BUCHER automation

User Manual

60888150_00

Functional Description - Integrated Safety Function S1 – JM-3000 rev. B

JM-3000 Servo Amplifier rev. B

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Translation of the german original User Manual

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Table of contents

1 Introduction

1.1 Information on this document

This document forms an integral part of the product and must be read and understood prior to using it. It contains important and safety-related information for the proper use of the product as intended.

Target Groups

This document is intended for specialists with appropriate qualifications.
Only competent and trained personnel are allowed to put this device into operation.
During the whole product life cycle, safe handling and operation of the device must be ensured. In the case of missing or inadequate technical knowledge or knowledge of this document any liability is excluded.

Availability of Information

Make sure this document is kept at the ready in the vicinity of the product throughout its service life.
For information on new revisions of this document, visit the download area on our website. This document is not subject to any updating service.

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For further information refer to the following information products:

– User manuals
  Information on commissioning Bucher-Automation products
– Online help for the JetSym software
  Functions of software products with application examples

ⓘ Info

EtherCAT®

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Contents

This description of the STO safety function contains information on how to commission and test the “Safe Torque Off (STO)” safety function.

NOTICE! This document does not replace the user manual for JM-3000 servo amplifiers and JM-3000 supply units. It supplements these manuals with a description of safety function S1 (STO and SBC).

NOTICE! The complete documentation can be found on the USB stick included with delivery (article number 60888000).

1.2 Typographical conventions

This manual uses different typographical effects to support you in finding and classifying information. Below, there is an example of a step-by-step instruction:

✓ This symbol indicates requirements which have to be met before executing the following action.

► This sign or a numbering at the beginning of a paragraph marks an action instruction that must be executed by the user. Execute the instructions one after the other.

⇨ The target after a list of instructions indicates reactions to, or results of these actions.

ⓘ Info

Further information and practical tips

In the info box you will find helpful information and practical tips about your product.

1.3 Risk assessment

Before a machine can be enabled for regular operation, its manufacturer must carry out a risk assessment procedure according to the Machinery Directive 2006/42/EC. The manufacturer should thereby identify the relevant health and safety requirements for its machinery and take the appropriate measures to that end. To reduce the risk, the manufacturer is obliged to adopt protective measures. These include:

1. An inherently safe design (see EN ISO 12100:2010).
2. Use of guards and protective devices (see EN ISO 12100:2010).
3. Provision of user information that informs about the machine's intended use, warns the user about the residual risk, and defines the required behavior (see EN ISO 12100:2010).

The risk assessment procedure is a multi-stage process and is described in more detail in EN ISO 12100:2010.

Following a risk assessment, which has been successfully prepared by the machine manufacturer, the pre-requisites have been met to define the requirements for the safety-related controllers according to EN ISO 13849-1.

A required performance level (PLr) must be defined and documented for each safety function carried out by the safety-related controller. The achieved performance level (PL) of the respective safety function must meet the requirements of PLr. It is the task of the user of the integrated safety equipment to thoroughly study the associated guidelines and standards, and the legal situation.

1.4 Definition of terms

Term	Description
STO = Safe Torque OFF	When the STO safety function is in effect, the energy supply to the drive is safely interrupted (no electrical isolation). The drive must not be able to generate any torque and thus no dangerous movement. The standstill position is not monitored. The STO safety function meets the requirements of stop category 0 to EN 60204-1.
SBC = Safe Brake Control	The SBC function acts as a safe control of the holding brake. Depending on the preselection of the S-ADR DIL switch block, SBC is always activated in parallel with STO when enabled.
OSSD = Output Signal Switching Device	An OSSD is a safe output switching element. A safe output switching element of this type is safe because the safe controller continuously sends the smallest possible test pulse to the output and is able in this manner to determine whether the downstream semiconductor is still capable of switching.
TP generator = test pulse generator	The TP generator of JM-3000 supply units generates test pulses (signatures) so that downstream peripheral devices can be checked for short circuits and cross faults. With the appropriate setting of the S-ADR DIL switch block, the corresponding STO inputs expect the signature generated by the TP generator. If the result expected by the STO inputs does not occur, the system goes into the safe state (see STO or SBC).

Tab. 1: Acronyms

2 Safety

2.1 General Information

When placed on the market, this product corresponds to the current state of science and technology.

In addition to the operating instructions, the laws, regulations and guidelines of the country of operation or the EU apply to the operation of the product. The operator is responsible for compliance with the relevant accident prevention regulations and generally accepted safety rules.

2.2 Scope of application

This document applies to the following devices only:

JM-35xx-S1, JM-D35xx-S1, JM-T35xx-S1 and JM-35xxB-S1, JM-D35xxB-S1, JM-T35xxB-S1

It is limited to a description of the STO and SBC functions, the digital inputs on X11 and the S-ADR DIL switch block of the servo amplifier.

The serial number can be found on the nameplate of the servo amplifiers.

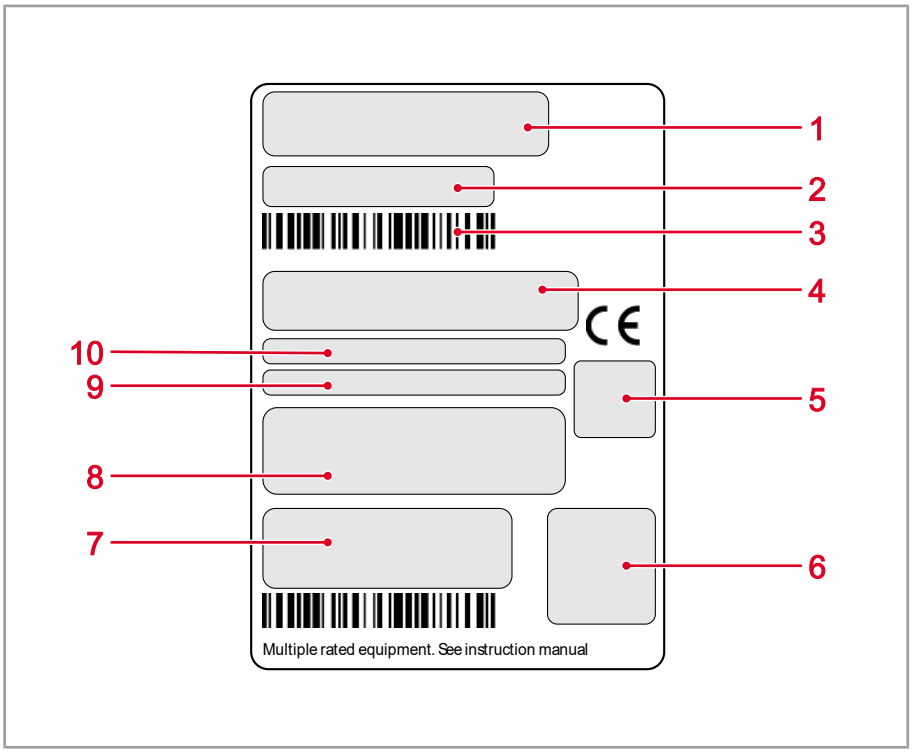


Fig. 1: Nameplate

1	Model code number
2	Serial number
3	Barcode serial number
4	Company logo and address
5	Mandatory sign
6	Certification mark
7	Software revision and various details
8	Power data
9	Item number
10	Model code number

2.3 Purpose

2.3.1 Intended use

The servo amplifier is intended solely for connecting electric motors of various types and various position encoders according to the user manual.

The STO safety function is only available for servo amplifiers with the "S1" option according to the type code.

You may only use the servo amplifier in the closed IP54 control cabinet, taking ambient conditions into account.

The servo amplifier is a product that can be used in electrical installations or machines in the second environment (industrial) with category C1 according to EN 61800-3. This requires EMC-compliant installation.

SELV

PELV

The servo amplifier is intended for connection to a power supply of 560V DC from the JM-3000 supply unit.

A 24 V DC power supply unit (SELV or PELV) is required for the control voltage.

Always use the servo amplifier as intended. The following instructions must be followed as a prerequisite for intended use.

– Always follow the safety instructions. Unauthorized modifications and changes to the servo amplifier are not permitted.
– The operator is obliged to immediately report any changes that affect the safety of the servo amplifier.
– Install and operate the servo amplifier only as specified in this description.
– The servo amplifier may only be installed and operated in flawless technical condition.

2.3.2 Usage other than intended

NOTICE! The STO safety function cannot be used for DC motors with brushes.

– Do not operate the servo amplifier outside its specifications and application examples specified in the user manual.
– The servo amplifier must not be operated under operating conditions that differ from the specified ambient conditions.
– Bucher Automation AG assumes no liability and will not honor warranty claims for damage in the event of usage other than intended.

2.4 Warnings used in this document

⚠ DANGER

High risk

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Medium risk

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Low risk

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Material damage

Indicates a situation which, if not avoided, could result in malfunctions or material damage.

2.5 General Safety Instructions

⚠ DANGER

Risk due to high electrical voltage

Touching live parts may result in death or severe injury.

► Carry out the following steps before starting work to ensure safety.

☑ Prepare for turning off the system. Inform everyone involved who will be affected by the process.

☑ Isolate the drive system from the power supply and secure it against being turned on again.

☑ Wait for the discharge time (approx. 10 minutes) and check all power connections to ensure they are at zero potential.

☑ Ground according to requirements.

☑ Cover over neighboring live parts.

☑ Ensure the drives cannot move.

⚠ DANGER

Danger due to high operating voltage!

The high operating voltage of the device leads to severe injuries or death.

Comply with the following rules throughout the entire work process.

► Do not remove any covers during operation and keep the switch cabinet doors closed.

► Check whether all live connections are safely protected against contact.

► Never open the device.

► Never touch the wiring terminals of the device for voltage supply and DC link voltage during operation.

⚠ DANGER

Risk of electric arc due to improper handling

Improper handling can result in an electric arc, which may lead to severe injury or death.

► Open the plug connections only in de-energized state.

► Install the device only in an environment where there is no risk of fire, without any flammable gases or vapors.

► Observe the specified limit values for voltage.

► Wire according to regulations.

⚠ WARNING

Non-observance of safety instructions may result in injuries or physical damage

- ► Prior to assembling and installing the device, read and follow the safety precautions and restrictions of use as set out in the Safety chapter.
- ► Only authorized qualified personnel is allowed to perform any kind work on the device.

⚠ WARNING

Risk of crushing due to uncontrolled axis movements

High mechanical forces due to axis movements and accelerations.

- ► Keep out of the hazard zone of the machines.
- ► Do not disable any safety equipment.
- ► Have malfunctions eliminated by qualified personnel.

⚠ WARNING

Risk of burns due to hot surfaces

The device may become hot during operation and can cause burns if touched.

- ► Take protective measures to prevent inadvertent contact with the device, e.g. protective covers.
- ► Make sure that no temperature-sensitive parts, e.g. connection cables, are attached or fastened to the device.
- ► Ensure there is adequate heat dissipation and maintain the required distances during installation so as not to prevent or restrict ventilation.
- ► Allow the device to cool off for a while before carrying out cleaning or maintenance work.
- ► Wear personal protective equipment.

⚠ WARNING

Danger for persons with pacemakers and implants!

Operating the device generates an electromagnetic field. Electric, magnetic and electromagnetic fields are a health risk in particular to persons with pacemakers and implants.

- ► If you belong to the above group of persons you must not be in the immediate vicinity of the device.
- ► Keep a minimum distance as specified below:
  300 mm from a de-energized device, for example when doing installation work;
  600 mm from an energized device running in normal operation.

⚠ WARNING

Risk of death due to falling loads during lifting and transport processes

Improperly performed lifting and transport processes as well as unsuitable or defective devices and tools can lead to severe or fatal injuries and material damage.

- ► Lifting devices, industrial trucks and load handling attachments must meet requirements.
- ► The load capacity of the lifting equipment and load handling attachments must be in line with the weight of the load being transported.
- ► Fasten and secure the load to be transported carefully to the lifting equipment.
- ► Do not stand in the swivel range of lifting equipment or under suspended loads.

⚠ CAUTION

Risk from unwanted coastdown!

Triggering the STO function by deactivating the digital input only interrupts the energy supply for the drive and the motor movement can no longer be controlled. The voltage of the DC bus is not disconnected!

- ► Always stop the drive before you trigger the STO function.
- ► In case of suspended loads, install a mechanical brake to prevent the load from falling down.

NOTICE

Damaged devices

Damaged devices may cause considerable physical damage.

- ► Check the device for external damage and faulty connections.
- ► Ensure to install only fully functional devices.

NOTICE

Material damage due to loose power connection

Vibrations or insufficient tightening torques can lead to loose power connections. This can lead to fire damage, defects in the device or malfunctions.

- ► Tighten all power connections to the specified tightening torques.
- ► Check all power connections at regular intervals, especially after transport.

NOTICE

Inadequate accessories might cause damage to the product

Parts and equipment from other manufacturers might impede the function of the device and cause damage to the product.

- ► Only use accessories recommended by Bucher Automation AG.

3 Functional description

Malfunctions of the servo amplifier must be covered by overload monitoring of the movement or by other measures in the application. The user is responsible for this coverage and the response. The safety system makes the STO and SBC safety functions available and the user can use these as a response to malfunctions of the servo amplifier in the application.

3.1 STO – Safe Torque Off

The servo amplifiers support the STO safety function (Safe Torque Off) according to the requirements of EN 61800-5-2, EN ISO 13849-1 "PL e" and EN 61508 / EN 62061 "SIL 3." The safety-related characteristics can be found in section Safety-related characteristics [▶ 31].

The STO shutdown occurs within 3.0 ms.

The safety-related parts must be designed so that:

– an individual error in each of these parts does not lead to the loss of the safety function and

– the individual errors are detected during or before the next request of the safety function.

For the STO safety function, the servo amplifiers are equipped with additional logic circuits. The logic interrupts the supply voltage of the pulse amplifiers for controlling the power stage. Two inputs are used for two channels to prevent a torque from being generated in the motor.

⚠ DANGER

Danger of injury due to unintended axis movement!

Loads or mechanical influences can cause unintended movement of vertical axes.

► Use additional protective measures such as mechanical brakes.

⚠ WARNING

Danger of injury due to uncontrolled restart!

The device restarts when the safety function is deactivated.

► Provide external measures which ensure that the drive starts up again only after explicit acknowledgment.

NOTICE

Unintended axis movement due to short circuit

► A brief axis movement of max. 180° can be triggered by a short-circuit in offset branches of the power section.

3.2 SBC – Safe Brake Control

The SBC function can be requested at the same time as the request for STO1. This must be preset with the S-ADR DIL switch block. The SBC function affects all brake outputs of the servo amplifier.

A holding brake that is active in de-energized state is controlled and monitored in a safe two-channel system.

The servo amplifiers support the SBC safety function (Safe Brake Control) according to the requirements of EN 61800-5-2, EN ISO 13849-1 "PL d" category 3 and EN 61508 / EN 62061 "SIL 2."

The safety-related characteristics can be found here [▶ 31].

The SBC shutdown occurs within 3 ms.

The specified shutdown / response time refers to the switching of the internal brake switch.

However, the drop in the brake holding voltage and thus the engaging of the brake depends on additional factors (such as inductance, resistive load, etc.).

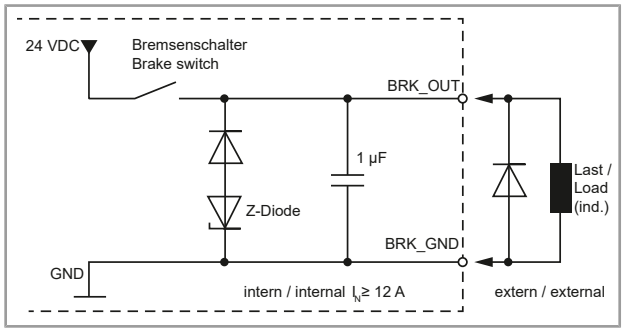


Fig. 2: Measuring circuit for worst-case response time with $I_N \geq 12$ A

The Zener diode shown in the equivalent circuit diagram is responsible for the functionally rapid engaging of a connected brake.

To determine the "real" worst-case response time for the purpose of functional safety, however, a measurement must usually be made with a connected load.

For devices with a nominal current ≥ 12 A, a free-wheeling diode must be interconnected in parallel to the load for this measurement.

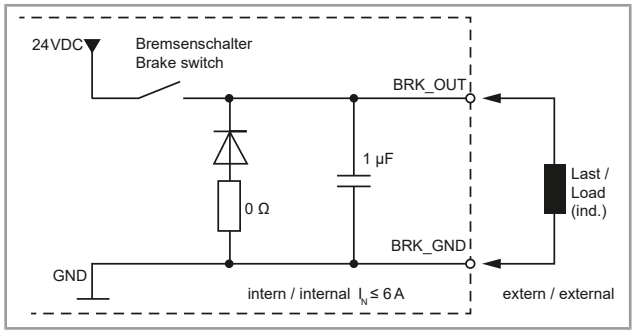


Fig. 3: Measuring circuit for worst-case response time with $I_N \leq 6$ A

For devices ≤ 6 A, a 0-ohm resistor is fitted instead of the Zener diode.

The SBC function is used in combination with the STO functions to prevent an axis from moving in torque-free state, for example due to gravity.

Prerequisites:

– Only brakes, contactors or relays with a minimum holding voltage ≥ 5 V may be connected to the brake driver outputs of the system.

– The switching elements that are used must be designed in accordance with the desired PL and category to EN ISO 13849-1 or SIL to EN 61508/EN 62061 or they must have a corresponding safety-related approval.

NOTICE! The opening of the brake can be delayed by up to 200 ms by internal diagnostics of the brake output.

⚠ CAUTION

Brake does not open due to an error.

This can lead to wear or destruction of the brake, resulting in the loss of the safety function.

- ► The "Brake does not open" error must be taken into consideration in the design of the brake(s) and validation.
- ► The possibility of error "Brake does not open" must be ruled out by one of the following measures:
  - ► Use of a safety brake with a manufacturing specification that rules out the possibility of this error with the required safety integrity.
  - ► Definition and validation of a second braking option in the application. This can be achieved for example by using two brakes, with each brake capable of providing the braking torque required for the application by itself.
  - ► In addition, the function of the brakes must be validated regularly.

NOTICE

Faulty wiring will lead to damage of the device or motor

The possibility of a dangerous short circuit must be ruled out by suitable wiring.

- ► Use suitable wiring to rule out the possibility of errors "Brake driver output short circuit" and "Short circuit between any motor supply line wire against any brake supply line wire."

ⓘ Info

If the SBC is not being used, from HW revision A2 the test pulses are switched off at the brake output

4 Overview of connections

The servo amplifier provides two separate inputs (STO1/STO2) for the STO request. These inputs are designed with two channels (CH1/CH2). They can be assigned to the connected drive axes by using the DIL switch block (S-ADR).

The SBC safety function is linked with the STO1 inputs and can also be preset by using the DIL switch block (S-ADR).

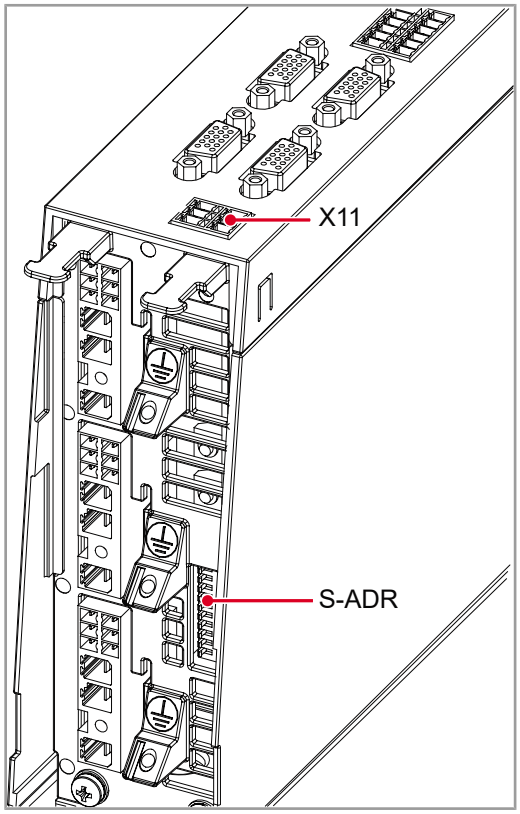


Fig. 4: Position of STO connections

4.1 Connection X11

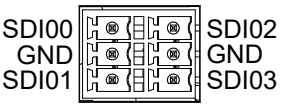


Fig. 5: Terminal X11, 6 pins

Designation	Type	Function
SDI00	Safe digital input	STO 1 CH1
SDI01	Safe digital input	STO 1 CH2
SDI02	Safe digital input	STO 2 CH1
SDI03	Safe digital input	STO 2 CH2
GND	Ground reference	GND
GND	Ground reference	GND

Tab. 2: Terminal assignment of X11/Safe-DI

Designation	Specification	Comment	Electrical isolation
STO1 CH1 SBC STO1 CH2 SBC	Enabling of output stage = high level Tripping the STO function = low level		Yes
	Request STO = low level	Applies to the holding brakes of all connected axes. The SBC function must be pre-set with the S-ADR DIL switch block.	
	OSSD-capable	Tested semi-conductor outputs	
	Low/high switching level: < 5 V / > 15 V DC $U_{In\ max}$ up to 30 V $I_{In\ max}$ = 15 mA (in the range -3 V … 30 V) Input characteristics type 1 to EN 61131-2		
STO2 CH1 STO2 CH2	Enabling of output stage = high level Tripping the STO function = low level		
	OSSD-capable	Tested semi-conductor outputs	
	Low/high switching level: < 5 V / > 15 V DC $U_{In\ max}$ up to 30 V $I_{In\ max}$ = 15 mA (in the range -3 V … 30 V) Input characteristics type 1 to EN 61131-2		

Tab. 3: Specification of X11/Safe-DI

ⓘ Info

Filtering out OSSD test pulses

The OSSD test pulses (Output Signal Switching Device) to be filtered out must comply with the following specification:

– The duration of the test pulses must be ≤ 0.75 ms.

– The repetition rate of the test pulses must be ≥ 30 ms.

NOTICE

Damage to the device due to operating error

If the duration of the test pulses is within the range from 0.75 ms … 2 ms, this will result in unwanted shutdown after an unpredictable time.

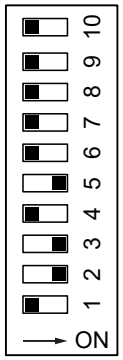
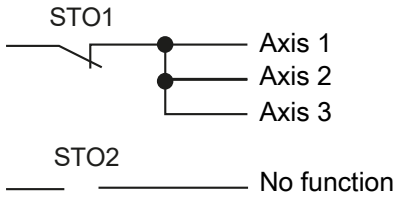
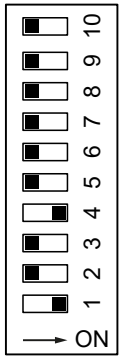
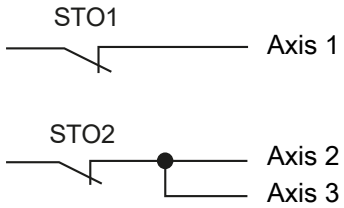
This applies regardless of whether monitoring of external test pulses is turned on or off.

4.2 Electrical isolation concept

– Digital inputs SDI00/SDI01/GND are isolated against SDI02/SDI03/GND
– All inputs are isolated against the 24 V supply.
– All inputs are isolated against PE.
– Maximum permissible insulating voltage: SELV/PELV
– Maximum permissible input voltage: - 60 V ... 60 V

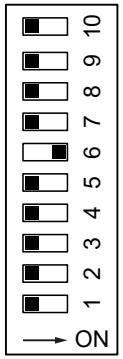
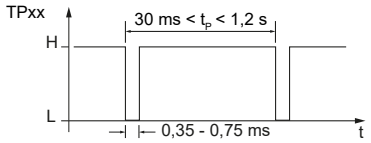
4.3 Overview of S-ADR DIL switch block

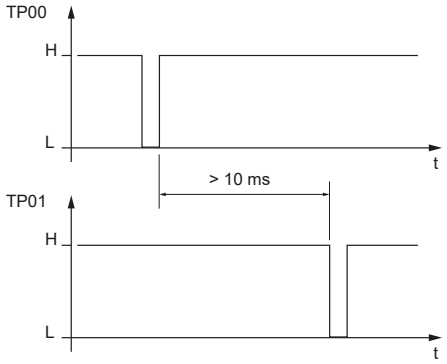
DIP switch settings for selecting STO inputs

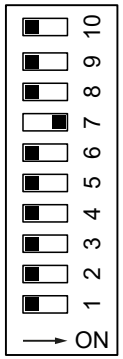
Switch	Switch position	Status	Function	Comment
1 … 5		Combined circuit of all existing axes		– Since the JM-3000 can be designed as a single-axis, double-axis or triple-axis servo amplifier, it has two STO1/STO2 digital inputs, each of which is designed with two channels. – If double-axis or triple-axis servo amplifiers are used, two different presettings can be selected with the S-ADR DIL switch block: – STO1 (all 2 or 3 axes are switched off via STO1 in 2 channels) or – STO1 (for axis 1) and STO2 (for axes 2 and 3).
		Separate switching of the axes that are present		

Tab. 4: DIP switch settings for selecting STO inputs

DIP switch settings for selecting test pulse monitoring

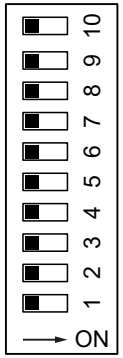
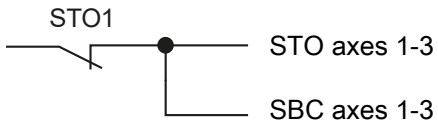
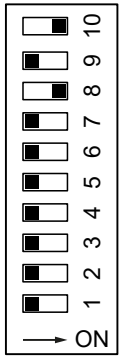
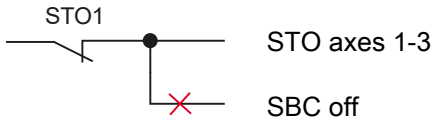
<table>
<tr><th>Switch</th><th>Switch position</th><th>Status</th><th>Format of the test pulses</th><th>Comment</th></tr>
<tr><td rowspan="3">6 … 7</td><td rowspan="2"> 
</td><td rowspan="2">Monitoring of test pulses at the input is switched on</td><td> 

Specification of test pulses</td><td rowspan="3">– To detect short circuits and cross faults in the wiring of the inputs, test pulses can in addition be modulated to the input signals.
– The test pulses can be monitored by the servo amplifier.
– Test pulses for the STO inputs can come from the supply unit or from safe outputs of a safety PLC. There must be a phase shift greater than 10ms between the test pulses on STO1 (TP00) and the test pulses on STO2 (TP01).</td></tr>
<tr><td> 

Phase shift between TP00 and TP01</td></tr>
<tr><td> 
</td><td>Monitoring of test pulses at the input is switched off</td><td></td></tr>
</table>

Tab. 5: DIP switch settings for selecting test pulse monitoring

DIP switch settings for selecting SBC

Switch	Switch position	Status	Function	Comment
8 … 10		SBC active		– **The SBC safety function is permanently connected to input STO1 (X11/SDI00 and SDI01).** – The number of axes depends on the STO setting
		SBC off		

Tab. 6: DIP switch settings for selecting SBC

5 Wiring

✓ The procedures below must be followed for wiring of STO inputs in enclosed control cabinets.

► Connect the output of the controlling safety relay with the STO input using one of the following options:

– A three-pin cable that includes the GND and both channels of the corresponding STO or
– Three single twisted conductors connected with each other (GND and the two channels of the STO) or
– Shielded single conductors.

NOTICE

Faulty wiring will lead to damage of the device

The possibility of a dangerous short circuit must be ruled out by suitable wiring.

► Use suitable wiring to rule out the possibility of errors "Brake driver output short circuit" and "Short circuit between any motor supply line wire against any brake supply line wire."

⇨ As a user of the safety system:

► Rule out the possibility of a short circuit of the "Brake driver output" against 24 V by means of a suitable design of the wiring.

► In addition, rule out the possibility of a short circuit of any brake output of a servo amplifier against any brake output of the other servo amplifier with a suitable design of the wiring.

5.1 Sample circuits for STO or SBC control

In the sample circuits below it is assumed that the switching elements used have or are designed for a safety-related approval according to the required PL to EN ISO 13849-1 or SIL to EN 61508 / EN 62061.

The following points must also be observed:

– The safety regulations and EMC Directive must be observed.
– With regard to the applicable error exclusions, refer to the table in appendix D of standard EN ISO 13849-2.

The following examples and their characteristic architecture are mainly responsible for the assignment to a wiring and commissioning category according to EN ISO 13849-1. The maximum possible performance levels according to EN ISO 13849 resulting from this also depend on the following factors of the external components:

– Structure (single or redundant)
– Detection of common cause failures (CCF)
– Degree of diagnostic coverage on request (DCavg)
– Mean time to dangerous failure of a channel (MTTFd)

ⓘ Info

Examples 1, 2 and 3 below illustrate STO control by means of safety relays.

Contactors and relays exhibit great variance in bounce behavior regardless of safe or non-safe design. Therefore, unwanted "shutdowns" of the STO safety function or error messages of the safety system may occur.

Because of this, we recommend implementing the circuitry with safe digital outputs of an overlaid safety controller or similar means (see examples 4 to 6).

5.1.1 STO control via safety relay with test pulses

NOTICE! The possibility of error "Both contacts of a safety relay are not opening" must be ruled out by the use of a suitable switching element.

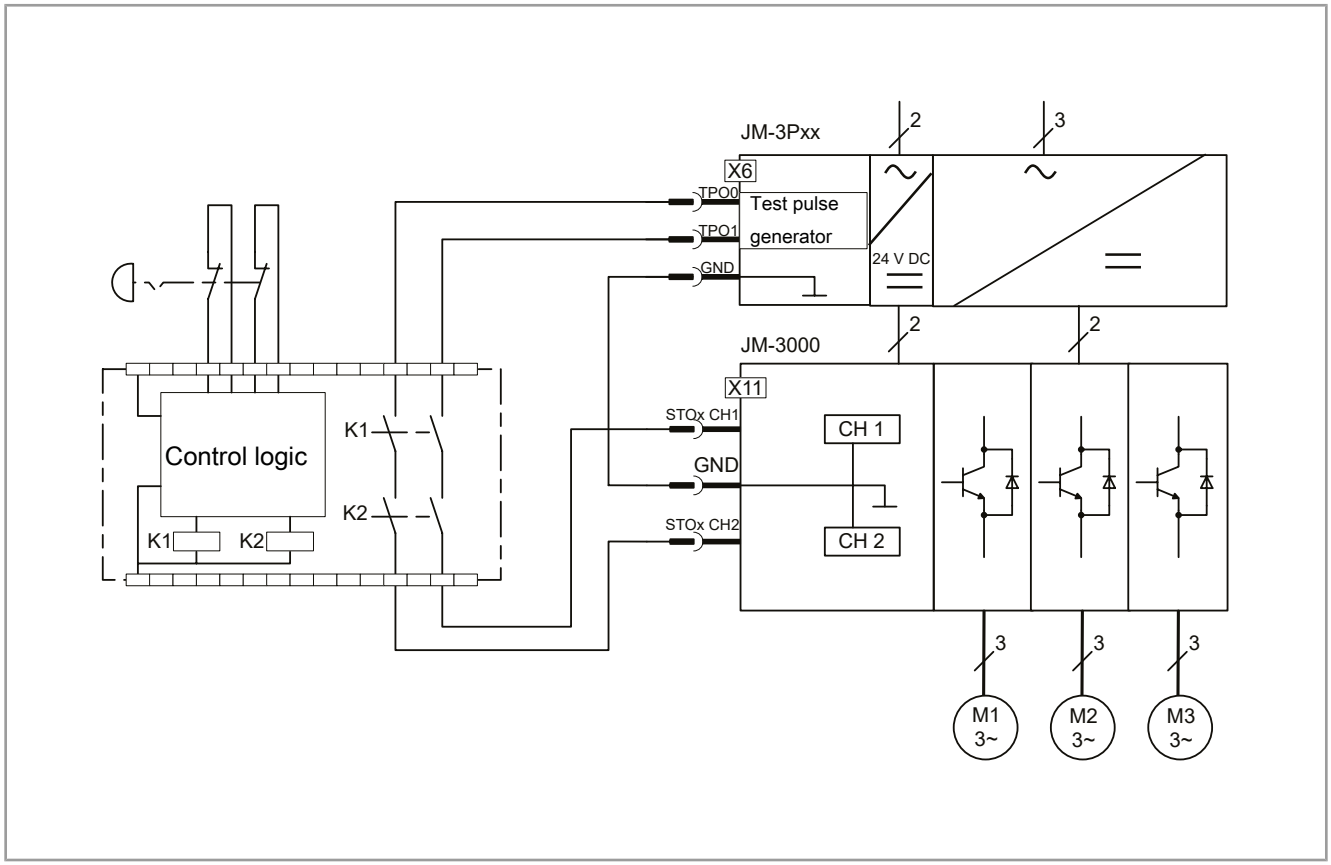


Fig. 6: STO control via safety relay with test pulses

5.1.2 STO control via safety relay

NOTICE

- The possibility of error "Both contacts of a safety relay are not opening" must be ruled out by the use of a suitable switching element.
- The possibility of error "Simultaneous short circuit of the outputs against +24V DC" must be ruled out by a suitable design of the safety relay and the wiring.
- The possibility of error "Short circuit between the outputs" must be ruled out by suitable measures and the wiring.
- The possibility of error "Any short circuit in the supply line from the safety relay to the safe inputs except for STOx against GND" must be ruled out by means of suitable wiring.

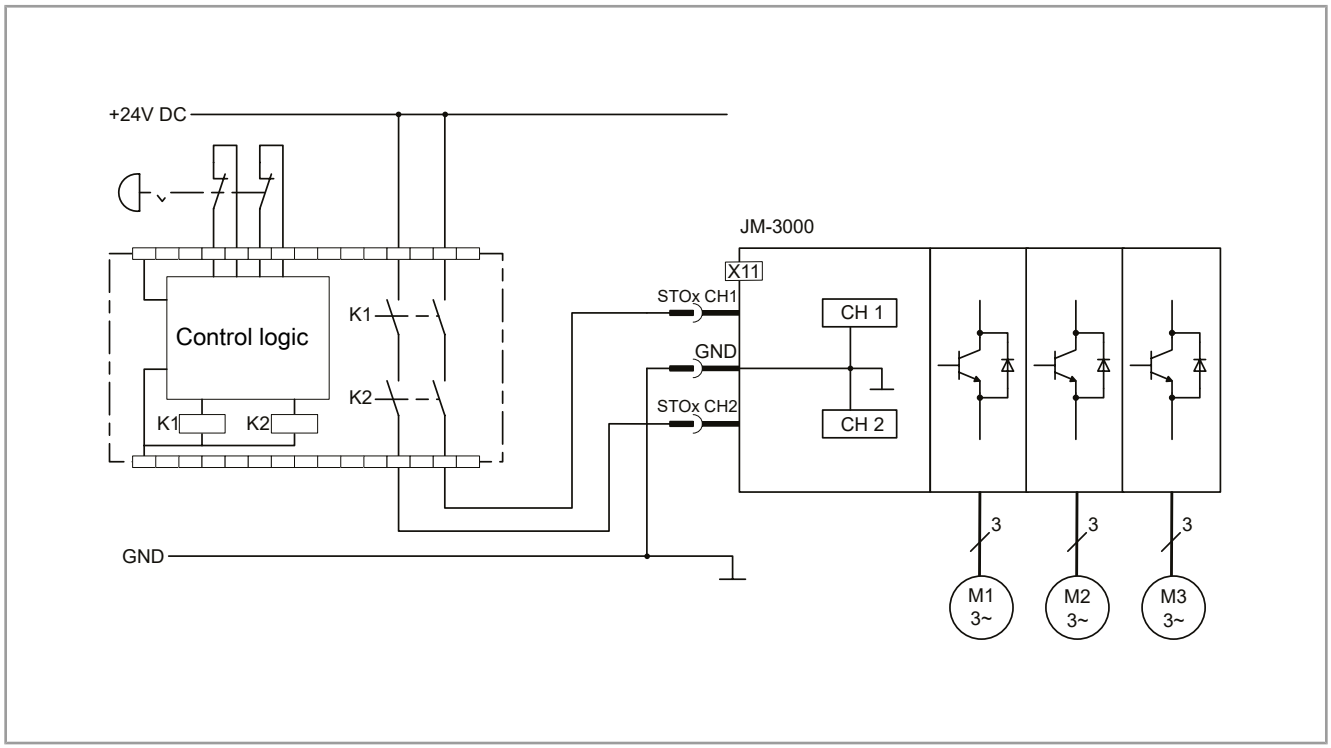


Fig. 7: STO control via safety relay

5.1.3 STO control via safety relay variant 2

NOTICE

- The possibility of error "Both contacts of a safety relay are not opening" must be ruled out by the use of a suitable switching element.
- The possibility of error "One contact of a safety relay is not opening" must be ruled out by the use of a suitable switching element.
- The possibility of error "Short circuit between input and output of the same channel of the safety relay" must be ruled out by the design of the safety relay and the wiring.
- The possibility of error "Any short circuit in the supply line from the safety relay to the safe inputs except for STOx against GND" must be ruled out by means of suitable wiring.

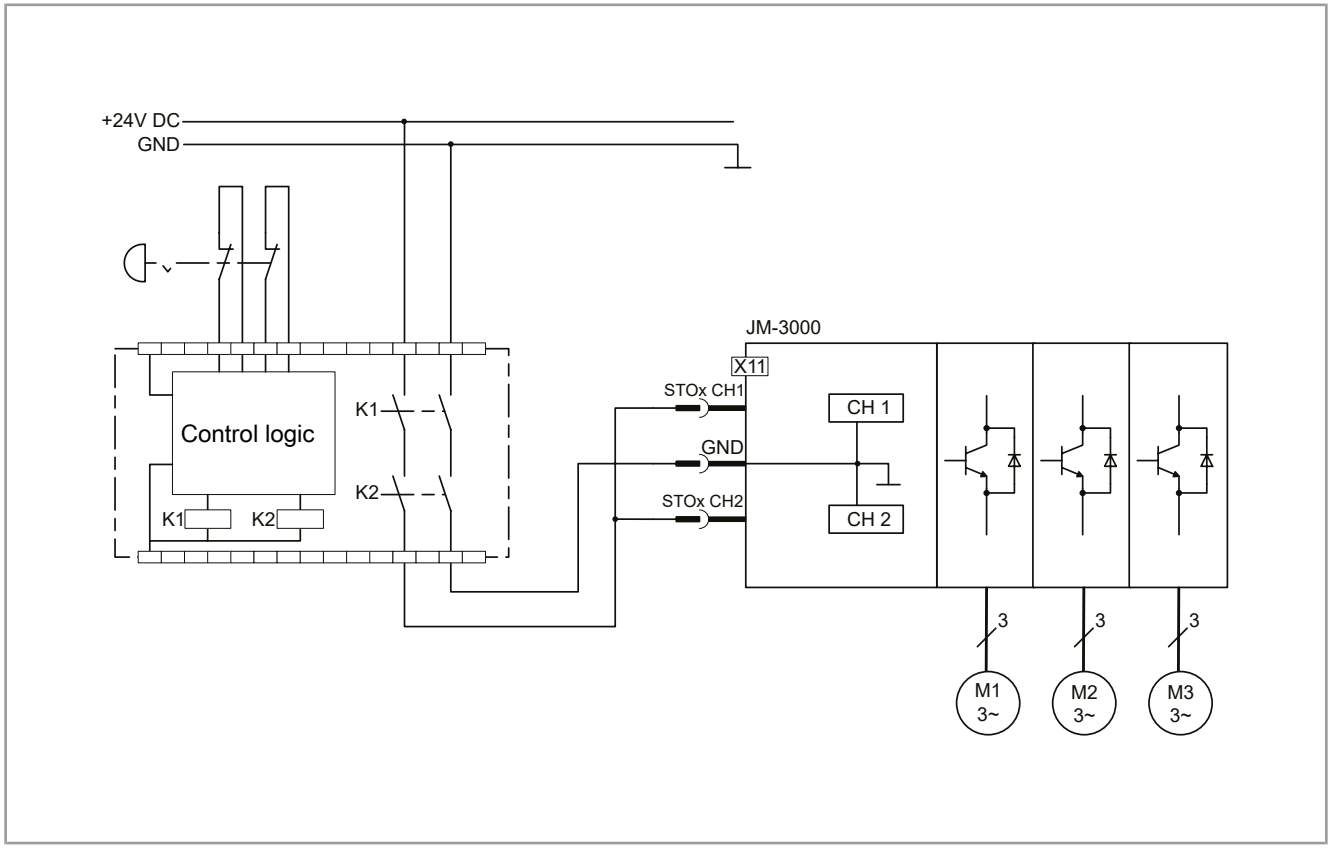


Fig. 8: STO control via safety relay variant 2

5.1.4 STO control via light barrier with OSSD outputs

Control directly via non-contact AOPD (Active Optoelectronic Protective Device) with OSSD outputs.

NOTICE

- ► Error "Short circuit at the OSSD outputs against +24V DC and other outputs" must be detected by the external safety relay by means of suitable diagnostic measures and a suitable response must be implemented.
- ► The possibility of error "Simultaneous short circuit of both outputs against +24V DC" must be ruled out by a suitable design of the wiring.

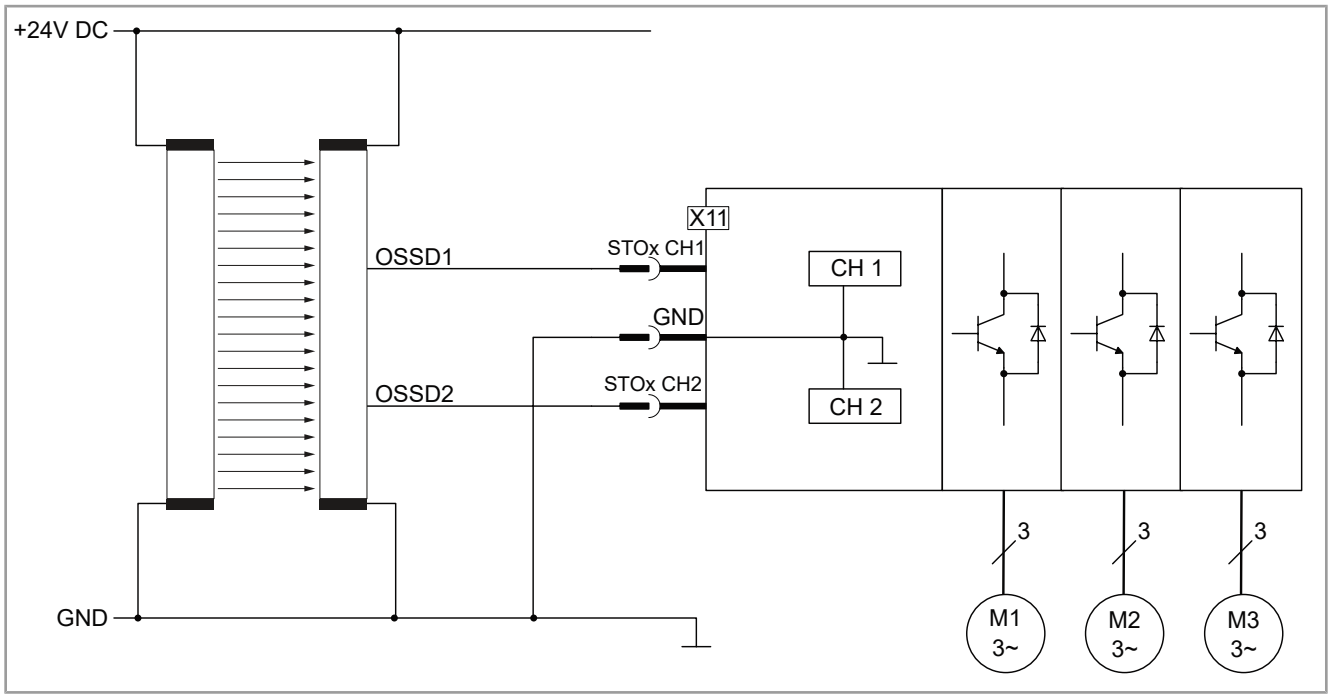


Fig. 9: STO control via light barrier with OSSD outputs

5.1.5 STO control with Hi/Lo-switching outputs

Control via external safety controller with Hi/Lo-switching outputs.

NOTICE

- ► Error "Short circuit at the OSSD outputs against +24V DC and other outputs" must be detected by the external safety relay by means of suitable diagnostic measures and a suitable response must be implemented.
- ► The possibility of error "Simultaneous short circuit of both outputs against +24V DC" must be ruled out by a suitable design of the wiring.

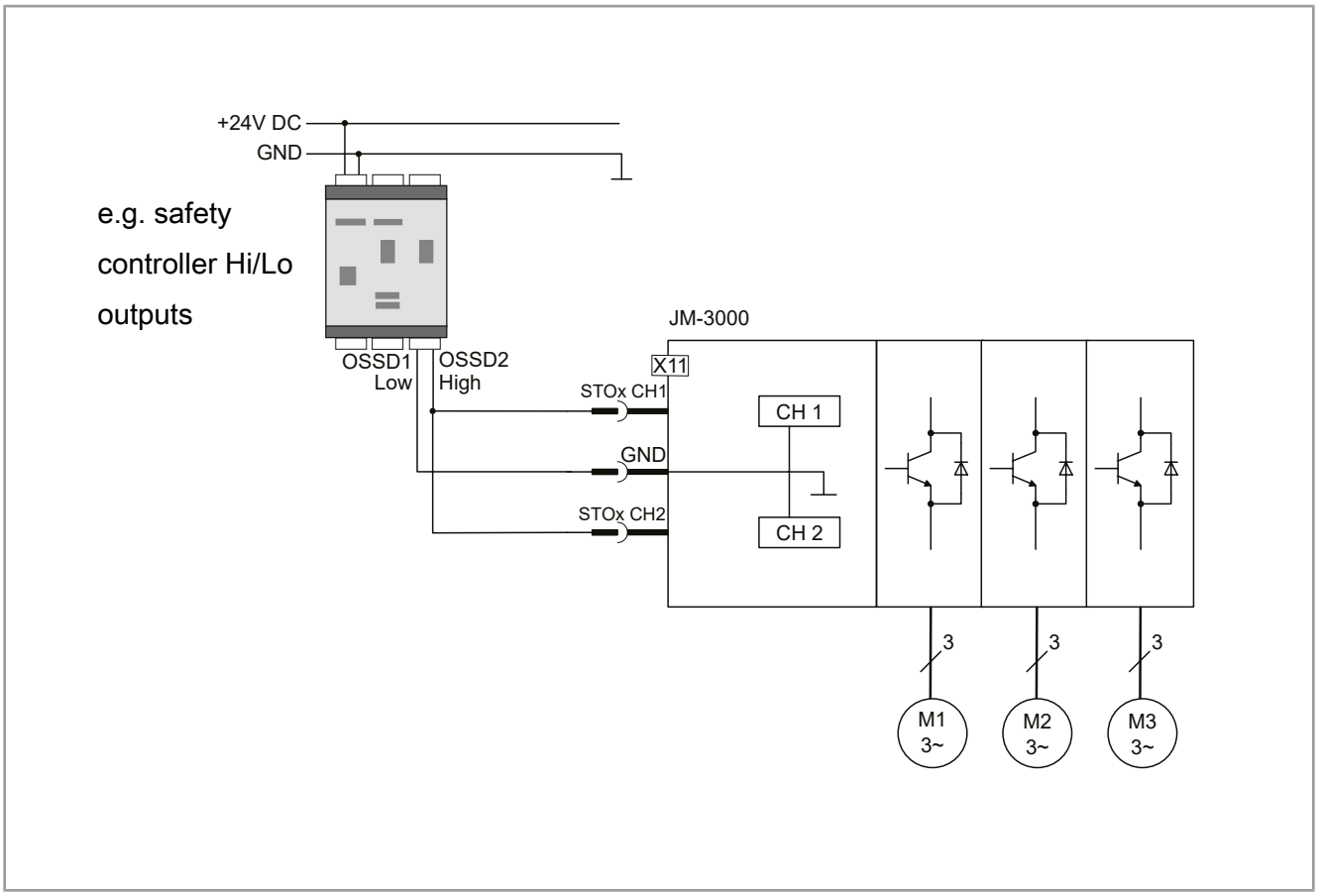


Fig. 10: STO control with Hi/Lo-switching outputs

5.1.6 STO control with Hi/Hi-switching outputs

Control via external safety controller with Hi/Hi-switching outputs.

NOTICE

- ► Error "Short circuit at the OSSD outputs against +24V DC and other outputs" must be detected by the external safety relay by means of suitable diagnostic measures and a suitable response must be implemented.
- ► The possibility of error "Simultaneous short circuit of both outputs against +24V DC" must be ruled out by a suitable design of the wiring.

Notice

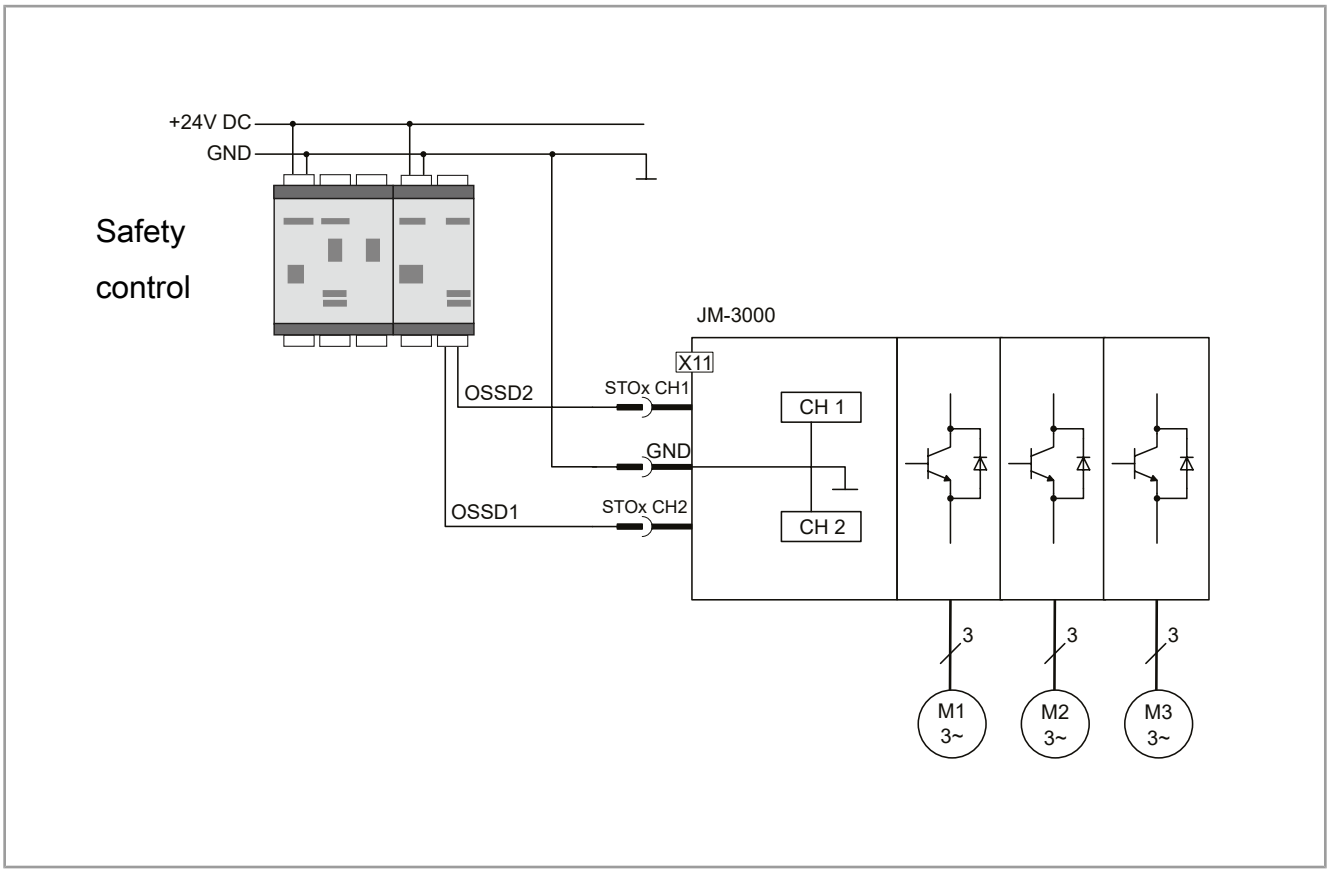


Fig. 11: STO control with Hi/Hi-switching outputs

5.1.7 STO control with JSC-110-1-RS

Control with Hi/Lo-switching outputs from safety controller JSC-110-1-RS.

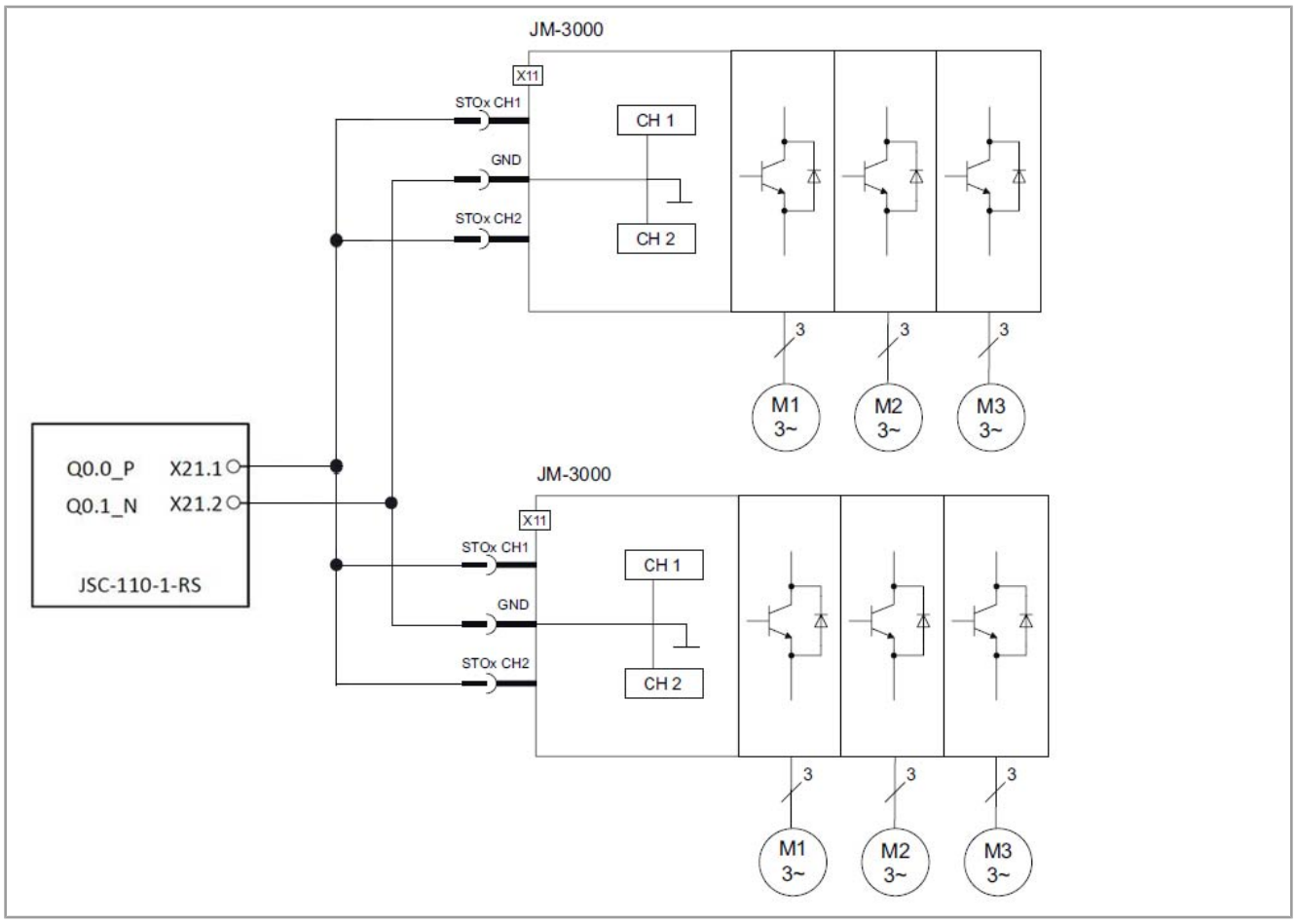


Fig. 12: STO control with JSC-110-1-RS

6 Validation

► Always define a validation plan.

The plan records the tests and analyses you used to determine the conformity of the solution with the requirements from your application.

ⓘ Info After an update of the safety firmware, the new version must be validated for correctness.

6.1 Validating the STO safety function

The STO safety function must be validated against the safety requirements from the application in the following cases:

– During commissioning
– After changes in the application
– After repairs or replacement of a device

The following table shows the test steps to be carried out.

► Work through the table from top to bottom.

Designation	State / event	Expected result
Output state	– System is turned on. – Torque is enabled (STO input is "active"). – Servo amplifier generates torque.	Motor axis is actively in motion or torque is applied
Test step 1	STO input becomes "inactive."	Motor axis coasts to a stop or no torque is applied and no error message is generated.
Test step 2	STO input becomes "active."	Servo amplifier can apply torque.

Tab. 7: STO test steps

6.2 Validating the SBC safety function

ⓘ Info When all brakes are engaged simultaneously, an internal test is initiated. This test must be carried out at least once a year to achieve safety integrity (SIL2 / PL d) and at least once every 24 h to achieve safety integrity (SIL3 / PL e). This test is always performed automatically when the system is turned on.

6.2.1 Validation of the SBC safety function (for hardware version A1 6xxx_00)

The SBC safety function must be validated according to the table below against the safety requirements from the application in the following cases:

– During commissioning
– After changes in the application
– After repairs or replacement of a device
– Once a year

Designation	State / event	Expected result
Output state	– System is turned on. – S-ADR is set to "SBC active." – Brakes are free (STO1 input is "active"). – Servo amplifier has vented brake(s).	Brake(s) is/are open.
Test step 1	STO input becomes "inactive."	Brake(s) has/have engaged and no error message is generated.
Test step 2	STO input becomes "active."	Brake(s) is/are open.

Tab. 8: SBC test steps

6.2.2 Validation of the SBC safety function (for JM-3000 HW variant A2 and JM-3000 rev. B)

If the SBC safety function is used, the user must validate it regularly, but at least once a year, according to the table below.

Designation	Event
Test step 1	Engage all brakes safely (by requesting the SBC safety function for all axes) and simultaneously for at least 100 ms.
Test step 2	After that the application can vent the brakes again in any combination and order.

Tab. 9: SBC test steps

6.3 Validating monitoring by test pulses

If monitoring of the STO inputs is carried out by using external test pulses, for example by using the TP generator of the supply unit, this must be validated in the following cases:

– During commissioning
– After changes in the application
– After repairs or replacement of a device

The following table shows the test steps to be carried out.

► Work through the table from top to bottom.

Designation	State / event	Expected result
Output state	System is turned on. Inputs of the safety functions are "active" (turned on). Servo amplifier has vented brake(s)*.	Brake* and torque are enabled.
Test step 1	Short-circuit one of the outputs of the TP generator against 24 V.	After maximum 2.4 seconds, the safety system of the brake* is activated and switches off the torque. An error message is generated.
* Applies only in the case where S-ADR is switched to "SBC active."		

Tab. 10: Test steps for STO monitoring through external test pulses

► Perform a restart to start the system again.

6.4 Safety-related characteristics

Acceptance of STO shutdown of JM-3000

Safety-related characteristics to EN 62061 / EN 61508		Safety-related characteristics to EN ISO 13849	
SIL:	CL 3	PL:	e
HFT:	1	Category:	4
PFH:	5.03 E-09 1/h		

Tab. 11: STO shutdown of JM-3000

Acceptance of SBC shutdown of JM-3000

Safety-related characteristics to EN 62061 / EN 61508		Safety-related characteristics to EN ISO 13849	
SIL:	CL 2	PL:	e
HFT:	1	Category:	3
PFH:	5.47 E-09 1/h		

Tab. 12: SBC shutdown of JM-3000

EU-Konformitätserklärung

EC declaration of conformity

BUCHER automation

Hersteller / *manufacturer*	**Bucher Automation AG** **Thomas-Alva-Edison-Straße 10** **D-71672 Marbach am Neckar**
Geräteart / *model*	**Servoverstärker** / ***servo amplifier***
Produkt / *product*	**JM-35xxB-S1A2** **JM-35xxB-S1TDA2** **JM-D35xxB-S1A2** **JM-D35xxB-S1TDA2** **JM-T35xxB-S1A2** **JM-T35xxB-S1TDA2**

Das aufgeführte Produkt entspricht unter Beachtung der Informationen und Anweisungen in der zugehörigen Produktdokumentation den folgenden EG-Richtlinien und Normen.

Die Inbetriebnahme des genannten Produktes ist so lange untersagt, bis das Produkt in die Maschine eingebaut wird und den zutreffenden Richtlinien entspricht. Die Informationen und Anweisungen in der Dokumentation des gelieferten Produkts sind zusätzlich zu beachten.

The listed product complies with the following EC directives and standards, taking into account the information and instructions in the associated product documentation.

Commissioning of the listed product is prohibited until the product is installed in the machine and complies with the applicable directives. The information and instructions in the documentation of the supplied product must also be observed.

- EG-Richtlinien / *EU directives*

2014/30/EU	EMV-Richtlinie *EMC directive*
2006/42/EG	Maschinenrichtlinie *Machinery directive*

- harmonisierte, internationale oder nationale Normen / *harmonized, international or national standards*

  Normen der Maschinenrichtlinie / *Standards of the machinery directive*

  EN ISO 13849-1: 2015 OJ C 173 - 13/05/2016
  Sicherheit von Maschinen - Sicherheitsbezogene Teile von Steuerungen - Allgemeine Gestaltungsleitsätze;
  Safety of machinery - Safety-related parts of control systems - General principles for design;

  IEC 61800-5-2: 2016
  Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl - Anforderungen an die Sicherheit - Funktionale Sicherheit;
  Adjustable speed electrical power drive systems - Safety requirements - Functional;

  IEC 62061: 2005 + A1: 2012 + A2: 2015 OJ C 136 - 26/05/2010
  Sicherheit von Maschinen - Funktionale Sicherheit sicherheitsbezogener elektrischer, elektronischer und programmierbarer elektronischer Steuerungssysteme;
  Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems;

  sonstige Normen / *other Standards*

  IEC 61508 parts 1 to 7: 2010
  Funktionale Sicherheit sicherheitsbezogener elektrischer/elektronischer/programmierbarer elektronischer Systeme;
  Functional safety of electrical/electronic/programmable electronic safety-related systems;

EU-Konformitätserklärung

EC declaration of conformity

BUCHER automation

Geräteart / *model*	**Servoverstärker / *servo amplifier***
Produkt / *product*	**JM-35xxB-S1A2** **JM-35xxB-S1TDA2** **JM-D35xxB-S1A2** **JM-D35xxB-S1TDA2** **JM-T35xxB-S1A2** **JM-T35xxB-S1TDA2**

*** Fortsetzung des Dokuments / *Continuation of the document* ***

Normen der EMV-Richtlinie / *Standards of the EMC directive*

EN IEC 61800-3: 2018
Drehzahlveränderbare elektrische Antriebe - EMV-Anforderungen einschließlich spezieller Prüfverfahren;
Adjustable speed electrical power drive systems - EMC requirements and specific test methods;

Normen der Niederspannungsrichtlinie / *Standards of the low voltage directive*

EN 61800-5-1: 2007 + A1: 2017 OJ L 457 - 21/12/2021
Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl - Anforderungen an die Sicherheit - Elektrische, thermische und energetische Anforderungen;
Adjustable speed electrical power drive systems - Safety requirements - Electrical, thermal and energy;

EG-Baumusterprüfverfahren / *EC type examination*

Benannte Stelle / *Notified body:*	TüV Rheinland Industrie Service GmbH Am Grauen Stein 51105 Köln, Deutschland
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Bescheinigungs-Nr. / *Certificate no.:*	01/205/5466.02/24

Die alleinige Verantwortung für die Ausstellung dieser Konformitätserklärung trägt der Hersteller.
This declaration of conformity is issued under the sole responsibility of the manufacturer.

Zur Zusammenstellung technischer Unterlagen bevollmächtigte Person
Authorised person for compiling technical files

Bucher Automation AG, Thomas-Alva-Edison-Straße 10, D-71672 Marbach am Neckar

Ort / *place*:	Marbach
Datum / *date*:	07.05.2024
Unterzeichner / *signed by*:	Christian Benz Vorstandsvorsitzender / CEO

List of figures

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