☐
	– If only STO-A is activated - is the drive shut down immediately and the "discrepancy time violation" error (Display 52-1) reported in the ARS 2000 SE after the discrepancy time has lapsed?	Yes ☐ No ☐	☐
	– If only STO-B is activated - is the drive shut down immediately and the "discrepancy time violation" error (Display 52-1) is reported in the ARS 2000 SE after the discrepancy time has lapsed?	Yes ☐ No ☐	☐
	– Is a short circuit detected between STO-A and STO-B or has a suitable fault exclusion been defined?	Yes ☐ No ☐	☐
	– Only when using a safety switching device with analysis of the feedback contact C1/C2: Is the drive shut down on a short-circuit from C1 to C2?	Yes ☐ No ☐	☐
	– Is a restart inhibited? I.e. no movement occurs when the emergency stop button is pressed and the enable signals are active unless a start command is acknowledged beforehand.	Yes ☐ No ☐	☐

Table 11: Questions for validation in accordance with EN ISO 13849-1 and -2 (example)

5 Operation

5.1 Obligations of the operator

The operational capability of the safety equipment must be checked at adequate intervals. It is the responsibility of the operator to choose the type of check and time intervals in the specified time period. The check must be made in a way that proves proper functioning of the safety equipment in interaction with all components.

5.2 Maintenance and care

The servo drive ARS 2000 SE with integrated STO function does not require any maintenance.

5.3 Protective functions

5.3.1 Voltage monitoring

The input voltages at STO-A and STO-B are monitored. If the input voltage at STO-A or STO-B is too high or too low, the driver supply for the power semiconductors of the servo drive are safely switched off. The power output stage (PWM) is thus switched off.

5.3.2 Protection against overvoltage and reverse polarity

The control inputs STO-A and STO-B are protected against overvoltage and reverse polarity of the control voltage ➔ Section 7.1.4, Table 18.

The 24 V DC supply voltage for the servo drive routed to [X40] is short-circuit resistant.

5.4 Diagnostics and troubleshooting

5.4.1 Display on the servo drive

Display	Description
	“H”: The servo drive is in the “safe status”. This does not have the same meaning as the information on the status of the safety function STO (Safe Torque Off). No special display is intended for the “unsafe status”; the normal status displays of the servo drive are represented.

Table 12: Seven segment display on the servo drive

5.4.2 Error messages

When an error occurs, the servo drive shows an error message cyclically in the seven-segment display on the front of the servo drive. The error message consists of an E (for Error), a main index (xx) and sub-index (y), e.g.: E 5 1 0.
Warnings have the same number as an error message. The difference is that a warning is displayed with a prefixed and suffixed hyphen, e.g. - 1 7 0 -.
Table 13 lists the error messages that are relevant for the functional safety in combination with the integrated STO circuit.

For more information about other error messages, please refer to the corresponding documentation, for example the relevant product manuals, the software manual or the fieldbus- specific product manuals. See Table 1, page 12.

Where an error message cannot be acknowledged, the cause must first be remedied in accordance with the recommended measures. Then reset the servo drive, and check whether the cause of the error, and the error message, have been eliminated.

Error message		Meaning of the error message	Measures
Main-index	**Sub-index**		
51 [1)]	0, 2 or 3	The servo drive has detected a problem with the integrated STO circuit.	❖ STO circuit defective. No measures possible, please contact the manufacturer. If possible, replace by another ARS 2000 SE.
	1	Integrated STO circuit: Faulty driver supply – Internal voltage error of the STO circuit	❖ STO circuit defective. No measures possible, please contact the manufacturer. If possible, replace by another ARS 2000 SE.
52	1	Integrated STO circuit: Discrepancy time expired	❖ Control ports STO-A and STO-B are not actuated simultaneously. ❖ Control ports STO-A and STO-B are not wired in the same way. Check discrepancy time.
	2	Integrated STO circuit: Failure of driver supply with active PWM	❖ The safe status was requested with enabled power output stage. Check link to the safety-oriented interface.
1) The messages of error group 51 cannot be acknowledged.			

Table 13: Error messages relating to the integrated STO circuit

6 Conversion

6.1 Repair and replacement of the integrated STO circuit

Repair or maintenance of the integrated STO circuit is not allowed. Also, the integrated STO circuit cannot be replaced by the customer. If necessary, the complete servo drive has to be replaced.

6.2 Replacing the previous series ARS 2000 with the ARS 2000 SE

6.2.1 ARS 2000

The devices of the previous ARS 2000 series also have an integrated STO “Safe Torque Off” in accordance with EN ISO 13849-1, Cat. 3 / PL d. The two-channel arrangement required by the STO function is achieved via two separate switch-off paths:

– 1st switch-off path: Output stage enable via [X1.21], switch-off of the power output phase (PWM signals disabled). The power semiconductor drivers are no longer activated by pulse patterns.
– 2nd switch-off path: Power supply to the six output stage power semiconductors IGBTs via [X3] is interrupted by means of a relay. The driver supply for the power semiconductors (IGBT optocouplers) is disconnected by means of a relay. This prevents the pulse pattern (PWM signals) reaching the power semiconductors.

The ARS 2000 also has a floating feedback contact ([X3] Pins 5 and 6) which, as a diagnostics output, indicates the presence of the driver supply.

6.2.2 ARS 2000 SE

Devices of the ARS 2000 SE series have the safety function STO “Safe Torque Off” in accordance with EN 61800-5-2 SIL3, and/or EN ISO 13849-1, Cat. 4 / PL e. The two switch-off paths are realised via the control ports STO-A [X40.1] and STO-B [X40.3]. The potential-free feedback contact ([X40] Pins 5 and 6) is also present.

6.2.3 Modifications to the connection wiring

Converting an existing application with STO from ARS 2000 to ARS 2000 SE requires the following modifications to be made to the connection wiring:

❖ 1st switch-off path:
Retain output stage enable wiring [X1.21] and route in parallel to STO-A [X40.1].
Connect GNDA [X40.2] to 0 V [X40.8] to link the reference potential.

- 2nd switch-off path:
  Now route driver supply wiring [X3.RELAY] to STO-B [X40.3].
  Connect GNDB [X40.4] with 0 V [X40.8] to link the reference potential.
- Feedback contact:
  Relay connection for the feedback contacts [X3.5] and [X3.6] to [X40.5] and [X40.6].

Note

During operation, the feedback contacts on the ARS 2000 and the ARS 2000 SE show compatible behaviour.

When the logic supply (24 V) is switched off, they behave differently:

- ARS 2000: Contact closed.
- ARS 2000 SE: Contact open.

6.2.4 Information for configuration

The ARS 2000 SE exhibits a higher performance than the ARS 2000. Use of this feature represents an essential modification to the machine.

Note

The parameter set of the ARS 2000 must be transferred with the same values to the parameter block of the ARS 2000 SE. If these values are changed, which in turn poses a higher risk, a new risk assessment must be performed on the machine.

Note

Once the servo drive has been replaced, the safety function must be validated in accordance with the machine manufacturer’s specifications.

7 Technical appendix

7.1 Technical data

7.1.1 Safety engineering

Safety indicators			
Safety function		STO	– Safe Restart Interlock (STO, Safe Torque Off) to EN 61800-5-2 with SIL 3 – Safe Restart Interlock (STO, Safe Torque Off) to EN ISO 13849-1 with category 4 and PL e
SIL		SIL 3 / SIL CL 3	Safety integrity level according to EN 61800-5-2
Category		4	Classification in category in accordance with EN ISO 13849-1
PL		PL e	Performance level in accordance with EN ISO 13849-1
DCavg	[%]	97	Average Diagnostic Coverage
HFT		1	Hardware Failure Tolerance
SFF	[%]	99,17	Safe Failure Fraction
PFH		$1{,}27 \times 10^{-10}$	Probability of dangerous Failure per Hour
PFD		$2{,}54 \times 10^{-5}$	Probability of dangerous Failure on Demand
T	[Years]	20	Proof Test Interval Duration of use in accordance with EN ISO 13849-1
MTTFd	[Years]	100	Mean time to dangerous failure Calculated at 1443 years, limited to 100 years

Table 14: Technical data: Safety indicators

Safety specifications	
Product type testing	The functional safety equipment of the product was certified by an independent testing authority in accordance with Section 1.1.4; see EC product type test certificate (available at http://www.metronix.de).
Certifying body	TÜV 01/205/5245.03/24
Reliable component	Yes

Table 15: Technical data: Safety specifications

7.1.2 General

Certifications (STO function for servo drives ARS 2000 SE)	
CE marking (see declaration of conformity, available at http://www.metronix.de).	In accordance with EU EMC Directive
	In accordance with EU machine directive
	The device is intended for industrial use. Measures for interference suppression may need to be implemented in residential areas.

Table 16: Technical data: Certification

7.1.3 Operating and environmental conditions

The following operating and environmental conditions correspond with those of the servo drive ARS 2000 SE.

Area	**Values**	
Admissible temperature ranges	Storage temperature:	-25 °C to +70 °C
	Operating temperature:	0 °C to +40 °C +40 °C to +50 °C at reduced power 2,5 %/K
Admissible installation height	Mounting height maximum 2000 m above msl, above 1000 m above msl with power reduction 1% per 100 m	
Humidity	Relative humidity up to 90 %, not bedewing	
Protection degree	IP20	
Protection class	I	
Pollution degree	2	
CE conformity Low-voltage directive: EMC directive:	 2014/35/EU verified by application of the harmonised standard EN 61800-5-1 2014/30/EU verified by application of the harmonised standard EN 61800–3	
cULus certification:	See in the Product Manuals “Servo drives ARS 2100 SE” and “Servo drives ARS 2300 SE”	

Table 17: Technical data: Ambient conditions and qualification

7.1.4 Electrical data

Control ports STO-A, 0V-A / STO-B, 0V-B [X40]		
Nominal voltage	[V]	24 (related to 0V-A/B)
Voltage range	[V]	19,2 … 28,8
Permissible residual ripple	[%]	2 (related to nominal voltage 24 V)
Overvoltage discharge	[V]	31 (disconnect in case of error)
Nominal current	[mA]	20 (typical; maximum 30)
Starting current	[mA]	450 (typical, duration approx. 2 ms; max. 600 at 28,8 V)
Input voltage threshold		
Switching on	[V]	approx. 18
Switching off	[V]	approx. 12,5
Switching time from high to low (STO-A/B_OFF)	[ms]	10 (typical; maximum 20 at 28,8 V)
Switching time from low to high (STO-A/B_ON)	[ms]	5 (typical; maximum 7)
Maximum positive test impulse length at logic 0	[µs]	< 300 (related to nominal voltage 24 V and intervals >2 s between impulses)

Table 18: Technical data: Electrical for ports STO-A and STO-B

Switch-off time to power output stage inactive and maximum tolerance time for test pulse											
Input voltage (STO-A/B)	[V]	19	20	21	22	23	24	25	26	27	28
Typical switch-off time (STO-A/B_OFF)	[ms]	4,0	4,5	5,0	6,0	6,5	7,0	7,5	8,0	8,5	9,5
Maximum tolerance time for test pulse at 24 V signal	[ms]	<2,0	<2,0	2,0	2,5	3,0	3,5	4,5	5,0	5,5	6,0

Table 19: Typical switch-off time and minimum tolerance time for test pulse (OSSD signals)

Feedback contact C1, C2 [X40]		
Version		Relay contact, normally open
Max. voltage	[V DC]	< 30 (overvoltage-proof up to 60 V DC)
Nominal current	[mA]	< 200 (not short circuit proof)
Voltage drop	[V]	≤ 1
Residual current (contact opened)	[µA]	< 10
Switching time closing (T_C1/C2_ON)	[ms]	< (STO-A/B_OFF 1) + 5 ms)
Switching time opening (T_C1/C2_OFF)	[ms]	< (STO-A/B_ON 1) + 5 ms)
1) STO-A/B_OFF, STO-A/B_ON ➔ Table 18		

Table 20: Technical data: Electrical data of the feedback contact C1/C2

Auxiliary supply 24V, 0V [X40] – output		
Version		Logic supply voltage routed out of the servo drive (fed in at [X9], not additionally filtered or stabilised). Reverse polarity protected, overvoltage-proof up to 60 V DC.
Nominal voltage	[V]	24
Nominal current	[mA]	100 (short circuit proof, max 300 mA)
Voltage drop	[V]	≤ 1 (for nominal current)

Table 21: Technical data: Electrical data of the auxiliary supply output

Electrical isolation	
Electrically isolated potential ranges	STO-A / 0V-A
	STO-B / 0V-B
	C1 / C2
	24V / 0V (Logic supply to the servo drive)

Table 22: Technical data: Electrical isolation [X40]

Cabling		
Max. cable length		
Unscreened	[m]	30
Screened	[m]	> 30
Screening		When wiring outside the control cabinet and cable lengths > 30 m guide screening into the control cabinet.
Cable cross section (flexible conductors, wire end sleeve with insulating collar)		
One conductor	mm²	0,25 … 0,5
Two conductors	mm²	2 x 0,25 (with twin wire end sleeves)
Tightening torque M2	[Nm]	0,22 … 0,25

Table 23: Technical data: Cabling to [X40]

8 Glossary

Term/abbreviation	Description
Cat.	Safety category in accordance with EN ISO 13849-1, Stages 1-4.
CCF	Common Cause Failure in accordance with EN ISO 13849-1.
DC avg	Average Diagnostic Coverage in accordance with IEC 61508 and EN 61800-5-2.
EMERGENCY SWITCHING OFF	In accordance with EN 60204-1: Electrical safety in case of emergency by switching off the electrical energy to all or part of the installation. EMERGENCY SWITCHING OFF is to be used where a risk of electric shock or other electrical risk exists.
Emergency stop	In accordance with EN 60204-1: Functional safety in an emergency by bringing a machine or movable parts to a standstill. Emergency stop is used to stop a process or a motion if this creates a danger.
HFT	Hardware Fault Tolerance in accordance with IEC 61508.
MSC	Metronix ServoCommander™, software for configuration and commissioning.
MTTFd	Mean Time To dangerous Failure: Time in years up to the first dangerous failure occurs with 100 % probability in accordance with EN ISO 13849-1.
OSSD	Output Signal Switching Device: Output signals with 24 V cycle rates for error detection.
PFD	Probability of Failure on Demand in accordance with IEC 61508.
PFH	Probability of Dangerous Failures per Hour in accordance with IEC 61508.
PL	Performance Level in accordance with EN ISO 13849-1: Stages a … e.
PWM	Pulse-width modulation. Here, signifies the digital activation of the power semiconductors with a variable duty cycle to allow the adjustment of a voltage at the motor output.
Safety switching device	Device for executing safety functions or restoring the machine to a safe status after the power supply to dangerous machine functions has been switched off. The desired safety function is achieved only in combination with other measures, although switch-off can occur on a servo drive, for example.
SFF	Safe Failure Fraction [%], ratio of the failure rates of safe and dangerous (but recognisable) failures to the sum of all failures in accordance with IEC 61508.
SIL	Safety Integrity Level, discrete stages for defining the requirements for the safety integrity of safety functions in accordance with IEC 61508, EN 62061 and EN ISO 13849.
SIL CL	Maximum SIL that can be required from a sub-system.
SS1	Safe Stop 1, according to EN 61800-5-2.
STO	Safe Torque Off in accordance with EN 61800-5-2.
T	Duration of use in accordance with EN ISO 13849-1.

Table 24: Terms and abbreviations