

User Manual



60887706_02

Functional Description - Integrated Safety Function S1 - JM-2000 and JM-D2000 Servo Amplifier

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Translation of the german original User Manual

Revision	1.02
Date of issue	5/5/2025

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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 the commissioning of products from the Bucher-Automationproduct family
- Online help for the JetSym software
Functions of software products with application examples

Content

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

NOTICE



Applicable documents

This document does not replace the user manual for JM-2000 servo amplifiers. 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 the respective 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 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 power 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.
OSSD = output signal switching device	An OSSD is a safe output switching element. An output switching element of this type is safe because the safe controller continuously sends the smallest possible test pulse to the output and in doing so is able to determine whether the downstream semiconductor is still capable of switching and that there is no short circuit present.
Debounce time ► 33]	Specified time period during which a signal must be present on at least one input in order for it to be detected and processed by the system.
Discrepancy time ► 33]	Time offset between channels 1 and 2. If signals differ from each other for longer than specified in the discrepancy time, the system must report a fault condition induced by an error.

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-2203-S1, JM-2403-S1, JM-2206-S1, JM-2406-S1, JM-2410-S1, JM-2414-S1, JM-2423-S1, JM-D2203-S1, JM-D2206-S1, JM-D2403-S1, JM-D2406-S1 and JM-D2410-S1.

It describes only the STO and SBC features.

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

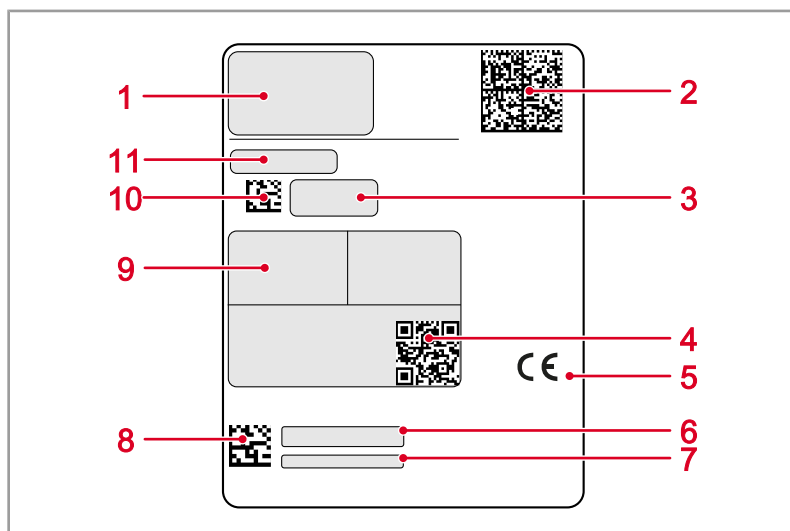


Fig. 1: Nameplate

1	Company logo and address
2	Scan - order code, serial number and various details
3	Item number
4	Scan - link to the download area
5	Certification mark
6	Hardware revision
7	Serial number
8	Scan - serial number
9	Various details
10	Scan - article number
11	Order code

2.3 Purpose

2.3.1 Intended use

The servo amplifiers are components designed for installation in industrial and commercial systems and machines. Installation is only permitted in stationary equipment. You may only use the servo amplifier in closed control cabinets meeting the requirements of IP54 or higher, taking ambient conditions into account.

When the servo amplifier is installed in a machine, commissioning (i.e., commencement of intended use) of the servo amplifier is prohibited until it has been determined that the machine is in compliance with the Machinery Directive 2006/42/EC. Commissioning (i.e., commencement of intended use) is only permitted if the EMC Directive (2014/30/EU) is complied with.

2.3.2 Non-intended use

Use of the servo amplifier outside of the application areas given here or under operating ranges and ambient conditions other than those described in the documentation is considered non-intended use.

- The servo amplifier must not be used outside a control cabinet.

The following application areas are considered non-intended use:

- Installation in vehicles. Use of the device in non-stationary equipment is considered an exceptional environmental condition and is only permitted after special agreement.
- Use of the device for the operation of passenger elevators.
- Installation in environments where there are hazardous oils, acids, gases, vapors, dusts, rays, etc.
- Use in special application areas (e.g. where there is a risk of explosion, corrosion or fire).
- Untypical generation of higher frequency on-board networks.

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



Danger due to high electrical voltage

Touching live parts may result in death or severe injuries. Carry out the following steps before starting work to ensure safety:

- ▶ Prepare for shutting 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. 3 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**Risk of injury due to electric shock**

Triggering the STO function does not include safe electric isolation. The device or equipment is not de-energized!

- ▶ Safe electric isolation requires the installation of additional isolating equipment, e.g. a mains switch, that disconnects power supply.

 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 merely interrupts the energy supplied to the drive while the motor movement can no longer be controlled.

- ▶ 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**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 Overview of connections

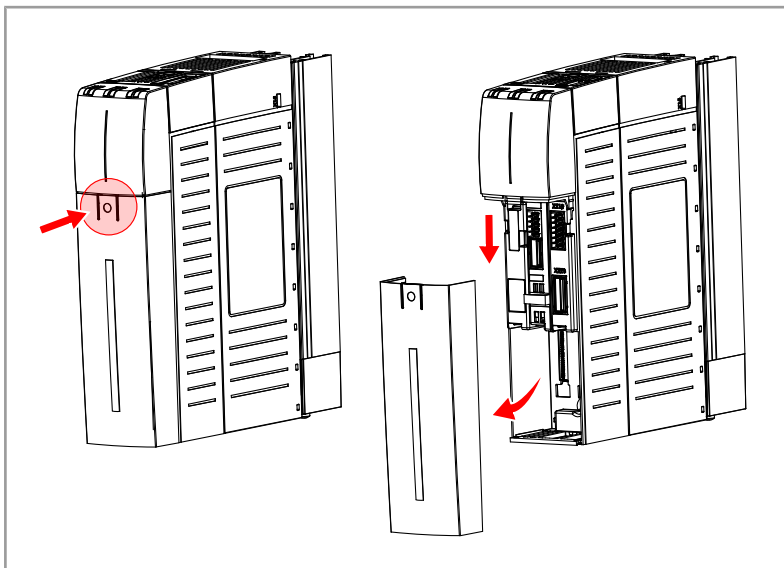
By default, the servo amplifier comes pre-assembled with the safety module.

3.1 Removing the lower front cover

To access the connections and encoder plug-in slots on the front of the device, the lower front cover must be removed. It is not necessary to remove the upper front cover.

Procedure

1. Gently push down the depression in the middle of the lower front cover.
2. Pull the front cover down and off.



3.2 Connections

Front connections



Fig. 2: Front connections on the JM-2203 and JM-2403

1	Connection X841 - STO + SBC [► 18]
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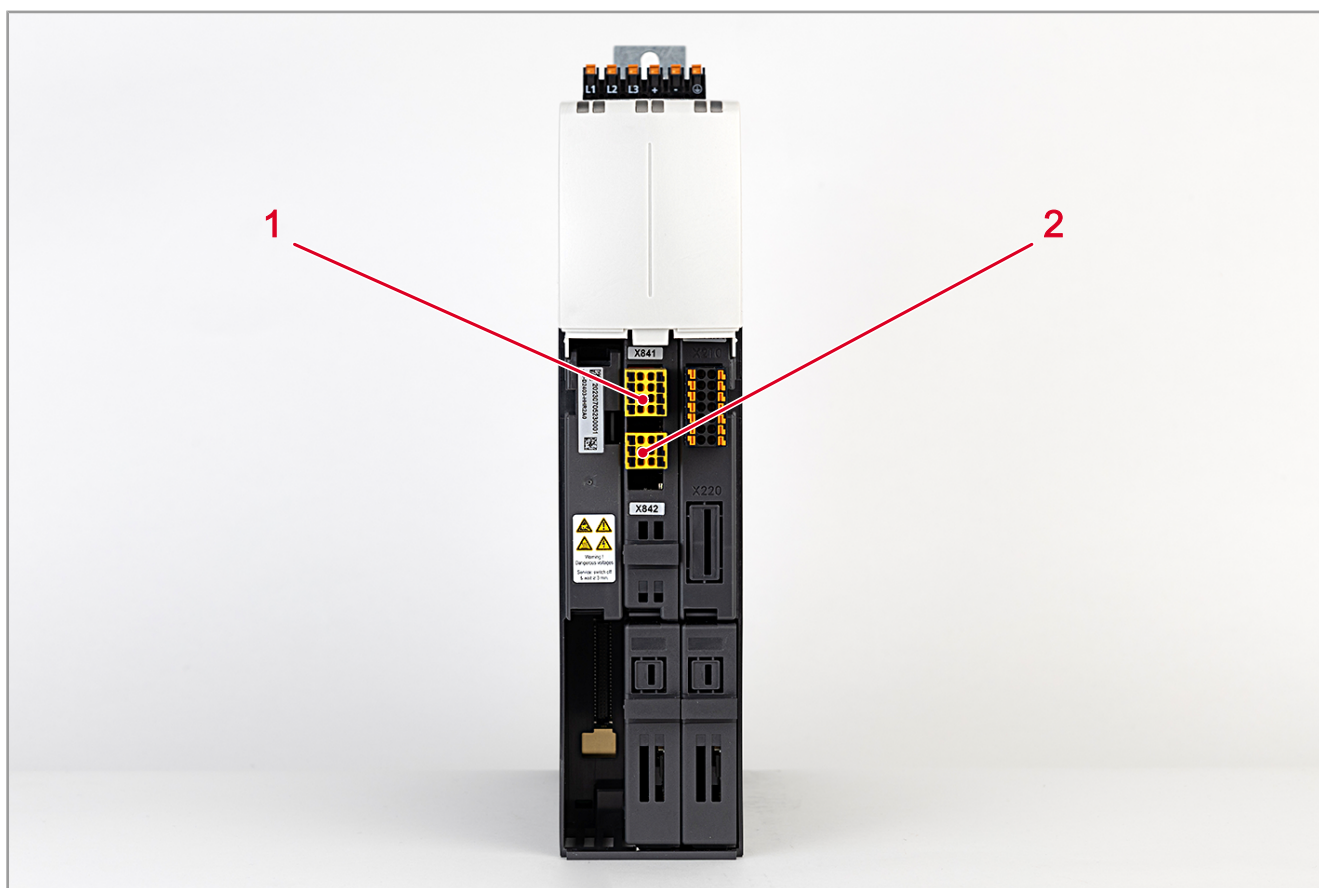


Fig. 3: Front connections on the JM-D2203, JM-D2206 and JM-D2403

1	Connection X841 - STO + SBC [► 18]
2	Connection X842 - STO + SBC [► 19]

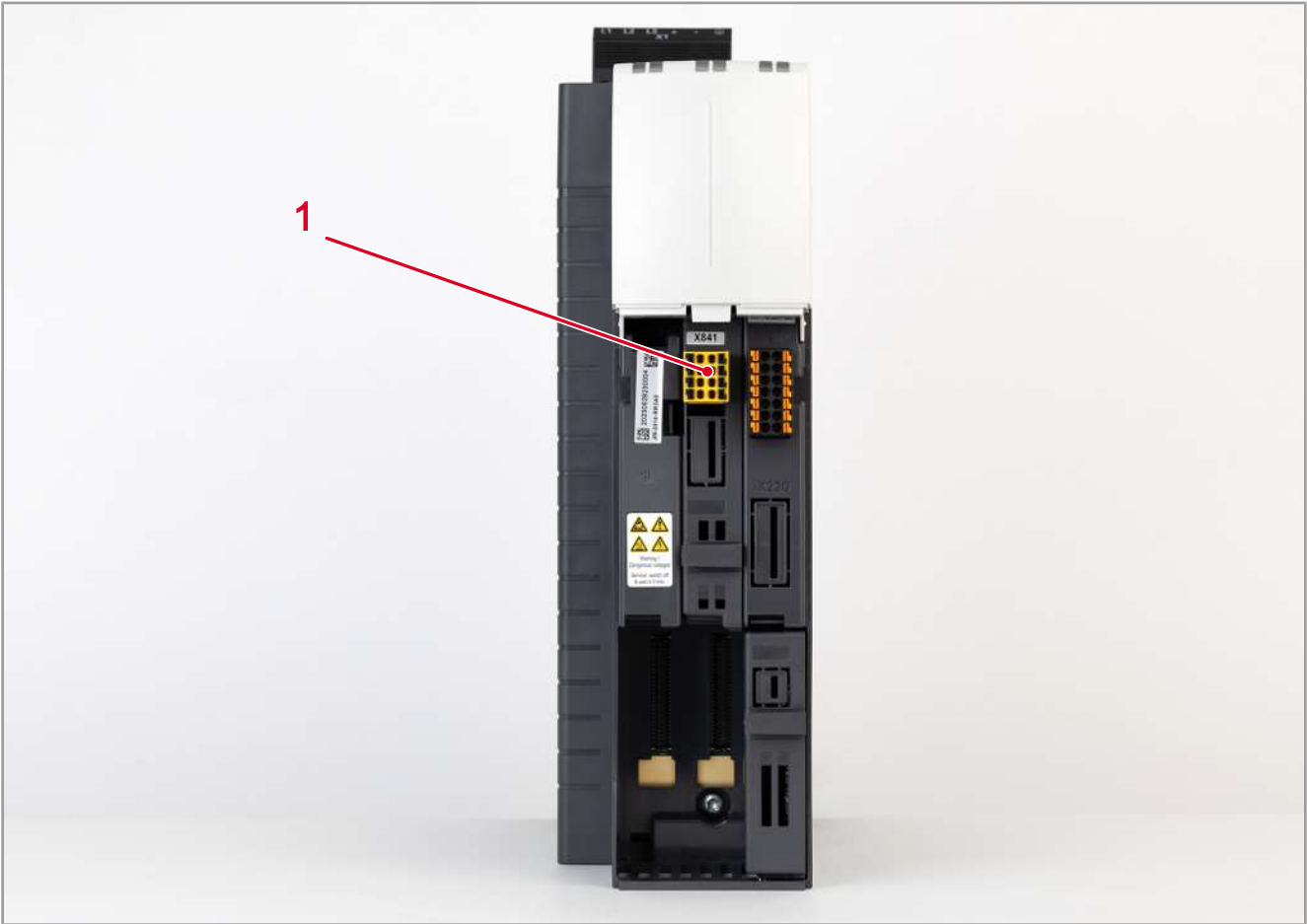


Fig. 4: Front connections on the JM-2414 and JM-2423

1	Connection X841 - STO + SBC [► 18]
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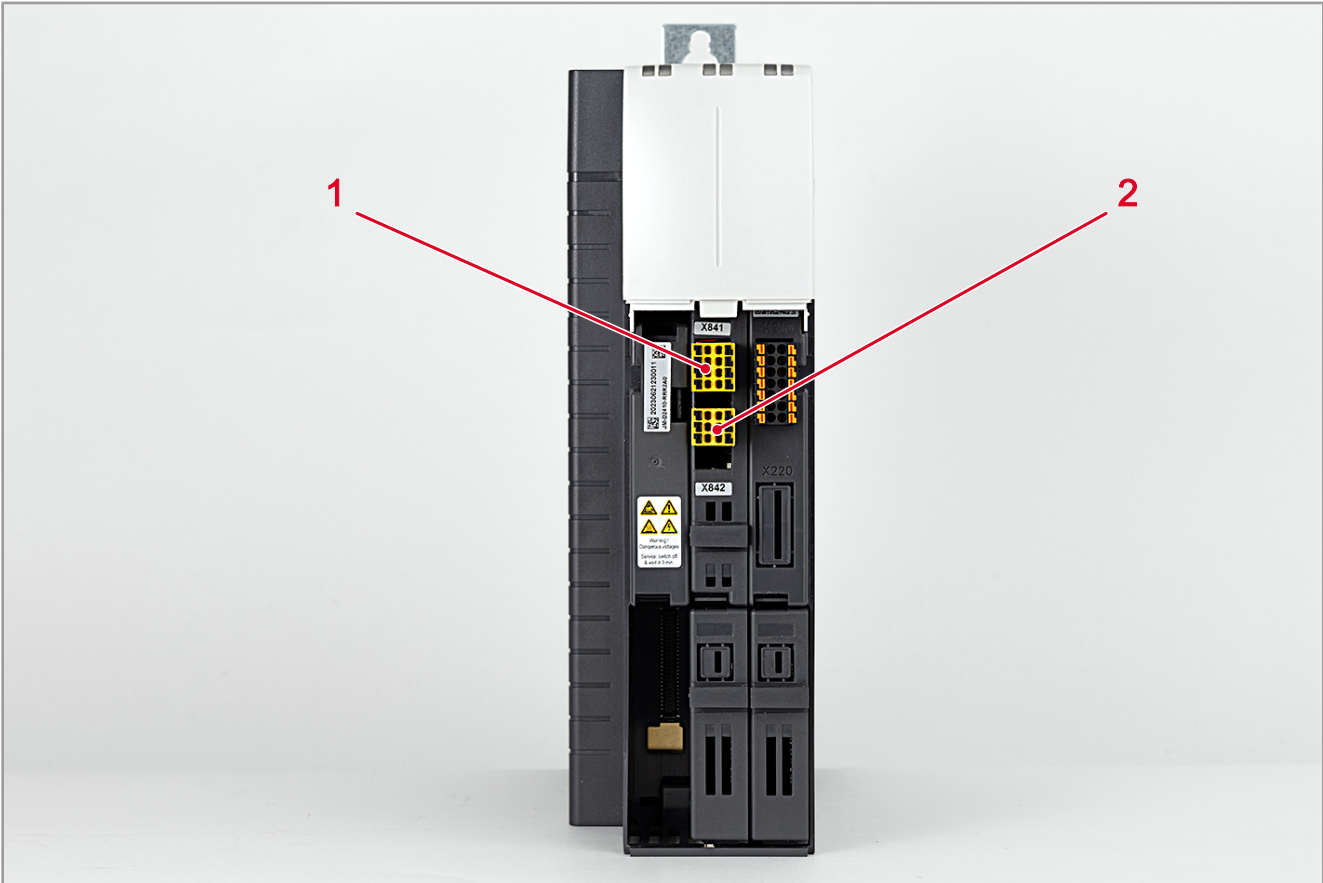


Fig. 5: Front connections on the JM-D2410

1	Connection X841 - STO + SBC [► 18]
2	Connection X842 - STO + SBC [► 19]

3.3 Connection X841 – STO + SBC [S1]

X841 connects to:

- STO for axis 1
- SBC for axis 1

Pin assignment X841

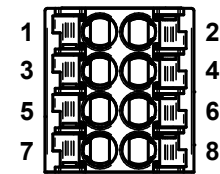


Fig. 6: Terminal X841, 8 pins

Pin	Signal	Description
1	AX1_STOA_In	STO input AX1 - requirement for pulse lock, channel A
2	AX1_STOB_In	STO input AX1 - requirement for pulse lock, channel B
3	GND_AX1	Reference potential AX1
4	GND_AX1	Reference potential AX1
5	AX1_SBCA_In	SBC input AX1 - requirement for safe brake, channel A
6	AX1_SBCB_In	SBC input AX2 - requirement for safe brake, channel B
7	n.c.	n.c.
8	n.c.	n.c.

Tab. 2: Pin assignment – connection X841

Parameter	Description	
PLC-compatible	Yes; EN 61131-2 type 3-compatible	
Debounce time	4 ms max	
OSSD pulse (test pulses)	max length	800 µs
	Min. test pulse spacing	33 ms
Low	-3 V ... 5 V	
High	11 V ... 30 V	
Line cross-section	With wire end ferrule: 0.25 ... 0.75 mm ²	
	Without wire end ferrule: 0.25 ... 1.5 mm ²	

Tab. 3: Technical data for X841

3.4 Connection X842 – STO + SBC [S1]

X842 connects to:

- STO for axis 2
- SBC for axis 2

Pin assignment X842

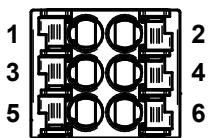


Fig. 7: Terminal X842, 6 pins

Pin	Signal	Description
1	AX2_STOA_In	STO input AX2 - requirement for pulse lock, channel A
2	AX2_STOB_In	STO input AX2 - requirement for pulse lock, channel B
3	GND_AX2	Reference potential AX2
4	GND_AX2	Reference potential AX2
5	AX2_SBCA_In	SBC input AX2 - requirement for safe brake activation, channel A
6	AX2_SBCB_In	SBC input AX2 - requirement for safe brake activation, channel B

Tab. 4: Pin assignment – connection X842

Parameter	Description	
PLC-compatible	Yes; EN 61131-2 type 3-compatible	
Debounce time	4 ms max	
OSSD pulse (test pulses)	max length	800 µs
	Min. test pulse spacing	33 ms
Low	-3 V ... 5 V	
High	11 V ... 30 V	
Line cross-section	With wire end ferrule: 0.25 ... 0.75 mm ²	
	Without wire end ferrule: 0.25 ... 1.5 mm ²	

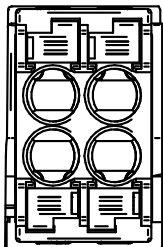
Tab. 5: Technical data for X842

3.5 Connection X12 – DC 24 V supply

X12 connects to:

- DC 24 V supply

Pin assignment



X12	
24Vin	GND
24Vin	GND

Tab. 6: Pin assignment – connection X12

Fig. 8: Terminal X12,
4 pins

- The 2 inputs for 24Vin are connected internally.
- The 2 GND inputs are connected internally.
- The second input can be used in each case to loop through additional drive controllers. The max. possible current load is 8 amps.

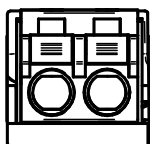
The number of JetMove servo amplifiers for looping the DC 24 V voltage and GND through depends on the motor type (without or with brake) and the holding current of the motor brake. For larger motors with holding brake you can wire to max. one additional JetMove.

3.6 Connection X21 – motor holding brake axis 1

X21 connects to:

- Motor holding brake for axis 1

Pin assignment



X21	
B+	B-

Tab. 7: Pin assignment – connection X21

Fig. 9: Connection X21,
2 pins

Parameter	Description
Output voltage	24 V
Maximum current	2.0 A
Overload protection	existing
Freewheeling diode	Integrated
Maximum inductance	500 mH
Maximum capacity	500 nF

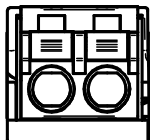
Tab. 8: Technical data for X21

3.7 Connection X22 – motor holding brake axis 2

X22 connects to:

- Motor holding brake for axis 2

Pin assignment



X22	
B+	B-

Tab. 9: Pin assignment – connection X22

Fig. 10: Connection X22,
2 pins

Parameter	Description
Output voltage	24 V
Maximum current	2.0 A
Overload protection	existing
Freewheeling diode	Integrated
Maximum inductance	500 mH
Maximum capacity	500 nF

Tab. 10: Technical data for X22

4 STO and SBC 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 or SBC using one of the following options:
 - A 3-pin cable that includes the GND and both channels of the corresponding STO or SBC or
 - 3 single conductors connected with each other (GND and the two channels of the STO or SBC)
- ▶ Connect X12 to an external 24 V power supply unit designed to meet the requirements of SELV/PELV 24 V voltage.

The external power supply unit covers the increased current demand of the motor brake thereby ensuring correct functioning of the SBC feature.

NOTICE



Overriding of the safe galvanic isolation of signals and voltages

Using multi-core wires can override the safe galvanic isolation of signals and voltages and cause short circuit conditions. This, in turn, may detrimentally affect any integrated safety function.

- ▶ Use wire end ferrules and/or take other suitable mitigating measures.

NOTICE



Overriding of the safe galvanic isolation of signals and voltages due to incorrect wiring

Short circuits can override the safe galvanic isolation of signals or voltages and must be ruled out by means of suitable wiring.

- ▶ Use suitable wiring to rule out the error “Short-circuit between any two adjacent conductors” for safety signals and voltages:
 - STO
 - SBC
 - motor supply line
 - brake supply line
- ▶ For details on the requirements of applying fault exclusions on lines and cables refer to ISO 13849-2:2012, table D.4.
- ▶ Apply a wiring technology compliant with the EN 60204-1 standard.

4.1 Sample circuits for STO or SBC control

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

In addition, the following points must 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 the EN ISO 13849-2 standard.

The following examples and their characteristic architecture are mainly responsible for the assignment to a 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

Fig. 11 below illustrates 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 figures 12 and 13).

NOTICE! The following examples apply to STO control and in a similar way to SBC control. Use the corresponding pins of the connectors.

4.2 Control via safety relay

NOTICE



- ▶ The possibility of error "Both contacts of a safety relay are not opening" must be ruled out by using a suitable switching element.
- ▶ The possibility of error "Simultaneous short circuit of the outputs against +24 V 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 STO-x against GND" must be ruled out by means of suitable wiring.

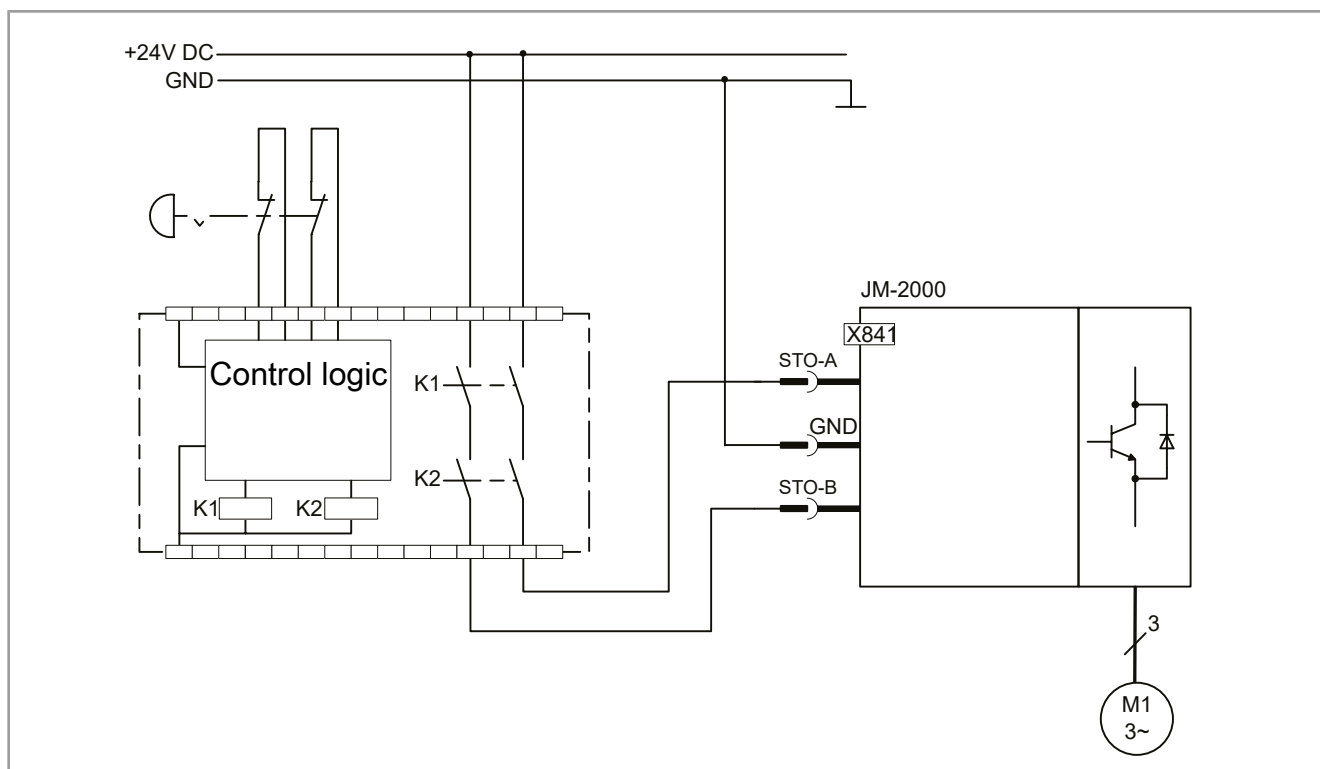


Fig. 11: Control via safety relay

4.3 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 +24 V DC and other outputs" must be detected by the AOPD or light barrier by means of suitable diagnostic measures and a suitable response must be implemented.
- ▶ The possibility of error "Simultaneous short circuit of both outputs against +24 V DC" must be ruled out by a suitable design of the wiring.

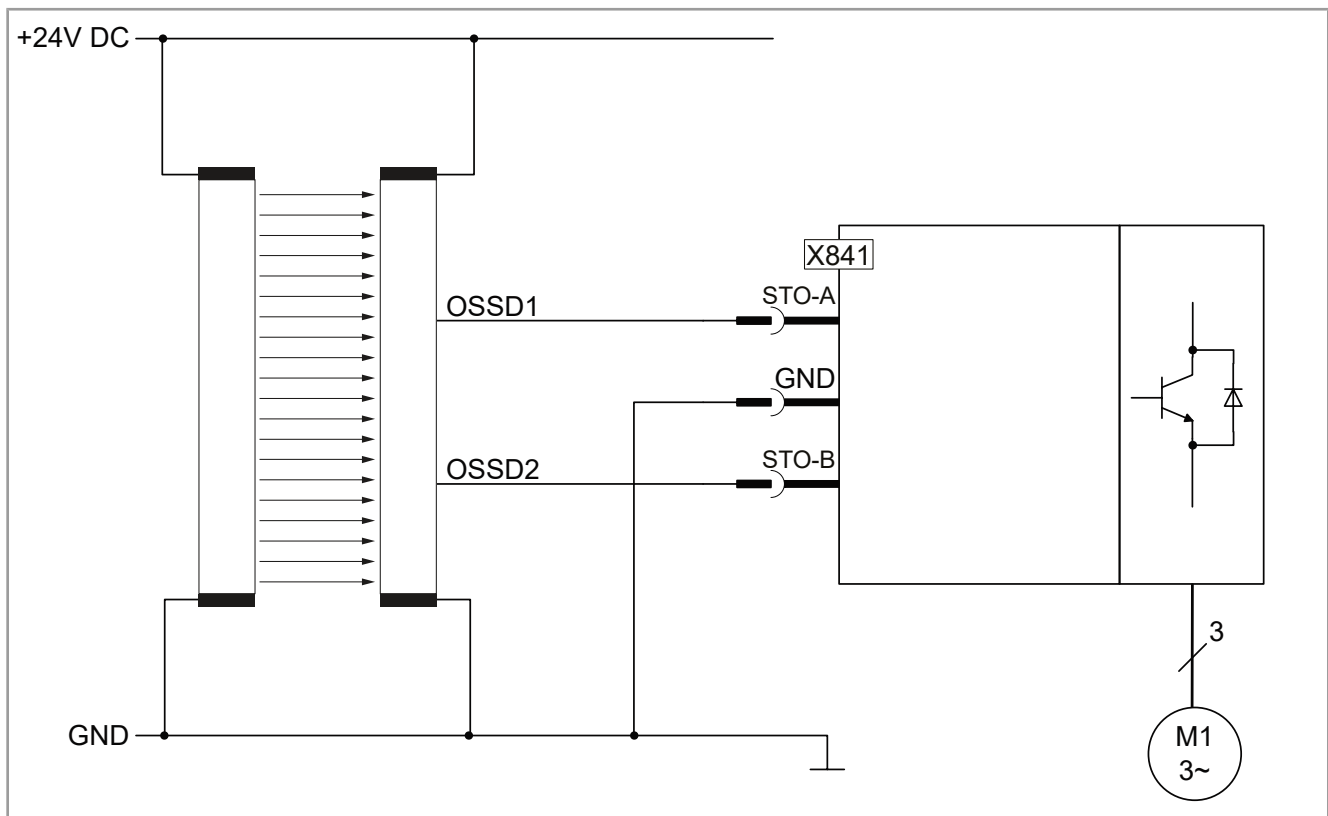


Fig. 12: Control via light barrier with OSSD outputs

4.4 Control with pp switching outputs

Control by means of external safety controller with pp switching outputs.

NOTICE



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

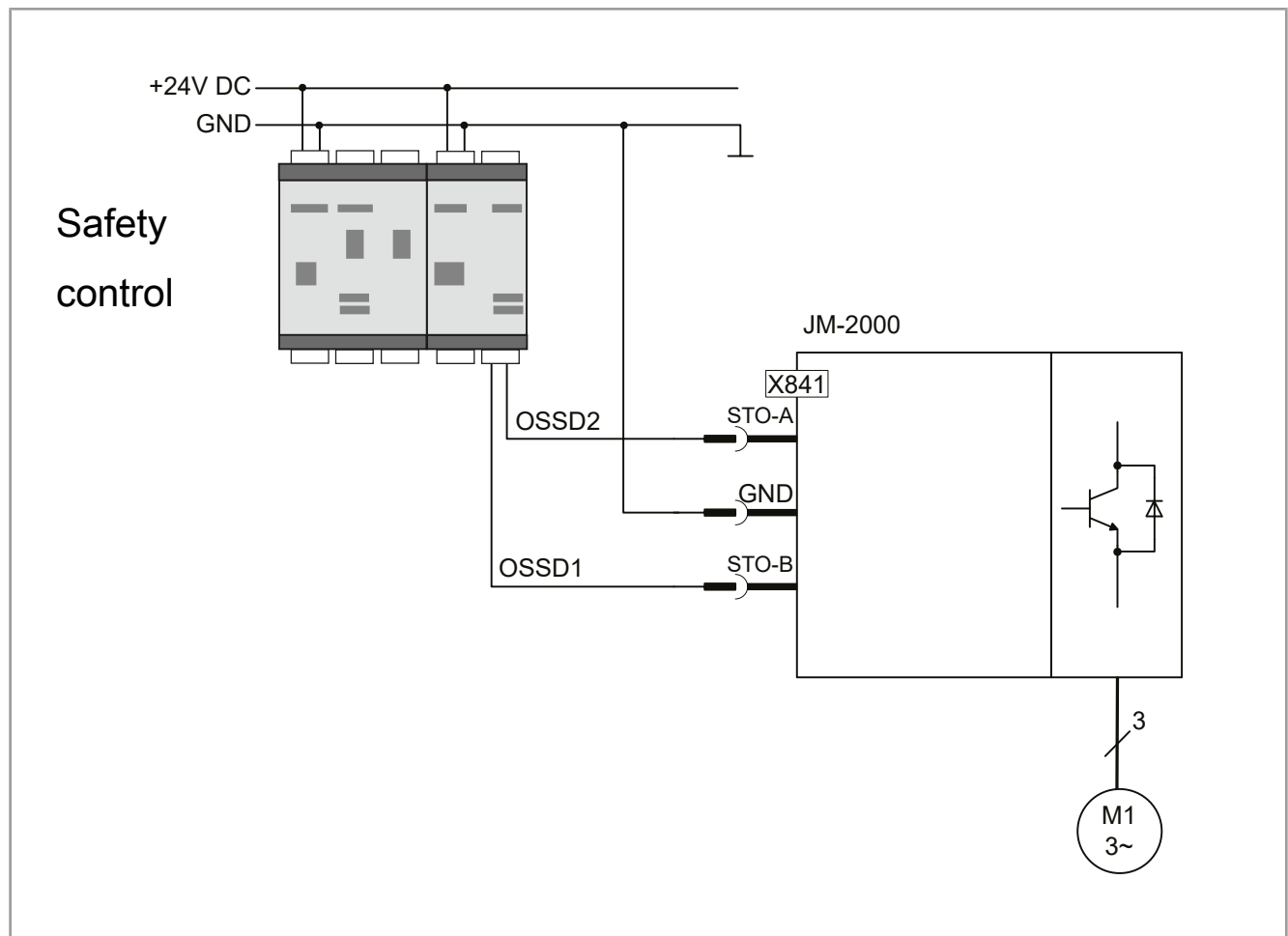


Fig. 13: Control with pp switching outputs

4.5 Restart inhibit and release

⚠ 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.

According to DIN EN ISO 13849-1, acknowledgment (confirmation) of the safeguard having initiated the stop command is referred to as a **manual reset**.

Re-establishment of the safety function by resetting of the safeguard cancels the stop command.

This cancellation of the stop command must be confirmed by a manual separate and deliberate action, e.g. by pressing an ON button that is to be located outside the safeguarded area and integrated in the SRP/CS (safety-related parts of control systems).

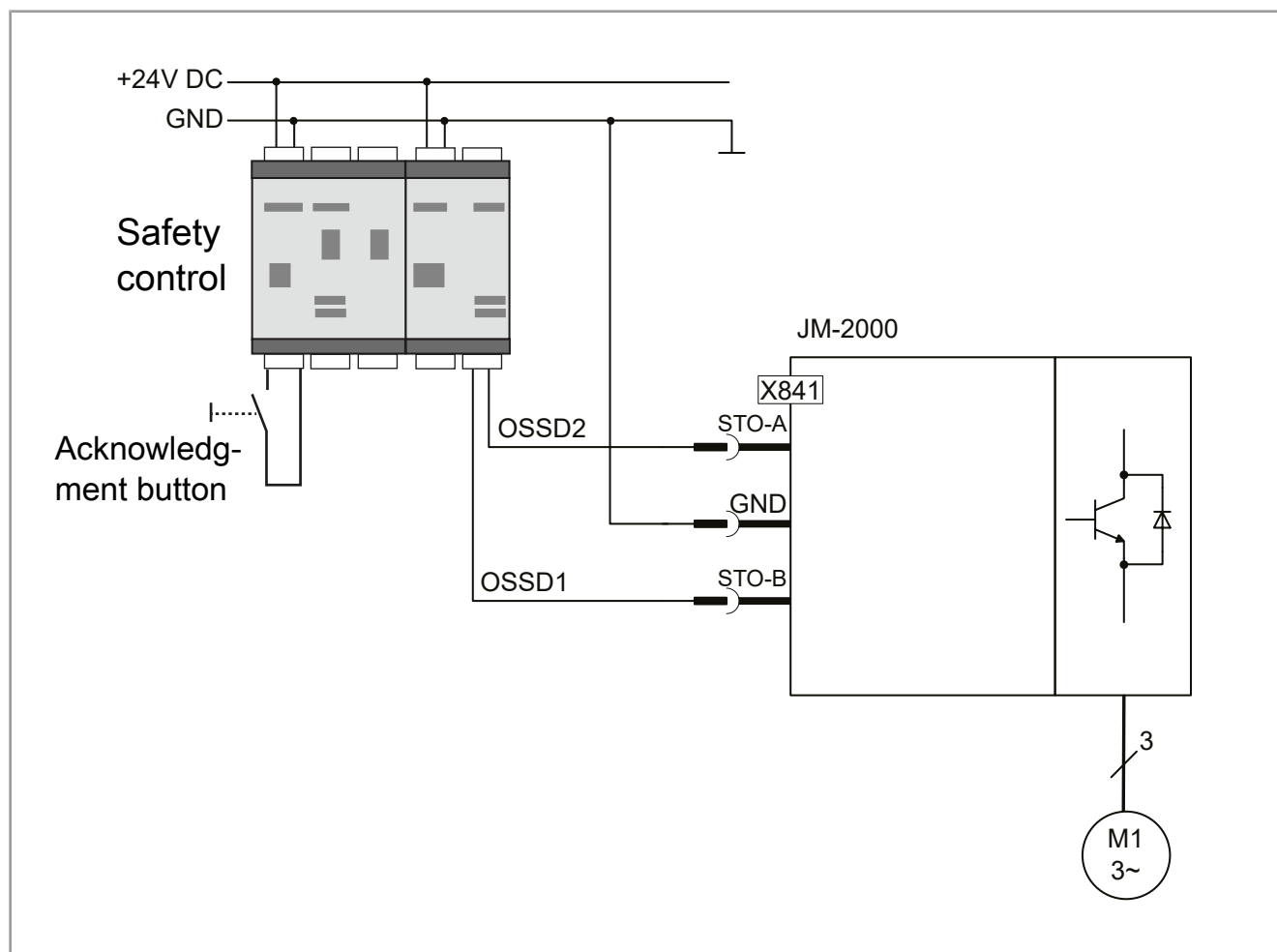


Fig. 14: External restart inhibit

4.6 Controlling double-axis operation

NOTICE



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

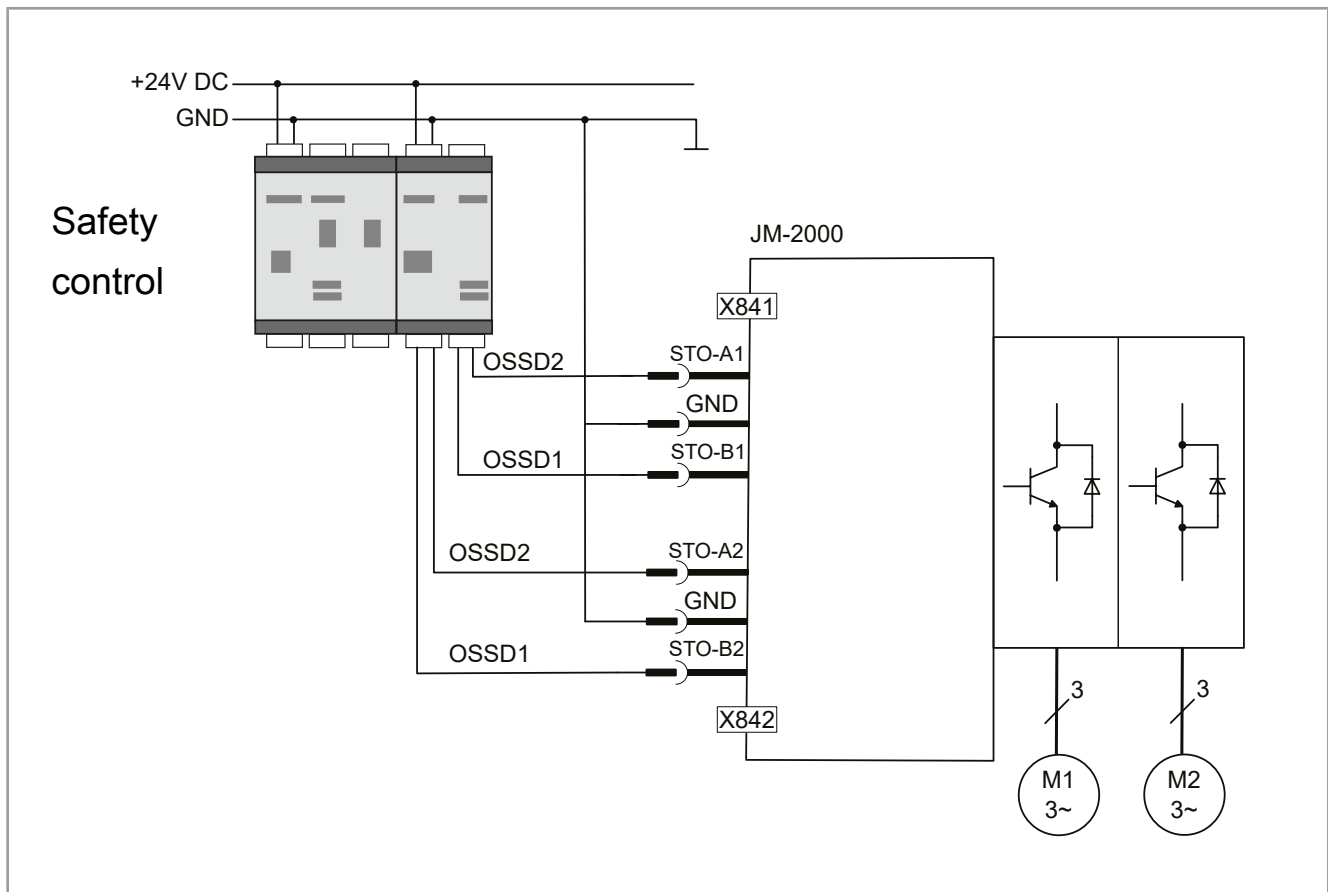


Fig. 15: Wiring example – double-axis operation

4.7 Controlling a motor brake

NOTICE



Separate Hi-side and Lo-side switches fed with dedicated OSSD pulses are used to switch the brake ports.

- Connect the motor brake to both ports ensuring the connection is **potential-free**.

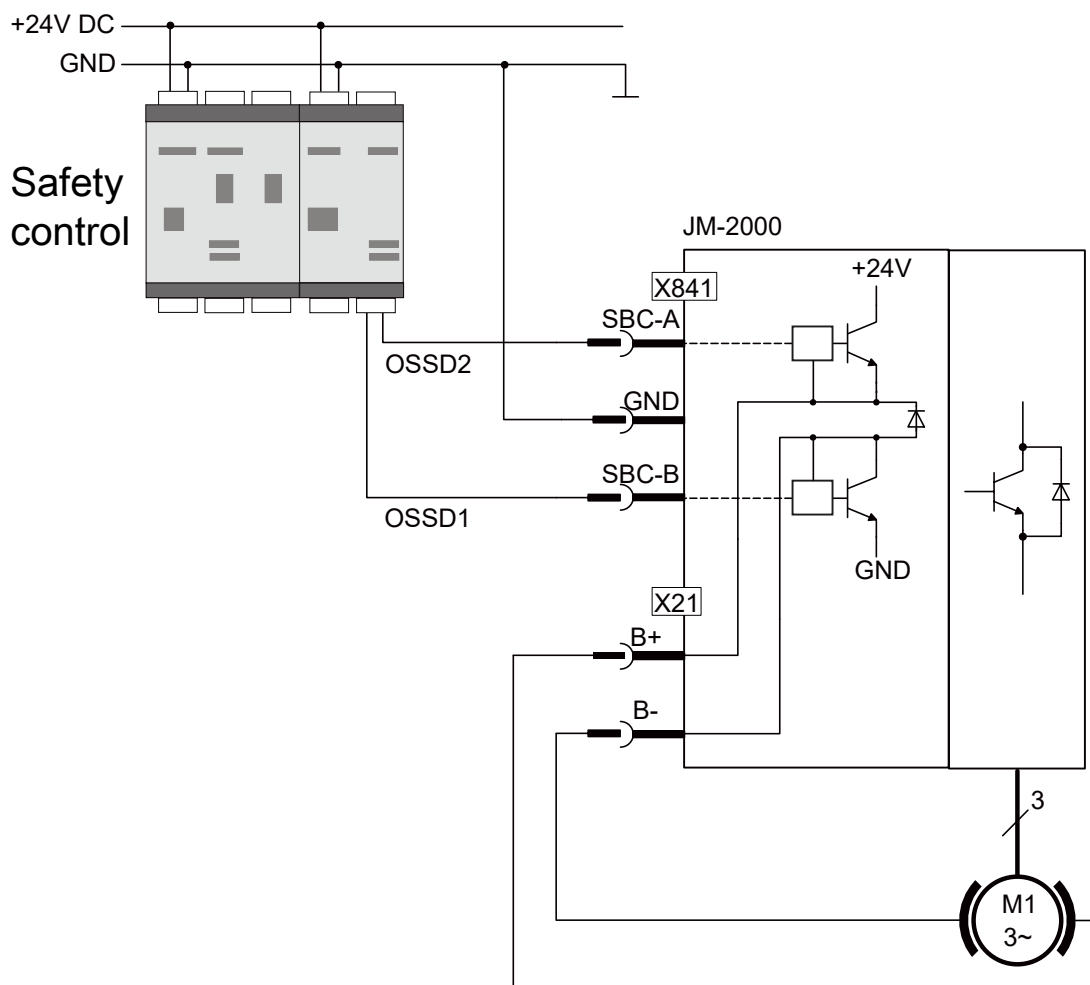


Fig. 16: Wiring example – motor brake

5 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.

5.1 Overview of functions

NOTICE



- ▶ Take into consideration the following requirements starting with the engineering stage.
- ▶ Only use brakes that are designed to meet your requirements.

Safety definition / time behavior:

The application's total reaction time is the sum of:

- Reaction time of the S1 assembly = 20 ms max
- Data transfer time: application-specific
- Processing speed of the safety PLC: application-specific

Safety definition / safe state

The safe state of a servo amplifier is defined as follows:

- Power amplifier is disabled
- Control inputs are disabled
- SBC brake function is enabled

Safety definition / safe brake

The safe state of the mechanical brake is defined as follows:

- The brake closes when the power supply and/or the control inputs are disabled (fail-safe state).
- Only after power supply was re-established **AND**
- the respective control inputs were enabled, does the brake open.

5.2 Stop categories in accordance with DIN EN 60204-1

Stop function

- The stop function halts the drive during normal operation.
- The stop function is defined in DIN EN 60204-1.
- Stop functions must override allocated start functions.
- The configuration of category 0 and category 1 stops must allow them to be triggered independently of the operating mode, where a category 0 stop takes priority.

- Take precautions that allow to connect safeguards and interlocks as needed.
- If necessary, the stop function must feed its status to the control logic.
- Resetting the stop function must not result in a hazardous situation.

Stop categories

- The stop categories are distinguished by the method of bringing electrical machinery to a standstill.
- The machine or equipment manufacturer must define the stop category by means of a risk evaluation procedure.

Stop category 0

The STO function results in an uncontrolled machine stop by cutting the power supply. The motor is turned off and either coasts to a halt or is mechanically decelerated.

This category may be used to shut the system down in a hazardous situation.

Stop category 1

This category allow for a controlled stop by cutting the power supply only after the motor has come to a standstill.

Here, the following steps must be carried in the given order:

1. Deceleration of the motor by applying a brake ramp controlled by the drive.
2. Locking of the drive after the motor has come to a stand still.

This category, too, may be used to shut the system down in a hazardous situation.

5.3 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 indicators ▶ 38](#).

The STO shutdown occurs within 20 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 torque from being generated in the motor.

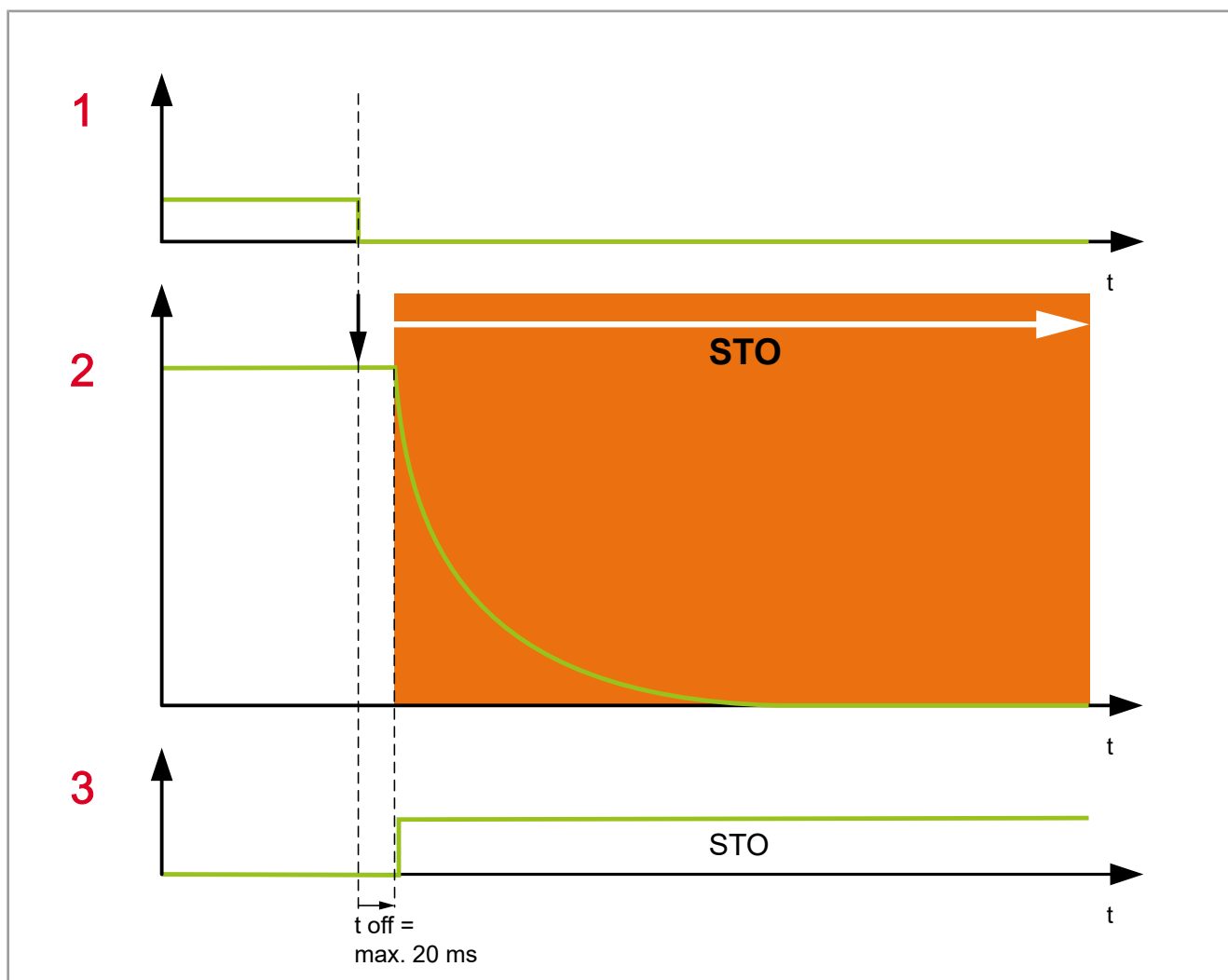


Fig. 17: Flow chart

1	STO request
2	Speed
3	STO active

DANGER



Danger of injury due to unintended axis movement!

External loads or mechanical influences can cause unintended movement of vertical axes that the STO function cannot stop on its own.

- 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.



⚠ CAUTION

Risk of crushing following unintended axis movement due to short circuit or power section error

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

- ▶ Give this potential hazard consideration when engineering the project and make suitable design decisions.

5.4 SBC – safe brake control

The SBC function supplies a safe dual-channel output signal to the brake terminals X21/X22 that can be used to control a safe brake.

SBC function behavior

Opening the respective brake requires the dedicated signal inputs XX841/842.5 and X841/842.6 to be HIGH. Closing the respective brake requires at least one of the dedicated signal inputs XX841/842.5 or X841/842.6 to be LOW.

5.5 Relevant values

Parameter	Values
Debounce time	4 ms
Discrepancy time	500 ms

Tab. 11: Relevant values

5.6 Status display

The LEDs of the status display indicate the states of the safety functions and servo amplifier.

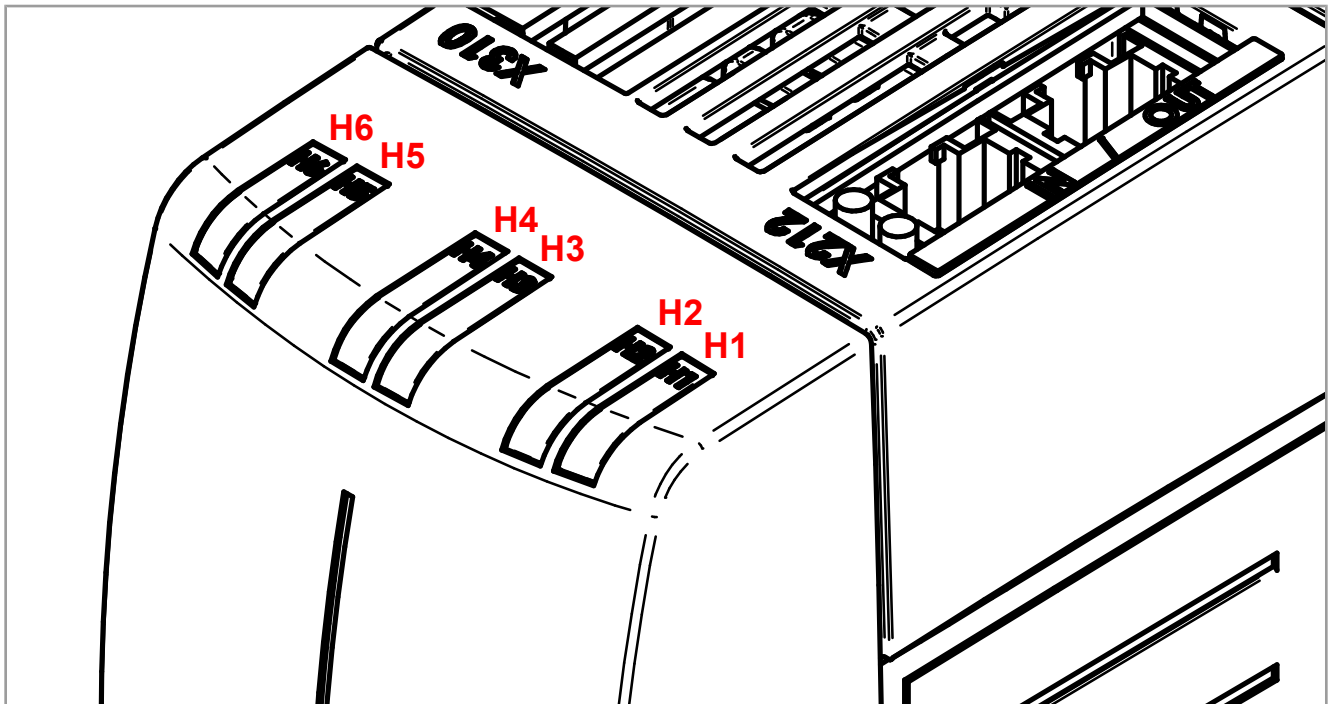


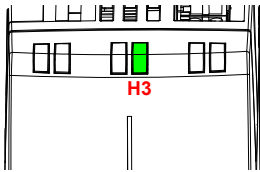
Fig. 18: Status indication

LED	Safety system S1
H1	Amplifier status – axis 1
H2	Amplifier status – axis 2
H3	Safety status – axis 1
H4	Safety status – axis 2
H5 / H6	-

5.6.1 Diagnosing error via LEDs

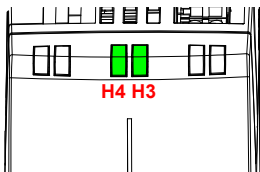
Safety status LEDs

Safety function S1 – single drives



LED	H3	Description
Color	Green	STO is not active.
Status	ON	
Color	Green	STO is active.
Status	Flashing at 1 Hz	
Color	Red	Bootloader, initialization, configuration, startup until ready to switch on or error.
Status	ON	
Color	-	Reset or no voltage.
Status	OFF	

Safety function S1 – double drives



LED	H4 axis 2	H3 axis 1	Description
Color	Green	Green	STO is not active.
Status	ON	ON	
Color	Green	Green	STO is active.
Status	Flashing at 1 Hz	Flashing at 1 Hz	
Color	Red	Red	Bootloader, initialization, configuration, startup until ready to switch on or error.
Status	ON	ON	
Color	-	-	Reset or no voltage.
Status	OFF	OFF	

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 deriving from the application in the following cases:

- During (first) commissioning
- After changes in the application
- After repairs or replacement of a device

The following table shows the test steps to be carried out for each axis individually.

- Perform the steps in the order given in the table (top to bottom).

Designation	State / event	Expected result
Output state	– System is turned on. – Torque is enabled (STO inputs are HIGH). – Servo amplifier generates torque.	Motor axis is actively in motion or torque is applied
Test step 1	STO inputs switch to LOW.	Motor axis coasts to a stop or no torque is applied, and H3 or H4 starts blinking green. The LED lighting up red signals that the discrepancy time was exceeded. ► Check the wiring and the safety relays.
Test step 2	STO inputs switch to HIGH.	Servo amplifier can apply torque.

Tab. 12: STO test steps

NOTICE



When commissioning or restarting the equipment from a de-energized condition (OFF/ON), it must be ruled out that errors have accumulated in the external components of the safety chain. This must be done through tests or diagnosis.

- The user must perform and confirm the required 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.

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

- During (first) commissioning
- After changes in the application
- After repairs or replacement of a device

The following table shows the test steps to be carried out for each axis individually.

- Perform the steps in the order given in the table (top to bottom).

Designation	State / event	Expected result
Output state	– System is turned on. – SBC inputs are HIGH. – Servo amplifier has opened the brake.	The brake is open.
Test step 1	SBC inputs switch to LOW.	Brake has closed and there is no error message. The H3 or H4 LED lighting up red signals that the discrepancy time was exceeded. ► Check the wiring and the safety relays.
Test step 2	SBC inputs switch to HIGH.	The brake is open.

Tab. 13: SBC test steps

NOTICE



When commissioning or restarting the equipment from a de-energized condition (OFF/ ON), it must be ruled out that errors have accumulated in the external components of the safety chain. This must be done through tests or diagnosis.

- The user must perform and confirm the required steps.

6.3 Safety indicators

Safety parameter	Value		Standards
Category	Cat 4		ISO 13849
Performance level	PL e		ISO 13849
Safety integrity level	SIL 3		EN 61508/EN 62061
PFH _D	STO	1.29*10 ⁻⁹	EN 61508/EN 62061
	SBC	1.61*10 ⁻⁹	
SFF[%]	STO	99	EN 61508/EN 62061
	SBC	99	
Compliance test interval	20 years		
Service life	20 years		
Restart inhibit/release	STO	External	
	SBC	External	

Tab. 14: STO and SBC safety indicators

7 Maintenance

7.1 Repairs

Defective components could cause dangerous malfunctions and could compromise safety.

Only the manufacturer is allowed to repair the device.

It is forbidden to open the device.

Modifications to the device

Modifications and alterations to the device and its functions are not allowed. In the case of modifications to the device, any liability is excluded.

The original parts are specifically designed for the device. Parts and equipment from other manufacturers must, therefore, not be used.

Any liability for any damages resulting from the use of non-original parts and equipment is excluded.

7.2 Storage and Shipment

Storage

When storing the device, observe the environmental conditions given in chapter *Technical specifications* in the JM-2000 servo amplifier User Manuals.

Shipment and packaging

The device contains electrostatically sensitive components which can be damaged if not handled properly. Damages to the device may impair its reliability.

To protect the device from impact or shock, it must be shipped in its original packaging, or in an appropriate protective ESD packaging.

In case of damaged packaging inspect the device for any visible damage, and inform your freight forwarder and the Bucher Automation AG of the damage caused during shipment. If the device is damaged or has been dropped, it is strictly forbidden to use it.

7.3 Return and Disposal

Disposal options

Return your Bucher Automation AG product to us for proper disposal. Visit our [website](#) for detailed information and to download the required Returns form.

Meaning of WEEE icon

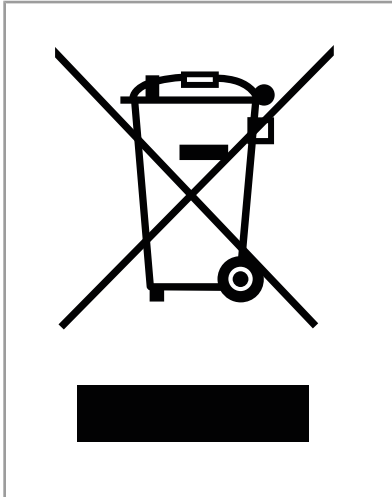


Fig. 19: WEEE icon – crossed out trash can

The product is waste electronic equipment and must be disposed of by a certified waste management facility. Do not dispose of the product with normal household waste. Applicable local environmental directives and regulations must be complied with.

Batteries

Prior to disposing of waste electronics, remove any batteries where this is possible in a safe and non-destructive way. Dispose of batteries properly.

Personal data

It is the responsibility of the customers to delete any personal data stored on waste electric and electronic equipment prior to disposal.

8 Service

8.1 Technical support

In case of questions, suggestions, or issues, please contact our experts from Technical Support. You may reach out by phone or through the contact form on our homepage:

[Technical Support | www.bucherautomation.com](https://www.bucherautomation.com/Technical-Support)

Or email us:

support@bucherautomation.com

Please supply the following information when contacting Technical Support:

- Hardware revision and serial number
The hardware revision and serial number is printed on the nameplate of the product.

Hersteller / manufacturer

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

Geräteart / model

Servoverstärker / servo amplifier

Produkt / product

JM-D2203-S1xxxR1A0	JM-2203-S1xxR1A0
JM-D2206-S1xxxR1A0	JM-2206-S1xxR1A0
JM-D2403-S1xxxR1A0	JM-2403-S1xxR1A0
JM-D2406-S1xxxR1A0	JM-2406-S1xxR1A0
JM-D2410-S1xxxR1A0	JM-2410-S1xxR1A0
	JM-2414-S1xxR1A0
	JM-2423-S1xxR1A0

x = encoder type: **R (resolver)**
 A (HIPERFACE, SSI, SinCos)
 H (HIPERFACE DSL)
 I (incremental encoder)
 E6 (EnDat 2.2)

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**

2011/65/EU	RoHS <i>RoHS</i>
2014/30/EU	EMV-Richtlinie <i>EMC directive</i>
2009/125/EG	Ökodesign-Richtlinie <i>ecodesign directive</i>
2006/42/EG	Maschinen-Richtlinie <i>machinery directive</i>

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

EN IEC 61800-5-1: 2023

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;

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;

Geräteart / model	Servoverstärker / servo amplifier	
Produkt / product	JM-D2203-S1xxxR1A0	JM-2203-S1xxR1A0
	JM-D2206-S1xxxR1A0	JM-2206-S1xxR1A0
	JM-D2403-S1xxxR1A0	JM-2403-S1xxR1A0
	JM-D2406-S1xxxR1A0	JM-2406-S1xxR1A0
	JM-D2410-S1xxxR1A0	JM-2410-S1xxR1A0
		JM-2414-S1xxR1A0
		JM-2423-S1xxR1A0
x = encoder type:		
	R	(resolver)
	A	(HIPERFACE, SSI, SinCos)
	H	(HIPERFACE DSL)
	I	(incremental encoder)
	E6	(EnDat 2.2)

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

Normen der Maschinen-Richtlinie / *Standards of the machinery directive*

EN ISO 13849-1: 2023 OJ L, 2024/1329 - 15/05/2024

Sicherheit von Maschinen - Sicherheitsbezogene Teile von Steuerungen - Allgemeine
Gestaltungsleitsätze;
Safety of machinery - Safety-related parts of control systems - General principles for design;

EN ISO 13849-2: 2012 OJ C 99 - 05/04/2013

Sicherheit von Maschinen - Sicherheitsbezogene Teile von Steuerungen - Validierung;
Safety of machinery - Safety-related parts of control systems - Validation;

EN 61800-5-2: 2007 OJ C 309 - 18/12/2009

Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl - Anforderungen an die Sicherheit -
Funktionale Sicherheit;
Adjustable speed electrical power drive systems - Safety requirements - Functional;

EN 61800-5-2: 2017

Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl - Anforderungen an die Sicherheit -
Funktionale Sicherheit;
Adjustable speed electrical power drive systems - Safety requirements - Functional;

EN IEC 62061: 2021 OJ L 115 - 13/04/2022

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;*

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-Ring 10, 71672 Marbach am Neckar

Ort / place: Marbach am Neckar
Datum / date: 03.03.2025
Unterzeichner / signed by: Christian Benz
Vorstandsvorsitzender / CEO



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