Rexroth
Bosch Group

Rexroth IndraDrive

Integrated Safety Technology
"Safe Torque Off" (as of MPx-16)

SAFETY
ON
BOARD

Title	Rexroth IndraDrive Integrated Safety Technology "Safe Torque Off" (as of MPx-16)
Type of Documentation	Application Manual
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Purpose of Documentation

This documentation

- is used to make oneself familiar with the subject of "Integrated Safety Technology "Safe Torque Off"",

- contains information on mounting and maintenance, on proper and safe operation and on the decommissioning of the integrated safety technology "Safe Torque Off" of IndraDrive Cs, IndraDrive Mi, IndraDrive M / IndraDrive ML / IndraDrive C with control sections of the Cxx02 type,

- is addressed to persons who mount, operate and maintain IndraDrive Cs, IndraDrive Mi, IndraDrive M / IndraDrive ML / IndraDrive C with control sections of the Cxx02 type with integrated safety technology "Safe Torque Off".

Record of Revision

Edition	Release Date	Notes
DOK-INDRV*-SI3-OP-MAN*-OP01-EN-P to DOK-INDRV*-SI3-**VRS**-AP08-EN-P	2010-10 to 2017-08	See chapter "About this documentation", marginal note "Editions of this documentation"

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Editorial Department

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1   Introduction

1.1   About this documentation

Editions of this documentation

Edition	Release date	Notes
DOK-INDRV*-SI3-OP-MAN*-OP01-EN-P	2010-10	First edition
DOK-INDRV*-SI3-**VRS**-AP02-EN-P	2011-07	• Corrections • Optional module "L3" included Replaces DOK-INDRV*-SI3-OP-MAN*-OP01-EN-P
DOK-INDRV*-SI3-**VRS**-AP03-EN-P	2011-10	Declaration of Conformity updated
DOK-INDRV*-SI3-**VRS**-AP04-EN-P	2012-04	Information included on IndraDrive Mi
DOK-INDRV*-SI3-**VRS**-AP05-EN-P	2013-05	• Declaration of Conformity of IndraDrive Mi included • Corrections • Information included on IndraDrive M / IndraDrive C with control sections of the Cxx02 type
DOK-INDRV*-SI3-**VRS**-AP06-EN-P	2014-07	• Information included on IndraDrive ML with control sections of the Cxx02.5 type • Safety instruction regarding the use of a 24 V power supply unit with protection by **SELV**[1] in accordance with IEC 60950-1 or **PELV**[2] in accordance with IEC 60204-1 for the selection and the 24 V supply of devices with integrated safety technology.
DOK-INDRV*-SI3-**VRS**-AP07-EN-P	2015-11	• Information included on IndraDrive Mi (KNK03, KMV03 and KMS03) • Corrections
DOK-INDRV*-SI3-**VRS**-AP08-EN-P	2017-08	• Declaration of Conformity for L3 included for KSM03 • Declaration of Conformity for L3/L4 updated for HCS01 • Declaration of Conformity for L3 updated for KSM02, KMS02 • Declaration of Conformity for L3 updated for HMU05 • Corrections

Tab. 1-1:   Record of revisions

Means of representation in this documentation   To facilitate reading of this documentation, the table below contains the means of representation and notations of recurring terms.

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[1] *Safety Extra Low Voltage*

[2] *Protective Extra Low Voltage*

Introduction

What?	How?	For example...
Important facts to be highlighted in the body text	Boldface	With the safety function "Safe parking axis", the following monitoring functions are **deactivated**: ...
Parameter names, diagnostic message names, function designations	Quotation marks	The missing speed information can be replaced via the control bit "defined safety with parked axis" in "P-0-3210, Safety technology configuration".

Tab. 1-2:   Conventions of notation

Notes and tips are highlighted in the text. A symbol tells you what kind of note or tip is used in the text:

☞   This box contains important information that should be taken into consideration.

💡   This symbol highlights useful tips and tricks.

Signal words in accordance with ANSI Z535.6-2011 draw the reader's attention to hazards (see "Explanation of signal words and the safety alert symbol").

Structure of documentation   Concerning integrated safety technology, the descriptions of the IndraDrive systems have the following structure:

- **Application Manual** on the optional safety technology modules "Safe Torque Off" ("L3", "L4") (this documentation)

    – is used to make oneself familiar with the subject of "Integrated Safety Technology "Safe Torque Off"",

    – contains information on mounting and maintenance, on proper and safe operation and on the decommissioning of the integrated safety technology "Safe Torque Off" of IndraDrive Cs, IndraDrive Mi, IndraDrive M / IndraDrive ML / IndraDrive C with control sections of the Cxx02 type,

    – is addressed to persons who mount, operate and maintain IndraDrive Cs, IndraDrive Mi, IndraDrive M / IndraDrive ML / IndraDrive C with control sections of the Cxx02 type with integrated safety technology "Safe Torque Off".

- Application Manual on the optional safety technology modules "Safe Motion" ("S3", "S4", "S5", "SB", "SD")

    – is used to make oneself familiar with the subject of "Integrated Safety Technology "Safe Motion"",

    – contains information on mounting and maintenance, on proper and safe operation and on the decommissioning of the integrated safety technology "Safe Motion" of IndraDrive Cs, IndraDrive Mi and IndraDrive M / IndraDrive ML / IndraDrive C with control sections of the Cxx02 type,

    – is addressed to persons who mount, operate and maintain IndraDrive Cs, IndraDrive Mi and IndraDrive M / IndraDrive ML / IndraDrive C with control sections of the Cxx02 type with integrated safety technology "Safe Motion".

- **Project Planning Manuals**

    Assist with electrical design and installation of the drive system, as well as its components

Introduction

- **Parameter description** for Rexroth IndraDrive with the firmware versions MPx-1x and above, and PSB

  Apart from the specific safety technology parameters, all other drive parameters are documented in the Parameter Description

- **Description of diagnostic messages** for Rexroth IndraDrive with the firmware versions MPx-1x and above, and PSB

  Apart from the specific diagnostic messages of safety technology, all other diagnostic messages are documented in the Description of Diagnostic Messages (also called "Troubleshooting Guide").

☞ For an overview of reference documentations, please refer to: "Documentations"

Your Feedback

Your experience is important for our improvement processes of products and documentations.

If you discover mistakes in this documentation or suggest changes, you can send your feedback to the following e-mail address:

Dokusupport@boschrexroth.de

We need the following information to handle your feedback:

- The number indicated under "Internal File Reference".
- The page number.

1.2 Documentations

1.2.1 Drive systems, system components

Drive systems, system components

Title Rexroth IndraDrive …	Kind of documentation	Document typecode[1)] DOK-INDRV*-…	Material number R911…
…Cs Drive Systems with HCS01	Project Planning Manual	HCS01******-PRxx-EN-P	322210
…Mi Drive Systems with KCU02 KSM02, KMS02/03, KMV03	Project Planning Manual	KCU02+KSM02-PRxx-EN-P	335703
Drive Systems with HMV01/02 HMS01/02, HMD01, HCS02/03	Project Planning Manual	SYSTEM*****-PRxx-EN-P	309636
Supply Units, Power Sections HMV, HMS, HMD, HCS02, HCS03	Project Planning Manual	HMV-S-D+HCS-PRxx-EN-P	318790
ML, Drive Systems with HMU05	Project Planning Manual	Hxx05******-PRxx-EN-P	344279
Drive Controllers Control Sections CSB01, CSH01, CDB01	Project Planning Manual	CSH********-PRxx-EN-P	295012

Introduction

Title Rexroth IndraDrive …	Kind of documentation	Document typecode[1)] DOK-INDRV*-…	Material number R911…
Control Sections CSE02, CSB02, CDB02, CSH02	Project Planning Manual	Cxx02******-PRxx-EN-P	338962
Additional Components and Accessories	Project Planning Manual	ADDCOMP****-PRxx-EN-P	306140

1)   In the document typecodes, "xx" is a wild card for the current edition of the documentation (example: PR01 is the first edition of a Project Planning Manual)

Tab. 1-3:   Documentations – Drive systems, system components

1.2.2   Motors

Title Rexroth IndraDyn …	Type of documentation	Document typecode[1)] DOK-MOTOR*-…	Material number R911…
A Asynchronous Motors MAD / MAF	Project Planning Manual	MAD/MAF****-PRxx-EN-P	295781
H Synchronous Kit Spindle Motors	Project Planning Manual	MBS-H******-PRxx-EN-P	297895
L Synchronous Linear Motors	Project Planning Manual	MLF********-PRxx-EN-P	293635
L Ironless Linear Motors MCL	Project Planning Manual	MCL********-PRxx-EN-P	330592
S Synchronous Motors MKE	Project Planning Manual	MKE*GEN2***-PRxx-EN-P	297663
S Synchronous Motors MSK	Project Planning Manual	MSK********-PRxx-EN-P	296289
S Synchronous Motors MSM	Data Sheet	MSM********-DAxx-EN-P	329338
S Synchronous Motors MS2N	Project Planning Manual	MS2N*******-PRxx-EN-P	347583
T Synchronous Torque Motors	Project Planning Manual	MBT********-PRxx-EN-P	298798

1)   In the document typecodes, "xx" is a placeholder for the current edition of the documentation (e.g.: PR01 is the first edition of a Project Planning Manual)

Tab. 1-4:   Documentations – motors

1.2.3   Gearboxes

Title	Kind of documentation	Document typecode[1)]	Material number
Rexroth GTP Planetary Gearboxes	Project Planning Manual	DOK-GEAR**-GTP********-PRxx-EN-P	R911267495
Rexroth GTM Planetary Gearboxes	Project Planning Manual	DOK-GEAR**-GTM********-PRxx-EN-P	R911297321
Rexroth GTE Planetary Gearboxes	Project Planning Manual	DOK-GEAR**-GTE********-PRxx-EN-P	R911308842

1)   In the document typecodes, "xx" is a wild card for the current edition of the documentation (example: RE02 is the second edition of a Reference Book)

Tab. 1-5:   Documentations – Gearboxes

1.2.4   Cables

Title	Kind of documentation	Document typecode[1)] DOK-CONNEC-...	Material number R911...
Rexroth Connection Cables IndraDrive and IndraDyn	Selection Data	CABLE*INDRV-CAxx-EN-P	322949

1)   In the document typecodes, "xx" is a wild card for the current edition of the documentation (example: CA02 is the second edition of the documentation "Selection Data")

Tab. 1-6:   Documentations – Cables

1.2.5   Firmware

Title Rexroth IndraDrive ...	Type of documentation	Document typecode[1)] DOK-INDRV*-...	Material number R911...
MPx-20 Functions	Application Manual	MP*-20VRS**-APxx-EN-P	345608
MPx-20 Version Notes	Release Notes	MP*-20VRS**-RNxx-EN-P	345606
Power Supply Basic PSB-20 Functions	Application Manual	PSB-20VRS**-APxx-EN-P	345610
Power Supply Basic PSB-19 Functions	Application Manual	PSB-19VRS**-APxx-EN-P	345602
MPx-18 Functions	Application Manual	MP*-18VRS**-APxx-EN-P	338673
MPx-18 Version Notes	Release Notes	MP*-18VRS**-RNxx-EN-P	338658
MPx-17 Functions	Application Manual	MP*-17VRS**-APxx-EN-P	331236
MPx-17 Version Notes	Release Notes	MP*-17VRS**-RNxx-EN-P	331588
MPx-16 Functions	Application Manual	MP*-16VRS**-APxx-EN-P	326767
MPx-16 Version Notes	Release Notes	MP*-16VRS**-RNxx-EN-P	329272
MPx-16 to MPx-20 and PSB Parameters	Reference Book	GEN1-PARA**-RExx-EN-P	328651
MPx-16 to MPx-20 and PSB Diagnostic Messages	Reference Book	GEN1-DIAG**-RExx-EN-P	326738
Integrated Safety Technology "Safe Torque Off" (as of MPx-16)	Application Manual	SI3-**VRS**-APxx-EN-P	332634
Integrated Safety Technology "Safe Motion" (as of MPx-18)	Application Manual	SI3*SMO-VRS-APxx-EN-P	338920

Introduction

Title Rexroth IndraDrive ...	Type of documentation	Document typecode[1)] DOK-INDRV*-…	Material number R911…
Rexroth IndraMotion MLD Libraries as of MPx-17	Reference Book	MLD-SYSLIB2-RExx-EN-P	332627
Rexroth IndraMotion MLD Libraries as of MPx-18	Reference Book	MLD-SYSLIB3-RExx-EN-P	338916
Rexroth IndraMotion MLD as of MPx-17	Application Manual	MLD2-**VRS*-APxx-EN-P	334351
Rexroth IndraMotion MLD as of MPx-18	Application Manual	MLD3-**VRS*-APxx-EN-P	338914

1)   In the document typecodes, "xx" is a placeholder for the current edition of the documentation (e.g.: RE02 is the second edition of a Reference Book)

Tab. 1-7:   *Documentations – Firmware*

2   Important directions for use

2.1   Appropriate use

2.1.1   Introduction

Rexroth products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.

> ⚠ **WARNING**   **Personal injury and property damage caused by incorrect use of the products!**

The products have been designed for use in the industrial environment and may only be used in the appropriate way. If they are not used in the appropriate way, situations resulting in property damage and personal injury can occur.

☞   Rexroth as manufacturer is not liable for any damages resulting from inappropriate use. In such cases, the guarantee and the right to payment of damages resulting from inappropriate use are forfeited. The user alone carries all responsibility of the risks.

Before using Rexroth products, make sure that all the pre-requisites for an appropriate use of the products are satisfied:

- Personnel that in any way, shape or form uses our products must first read and understand the relevant safety instructions and be familiar with their appropriate use.

- If the products take the form of hardware, then they must remain in their original state, in other words, no structural changes are permitted. It is not permitted to decompile software products or alter source codes.

- Do not install damaged or faulty products or put them into operation.

- Make sure that the products have been installed in the manner described in the relevant documentation.

2.1.2   Areas of use and application

Drive controllers made by Rexroth are designed to control electric motors and monitor their operation.

Control and monitoring of the Drive controllers may require additional sensors and actuators.

☞   The drive controllers may only be used with the accessories and parts specified in this documentation. If a component has not been specifically named, then it may neither be mounted nor connected. The same applies to cables and lines.

Operation is only permitted in the specified configurations and combinations of components using the software and firmware as specified in the relevant Functional Descriptions.

Drive controllers have to be programmed before commissioning to ensure that the motor executes the specific functions of an application.

Drive controllers of the Rexroth IndraDrive series have been developed for use in single- and multi-axis drive and control tasks.

Important directions for use

To ensure application-specific use of Drive controllers, device types of different drive power and different interfaces are available.

Typical applications include, for example:

- Handling and mounting systems
- Packaging and food machines
- Printing and paper processing machines
- Machine tools

Drive controllers may only be operated under the assembly and installation conditions described in this documentation, in the specified position of normal use and under the ambient conditions as described (temperature, degree of protection, humidity, EMC, etc.).

2.2   Inappropriate use

Using the Drive controllers outside of the operating conditions described in this documentation and outside of the indicated technical data and specifications is defined as "inappropriate use".

Drive controllers may not be used, if …

- they are subject to operating conditions that do not meet the specified ambient conditions. This includes, for example, operation under water, under extreme temperature fluctuations or extremely high maximum temperatures.

- Furthermore, Drive controllers may not be used in applications which have not been expressly authorized by Rexroth. Please carefully follow the specifications outlined in the general Safety Instructions!

☞   Components of the Rexroth IndraDrive system are **products of Category C3** (with restricted distribution) in accordance with IEC 61800-3. This Category comprises EMC limit values for line-based and radiated noise emission. Compliance with this Category (limit values) requires the appropriate measures of interference suppression to be used in the drive system (e.g., mains filters, shielding measures).

These components are not provided for use in a public low-voltage mains supplying residential areas. If these components are used in such a mains, high-frequency interference is to be expected. This can require additional measures of interference suppression.

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3   Safety instructions for electric drives and controls

3.1   Definitions of terms

Application documentation
Application documentation comprises the entire documentation used to inform the user of the product about the use and safety-relevant features for configuring, integrating, installing, mounting, commissioning, operating, maintaining, repairing and decommissioning the product. The following terms are also used for this kind of documentation: Operating Instructions, Commissioning Manual, Instruction Manual, Project Planning Manual, Application Description, etc.

Component
A component is a combination of elements with a specified function, which are part of a piece of equipment, device or system. Components of the electric drive and control system are, for example, supply units, drive controllers, mains choke, mains filter, motors, cables, etc.

Control system
A control system comprises several interconnected control components placed on the market as a single functional unit.

Device
A device is a finished product with a defined function, intended for users and placed on the market as an individual piece of merchandise.

Electrical equipment
Electrical equipment encompasses all devices used to generate, convert, transmit, distribute or apply electrical energy, such as electric motors, transformers, switching devices, cables, lines, power-consuming devices, circuit board assemblies, plug-in units, control cabinets, etc.

Electric drive system
An electric drive system comprises all components from mains supply to motor shaft; this includes, for example, electric motor(s), motor encoder(s), supply units and drive controllers, as well as auxiliary and additional components, such as mains filter, mains choke and the corresponding lines and cables.

Installation
An installation consists of several devices or systems interconnected for a defined purpose and on a defined site which, however, are not intended to be placed on the market as a single functional unit.

Machine
A machine is the entirety of interconnected parts or units at least one of which is movable. Thus, a machine consists of the appropriate machine drive elements, as well as control and power circuits, which have been assembled for a specific application. A machine is, for example, intended for processing, treatment, movement or packaging of a material. The term "machine" also covers a combination of machines which are arranged and controlled in such a way that they function as a unified whole.

Manufacturer
The manufacturer is an individual or legal entity bearing responsibility for the design and manufacture of a product which is placed on the market in the individual's or legal entity's name. The manufacturer can use finished products, finished parts or finished elements, or contract out work to subcontractors. However, the manufacturer must always have overall control and possess the required authority to take responsibility for the product.

Product
Examples of a product: Device, component, part, system, software, firmware, among other things.

Project Planning Manual
A Project Planning Manual is part of the application documentation used to support the sizing and planning of systems, machines or installations.

Qualified persons
In terms of this application documentation, qualified persons are those persons who are familiar with the installation, mounting, commissioning and operation of the components of the electric drive and control system, as well as with the hazards this implies, and who possess the qualifications their

Safety instructions for electric drives and controls

work requires. To comply with these qualifications, it is necessary, among other things,

- to be trained, instructed or authorized to switch electric circuits and devices safely on and off, to ground them and to mark them.
- to be trained or instructed to maintain and use adequate safety equipment.
- to attend a course of instruction in first aid.

User   A user is a person installing, commissioning or using a product which has been placed on the market.

3.2 General information

3.2.1 Using the Safety instructions and passing them on to others

Do not attempt to install and operate the components of the electric drive and control system without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with these components. If you do not have the user documentation for the components, contact your responsible Rexroth sales partner. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the components.

If the component is resold, rented and/or passed on to others in any other form, these safety instructions must be delivered with the component in the official language of the user's country.

Improper use of these components, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, could result in property damage, injury, electric shock or even death.

3.2.2 Requirements for safe use

Read the following instructions before initial commissioning of the components of the electric drive and control system in order to eliminate the risk of injury and/or property damage. You must follow these safety instructions.

- Rexroth is not liable for damages resulting from failure to observe the safety instructions.
- Read the operating, maintenance and safety instructions in your language before commissioning. If you find that you cannot completely understand the application documentation in the available language, please ask your supplier to clarify.
- Proper and correct transport, storage, mounting and installation, as well as care in operation and maintenance, are prerequisites for optimal and safe operation of the component.
- Only qualified persons may work with components of the electric drive and control system or within its proximity.
- Only use accessories and spare parts approved by Rexroth.
- Follow the safety regulations and requirements of the country in which the components of the electric drive and control system are operated.
- Only use the components of the electric drive and control system in the manner that is defined as appropriate. See chapter "Appropriate Use".
- The ambient and operating conditions given in the available application documentation must be observed.

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- Applications for functional safety are only allowed if clearly and explicitly specified in the application documentation "Integrated Safety Technology". If this is not the case, they are excluded. Functional safety is a safety concept in which measures of risk reduction for personal safety depend on electrical, electronic or programmable control systems.

- The information given in the application documentation with regard to the use of the delivered components contains only examples of applications and suggestions.

  The machine and installation manufacturers must

  – make sure that the delivered components are suited for their individual application and check the information given in this application documentation with regard to the use of the components,

  – make sure that their individual application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.

- Commissioning of the delivered components is only allowed once it is sure that the machine or installation in which the components are installed complies with the national regulations, safety specifications and standards of the application.

- Operation is only allowed if the national EMC regulations for the application are met.

- The instructions for installation in accordance with EMC requirements can be found in the section on EMC in the respective application documentation.

  The machine or installation manufacturer is responsible for compliance with the limit values as prescribed in the national regulations.

- The technical data, connection and installation conditions of the components are specified in the respective application documentations and must be followed at all times.

National regulations which the user has to comply with

- European countries: In accordance with European EN standards

- United States of America (USA):

  – National Electrical Code (NEC)

  – National Electrical Manufacturers Association (NEMA), as well as local engineering regulations

  – Regulations of the National Fire Protection Association (NFPA)

- Canada: Canadian Standards Association (CSA)

- Other countries:

  – International Organization for Standardization (ISO)

  – International Electrotechnical Commission (IEC)

3.2.3   Hazards by improper use

- High electrical voltage and high working current! Danger to life or serious injury by electric shock!

- High electrical voltage by incorrect connection! Danger to life or injury by electric shock!

Safety instructions for electric drives and controls

- Dangerous movements! Danger to life, serious injury or property damage by unintended motor movements!
- Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electric drive systems!
- Risk of burns by hot housing surfaces!
- Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!
- Risk of injury by improper handling of batteries!
- Risk of injury by improper handling of pressurized lines!

3.3 Instructions with regard to specific dangers

3.3.1 Protection against contact with electrical parts and housings

☞   This section concerns components of the electric drive and control system with voltages of **more than 50 volts**.

Contact with parts conducting voltages above 50 volts can cause personal danger and electric shock. When operating components of the electric drive and control system, it is unavoidable that some parts of these components conduct dangerous voltage.

High electrical voltage! Danger to life, risk of injury by electric shock or serious injury!

- Only qualified persons are allowed to operate, maintain and/or repair the components of the electric drive and control system.
- Follow the general installation and safety regulations when working on power installations.
- Before switching on, the equipment grounding conductor must have been permanently connected to all electric components in accordance with the connection diagram.
- Even for brief measurements or tests, operation is only allowed if the equipment grounding conductor has been permanently connected to the points of the components provided for this purpose.
- Before accessing electrical parts with voltage potentials higher than 50 V, you must disconnect electric components from the mains or from the power supply unit. Secure the electric component from reconnection.
- With electric components, observe the following aspects:

  Always wait **30 minutes** after switching off power to allow live capacitors to discharge before accessing an electric component. Measure the electrical voltage of live parts before beginning to work to make sure that the equipment is safe to touch.

- Install the covers and guards provided for this purpose before switching on.
- Never touch any electrical connection points of the components while power is turned on.
- Do not remove or plug in connectors when the component has been powered.

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- Under specific conditions, electric drive systems can be operated at mains protected by residual-current-operated circuit-breakers sensitive to universal current (RCDs/RCMs).

- Secure built-in devices from penetrating foreign objects and water, as well as from direct contact, by providing an external housing, for example a control cabinet.

High housing voltage and high leakage current! Danger to life, risk of injury by electric shock!

- Before switching on and before commissioning, ground or connect the components of the electric drive and control system to the equipment grounding conductor at the grounding points.

- Connect the equipment grounding conductor of the components of the electric drive and control system permanently to the main power supply at all times. The leakage current is greater than 3.5 mA.

- Establish an equipment grounding connection with a minimum cross section according to the table below. With an outer conductor cross section smaller than 10 mm^2 (8 AWG), the alternative connection of two equipment grounding conductors is allowed, each having the same cross section as the outer conductors.

Cross section outer conductor	Minimum cross section equipment grounding conductor Leakage current ≥ 3.5 mA	
	1 equipment grounding conductor	2 equipment grounding conductors
1.5 mm^2 (16 AWG)	10 mm^2 (8 AWG)	2 × 1.5 mm^2 (16 AWG)
2.5 mm^2 (14 AWG)		2 × 2.5 mm^2 (14 AWG)
4 mm^2 (12 AWG)		2 × 4 mm^2 (12 AWG)
6 mm^2 (10 AWG)		2 × 6 mm^2 (10 AWG)
10 mm^2 (8 AWG)		-
16 mm^2 (6 AWG)	16 mm^2 (6 AWG)	-
25 mm^2 (4 AWG)		-
35 mm^2 (2 AWG)		-
50 mm^2 (1/0 AWG)	25 mm^2 (4 AWG)	-
70 mm^2 (2/0 AWG)	35 mm^2 (2 AWG)	-
...	...	...

Tab. 3-1:   *Minimum cross section of the equipment grounding connection*

3.3.2 Protective extra-low voltage as protection against electric shock

Protective extra-low voltage is used to allow connecting devices with basic insulation to extra-low voltage circuits.

On components of an electric drive and control system provided by Rexroth, all connections and terminals with voltages up to 50 volts are PELV ("Protective Extra-Low Voltage") systems. It is allowed to connect devices

Safety instructions for electric drives and controls

equipped with basic insulation (such as programming devices, PCs, notebooks, display units) to these connections.

Danger to life, risk of injury by electric shock! High electrical voltage by incorrect connection!

If extra-low voltage circuits of devices containing voltages and circuits of more than 50 volts (e.g., the mains connection) are connected to Rexroth products, the connected extra-low voltage circuits must comply with the requirements for PELV ("Protective Extra-Low Voltage").

3.3.3   Protection against dangerous movements

Dangerous movements can be caused by faulty control of connected motors. Some common examples are:

- Improper or wrong wiring or cable connection
- Operator errors
- Wrong input of parameters before commissioning
- Malfunction of sensors and encoders
- Defective components
- Software or firmware errors

These errors can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

The monitoring functions in the components of the electric drive and control system will normally be sufficient to avoid malfunction in the connected drives. Regarding personal safety, especially the danger of injury and/or property damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

Dangerous movements! Danger to life, risk of injury, serious injury or property damage!

A **risk assessment** must be prepared for the installation or machine, with its specific conditions, in which the components of the electric drive and control system are installed.

As a result of the risk assessment, the user must provide for monitoring functions and higher-level measures on the installation side for personal safety. The safety regulations applicable to the installation or machine must be taken into consideration. Unintended machine movements or other malfunctions are possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, injury and/or property damage:

- Keep free and clear of the machine's range of motion and moving machine parts. Prevent personnel from accidentally entering the machine's range of motion by using, for example:
  - Safety fences
  - Safety guards
  - Protective coverings
  - Light barriers

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- Make sure the safety fences and protective coverings are strong enough to resist maximum possible kinetic energy.

- Mount emergency stopping switches in the immediate reach of the operator. Before commissioning, verify that the emergency stopping equipment works. Do not operate the machine if the emergency stopping switch is not working.

- Prevent unintended start-up. Isolate the drive power connection by means of OFF switches/OFF buttons or use a safe starting lockout.

- Make sure that the drives are brought to safe standstill before accessing or entering the danger zone.

- Additionally secure vertical axes against falling or dropping after switching off the motor power by, for example,
    - mechanically securing the vertical axes,
    - adding an external braking/arrester/clamping mechanism or
    - ensuring sufficient counterbalancing of the vertical axes.

- The standard equipment **motor holding brake** or an external holding brake controlled by the drive controller is **not sufficient to guarantee personal safety**!

- Disconnect electrical power to the components of the electric drive and control system using the master switch and secure them from reconnection ("lock out") for:
    - Maintenance and repair work
    - Cleaning of equipment
    - Long periods of discontinued equipment use

- Prevent the operation of high-frequency, remote control and radio equipment near components of the electric drive and control system and their supply leads. If the use of these devices cannot be avoided, check the machine or installation, at initial commissioning of the electric drive and control system, for possible malfunctions when operating such high-frequency, remote control and radio equipment in its possible positions of normal use. It might possibly be necessary to perform a special electromagnetic compatibility (EMC) test.

3.3.4 Protection against electromagnetic and magnetic fields during operation and mounting

Electromagnetic and magnetic fields!

Health hazard for persons with active implantable medical devices (AIMD) such as pacemakers or passive metallic implants.

- Hazards for the above-mentioned groups of persons by electromagnetic and magnetic fields in the immediate vicinity of drive controllers and the associated current-carrying conductors.

- Entering these areas can pose an increased risk to the above-mentioned groups of persons. They should seek advice from their physician.

- If overcome by possible effects on above-mentioned persons during operation of drive controllers and accessories, remove the exposed persons from the vicinity of conductors and devices.

Safety instructions for electric drives and controls

3.3.5 Protection against contact with hot parts

Hot surfaces of components of the electric drive and control system. Risk of burns!

- Do not touch hot surfaces of, for example, braking resistors, heat sinks, supply units and drive controllers, motors, windings and laminated cores!

- According to the operating conditions, temperatures of the surfaces can be **higher than 60 °C** (140 °F) during or after operation.

- Before touching motors after having switched them off, let them cool down for a sufficient period of time. Cooling down can require **up to 140 minutes**! The time required for cooling down is approximately five times the thermal time constant specified in the technical data.

- After switching chokes, supply units and drive controllers off, wait **15 minutes** to allow them to cool down before touching them.

- Wear safety gloves or do not work at hot surfaces.

- For certain applications, and in accordance with the respective safety regulations, the manufacturer of the machine or installation must take measures to avoid injuries caused by burns in the final application. These measures can be, for example: Warnings at the machine or installation, guards (shieldings or barriers) or safety instructions in the application documentation.

3.3.6 Protection during handling and mounting

Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!

- Observe the relevant statutory regulations of accident prevention.

- Use suitable equipment for mounting and transport.

- Avoid jamming and crushing by appropriate measures.

- Always use suitable tools. Use special tools if specified.

- Use lifting equipment and tools in the correct manner.

- Use suitable protective equipment (hard hat, safety goggles, safety shoes, safety gloves, for example).

- Do not stand under hanging loads.

- Immediately clean up any spilled liquids from the floor due to the risk of falling!

3.3.7 Battery safety

Batteries consist of active chemicals in a solid housing. Therefore, improper handling can cause injury or property damage.

Risk of injury by improper handling!

- Do not attempt to reactivate low batteries by heating or other methods (risk of explosion and cauterization).

- Do not attempt to recharge the batteries as this may cause leakage or explosion.

- Do not throw batteries into open flames.

- Do not dismantle batteries.

Safety instructions for electric drives and controls

- When replacing the battery/batteries, do not damage the electrical parts installed in the devices.
- Only use the battery types specified for the product.

☞   Environmental protection and disposal! The batteries contained in the product are considered dangerous goods during land, air, and sea transport (risk of explosion) in the sense of the legal regulations. Dispose of used batteries separately from other waste. Observe the national regulations of your country.

3.3.8 Protection against pressurized systems

According to the information given in the Project Planning Manuals, motors and components cooled with liquids and compressed air can be partially supplied with externally fed, pressurized media, such as compressed air, hydraulics oil, cooling liquids and cooling lubricants. Improper handling of the connected supply systems, supply lines or connections can cause injuries or property damage.

Risk of injury by improper handling of pressurized lines!

- Do not attempt to disconnect, open or cut pressurized lines (risk of explosion).
- Observe the respective manufacturer's operating instructions.
- Before dismounting lines, relieve pressure and empty medium.
- Use suitable protective equipment (safety goggles, safety shoes, safety gloves, for example).
- Immediately clean up any spilled liquids from the floor due to the risk of falling!

☞   Environmental protection and disposal! The agents (e.g., fluids) used to operate the product might not be environmentally friendly. Dispose of agents harmful to the environment separately from other waste. Observe the national regulations of your country.

Safety instructions for electric drives and controls

3.4   Explanation of signal words and the Safety alert symbol

The Safety Instructions in the available application documentation contain specific signal words (DANGER, WARNING, CAUTION or NOTICE) and, where required, a safety alert symbol (in accordance with ANSI Z535.6-2011).

The signal word is meant to draw the reader's attention to the safety instruction and identifies the hazard severity.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words DANGER, WARNING and CAUTION, is used to alert the reader to personal injury hazards.

⚠ DANGER

In case of non-compliance with this safety instruction, death or serious injury **will** occur.

⚠ WARNING

In case of non-compliance with this safety instruction, death or serious injury **could** occur.

⚠ CAUTION

In case of non-compliance with this safety instruction, minor or moderate injury could occur.

NOTICE

In case of non-compliance with this safety instruction, property damage could occur.

4 System overview

4.1 Introduction

4.1.1 Motivation and objectives

Overview

The operational safety of machines and installations depends largely upon the extent of dangerous movements generated by the machine.

In **normal operation** (also called productive operation or automatic operation), protective equipment prevents humans from accessing danger zones and keeps parts / materials from being thrown outward.

In the **special mode** (also called manual mode or setting-up mode), it is often necessary for persons to access danger zones when the entire installation has not been de-energized. In such situations machine operators must be protected by mechanisms internal to the drive and the control unit.

The integrated Rexroth safety technology provides the user the requirements, on the control unit and drive side, for realizing functions of personal and machine protection with a minimum of planning and installation work required. Compared to conventional safety technology, the integrated safety technology considerably increases the functionality and availability of your machine. Integrated safety technology is characterized by the following features:

- Complies with valid standards
- Increased system performance
- Reduced system costs
- Easy understanding of complex subjects
- Improved diagnostics
- Simplified certification
- Easy commissioning
- Independent of control units

Comparison with conventional safety technology

A drive and control system with integrated safety technology differs from systems with conventional safety technology by the fact that the safety functions are directly integrated in the intelligent drives in the form hardware and software. This increases the functionality in all operation modes with a maximum of safety (short reaction times).

The power contactor between controller and motor required for the conventional safety technology is not included in drive and control systems with the integrated safety technology "Safe Torque Off".

☞ The integrated safety technology is **not** intended to replace conventional safety technology, such as EMERGENCY STOP monitoring devices and safety door monitors.

Using the integrated safety technology increases the available personnel and machine safety, because the total reaction time of the system in the case of an error event, for example, is considerably reduced with regard to comparable systems with conventional safety technology. The safety signals are transmitted with conventional wiring.

System overview

4.1.2   Conceptual overview

An IndraDrive system consists of the components power section, control section (including the firmware), motor and the possibly required additional components.

The integrated safety technology is implemented based on the interaction of the hardware and firmware components.

☞ The figure below shows the **schematic diagram of IndraDrive controllers** with integrated safety technology "STO (Safe Torque Off) and SBC (Safe Brake Control)".

The special feature of the distributed servo drive KSM02 (IndraDrive Mi) is that the drive controller and the motor are one unit.

In contrast to the schematic diagram, **IndraDrive Mi, IndraDrive C IndraDrive M and IndraDrive ML do not feature the safe brake control** ("SBC")!
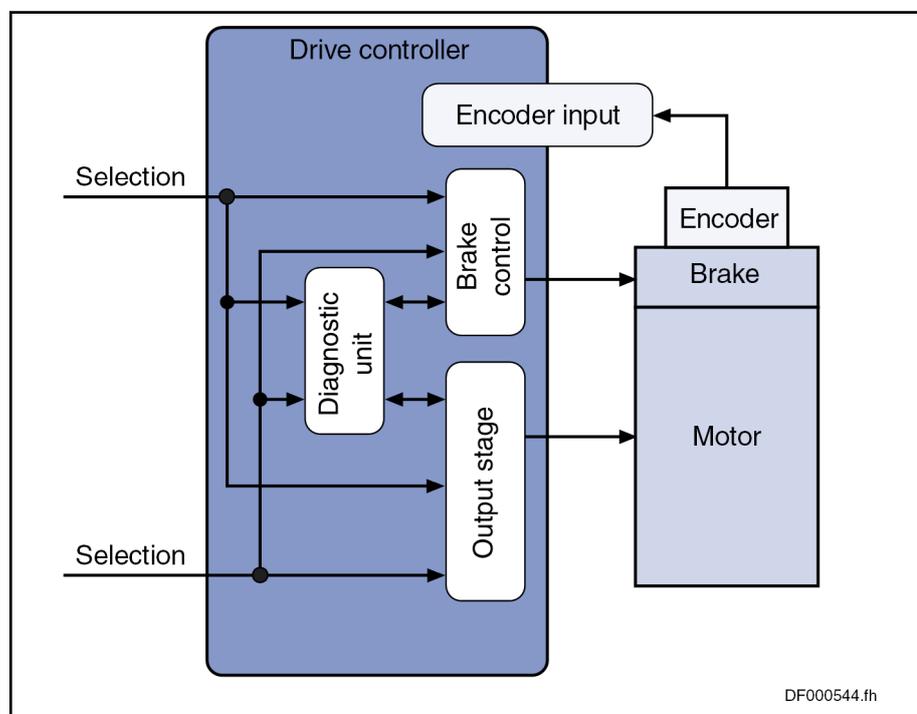
Fig. 4-1:   *Schematic diagram of IndraDrive with integrated safety technology "STO (Safe Torque Off) and SBC (Safe Brake Control)"*

☞ The safety functions "Safe Torque Off" and "Safe Brake Control" do not require any measuring system.

4.1.3   Risk assessment

Before a machine can be placed on the market, the manufacturer of the machine must carry out a risk assessment in accordance with the Machinery Directive 2006/42/EC in order to determine the hazards associated with the use of the machine.

The risk assessment is a multilevel, iterative process. The procedure is described in detail in "EN ISO 12100" - "General principles for design - Risk assessment and risk reduction". This documentation can only give you a very

short overview on the subject of risk assessment; users of integrated safety technology are obliged to intensively study the respective standards and legal status.

The risk assessment carried out provides you the requirements for determining the category for safety-related control units according to the valid C-standard the safety-relevant parts of the machine control have to comply with.

☞　　For more detailed information on the required Safety Integrity Levels (SIL) and Performance Levels (PL), please refer to the applied component- and machine-relevant standards in "Safety-relevant standards and regulations".

Procedure　To obtain the highest possible degree of safety, the machine manufacturer when choosing the solutions has to apply the following basic principles in the indicated order:

1. Eliminate or minimize the hazards by construction measures.

2. Take the required protective measures against hazards that cannot be eliminated.

3. Document the remaining risks and inform the user of these risks.

Simplification by use of integrated safety technology　When using integrated safety technology, the machine manufacturer will benefit from the following simplifications:

- The safety-related components of the **IndraDrive Cs** range with the **"L3" and "L4"** options are suited for **applications up to SIL3 of IEC 62061 or up to Category 4, PL e of ISO 13849**; i.e., the optional safety technology modules of the IndraDrive Cs range allow safety functions to be implemented that comply with SIL1, SIL2 or SIL3 of IEC 62061.

  The safety-related components of the **IndraDrive Mi** range with the **"L3"** option are suited for **applications up to SIL3 of IEC 62061 or up to Category 4, PL e of ISO 13849**; i.e., the optional safety technology modules of the IndraDrive Mi range allow safety functions to be implemented that comply with SIL1, SIL2 or SIL3 of IEC 62061.

  The safety-related components of the **IndraDrive C** and **IndraDrive M** ranges with the **"L3"** option are suited for **applications up to SIL3 of IEC 62061 or up to Category 4, PL e of ISO 13849**; i.e., the optional safety technology modules of the IndraDrive C and IndraDrive M ranges allow safety functions to be implemented that comply with SIL1, SIL2 or SIL3 of IEC 62061.

  The safety-related components of the **IndraDrive ML** range with the **"L3"** option are suited for **applications up to SIL3 of IEC 62061 or up to Category 4, PL e of ISO 13849**; i.e., the optional safety technology modules of the IndraDrive ML range allow safety functions to be implemented that comply with SIL1, SIL2 or SIL3 of IEC 62061.

- The safety functions integrated in IndraDrive Cs, IndraDrive Mi, IndraDrive C / IndraDrive M and IndraDrive ML[1] were certified by TÜV Rheinland®; this guarantees the user that the solution complies with the state-of-the-art / the conformity of the components in accordance with the Machinery Directive 2006/42/EC is ensured.

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[1]　The certification for IndraDrive ML is in preparation

System overview

Safety Integrity Level (SIL): relation between the SILs of IEC 62061 and the Performance Level (PL) of EN ISO 13849-1

Performance Level (PL)	Average probability of dangerous failure [1/h] (PFH)	Safety Integrity Level (SIL)	Risk
a	$\geq 10^{-5}...< 10^{-4}$	-	
b	$\geq 3*10^{-6}...< 10^{-5}$	1	low
c	$\geq 10^{-6}...< 3*10^{-6}$	1	
d	$\geq 10^{-7}...< 10^{-6}$	2	high
e	$\geq 10^{-8}...< 10^{-7}$	3	

Tab. 4-1:   Safety Integrity Level: failure limit values for a safety function of a PDS(SR)

4.2   Product presentation

4.2.1   What is "Integrated Safety Technology"?

IndraDrive Cs   The control sections of the IndraDrive Cs range can be equipped with the optional modules "L3" [STO (Safe Torque Off)] or "L4" [STO (Safe Torque Off) and SBC (Safe Brake Control)].

The mentioned optional modules equip IndraDrive Cs with integrated safety technology which provides the user with safe torque off and, if using the optional module "L4", additionally with the safe control of a brake.

IndraDrive Mi   The IndraDrive Mi systems with the distributed servo drive KSM02 and the distributed drive controllers KMS02/KMS03 can be equipped with the optional module "L3" [STO (Safe Torque Off)].

The optional module "L3" equips IndraDrive Mi with integrated safety technology that provides the user with Safe Torque Off.

IndraDrive M / IndraDrive C   The Cxx02 control sections of the IndraDrive M / IndraDrive C range can be equipped with the optional module "L3" [STO (Safe Torque Off)].

The optional module "L3" equips IndraDrive M / IndraDrive C with integrated safety technology that provides the user with Safe Torque Off.

IndraDrive ML   The Cxx02.5 control sections of the IndraDrive ML range can be equipped with the optional module "L3" [STO (Safe Torque Off)].

The optional module "L3" equips IndraDrive ML with integrated safety technology that provides the user with Safe Torque Off.

Definition
- "Safe Torque Off" means application-related safety functions which are applicable for personal protection at machines according to ISO 13849-1 Category 4, PL e and IEC 62061 SIL 3.
- "Safe Brake Control" means application-related safety functions which are applicable for personal protection at machines according to ISO 13849-1 Category 4, PL e and IEC 62061 SIL 3.

Selecting the function   The safety functions are selected via 24 V inputs at the drive controller.

Certification   The safety technology was certified by TÜV Rheinland ®. The NRTL listing by TÜV Rheinland of North America is available for HCS01; the other series are in preparation.

Certificates are available on the Internet/Extranet.

System overview

Requirements that can be realized
The integrated safety technology is independent of the type of master communication, the higher-level control unit and the supply modules. It is available as a functional characteristic of the standard drive system. The following requirements can be implemented in the machine or in the installation:

- Measures in accordance with ISO 12100-2, if accessing the danger zone is required, for example, for equipping, teaching or material withdrawal.

- Requirements for safety-related parts of control units according to ISO 13849-1 Category 4, PL e and IEC 62061 SIL 3, as required in EN 1010-1 (printing and paper converting machines), EN 12415 (turning machines) and EN 12417 (machining centres).

- Control functions in the case of an error according to IEC 60204-1 ("homogeneous redundancy").

4.2.2 Integrated safety technology as IndraDrive platform solution

Characteristics of IndraDrive Cs

The type code below shows the different characteristics of IndraDrive Cs:

Short type designation	1	2	3	4	5	6	7	8	9	1 0	1	2	3	4	5	6	7	8	9	2 0	1	2	3	4	5	6	7	8	9	3 0	1	2	3	4	5	6	7	8	9	4 0
Example:	H	C	S	0	1	.	1	E	-	W	0	0	1	3	-	A	-	0	2	-	E	-	S	3	-	E	C	-	N	N	-	N	N	-	N	N	-	F	W		
		①		②			③④		⑤		⑥				⑦		⑧			⑨		⑩			⑪			⑫			⑬			⑭			⑮				

①	Product:
	HCS = HCS

②	Series:
	01 = 01

③	Design:
	1 = 1

④	Power supply unit:
	E = Feeding

⑤	Cooling type:
	W = Air, internal

⑥	Maximum current [1]:
	0003 = 3 A
	0005 = 5 A
	0006 = 6 A
	0008 = 8 A
	0009 = 9 A
	0013 = 13 A
	0018 = 18 A
	0028 = 28 A
	0054 = 54 A

⑦	Degree of protection:
	A = IP20

System overview

Short type designation	1	2	3	4	5	6	7	8	9	1 0	1	2	3	4	5	6	7	8	9	2 0	1	2	3	4	5	6	7	8	9	3 0	1	2	3	4	5	6	7	8	9	4 0
Example:	H	C	S	0	1	.	1	E	-	W	0	0	1	3	-	A	-	0	2	-	E	-	S	3	-	E	C	-	N	N	-	N	N	-	N	N	-	F	W	
		①		②			③④		⑤			⑥				⑦		⑧			⑨		⑩			⑪			⑫			⑬				⑭			⑮	

⑧	Mains connection voltage [1]: 02 = 3 × AC 110 … 230 V 03 = 3 × AC 200 … 500 V
⑨	Control section design [2]: A = ADVANCED B = BASIC E = ECONOMY
⑩	Communication [2]: S3 = sercos 3 / EtherCAT CC = sercos 3 master (cross communication) ET = Multi-Ethernet
⑪	Interface 1: EC = Multi-encoder interface
⑫	Interface 2 [2]: CN = CANopen DA = Digital/analog I/O extension EC = Multi-encoder interface EP = Engineering port EM = Encoder emulation ET = Multi-Ethernet NN = Not equipped PB = PROFIBUS
⑬	Interface 3 [2] [3]: L3 = STO (Safe Torque Off) L4 = STO (Safe Torque Off) and SBC NN = Not equipped S4 = Safe Motion S5 = Safe Motion SB = Safe Motion Bus
⑭	Other design: NN = None
⑮	Firmware: FW = With control panel, firmware has to be ordered separately NW = Without control panel, without firmware

[1] See table "Possible combinations of maximum current and mains connection voltage"

[2] See table "Possible combinations of options"

3)   The L3, S4, S5 and SB interfaces guarantee both the function and the certification

Tab. 4-2:   Type code HCS01

Possible combinations of maximum current and mains connection voltage:

Mains connection voltage [V]	Maximum current [A]								
	3	5	6	8	9	13	18	28	54
3 × AC 110 … 230	✓	–	✓	–	✓	✓	✓	–	–
3 × AC 200 … 500	–	✓	–	✓	–	–	✓	✓	✓

Tab. 4-3:   Possible combinations of maximum current and mains connection voltage

Possible combinations of options:

Control section design	Communication	Interface 2								Interface 3					
		CN	DA	EC	EM	EP	ET	NN	PB	L3	L4	NN	S4	S5	SB
A	CC	✓	–	✓	✓	–	✓	✓	✓	✓	✓	✓	✓	✓	✓
		–	✓	–	–	–	–	–	–	–	–	✓	–	–	–
	ET	–	–	✓	✓	–	–	✓	–	✓	✓	✓	✓	✓	✓
		–	✓	–	–	–	–	–	–	–	–	✓	–	–	–
B	ET	✓	–	✓	✓	–	–	✓	✓	✓	✓	✓	✓	✓	✓
		–	✓	–	–	–	–	–	–	–	–	✓	–	–	–
		–	–	–	–	✓	–	–	–	✓	✓	✓	–	–	–
E	S3	–	–	–	–	✓	–	✓	–	✓	✓	✓	–	–	–

Tab. 4-4:   Possible combinations of options

☞   To employ the integrated safety technology, it is necessary to use at least the following firmware version or higher in the drive:

- "Safe Torque Off" (L3):

  IndraDrive Cs (HCS01.1): MPx-17V06 and above

- "Safe Torque Off" **and** "Safe Brake Control" (L4):

  IndraDrive Cs (HCS01.1): MPx-16V14 and above

Characteristics of IndraDrive Mi

The type codes below allow the devices of the "IndraDrive Mi" range to be identified and show their properties:

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	K	C	U	0	2	.	2	N	-	E	T	-	E	T	*	-	0	2	5	-	N	N	-	N	-	N	N	-	N	W										
		①		②		③④			⑤				⑥					⑦				⑧			⑨			⑩			⑪									

①	Product: KCU = KCU
②	Series: 02 = 2

System overview

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	K	C	U	0	2	.	2	N	-	E	T	-	E	T	*	-	0	2	5	-	N	N	-	N	-	N	N	-	N	W										
		①		②			③④			⑤				⑥				⑦				⑧		⑨		⑩			⑪											

③	**Design:** 2 = 2
④	**Configuration option:** N = Fixed configuration
⑤	**Master communication (input):** ET = Multi-Ethernet
⑥	**Master communication (output):** ET* = Multi-Ethernet
⑦	**DC fuse:** 025 = Nominal current: 25 A
⑧	**Interface:** NN = None
⑨	**Control panel:** N = Without
⑩	**Other design:** NN = None
⑪	**Firmware:** NW = Without firmware

Tab. 4-5:   Type code KCU02.2

☞ To employ the integrated safety technology "Safe Torque Off" (L3), it is necessary to use at least the design "2" or higher of the drive connection box:

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	K	M	S	0	2	.	1	B	-	A	0	1	8	-	P	-	D	7	-	E	T	-	E	N	H	-	L	3	-	T	O	-	F	W						
		①		②			③④			⑤		⑥				⑦			⑧				⑨				⑩				⑪			⑫			⑬			

①	**Product:** KMS = KMS
②	**Series:** 02 = 2
③	**Design:** 1 = 1
④	**Performance:** B = Basic

System overview

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	K	M	S	0	2	.	1	B	-	A	0	1	8	-	P	-	D	7	-	E	T	-	E	N	H	-	L	3	-	T	O	-	F	W						
		①			②			③④		⑤		⑥			⑦		⑧			⑨			⑩				⑪			⑫			⑬							

⑤	Cooling type: A = Natural convection (exterior heat sink)
⑥	Maximum current: 018 = 18 A
⑦	Degree of protection: P = IP65
⑧	Nominal DC bus voltage: D7 = DC 750 V
⑨	Master communication: ET = Multi-Ethernet
⑩	Encoder interface: ENH = Encoder Hiperface NNN = Without
⑪	Safety option: L3 = Safe Torque Off (STO) S3 = Safe Motion (without SBC) [1] SD = Safe Motion (with SBC) [1] NN = Without
⑫	Other design: NN = Without TO = Multi-Ethernet output coupling (2 × M12) ES = External master communication Multi-Ethernet (2 × M12)
⑬	Firmware: FW = Firmware has to be ordered as a separate subposition

[1]   Only if encoder interface = ENH

Tab. 4-6:   Type code KMS02

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	K	M	S	0	3	.	1	B	-	A	0	3	6	-	P	-	D	7	-	E	T	-	E	N	D	-	L	3	-	T	O	-	F	W						
		①			②			③④		⑤		⑥			⑦		⑧			⑨			⑩				⑪			⑫			⑬							

①	Product: KMS = KMS
②	Series: 03 = 3
③	Design: 1 = 1

System overview

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	K	M	S	0	3	.	1	B	-	A	0	3	6	-	P	-	D	7	-	E	T	-	E	N	D	-	L	3	-	T	O	-	F	W						
		①		②			③④			⑤		⑥			⑦		⑧			⑨				⑩				⑪			⑫			⑬						

④	Performance:
	B = Basic

⑤	Cooling type:
	A = Natural convection (exterior heat sink)
	B = Thermal interface

⑥	Maximum current:
	036 = 36 A

⑦	Degree of protection:
	P = IP65

⑧	Nominal DC bus voltage:
	D7 = DC 750 V

⑨	Master communication:
	ET = Multi-Ethernet

⑩	Encoder interface:
	END = Encoder Hiperface® and digital encoder

⑪	Safety option:
	L3 = Safe Torque Off (STO)
	SD = Safe Motion (with SBC) [1]
	NN = Without

⑫	Other design:
	ES = External master communication Multi-Ethernet (2 × M12)
	NN = Without
	TO = Multi-Ethernet output coupling (2 × M12)

⑬	Firmware:
	FW = Firmware has to be ordered as a separate subposition

[1]   Only if encoder interface = END

Tab. 4-7:   Type code KMS03

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	K	S	M	0	2	.	1	B	-	0	6	1	C	-	3	5	N	-	M	1	-	H	P	0	-	E	T	-	N	N	-	D	7	-	N	N	-	F	W	
		①		②			③④			⑤			⑥			⑦		⑧			⑨			⑩⑪⑫				⑬			⑭				⑮			⑯		⑰

①	Product:
	KSM = KSM

②	Series:
	02 = 2

System overview

Short type designation	1	2	3	4	5	6	7	8	9	1 0	1	2	3	4	5	6	7	8	9	2 0	1	2	3	4	5	6	7	8	9	3 0	1	2	3	4	5	6	7	8	9	4 0
Example:	K	S	M	0	2	.	1	B	-	0	6	1	C	-	3	5	N	-	M	1	-	H	P	0	-	E	T	-	N	N	-	D	7	-	N	N	-	F	W	
		①		②			③④				⑤				⑥				⑦	⑧			⑨			⑩⑪⑫			⑬				⑭			⑮			⑯		⑰

③	**Design:** 1 = 1
④	**Performance:** B = Basic
⑤	**Size:** 041 = Size 041 061 = Size 061 071 = Size 071 076 = Size 076
⑥	**Length:** C = Length C
⑦	**Winding:** 24 = Winding 24 35 = Winding 35 42 = Winding 42 61 = Winding 61
⑧	**Cooling type:** N = Natural convection
⑨	**Encoder:** S1 = Optical encoder, Hiperface single-turn, 128 signal periods S3 = Capacitive encoder, Hiperface single-turn, 16 signal periods M1 = Optical encoder, Hiperface multi-turn absolute, 128 signal periods M3 = Capacitive encoder, Hiperface multi-turn absolute, 16 signal periods
⑩	**Electrical connection:** H = Connector, hybrid
⑪	**Shaft:** G = Plain shaft with shaft sealing ring P = Shaft with keyway according to DIN 6885-1 with shaft sealing ring
⑫	**Holding brake:** 0 = Without holding brake 2 = Holding brake, DC 24 V, electrically releasing
⑬	**Master communication:** ET = Multi-Ethernet

System overview

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	K	S	M	0	2	.	1	B	-	0	6	1	C	-	3	5	N	-	M	1	-	H	P	0	-	E	T	-	N	N	-	D	7	-	N	N	-	F	W	
	①		②			③	④		⑤			⑥		⑦		⑧		⑨			⑩	⑪	⑫		⑬			⑭			⑮			⑯			⑰			

⑭	**Safety option:** L3 = Safe Torque Off (STO) NN = Without safety technology S3 = Safe Motion (without SBC) SD = Safe Motion (with SBC)
⑮	**Supply voltage:** D7 = DC 750 V
⑯	**Other design:** AE = ATEX version, external master communication Multi-Ethernet (2 × M12) AN = ATEX version AT = ATEX version, Multi-Ethernet output coupling (2 × M12) ES = External master communication Multi-Ethernet (2 × M12) NN = None TO = Multi-Ethernet output coupling (2 × M12)
⑰	**Firmware:** FW = Firmware has to be ordered as a separate subposition

Tab. 4-8:   KSM02 type code

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	K	M	V	0	3	.	1	R	-	B	0	0	0	7	-	P	-	D	7	-	E	T	-	N	N	N	N	-	F	W										
	①		②			③	④		⑤			⑥				⑦		⑧			⑨			⑩				⑪												

①	**Product:** KMV = Supply module
②	**Series:** 03 = 3
③	**Design:** 1 = 1
④	**Power supply unit:** R = Regenerative
⑤	**Cooling type:** A = Natural convection (exterior heat sink) B = Thermal interface (cold plate mounting) I = Thermal interface (insulated mounting) W = Forced cooling (exterior heat sink, mounted fan)

Short type designation	1	2	3	4	5	6	7	8	9	1 0	1	2	3	4	5	6	7	8	9	2 0	1	2	3	4	5	6	7	8	9	3 0	1	2	3	4	5	6	7	8	9	4 0
Example:	K	M	V	0	3	.	1	R	-	B	0	0	0	7	-	P	-	D	7	-	E	T	-	N	N	N	N	-	F	W										
		①		②			③④			⑤			⑥				⑦		⑧			⑨				⑩				⑪										

⑥	**Rated power:** 0007 = 7.5 kW [1] 01K5 = 1.5 kW [2] 05K0 = 5 kW [3] 06K0 = 6 kW [4]
⑦	**Degree of protection:** P = IP65
⑧	**Nominal DC bus voltage:** D7 = DC 750 V
⑨	**Master communication:** ET = Multi-Ethernet
⑩	**Other design:** NNNN = None
⑪	**Firmware:** FW = Firmware has to be ordered as a separate subposition

[1] Rated power "0007" only with cooling type "B"
[2] Rated power "01K5" only with cooling type "I"
[3] Rated power "05K0" only with cooling type "A"
[4] Rated power "06K0" only with cooling type "W"

Tab. 4-9: *KMV03 type code*

☞ To employ the integrated safety technology "Safe Torque Off" (L3), it is necessary to use at least the following firmware version or higher in the drive:

- IndraDrive Mi (KSM02.x): MPB-17V08 and above
- IndraDrive Mi (KMS02.x): MPB-17V10 and above
- IndraDrive Mi (KMS03.x): MPB-20V02 and above

Characteristics of IndraDrive M / IndraDrive C

The type codes below show the different characteristics of the control sections of IndraDrive C / IndraDrive M:

System overview

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	C	S	B	0	2	.	1	B	-	E	T	-	E	C	-	P	B	-	L	3	-	E	C	-	N	N	-	F	W											
		①		②			③④			⑤			⑥			⑦			⑧			⑨			⑩			⑪												

①	**Product:** CSB = Single-axis control section BASIC	
②	**Series:** 02 = 02	
③	**Design:** 1 = 1	
④	**Interface equipment:** A = Basic scope B = Extended scope	
⑤	**Communication:** ET = Multi-Ethernet	
⑥	**Interface 1:** EC = Multi-encoder interface	
⑦	**Interface 2:** NN = Not equipped PB = PROFIBUS CN = CANopen EC = Multi-encoder interface EM = Encoder emulation EP = Engineering port	
⑧	**Interface 3 (safety technology) [2]:** NN = Not equipped L3 = STO (Safe Torque Off) S4 = Safe Motion [2] S5 = Safe Motion [2] SB = Safe Motion Bus [2]	
⑨	**Interface 4:** NN = Not equipped EC = Multi-encoder interface [3] EM = Encoder emulation [4] DA = Digital/analog I/O extension [2]	

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	C	S	B	0	2	.	1	B	-	E	T	-	E	C	-	P	B	-	L	3	-	E	C	-	N	N	-	F	W											
		①		②			③④			⑤			⑥			⑦			⑧			⑨			⑩			⑪												

⑩	**Other design:**
	NN = None
⑪	**Firmware:**
	AW = With Advanced control panel, firmware has to be ordered separately
	FW = With Standard control panel, firmware has to be ordered separately
	NW = Without control panel, without firmware

1) The L3, S4, S5 and SB interfaces guarantee both the function and the certification
2) Only if interface equipment = B
3) Only if interface equipment = B and interface 2 = PB, CN or EP
4) Only if interface equipment = B and interface 2 = PB, CN, EP or EC

Tab. 4-10:   CSB02.1 type code

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	C	S	E	0	2	.	1	A	-	S	3	-	E	C	-	N	N	-	L	3	-	N	N	-	F	W														
		①		②			③④			⑤			⑥			⑦			⑧			⑨			⑩														

①	**Product:**
	CSE = Single-axis control section ECONOMY
②	**Series:**
	02 = 02
③	**Design:**
	1 = 1
④	**Interface equipment:**
	A = Basic scope
⑤	**Communication:**
	S3 = Sercos, EtherCAT
⑥	**Interface 1:**
	EC = Multi-encoder interface
⑦	**Interface 2:**
	NN = Not equipped
	EP = Engineering port
⑧	**Interface 3 (safety technology) 1):**
	NN = Not equipped
	L3 = STO (Safe Torque Off)

System overview

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	C	S	E	0	2	.	1	A	-	S	3	-	E	C	-	N	N	-	L	3	-	N	N	-	F	W														
		①			②			③④			⑤			⑥			⑦			⑧			⑨			⑩														

⑨	Other design:
	NN = None

⑩	Firmware:
	AW = With Advanced control panel, firmware has to be ordered separately
	FW = With Standard control panel, firmware has to be ordered separately
	NW = Without control panel, without firmware

1)   The L3 interface guarantees both the function and the certification

Tab. 4-11:   CSE02 type code

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	C	S	H	0	2	.	1	B	-	C	C	-	E	C	-	E	T	-	N	N	-	D	A	-	N	N	-	F	W											
		①			②			③④			⑤			⑥			⑦			⑧			⑨			⑩			⑪											

①	Product:
	CSH = Single-axis control section ADVANCED

②	Series:
	02 = 02

③	Design:
	1 = 1

④	Interface equipment:
	B = Extended scope

⑤	Communication:
	CC = sercos III master
	ET = Multi-Ethernet

⑥	Interface 1:
	EC = Multi-encoder interface

⑦	Interface 2:
	NN = Not equipped
	ET = Multi-Ethernet [1]
	PB = PROFIBUS [1]
	CN = CANopen [1]
	EC = Multi-encoder interface
	EM = Encoder emulation

System overview

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	C	S	H	0	2	.	1	B	-	C	C	-	E	C	-	E	T	-	N	N	-	D	A	-	N	N	-	F	W											
		①		②			③④			⑤			⑥			⑦			⑧			⑨			⑩			⑪												

⑧	Interface 3 (safety technology) [2]:
	NN = Not equipped
	L3 = STO (Safe Torque Off)
	S4 = Safe Motion
	S5 = Safe Motion
	SB = Safe Motion Bus
⑨	Interface 4:
	NN = Not equipped
	EC = Multi-encoder interface [3]
	EM = Encoder emulation [3]
	DA = Digital/analog I/O extension
⑩	Other design:
	NN = None
⑪	Firmware:
	FW = Firmware must be ordered as a separate subposition

1)   Only if communication = CC
2)   The L3, S4, S5 and SB interfaces guarantee both the function and the certification
3)   Only if interface 2 = ET, PB, CN or EC

Tab. 4-12:   CSH02.1 type code

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	C	D	B	0	2	.	1	B	-	E	T	-	E	C	-	E	C	-	E	M	-	L	3	-	L	3	-	E	M	-	N	N	-	F	W					
		①		②			③④			⑤			⑥			⑦			⑧			⑨			⑩			⑪			⑫			⑬						

①	Product:
	CDB = Double-axis control section BASIC
②	Series:
	02 = 02
③	Design:
	1 = 1
④	Interface equipment:
	B = Extended scope
⑤	Communication:
	ET = Multi-Ethernet
⑥	Interface 1 (axis 1):
	EC = Multi-encoder interface

System overview

Short type designation	1	2	3	4	5	6	7	8	9	1 0	1	2	3	4	5	6	7	8	9	2 0	1	2	3	4	5	6	7	8	9	3 0	1	2	3	4	5	6	7	8	9	4 0
Example:	C	D	B	0	2	.	1	B	-	E	T	-	E	C	-	E	C	-	E	M	-	L	3	-	L	3	-	E	M	-	N	N	-	F	W					
		①		②		③④			⑤			⑥			⑦			⑧			⑨			⑩			⑪			⑫			⑬							

⑦	**Interface 2 (axis 2):** EC = Multi-encoder interface
⑧	**Interface 3:** NN = Not equipped PB = PROFIBUS EC = Multi-encoder interface EM = Encoder emulation
⑨	**Interface 4 (safety technology axis 1) [1]:** NN = Not equipped L3 = STO (Safe Torque Off) S4 = Safe Motion S5 = Safe Motion SB = Safe Motion Bus
⑩	**Interface 5 (safety technology axis 2) [1]:** NN = Not equipped [2] L3 = STO (Safe Torque Off) [3] S4 = Safe Motion [4] S5 = Safe Motion [5] SB = Safe Motion Bus [6]
⑪	**Interface 6:** NN = Not equipped EC = Multi-encoder interface [7] EM = Encoder emulation [8] DA = Digital/analog I/O extension
⑫	**Other design:** NN = None
⑬	**Firmware:** AW = With Advanced control panel, firmware has to be ordered separately FW = With Standard control panel, firmware has to be ordered separately

[1]	The L3, S4, S5 and SB interfaces guarantee both the function and the certification
[2]	Only if interface 4 = NN
[3]	Only if interface 4 = L3
[4]	Only if interface 4 = S4
[5]	Only if interface 4 = S5
[6]	Only if interface 4 = SB
[7]	Only if interface 3 = PB or EC
[8]	Only if interface 3 = PB, EC or EM

Tab. 4-13:   CDB02 type code

☞ To employ the integrated safety technology "Safe Torque Off" (L3), it is necessary to use at least the following firmware version or higher in the drive:

- IndraDrive C (Cxx02.x control sections): MPx-18V06 and above
- IndraDrive M (Cxx02.x control sections): MPx-18V06 and above

Characteristics of IndraDrive ML

The type codes below show the different characteristics of the control sections of IndraDrive ML:

Short type designation	1	2	3	4	5	6	7	8	9	1 0	1	2	3	4	5	6	7	8	9	2 0	1	2	3	4	5	6	7	8	9	3 0	1	2	3	4	5	6	7	8	9	4 0
Example:	C	S	B	0	2	.	5	B	-	E	T	-	E	C	-	P	B	-	L	3	-	E	C	-	N	N	-	F	W												
		①		②			③④			⑤			⑥			⑦			⑧			⑨			⑩			⑪													

①	**Product:**
	CSB = Single-axis control section BASIC

②	**Series:**
	02 = 02

③	**Design:**
	5 = For Hxx05

④	**Interface equipment:**
	B = Extended scope

⑤	**Communication:**
	ET = Multi-Ethernet

⑥	**Interface 1:**
	EC = Multi-encoder interface

⑦	**Interface 2:**
	NN = Not equipped
	PB = PROFIBUS
	CN = CANopen
	EC = Multi-encoder interface
	EM = Encoder emulation
	EP = Engineering port

⑧	**Interface 3 (safety technology)** [1]**:**
	NN = Not equipped
	L3 = STO (Safe Torque Off)
	S4 = Safe Motion
	S5 = Safe Motion
	SB = Safe Motion Bus

System overview

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	C	S	B	0	2	.	5	B	-	E	T	-	E	C	-	P	B	-	L	3	-	E	C	-	N	N	-	F	W											
		①		②			③④			⑤			⑥			⑦			⑧			⑨			⑩			⑪												

⑨	**Interface 4:**
	NN = Not equipped
	EC = Multi-encoder interface [2]
	EM = Encoder emulation [3]
	DA = Digital/analog I/O extension
⑩	**Other design:**
	NN = None
⑪	**Firmware:**
	FW = Firmware has to be ordered as a separate subposition
	NW = Without control panel, without firmware

1) The L3, S4, S5 and SB interfaces guarantee both the function and the certification
2) Only if interface 2 = PB or CN
3) Only if interface 2 = PB, CN or EC

Tab. 4-14:   CSB02.5 type code

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	C	S	H	0	2	.	5	B	-	C	C	-	E	C	-	E	T	-	N	N	-	D	A	-	N	N	-	F	W											
		①		②			③④			⑤			⑥			⑦			⑧			⑨			⑩			⑪												

①	**Product:**
	CSH = Single-axis control section ADVANCED
②	**Series:**
	02 = 02
③	**Design:**
	5 = For Hxx05
④	**Interface equipment:**
	B = Extended scope
⑤	**Communication:**
	CC = sercos III master
	ET = Multi-Ethernet
⑥	**Interface 1:**
	EC = Multi-encoder interface

System overview

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	C	S	H	0	2	.	5	B	-	C	C	-	E	C	-	E	T	-	N	N	-	D	A	-	N	N	-	F	W											
		①		②			③④			⑤			⑥			⑦			⑧			⑨			⑩			⑪												

⑦	**Interface 2:** NN = Not equipped ET = Multi-Ethernet [1] PB = PROFIBUS [1] CN = CANopen [1] EC = Multi-encoder interface EM = Encoder emulation
⑧	**Interface 3 (safety technology) [2]:** NN = Not equipped L3 = STO (Safe Torque Off) S4 = Safe Motion S5 = Safe Motion SB = Safe Motion Bus
⑨	**Interface 4:** NN = Not equipped EC = Multi-encoder interface [3] EM = Encoder emulation [3] DA = Digital/analog I/O extension
⑩	**Other design:** NN = None
⑪	**Firmware:** FW = Firmware must be ordered as a separate subposition NW = Without control panel, without firmware

1) Only if communication = CC
2) The L3, S4, S5 and SB interfaces guarantee both the function and the certification
3) Only if interface 2 = ET, PB, CN or EC

Tab. 4-15:   CSH02.5 type code

☞ To employ the integrated safety technology "Safe Torque Off" (L3), it is necessary to use at least the following firmware version or higher in the drive:

- IndraDrive ML, CSB02.5 control sections: MPB-19 and above
- IndraDrive ML, CSH02.5 control sections: MPH-19 and above

System overview

4.3   Safety-relevant standards and regulations

4.3.1   General information

> ☞   Standard documents and sheets are subject to copyright protection and Bosch Rexroth must not pass them on. If required, contact the authorized sales agencies; in Germany directly contact Beuth Verlag GmbH (http://www.beuth.de).

Below the user will find a short overview of the relevant standards for the use of safety-related control units. The overview does not claim completeness; besides, only the safety-relevant standards and regulations for functional safety are taken into consideration.

4.3.2   Standards relevant to components

Product group	Standard	Title
Electric drives	IEC 61800-5-2	Adjustable speed electrical power drive systems, Part 5-2: Safety requirements - Functional
Complex controls	IEC 61508-1 to IEC 61508-7	Functional safety of electrical/electronic/programmable electronic safety-related systems

Tab. 4-16:   Standards relevant to components

4.3.3   Standards relevant to machinery

Standard	Title
ISO 12100	Safety of machinery - General principles for design - Risk assessment and risk reduction
IEC 60204-1	Safety of machinery - Electrical equipment of machines
IEC 62061	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
ISO 13849-1 ISO 13849-2	Safety of machinery - Safety-related parts of control systems Part 1: General principles for design Part 2: Validation
ISO 13850	Safety of machinery - Emergency stop - Principles for design
EN 1037	Safety of machinery - Prevention of unexpected start-up
ISO 13855	Safety of machinery - The positioning of protective equipment in respect of approach speed of parts of the human body
ISO 14119	Safety of machinery - Interlocking devices associated with guards - Principles for design and selection
ISO 11161	Safety of machinery - Integrated manufacturing systems - Basic requirements
ISO 10218-1 ISO 10218-2	Robots and robotic devices - Safety requirements for industrial robots Part 1: Robots Part 2: Robot system and integration
EN 1010-1	Safety of machinery - Safety requirements for the design and construction of printing and paper converting machines, Part 1: Common requirements
EN 848-3	Safety of woodworking machines - One side moulding machines with rotating tools, Part 3: Numerically controlled (NC) boring and routing machines

Standard	Title
EN 415-1 to EN 415-8	Safety of packaging machines Part 1 to Part 8
EN 201	Plastics and rubber machines - Injection moulding machines - Safety requirements
EN 12415	Safety of machine tools - Small numerically controlled turning machines and turning centres
EN 12417	Machine tools - Safety - Machining centres
EN 13218	Machine tools - Safety - Stationary grinding machines

Tab. 4-17:   Standards relevant to machinery

4.3.4   EC Directives

Description	Title	Notes
Directive 2006/42/EC	Machinery Directive	Valid since 2009-12-29
Directive 2006/95/EC	Low-Voltage Directive	
Directive 2004/108/EC	EMC Directive	

Tab. 4-18:   EC Directives

4.4   Overview of functions and characteristics

4.4.1   Characteristics of integrated safety technology

Introduction

This documentation describes the characteristics "Safe Torque Off" [pure hardware solution (optional safety technology module "L3")] and "Safe Torque Off and Safe Brake Control" [pure hardware solution (optional safety technology module "L4")] of the integrated safety technology.

The "Safe Motion" characteristic is described in the documentation "Rexroth IndraDrive; Integrated Safety Technology "Safe Motion" (MPx-18 and above)".

Drive system with optional safety technology module "Safe Torque Off"

With the optional safety technology module "Safe Torque Off" ("L3"), the energy supply to the motor can be safely interrupted. The drive in this case cannot generate any torque/force and, as a consequence, it cannot generate any dangerous movements, either (Safe torque off function).

The optional safety technology module "Safe Torque Off" features two 24 V inputs for dual-channel selection and two outputs for dynamization.

Drive system with optional safety technology module "Safe Torque Off and Safe Brake Control"

By means of the optional safety technology module "Safe Torque Off and Safe Brake Control" ("L4"), the drive can be protected against accidental restart and thereby be kept in a safe state (Safe torque off function).

In addition, an electrically releasing brake can be safely activated (Safe brake control function).

"Safe Torque Off and Safe Brake Control" are always selected at the same time.

System overview

The optional safety technology module "Safe Torque Off and Safe Brake Control" features two 24 V inputs for dual-channel selection and two outputs for dynamization.

4.4.2 Supported safety technology functions

	Safe Torque Off	Safe Brake Control	Safe stop 1 (Emergency stop), only in conjunction with an external, time-delayed safety selection device
IndraDrive Cs (optional safety technology modules "L3" and "L4")	✓	✓ (only with optional safety technology module "L4")	✓
IndraDrive Mi (optional safety technology module "L3")	✓	–	✓
IndraDrive C and IndraDrive M (optional safety technology module "L3")	✓	–	✓
IndraDrive ML (optional safety technology module "L3")	✓	–	✓

Tab. 4-19: *Supported safety technology functions*

4.4.3 Performance

Time response and reaction times

The reaction times of integrated safety technology of the optional safety technology modules "L3" and "L4" are as follows:

	Selection of the safety functions, i.e. transition from normal operation ("bb/Ab")		Deselection of the safety functions, i.e. transition to normal operation ("bb/Ab")	
	STO "Safe Torque Off"	SBC "Safe Brake Control" (only with optional safety technology module "L4")	STO "Safe Torque Off"	SBC "Safe Brake Control" (only with optional safety technology module "L4")
IndraDrive Cs	Up to 18 ms	Up to 18 ms + clamping delay of the brake	20 ms	20 ms
IndraDrive Mi IndraDrive M / IndraDrive C	Up to 18 ms	-	20 ms	-
IndraDrive ML (with MPx-19VRS)	108 ms	-	120 ms	-
IndraDrive ML (MPx-20VRS and above) N	18 ms	-	20 ms	-
P[1]	108 ms		120 ms	

[1] "P"="parallel operation is possible"; please see the type code for whether a universal inverter is suited for parallel operation: HMU05.1N-xxxxx-xxxx-N-xx-xx-**P**xx-NNNN

Tab. 4-20: *Reaction times of integrated safety technology*

System overview

☞ The above-mentioned reaction times only apply to the safety functions. To determine the total reaction time of the system, take the following aspects, among other things, into account:

- When **selecting** the safety functions
  - Time until at least a single-channel selection greater than 1 ms exists
- When **deselecting** the safety functions
  - Time until an error-free dual-channel deselection exists
  - Reaction time of the drive system after the setting of drive enable (put motor under current, release brake)

4.5 Safety characteristics of the safety system

4.5.1 Introduction

IndraDrive Cs

For using the optional safety technology modules "L3" and "L4", the IndraDrive Cs system has been certified according to IEC 61508, IEC 61800-5-2, IEC 62061 and ISO 13849-1.

IndraDrive Mi

For using the optional safety technology module "L3", the IndraDrive Mi system has been certified according to IEC 61508, IEC 61800-5-2, IEC 62061 and ISO 13849-1.

IndraDrive C / IndraDrive M

For using the optional safety technology module "L3", the IndraDrive C / IndraDrive M system has been certified according to IEC 61508, IEC 61800-5-2, IEC 62061 and ISO 13849-1.

IndraDrive ML

For using the optional safety technology module "L3", the IndraDrive ML system has been certified according to IEC 61508, IEC 61800-5-2, IEC 62061 and ISO 13849-1.

IndraDrive Cs, IndraDrive Mi, IndraDrive C, IndraDrive M and IndraDrive ML

The risk assessment and risk reduction of a machine require assessing the safety functions of the individual components. The interaction of the components has to be taken into account, too. In addition to the systematic suitability, it is also necessary to determine the total PFH value for the machine or the machine part (e.g., a safety zone). The total PFH value allows assessing whether the required "Safety Integrity Levels" (SIL_r) or "Performance Levels" (PL_r) have been complied with. As regards the optional safety technology modules "L3" and "L4", the paragraph below shows how the PFH value can be determined for a drive system and how additional external components have to be integrated.

💡 The manufacturer-independent software wizard "SISTEMA" is suited for calculating the total PFH value.

You can procure SISTEMA libraries from our website.

For more information, please see the website of "Institute for Occupational Safety and Health (IFA)" [Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (IFA)]. There you can download the SISTEMA software free of charge.

Your advantages:

- Quickly calculating the Performance Level
- Easily and quickly accessing safety characteristics
- Safety characteristics for certified components

System overview

4.5.2   Optional safety technology modules "L3" / "L4"

Drives equipped with the optional safety technology modules "L3" or "L4" comply with the following "Safety Integrity Levels" (SIL) or "Performance Levels" (PL):

- Up to SIL3 according to IEC 62061
- Up to Category 4, PL e according to ISO 13849-1

☞   For the IndraDrive Mi system, there are the following "Safety Integrity Levels" (SIL) or "Performance Levels" (PL), depending on the drive connection box design that is used:

- KCU02.2 / KCU02.3 / KMV03.1: SIL3 according to EN 61508, IEC EN 62061 and IEC 61800-5-2
- KCU02.2: Category 3, PL e according to EN ISO 13849-1
- KCU02.3 / KMV03.1: Category 4, PL e according to EN ISO 13849-1

Depending on the SBC functions and device range used, there are the following safety characteristics:

Description	IndraDrive Cs HCS01.1	IndraDrive C/M Cxx02.1	IndraDrive Mi		IndraDrive ML Hxx05.1 N[3]	IndraDrive ML Hxx05.1 P[4]
			KMS/ KSM02.1	KMS03		
$PFH_{Lx\ option}$ (without SBC function)[1], [2]	0.5×10^{-9} 1/h	0.5×10^{-9} 1/h	0.5×10^{-9} 1/h	0.5×10^{-9} 1/h	1×10^{-9} 1/h	$(1 \times 10^{-9}$ 1/h$)$ + $[(N-1) \times 0.4]$ [N = 1, 2, 4, 8 (number of "HMU" devices)]
$PFH_{SBC\ function}$[1], [2]	1×10^{-9} 1/h	-	-		-	
Mission Time	175,200 h (20 years)					
"Proof Test" interval	175,200 h (20 years)					
$MTTF_{d/channel}$[1]	> 200 years					
DC_{avg}	> 99 %					

1)   The specified safety characteristics refer to an average ambient temperature of 40 °C (see also "Ambient and operating conditions" in the Project Planning Manuals).
2)   PFH value of an axis with "Safe Torque Off", not taking additional components (e.g., brake) into account. To determine the actual PFH value, see chapter "Calculating the PFH component of an axis".
3)   Parallel operation is not possible
4)   Parallel operation is possible

System overview

☞ For the IndraDrive Mi system with KMS02/KSM02/KMS03, the PFH value of the drive connection box/the distributed supply unit has to be taken into account within the safety zone in addition to the PFH values of the axis:

- KCU02.2/KCU02.3: $<1.5\times10^{-9}$ 1/h
- KMV03.1: $<2.0\times10^{-9}$ 1/h (2 % of SIL3)

☞ **"Mission Time" and "Proof Test" interval**

- The "Mission Time" of all components used has to be observed and complied with. After the "Mission Time" of a component has elapsed, the component has to be discarded or replaced. It is not allowed to continue operating the component!
- After the component was discarded ("Mission Time" has elapsed), it has to be ensured that the component cannot be reused (e.g., by disabling it).
- There is no specified "Proof Test" for the IndraDrive system. Therefore, the "Mission Time" cannot be reset by a "Proof Test".

4.5.3 Calculating the PFH component of an axis

To determine the required total PFH value of an axis, the PFH values of the individual components relevant to the safety function and (if required) of the brake have to be used for calculation. The figure below illustrates all the components relevant to the calculation:
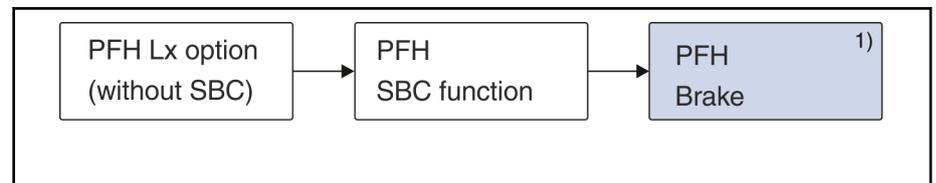
[1]   Use the value of the connected brake, if the safety function "SBC" is used.

Fig. 4-2:   *Safe Torque Off: Determining the PFH for an axis*

To calculate the PFH value of an axis, a valid PFH value has to be available for all components which have an influence on the safety function (if necessary, procure the PFH value from the component manufacturer).

$$PFH_{Axis} = PFH_{Lx\_option} + PFH_{SBC\_function} + PFH_{Brake}$$

Fig. 4-3:   *Safe Torque Off: Formula to calculate PFH for an axis*

The following conditions/restrictions apply to the general use of the formula for PFH calculation for an axis:

System overview

Variable	Value	Description
$PFH_{Lx\ option}$	See "Optional safety technology modules "Lx""	This value is **independent** of the safety functions used and thereby independent of the safety level to be achieved.
$PFH_{SBC\ function}$	See "Optional safety technology modules "Lx""	Enter "0" for this variable, if the safety function "SBC" is not used.
PFH_{Brake}[1]	See manufacturer's specification (when using Rexroth motors, see "Required motors and measuring systems")	Use the value of the connected brake, if the safety function "SBC" is used. If the safety function "SBC" is not used, enter "0" for this variable.

[1] $PFH = \lambda_D$

Tab. 4-21:   Variable description to calculate PFH for an axis

4.5.4   Calculating the total PFH value of a safety zone

To determine the required total PFH value of an installation or a safety zone, the PFH values of the individual axes and of the required external components have to be used for calculation as follows. The figure below illustrates all the components relevant to the calculation:
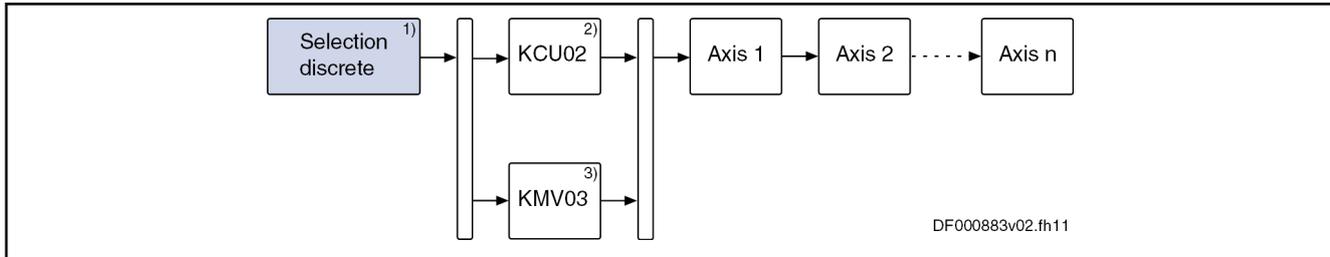
[1]   External component
[2]   Only for IndraDrive Mi with optional safety technology module
[3]   Only for IndraDrive Mi with optional safety technology module

Fig. 4-4:   Determining the PFH for a safety zone

To calculate the PFH value of a safety zone, a valid PFH value has to be available for all components which have an influence on the safety function (if necessary, procure the PFH value from the component manufacturer).

$$PFH_{SafetyZone} = PFH_{Selection\_discrete}{}^{[1]} + PFH_{KCU02}{}^{[2]} + PFH_{KMV03}{}^{[3]} + PFH_{Axis\_1} + PFH_{Axis\_2} + \ldots + PFH_{Axis\_n}$$

[1]   External component
[2]   Only for safety zone with at least one IndraDrive Mi with optional safety technology module
[3]   Only for safety zone with at least one IndraDrive Mi with optional safety technology module

Fig. 4-5:   Formula to calculate PFH for a safety zone

The following conditions/restrictions apply to the general use of the formula for PFH calculation for a safety zone:

Variable	Value	Description
$PFH_{Selection\_discrete}$	See manufacturer's specification	Enter the sum of the individual PFH values of the switches or safety devices involved in the selection.
PFH_{KCU02}	**KCU02.2:** 1.5×10^{-9} 1/h **KCU02.3:** 1.5×10^{-9} 1/h	Use the value of the drive connection box "KCU" here. Enter "0" for this value, if • no IndraDrive Mi with optional safety technology module has been included in the safety zone, or • a "KMV" distributed supply unit is used
$PFH_{KMV03.1}$	$<2.0 \times 10^{-9}$ 1/h	Use the value of the distributed supply unit here. Enter "0" for this value, if • no IndraDrive Mi with optional safety technology module has been included in the safety zone, or • a "KCU" drive connection box is used
PFH_{Axis_x}	See "Calculating the PFH component of an axis"	This value is **independent** of the safety level to be attained.

Tab. 4-22:   Variable description to calculate PFH for a safety zone

5   Functional principle of integrated safety technology

5.1   Basic functions

5.1.1   Overview

In the case of a standard drive, the axis / spindle / roll is moved according to the command values of the control unit. In this case, incorrect drive motion can be caused by operating errors, incorrect installation in the system, defects in parts or materials, failures in the system, etc. Incorrect drive motion can endanger persons staying in the danger zone of the drive motion, even if the errors only occur for a short time and occasionally.

It is therefore necessary to take measures that limit the effects of errors on the drive motion to a minimum. The residual risk of danger to persons is then considerably reduced.

During operation, the safety functions are monitored by the drive system. For this purpose, measures for detecting static error states were realized in the system:

- Dual-channel structure
- Comparison of the states of both channels
- Dynamization of static states

These measures ensure that a single error cannot cause the safety functions to be lost.

The installation or machine manufacturer has to determine in how far this is sufficient for an existing installation or machine by a risk assessment according to annex I of the Directive 2006/42/EC.

The following schematic diagram of an IndraDrive Cs device illustrates the basic functions and functional principles explained in this section. (The described basic functions and functional principles apply to IndraDrive Cs, IndraDrive Mi with Kxx02/Kxx03, IndraDrive C/IndraDrive M with Cxx02 control sections and IndraDrive ML with Cxx02.5 control sections):

Functional principle of integrated safety technology
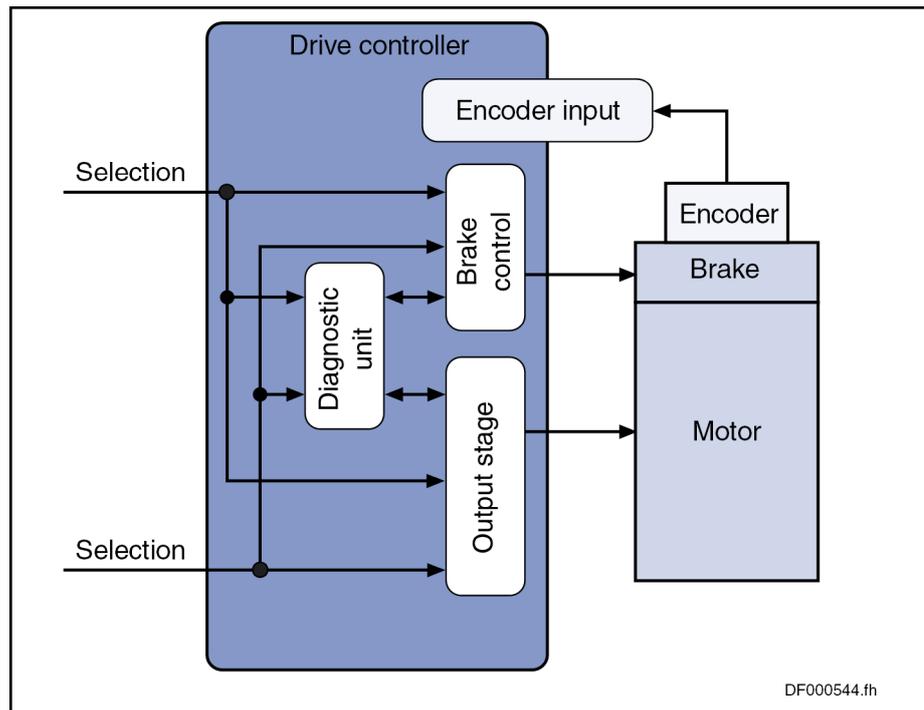
Fig. 5-1:   *Schematic diagram of IndraDrive Cs with integrated safety technology*

5.1.2   Dynamization

Brief description

Dynamization is to detect static error states in the safety-relevant circuits. Dynamization takes place automatically in the background without having an effect on the safety function or the standard drive functions.

Functional principle of dynamization

A safety function is selected via an N/C-N/C combination, i.e. a "0" signal at both inputs is evaluated when the safety functions are selected. Therefore, the dynamization of the external selection channels can only take place in the deselected state (normal operation).

Dynamization in the case of selection via an active safety unit

> 💡 An active safety unit is a safety switching device which selects the safe function via OSSD outputs. The active safety unit tests its outputs on its own.

> 💡 The "OSSD" (Output Signal Switching Device) is that part of a safe selection unit which has been connected to the machine control and which goes to the OFF state, when the safe selection unit triggers during the intended operation.

When the safety functions are selected via an active safety unit, the dynamization pulses of the OSSD outputs of the active safety unit are evaluated and monitored; therefore, other dynamization signals are not required.

The active safety unit must detect the following errors via its OSSD outputs:

- Short circuit of one or both selection signals with 24 V
- Short circuit of one or both selection signals with 0 V

Functional principle of integrated safety technology

- Short circuit between both selection signals

In order that all other relevant errors can be detected by the optional safety technology modules "L3"/"L4", the dynamization pulses of the OSSD outputs must comply with the following limit values:

	Value	Explanation
t_{PLmax}	1 ms	Maximum low time of the test pulse
t_{PLmin}	20 µs	Minimum low time of the test pulse
t_{Pmax}	1 h	Maximum periodic time of the test pulses
t_{Pmin}	500 µs	Minimum periodic time of the test pulses
t_{Vmax}	1 s	Maximum delay of the selection signals for selection or deselection
$t_{Dmin} = t_{PH} / t_P$	90 %	Minimum sampling ratio of the selection signals
t_{Bounce}	400 ms	Maximum bounce time for a selection or deselection
φ	-	Phase shift of the test pulses on both channels: no requirement

Tab. 5-1:   Limit values of the dynamization pulses of the OSSD outputs
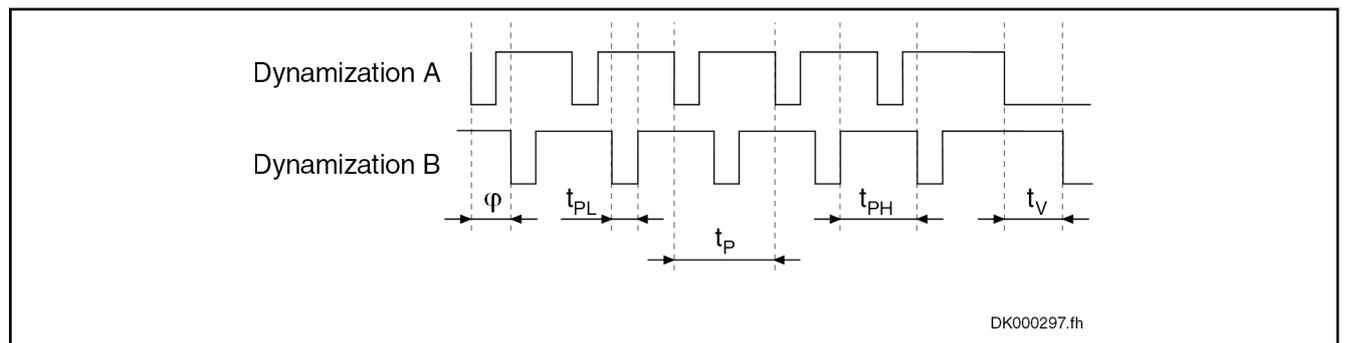

Fig. 5-2:   Example of dynamized selection signals

The figure below illustrates, in schematic form, the interconnection of an active safety unit and several drives with an "L option":

Functional principle of integrated safety technology
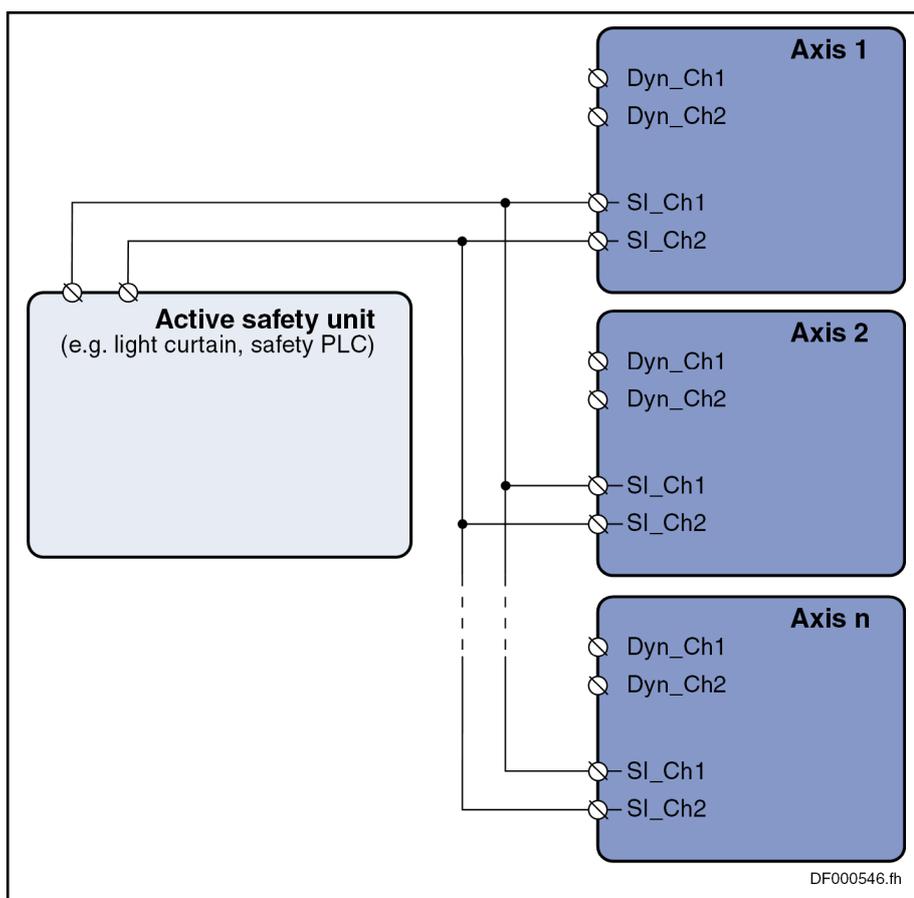
Fig. 5-3:   *Dynamization in the case of selection via an active safety unit*

☞   When choosing the safety unit, the maximum current consumption of the selection inputs of all drives of a safety zone has to be taken into account.

Dynamization in the case of selection via passive safety units

💡   A passive safety unit is a safety switching device with which the safe function is selected via isolated contacts.

When the safety functions of the "L options" are selected via a passive safety unit, the drive checks the wiring of the selection.

When selected via a passive safety unit, a 24 V supply has to be connected to X49.4.

When the selection of the safety functions takes place via a passive safety unit, the drive generates the dynamization pulses and makes them available via the "dynamization channel A" and "dynamization channel B" outputs. These two outputs allow supplying the isolated selection contacts of the passive safety unit.

The figure below illustrates, in schematic form, the interconnection of a passive safety unit and several drives with an "L option":

Functional principle of integrated safety technology

DF000545_V02.fh
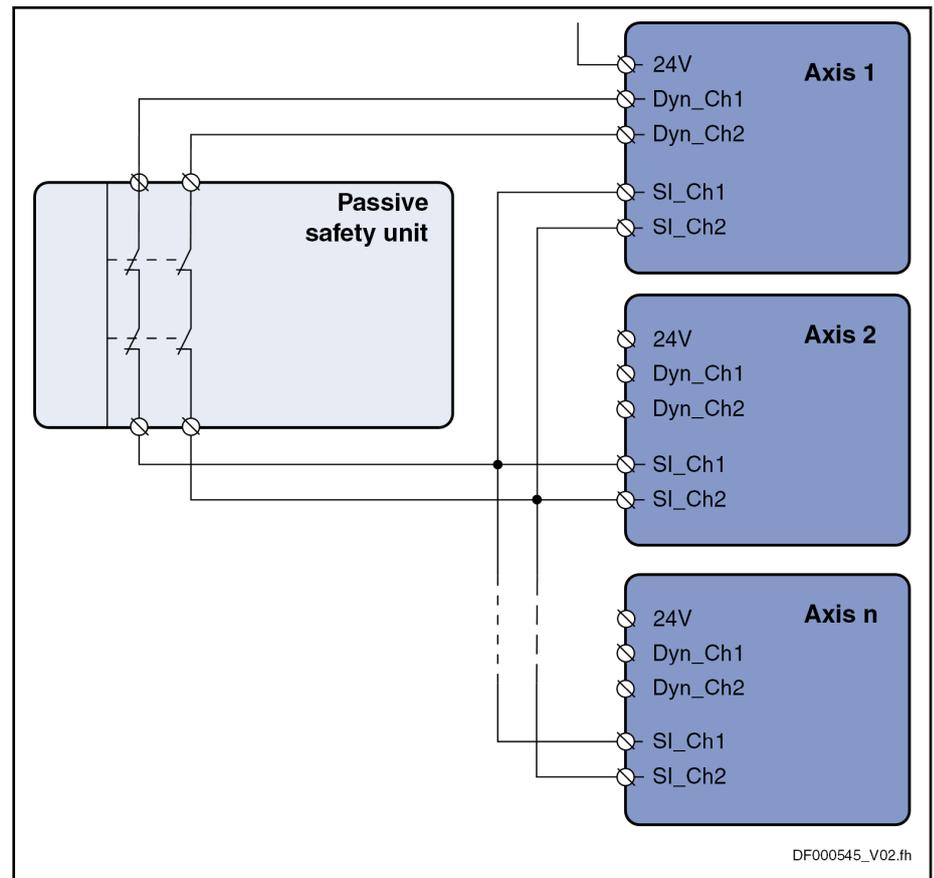
Fig. 5-4:   Dynamization in the case of selection via a passive safety unit

☞   At maximum, a safety zone may contain 25 drives with an optional safety technology module "L3"/"L4". If more than 25 drives are to be operated at a safety unit, multiple safety zones have to be set up.

DOK-INDRV*-SI3-**VRS**-AP08-EN-P   Bosch Rexroth AG   59/143
Rexroth IndraDrive Integrated Safety Technology "Safe Torque Off" (as of MPx-16)

Integrated safety functions

6 Integrated safety functions

6.1 Overview of safety functions

6.1.1 General information

The application-related safety functions "Safe Torque Off" and "Safe Brake Control" described below have been realized for personal protection in accordance with ISO 13849-1, Category 4, PL e and IEC 62061, SIL3.

☞ Before a safety function is selected, the drive system has to be put into the appropriate state by specifying the command values.

6.2 Safety functions in special mode "Safe standstill"

6.2.1 Safe Torque Off (STO)

Brief description

☞ Using the "Safe Torque Off" function requires the optional safety technology module "L3" or "L4".

The energy supply to the motor is safely interrupted with the safety function "Safe Torque Off". The drive cannot generate any torque/force and, as a consequence, it cannot generate any dangerous motions, either.

☞ Before selecting the safety function "Safe Torque Off", the drive system has to be decelerated via the command value input; there is no drive-controlled deceleration!

| ⚠ WARNING | Lethal injury and/or property damage caused by unintended axis motion! |

⇒ If external force influences are to be expected with the safety function "Safe Torque Off", e.g. in the case of a vertical axis, this motion has to be safely prevented by additional measures, e.g. a mechanical brake or a weight compensation. For such axes, Bosch Rexroth recommends using the safe braking and holding system.

| ⚠ WARNING | High electrical voltage! Danger to life, risk of injury by electric shock or serious injury! |

During the time a safety function is active, power is not removed from the motor; de-energize the motor's drive before working on it.

Features   The safety function "Safe Torque Off" (STO) has the following features:

- When the optional safety technology module "L4" is used and the safety function "Safe Torque Off" (STO) is selected, the "Safe Brake Control" (SBC) is automatically activated.
- Corresponds to stop category 0 according to IEC 60204-1
- Is suited for safety-relevant applications up to SIL 3 according to IEC 62061.

Integrated safety functions

- Is suited for safety-relevant applications up to Category 4, PL e (IndraDrive Mi with KCU02.2: Category 3, PL e) according to ISO 13849-1.
- The energy supply to the motor is safely interrupted via two channels.
- The **selection can take place via two channels**, alternatively by means of
  – a passive safety unit with dual-channel, isolated conventional (non-solid-state) normally closed contacts (e.g., safety switching device for emergency stop, safety door monitor, etc.) or
  – an active safety unit with plus-plus-switching or plus-minus-switching OSSD outputs (e.g., safety control units, laser scanners, etc.).
- In the case of IndraDrive Cs, IndraDrive C, IndraDrive M and IndraDrive ML, the **selection can take place via one channel**, alternatively by means of
  – a passive safety unit with an isolated conventional (non-solid-state) normally closed contact (designed in compliance with SIL3), e.g., safety switching device for emergency stop, safety door monitor, etc.

    In addition, the fault exclusion (short-circuit with other signals / potentials) in the wiring (considering IEC 61800-5-2: 2007, table D.1 or ISO 13849-2: 2008, table D.4) is required, or
  – by means of an active safety unit with plus-switching OSSD output (e.g., safety control units, laser scanners, etc.).

    In addition, the fault exclusion (short-circuit with other signals / potentials) in the wiring (considering IEC 61800-5-2: 2007, table D.1 or ISO 13849-2: 2008, table D.4) is required.
- The dynamization of the safety function selection takes place alternatively by means of
  – the OSSD dynamization of the active safety unit or
  – the dynamization outputs at the X49 terminal connector of the optional safety technology module "L3" or "L4" in the case of control by passive safety units.
- It is possible to set up a zone by connecting up to 25 drives in parallel.
- Online dynamization of the outputs and interrupting circuits
- Short reaction time (see chapter "Time response and reaction times" on page 46)
- The state of safety function "Safe Torque Off" is displayed via the parameter "P-0-0106, Operating status STO/SBC".

Pertinent parameters
The following parameters are used in conjunction with the safety function "Safe Torque Off":
- P-0-0101, Configuration STO/SBC
- P-0-0106, Operating status STO/SBC

Pertinent diagnostic messages
The following diagnostic messages can be generated in conjunction with the safety function "Safe Torque Off":
- A0011 STO/SBC active
- E8027 STO/SBC while drive enabled
- F3134 Dynamization time interval incorrect
- F8027 STO/SBC while drive enabled

Integrated safety functions

- F8300 Dynamization pulse width incorrect
- F8301 Error when checking selection signals
- F8302 Error when checking switch-off channels STO/SBC
- F8303 System error STO/SBC

With the safety function "Safe Torque Off" activated, the display of the drive controller's control panel shows "STO".

Safety function

The optional safety technology modules "L3"/"L4" feature two 24 V inputs for dual-channel selection and two dynamization outputs for operation at passive safety units.

☞   For pin assignments and technical data, please refer to the chapter "Project planning".

The safety function "Safe Torque Off" can be divided into the following topics which are described in detail below:

- Dynamization
- Requirements on the command value input
- Selecting the safety function "Safe Torque Off"

Dynamization   Dynamization is to detect static error states in the wiring and in the safety-relevant circuits. Dynamization takes place automatically in the background without having an effect on the safety function or the standard drive functions.

A safety function is selected via an N/C-N/C combination, i.e. a "0"-signal at both inputs is evaluated as the selection of the safety function. Therefore, the dynamization of the external selection channels can only take place in the deselected state (normal operation). Internal dynamizations are carried out independent of the selection.

For the dynamization of the safety function selection, we distinguish whether the safety function is selected via an active or a passive safety unit. The dynamization function is explained in the chapter on "Dynamization".

Dynamization pulses of a duration of 20 µs and more are recognized as valid dynamization pulses.

The dynamization pulses are monitored for:

- the time interval
- the pulse width
- the sampling ratio

The "L option" monitors whether the dynamization of the selection signals is carried out in the deselected state. Monitoring takes place so that dynamization is carried out at the latest after 1 hour in the deselected state (normal operation). For this purpose, the time in the deselected state is added in the drive and only reset by dynamization; i.e. an interim selection does not cause monitoring to be reset. Monitoring takes place independently for both selection channels. If the time interval is exceeded, the error message "F3134 Dynamization time interval incorrect" is generated.

☞   To increase the noise immunity, the safety technology tolerates the failure of a dynamization pulse, when the following 8 dynamization pulses occur within the time window described above.

Integrated safety functions

The safety technology monitors the sampling ratio of the dynamization pulse, too. When this is done, the dynamization pause must be at least 90% of a dynamization period. If the dynamization pause is shorter, the error message "F8300 Dynamization pulse width incorrect" is generated.

Requirements on the command value input

☞ Before selecting the safety function "Safe Torque Off", the drive system has to be decelerated via the command value input; there is no drive-controlled deceleration!

☞ The safety function "Safe Torque Off" corresponds to stop category 0 according to EN 60204-1.

If the safety function "Safe Torque Off" is selected with drive enable set, the safety function is executed while a diagnostic message is generated at the same time, because the drive must first be decelerated before the safety function is allowed to be activated.

MPx17V06 and below: The diagnostic message which is output is the warning "E8027 STO/SBC while drive enabled".

MPx17V08 and above: The parameter "P-0-0101, Configuration STO/SBC" can be used to select whether the drive is to react to the error with the fatal error "F8027 STO/SBC while drive enabled" or the fatal warning "E8027 STO/SBC while drive enabled".

The warning is automatically cleared when drive enable is removed, the error has to be cleared by the user.

💡 The diagnostic messages are recorded in "S-0-0375, Diagnostic numbers list".

⚠ DANGER	Lethal injury and/or material damage caused by coasting axes!

⇒ If the safety function"Safe Torque Off" is selected with drive enable having been set, the drive torque, independent of the diagnostic message which was set, is immediately disabled and the drive coasts to stop; the shutdown process is relatively slow and, above all, not safe!

Selecting the safety function "Safe Torque Off"

With IndraDrive Cs, IndraDrive C, IndraDrive M and IndraDrive ML, the safety function "Safe Torque Off" can be optionally selected via one channel or via two channels.

☞ In the case of "IndraDrive Mi", selection via one channel is not allowed!

The selection of the safety function is detected, when a "0"-signal is detected on both selection inputs. The selection can alternatively be made by means of active or passive safety units.

See also "Examples of application"

☞ In the case of the safety option "L4", the safety function "Safe Brake Control" is activated, too, when the safety function "Safe Torque Off" is selected and a brake is available. It is impossible to select or deselect both safety functions separately.

Integrated safety functions

The safety technology checks the selection signals for validity. In the case of single-channel selection, i.e. dual-channel selection is expected due to the wiring, but only one channel is selected, the second channel has to be selected before the first channel is deselected; otherwise, the error message "F8301 Error when checking selection signals" is generated.

☞   The tolerance time for the differing selection between the two selection channels is 1 s; the parameter setting cannot be changed.

For diagnostic purposes, the state of the safety function "Safe Torque Off" can be read via parameter "P-0-0106, Operating status STO/SBC".

Notes on commissioning

For examples of interconnection, please refer to "Examples of application"

Notes on project planning

When configuring the safety function "Safe Torque Off", it is absolutely necessary to observe the following safety instructions:

| ⚠ DANGER | Lethal injury and/or property damage caused by unintended axis motion! |

⇒ If external force influences are to be expected with the safety function "Safe Torque Off", e.g. in the case of a vertical axis, this motion has to be safely prevented by additional measures, e.g. a mechanical brake or a weight compensation. For such axes, Bosch Rexroth recommends using the safe braking and holding system.

| ⚠ WARNING | Injury and/or property damage caused by deviation from standstill position! |

⇒ Even if the control of the power section has been safely locked, momentary axis motion, depending on the number of poles of the motor, can be triggered, when two errors are occurring simultaneously in the power section with the voltage DC bus being active:

- Breakdown of a power semiconductor **and**
- Breakdown of another semiconductor

In this case, two of six semiconductors are affected in such a way that the motor shaft is aligning.

Synchronous motor example: In the case of a synchronous motor with 6 pole pairs, the motion can be a maximum of 30 degrees. For a directly driven ball screw, e.g. 20 mm per revolution, this corresponds to a one-time maximum linear motion of 1.67 mm.

When an asynchronous motor is used, the short circuits in two separate circuits of the power section have almost no effect, because the exciter field breaks down when the inverter is shut down and has completely died down after approx. 1 s.

Integrated safety functions

6.2.2   Safe Brake Control (SBC)

Brief description

☞ | Using the "Safe Brake Control (SBC)" function requires the optional safety technology module "L4".

The safety function "Safe Brake Control (SBC)" switches off the motor holding brake safely (via two channels).

☞ | Before selecting the safety function "Safe Brake Control (SBC)", the drive system has to be decelerated via the command value input; there is no drive-controlled deceleration!

Features   The safety function "Safe Brake Control" (SBC) has the following features:

- The safety function "Safe Brake Control" (SBC) is automatically activated when the safety function "Safe Torque Off" (STO) is selected. It is not possible to select the function separately.
- Is suited for safety-relevant applications up to Category 4, PL e according to ISO 13849-1 or SIL 3 according to IEC 62061.
- The energy supply to the motor holding brake is safely interrupted via two channels.
- Only self-holding (electrically releasing) brakes are supported.
- Online dynamization of the outputs and interrupting circuits

⚠ **WARNING** | The safety function "Safe Brake Control" only tests the control of the brake, not the brake function! If the brake function is insufficient, the axis might move in an uncontrolled way!

The function of the brake has to be cyclically checked.

- Short reaction time (see chapter "Time response and reaction times" on page 46)
- The state of the safety function "Safe Brake Control" is displayed via the parameter "P-0-0106, Operating status STO/SBC".

Pertinent parameters   The following parameter is used in conjunction with the safety function "Safe Brake Control":

- P-0-0106, Operating status STO/SBC

Pertinent diagnostic messages   The following diagnostic messages can be generated in conjunction with the safety function "Safe Brake Control" (SBC):

- A0011 STO/SBC active
- C0256 Safety technology configuration error
- E8027 STO/SBC while drive enabled
- F3134 Dynamization time interval incorrect
- F8027 STO/SBC while drive enabled
- F8300 Dynamization pulse width incorrect
- F8301 Error when checking selection signals
- F8302 Error when checking switch-off channels STO/SBC

Integrated safety functions

- F8303 System error STO/SBC

With the safety function "Safe Brake Control" activated, the display of the IndraDrive Cs control panel shows "STO", because safe brake control can only be activated in conjunction with safe torque off (STO).

Safety function

The safety function "Safe Brake Control (SBC)" switches off the motor holding brake safely (via two channels). It is automatically activated when the safety function "Safe Torque Off" (STO) is selected. It is not possible to select or deselect the function separately.

☞   Before selecting the safety function "Safe Torque Off" and thereby simultaneously activating the safety function "Safe Brake Control", the drive system should be decelerated via the command value input to prevent wear of the brake; there is no drive-controlled deceleration!

⚠ DANGER	Lethal injury and/or property damage caused by long braking distances!

⇒ If the safety function "Safe Brake Control" and thereby the safety function "Safe Torque Off" is selected with drive enable having been set, the drive torque is immediately disabled, the motor brake is applied and the drive is decelerated using only the motor brake; depending on the motor brake, the shutdown process can be relatively slow and, above all, is not safe!

Notes on commissioning

For examples of interconnection, please refer to "Examples of application"

Notes on project planning

⚠ WARNING	High electrical voltage! Danger to life, risk of injury by electric shock or serious injury!

During the time a safety function is active, power is not removed from the motor; de-energize the motor's drive before working on it.

- As the safety function "Safe Brake Control" cannot be deactivated, it is only allowed to operate self-holding (electrically releasing) brakes at drives with the optional safety technology module "L4".

  If an electrically clamping brake is configured in "P-0-0525, Holding brake control word", the transition command error "C0256 Safety technology configuration error" is generated when the drive is switched to the operating mode (OM).

- When selecting the brake, it has to be taken into account that the brake outputs are tested online during operation. For this purpose, the outputs are switched off for a short time (≤1 ms) and the brake is controlled. If a very fast acting brake is used, it cannot be excluded that the brake applies.

- When selecting the brake, it has to be taken into account that the brake current is monitored for a fixed minimum value (see also "Allowed motor holding brakes").

Integrated safety functions

- When selecting the brake and the 24 V power supply, it has to be taken into account that the brake is directly operated with the supply voltage; a supply voltage failure (e.g., overvoltage) can cause the brake to fail!

7 Examples of application

7.1 Examples of application for IndraDrive Cs, IndraDrive C and IndraDrive M

☞ The diagrams of the passive safety units show the safety function in its deselected state. The switches in the passive safety units are for exemplary purposes only. The decisive factor is that the passive safety unit complies with the safety level the application requires.

7.1.1 STO and SBC functions ("L4" only) when selected using passive safety units

Dual-channel wiring
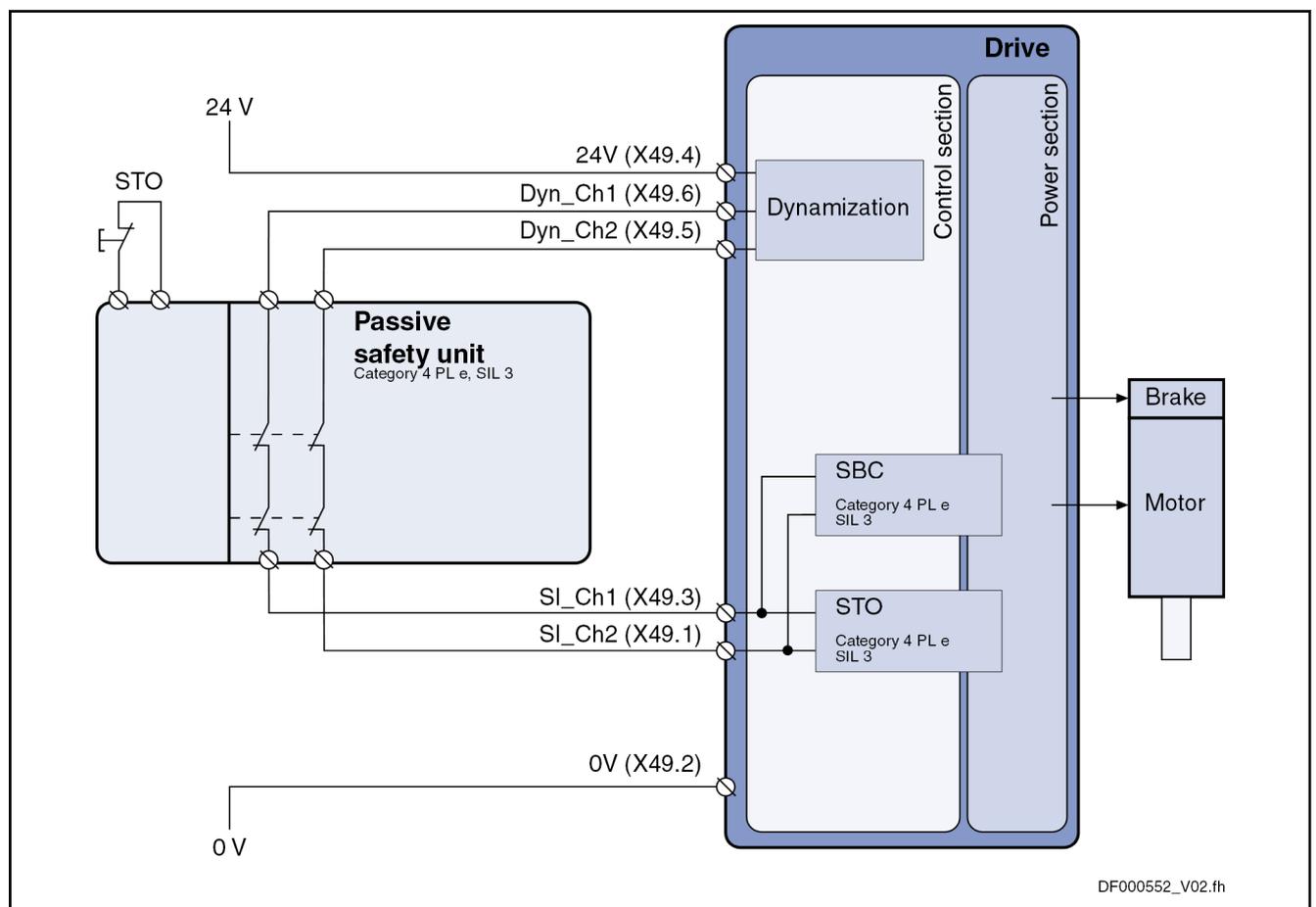
Fig. 7-1: STO function and SBC function (only IndraDrive Cs with "L4") with *dual-channel* wiring and *passive* safety unit

☞ The assignment of the dynamization signals can be selected as desired.

Examples of application

Single-channel wiring
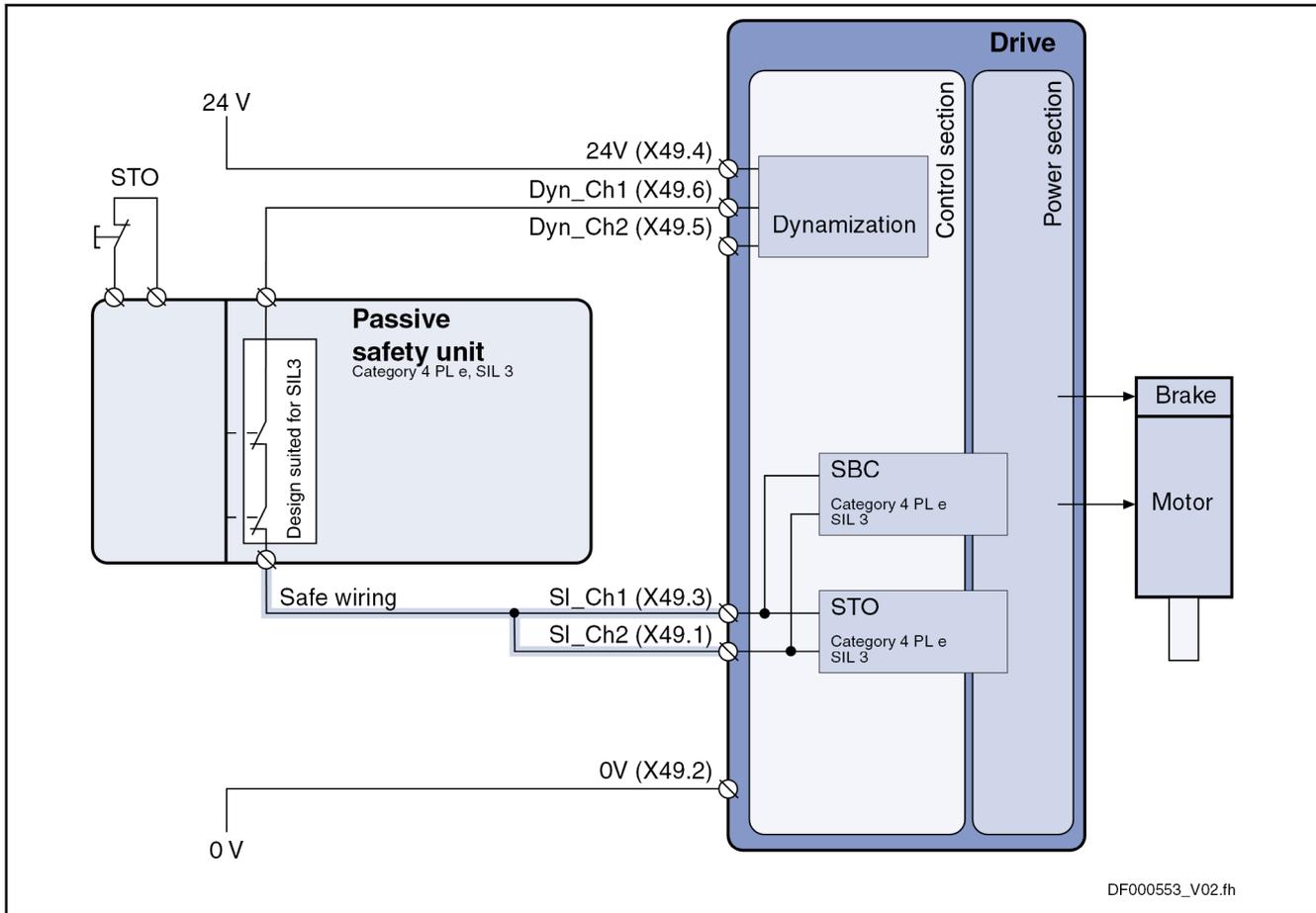


Fig. 7-2:   STO function and SBC function (only IndraDrive Cs with "L4") with
                 single-channel wiring and *passive* safety unit

If the wiring (as illustrated above) between the passive safety unit and connector X49 of the "L option" is to be a single-channel wiring, the wiring has to be implemented as a "safe wiring". For this purpose, the following fault exclusions have to be made:

- Short circuits with other potentials
- Short circuit with 24 V
- Short circuit with ground

☞   See also EN 61800-5-2: 2007, table D.1

In the case of single-channel wiring between the passive safety unit and connector X49 of the "L option", the internal structure of the passive safety unit, too, has to meet the requirements of the "safe wiring".

☞   Application engineers are free to choose any dynamization signal.

7.1.2 STO and SBC functions ("L4" only) when selected using active safety units

Dual-channel wiring

Plus-plus-switching safety unit

When the safety function is selected by means of a plus-plus-switching safety unit, the following errors have to be detected by the OSSD outputs:

● Short circuit of the selection signals with 24 V

● Short circuit between the two selection signals
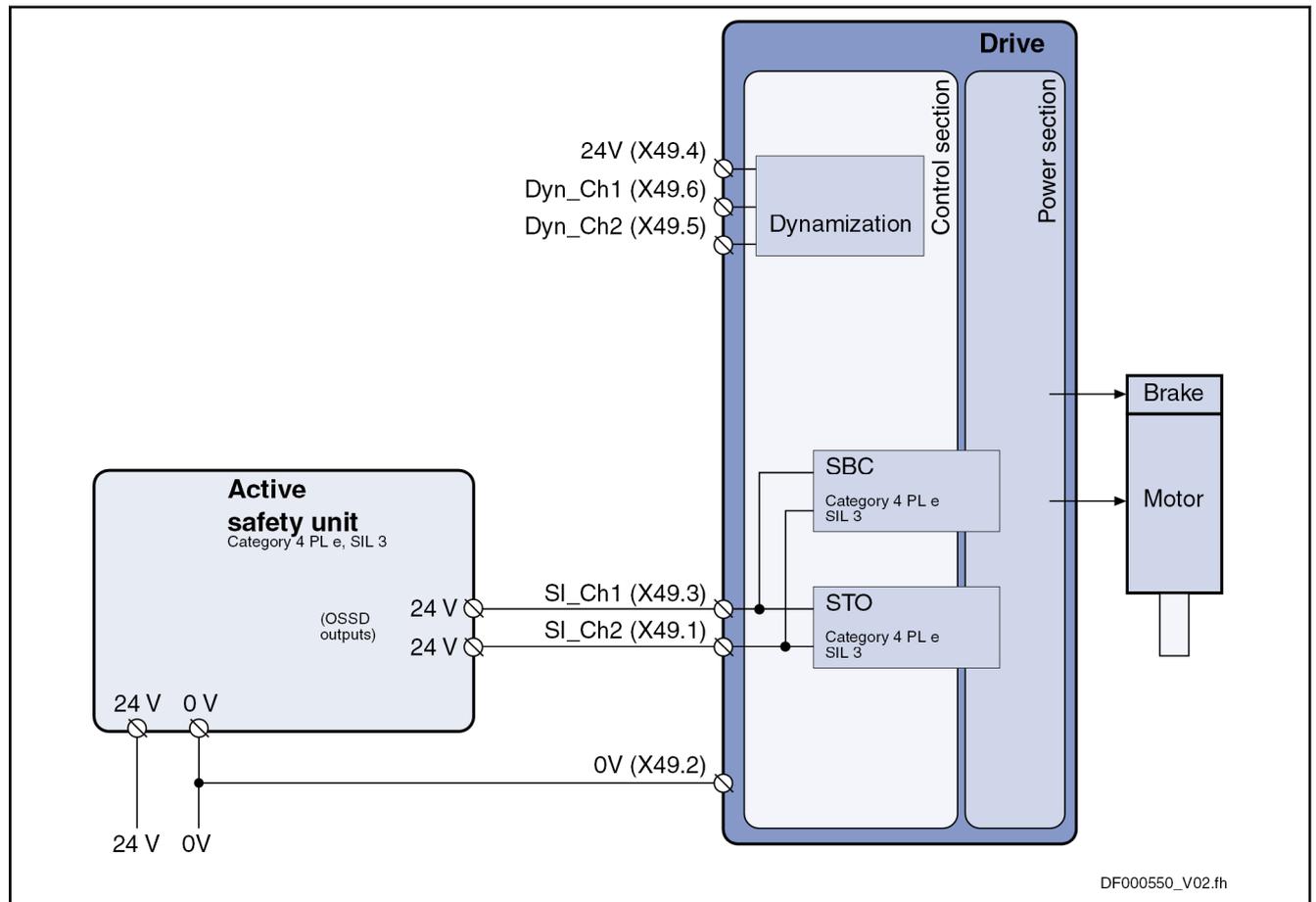
*Fig. 7-3:   STO function and SBC function (only IndraDrive Cs with "L4") with **active** safety unit (**plus-plus-switching** outputs)*

Plus-minus-switching safety unit

When the safety function is selected by means of a plus-minus-switching safety unit, the following errors have to be detected by the OSSD outputs:

● Short circuit of the plus-switching selection signal against 24 V

● Short circuit of the minus-switching selection signal against 0 V

Examples of application
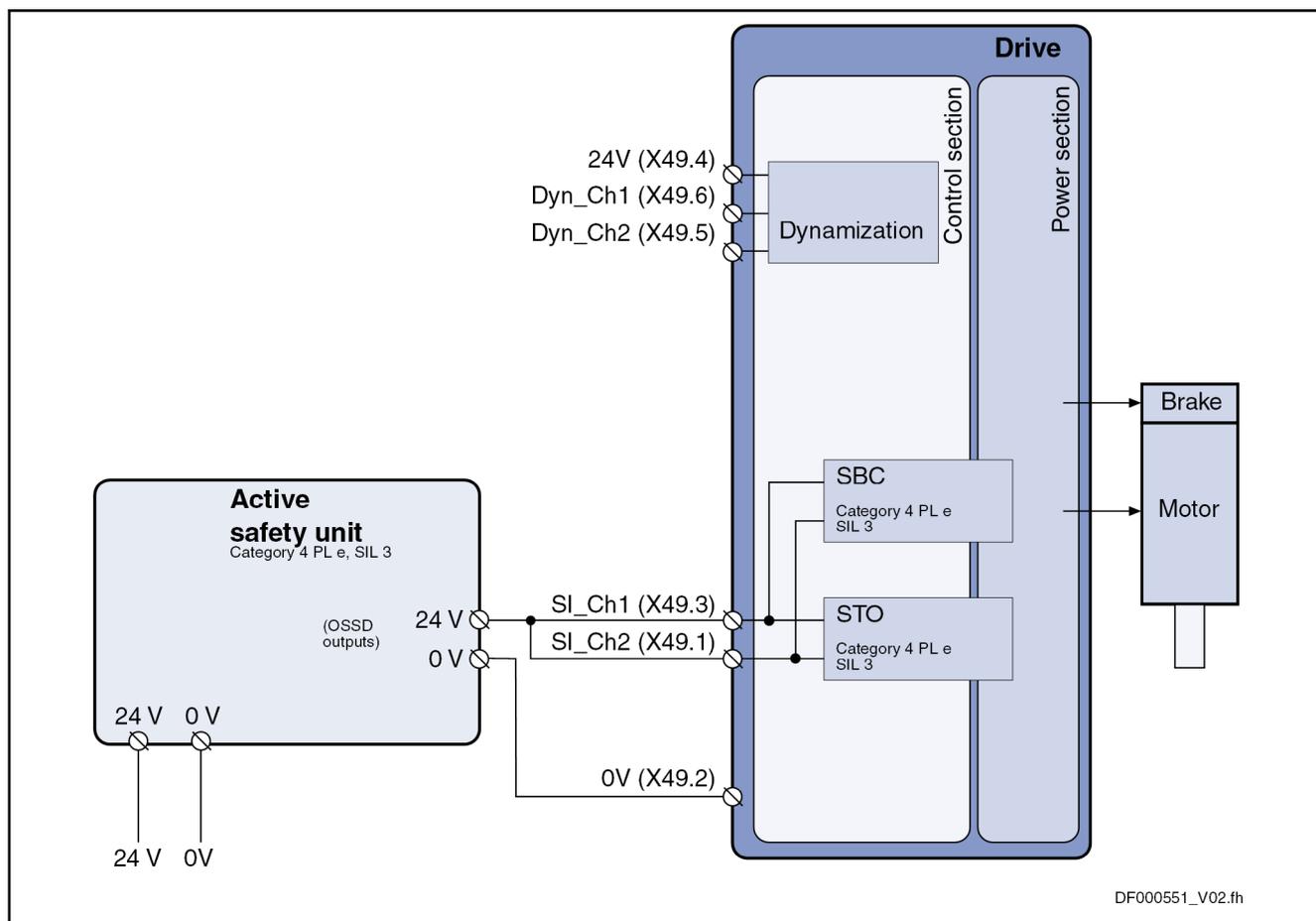
Fig. 7-4:   *STO function and SBC function (only IndraDrive Cs with "L4") with*
             active *safety unit (**plus-minus-switching** outputs)*

Single-channel wiring

When the safety function is selected by means of a safety unit, the short circuit with 24 V has to be detected by the OSSD output.

Examples of application
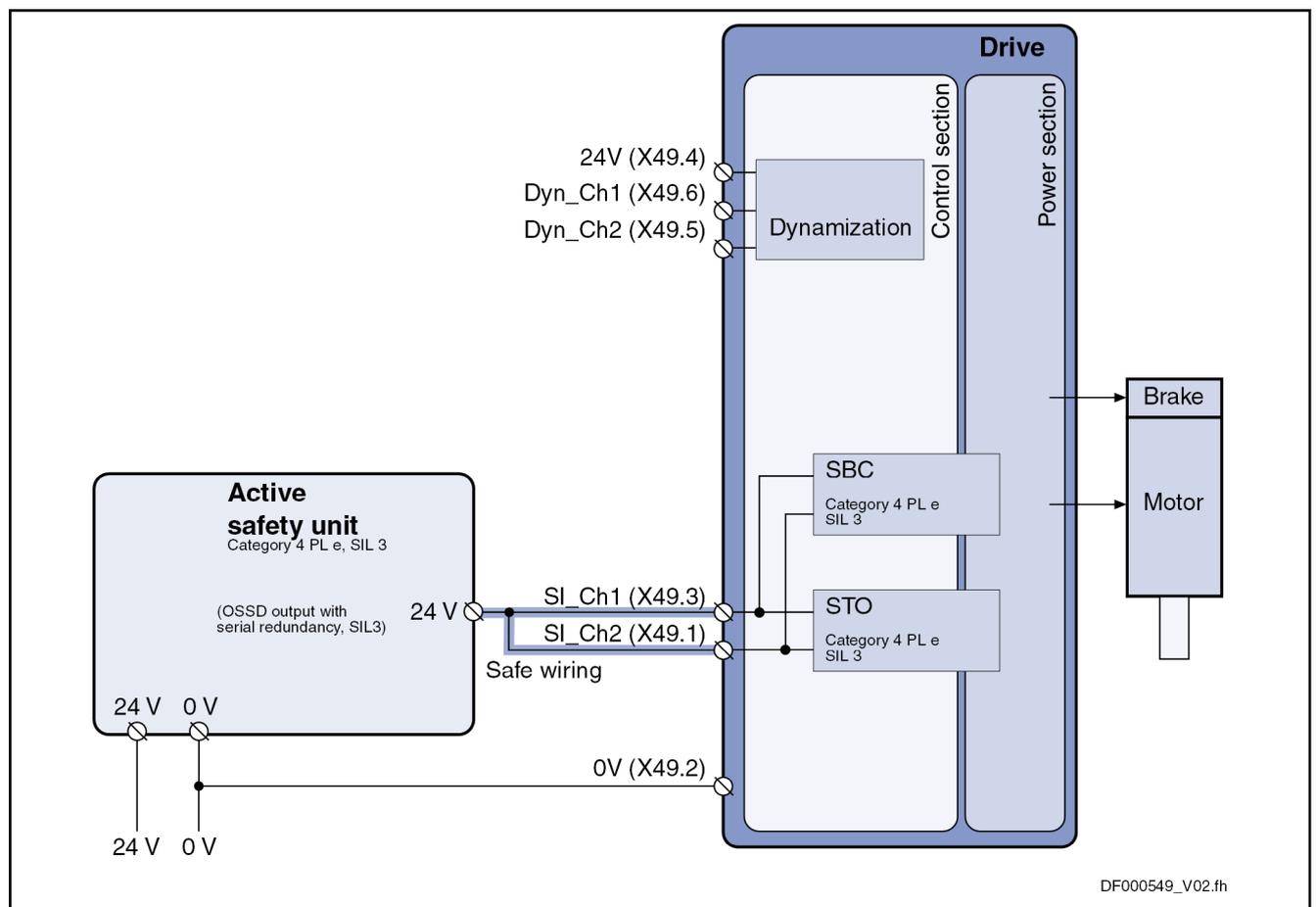
Fig. 7-5:   *STO function and SBC function (only IndraDrive Cs with "L4") with* **single-channel wiring** *and* **active** *safety unit*

If the wiring between the active safety unit and connector X49 of the "L option" is to be a single-channel wiring (as illustrated above), the wiring has to be implemented as a "safe wiring". For this purpose, the following fault exclusions have to be made:

- Short circuits with other potentials
- Short circuit with 24 V
- Short circuit with ground

☞   See also EN 61800-5-2: 2007, table D.1

If the wiring between the active safety unit and connector X49 of the "L option" is a single-channel wiring, the OSSD output has to be designed with "serial redundancy" in accordance with SIL3.

Examples of application

7.1.3   "Safe stop 1 (emergency stop)" function with "L3"/"L4" option

Using the E-Stop function of the drive (or the NC stop of the control unit), the STO function can be extended to obtain the "Safe stop 1 (Emergency stop)" function. For this purpose, the selecting safety unit (active or passive) first has to shut down the drive by means of the E-Stop function (or the NC stop of the control unit) and select the STO function after a fixed time that has been set is over. The selection always has to take place after the time that has been set, independent of the axis state.
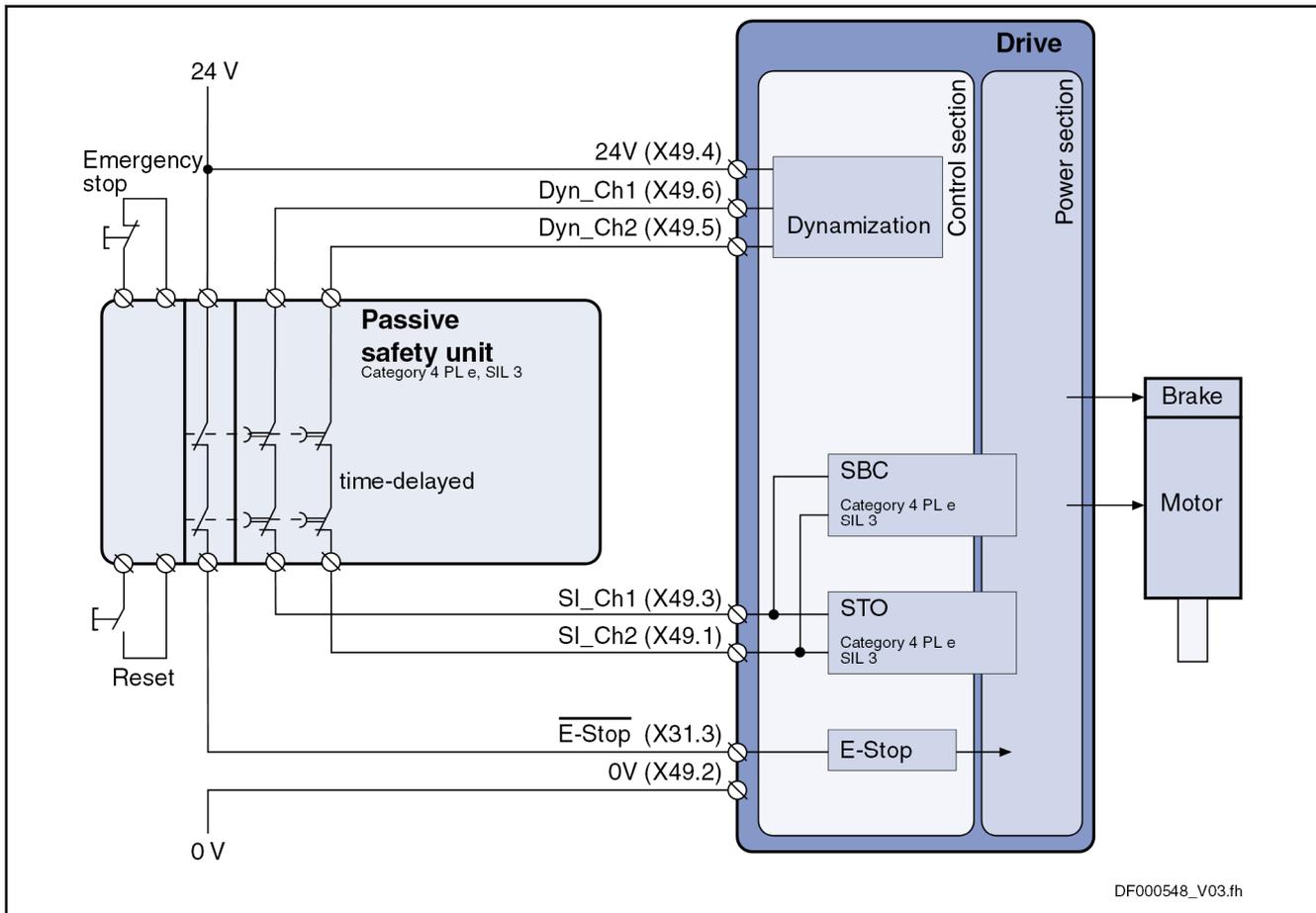
Fig. 7-6:   SS1 function (including "SBC") with **dual-channel** wiring and **passive** safety unit

7.1.4 Zone setup
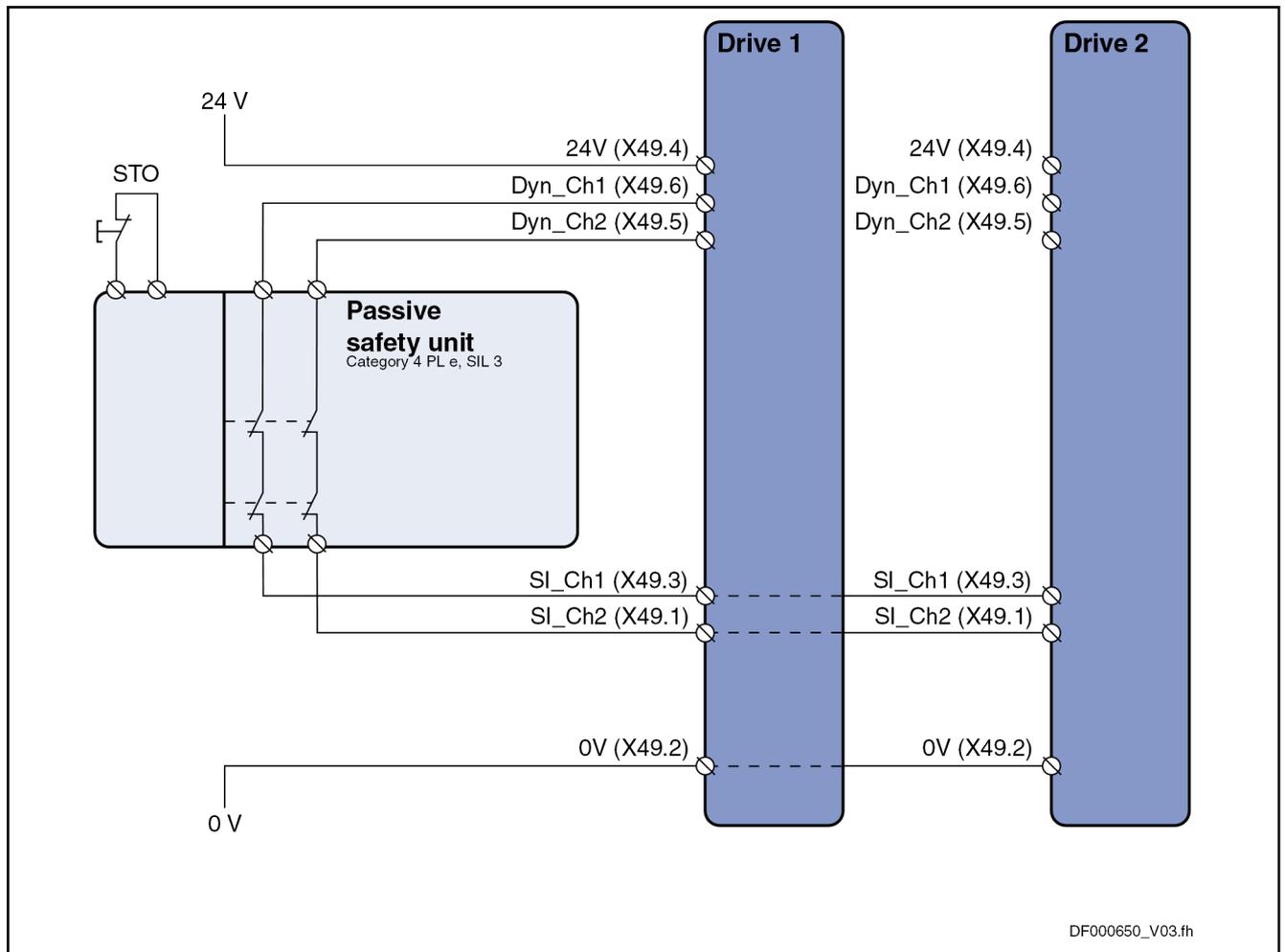
Fig. 7-7:   Example of zone setup (in this case: 2 IndraDrive in a safety zone with dual-channel wiring and passive safety unit)

7.2 Examples of application for IndraDrive Mi

7.2.1 Single-channel selection

☞   In the case of "IndraDrive Mi", selection via one channel is not allowed!

Examples of application
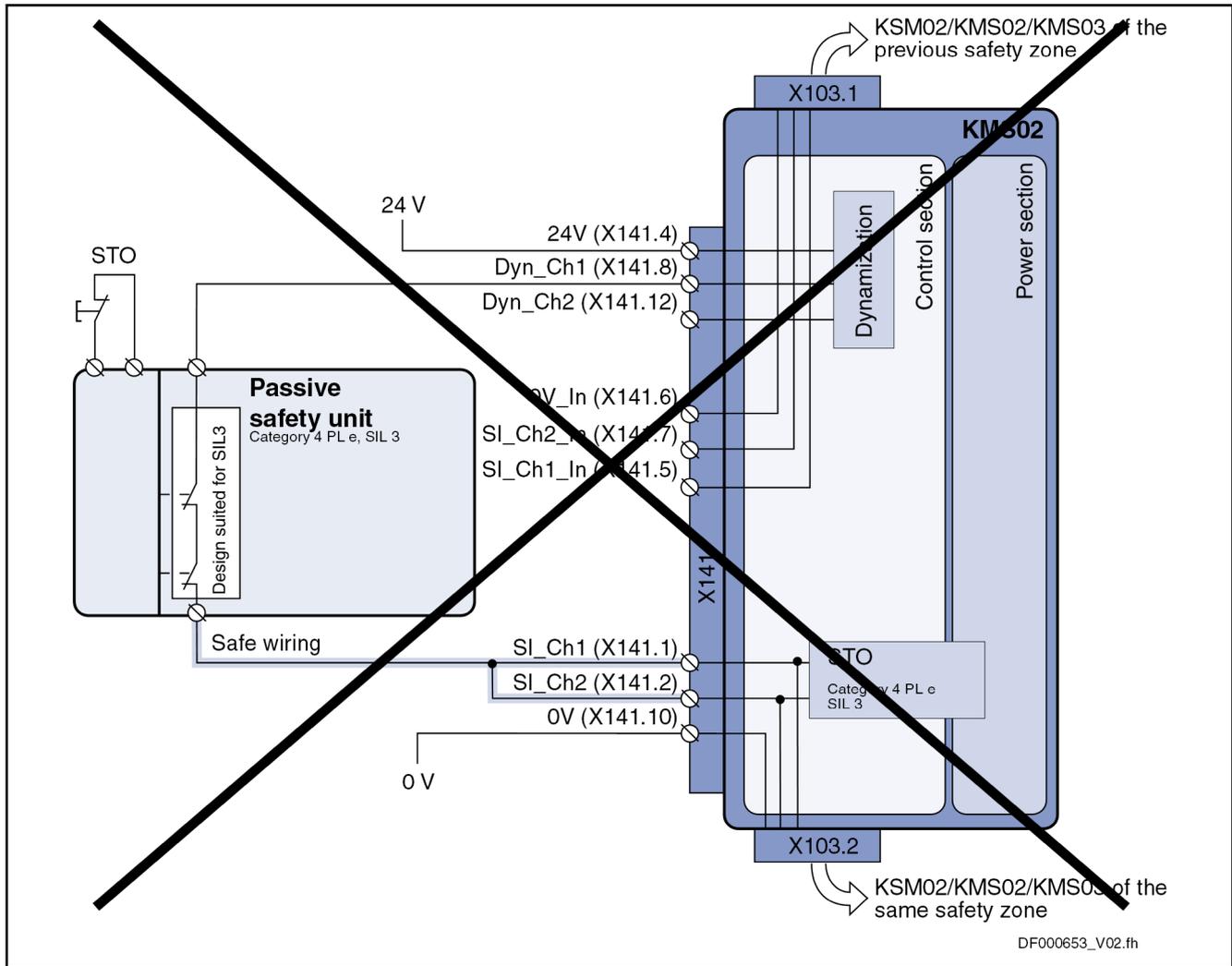
Fig. 7-8: *Inadmissible **single-channel** wiring of IndraDrive Mi*
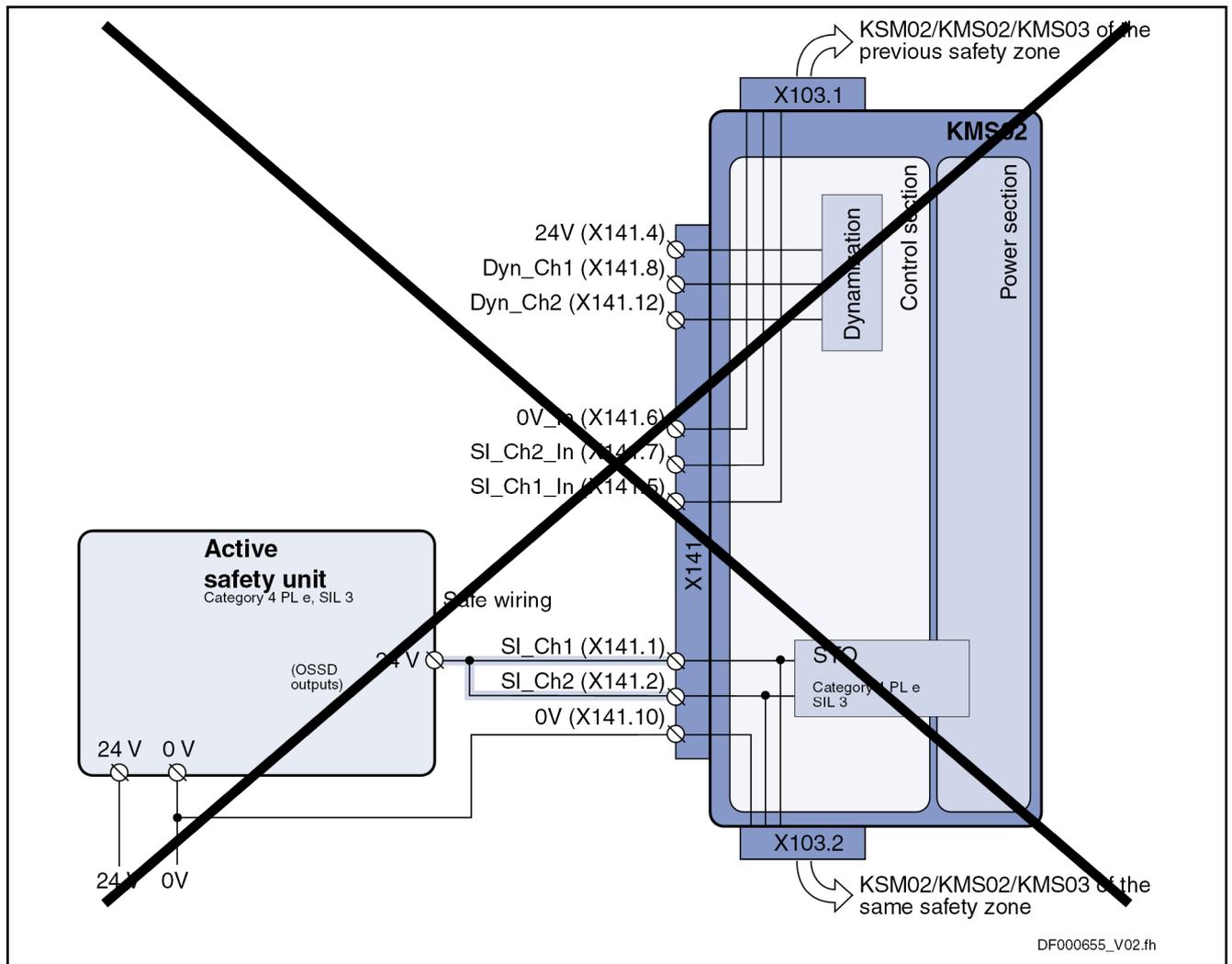
Fig. 7-9:   *Inadmissible **single-channel** wiring of IndraDrive Mi*

7.2.2   Central selection

Selection via the passive safety unit

☞   It is **not** possible to connect a passive safety unit to KMV03.

Examples of application
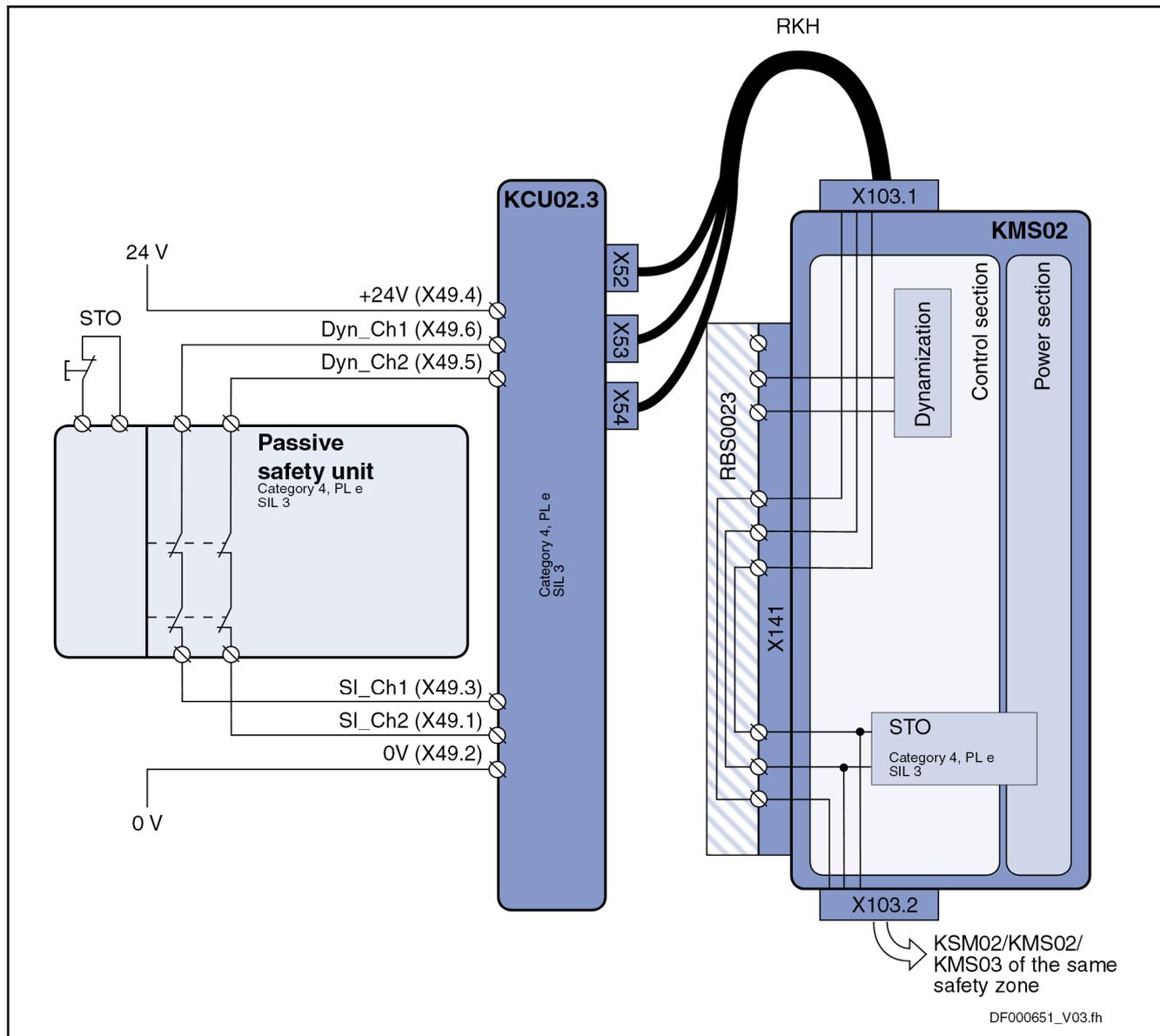
Fig. 7-10:   KCU02 with **dual-channel** wiring and **passive** safety unit

Selection via the active safety unit

Plus-plus-switching safety unit

☞   It is also possible to connect an active safety unit to KMV03.

When the safety function is selected by means of a plus-plus-switching safety unit, the following errors have to be detected by the OSSD outputs:

- Short circuit of the selection signals with 24 V
- Short circuit between the two selection signals
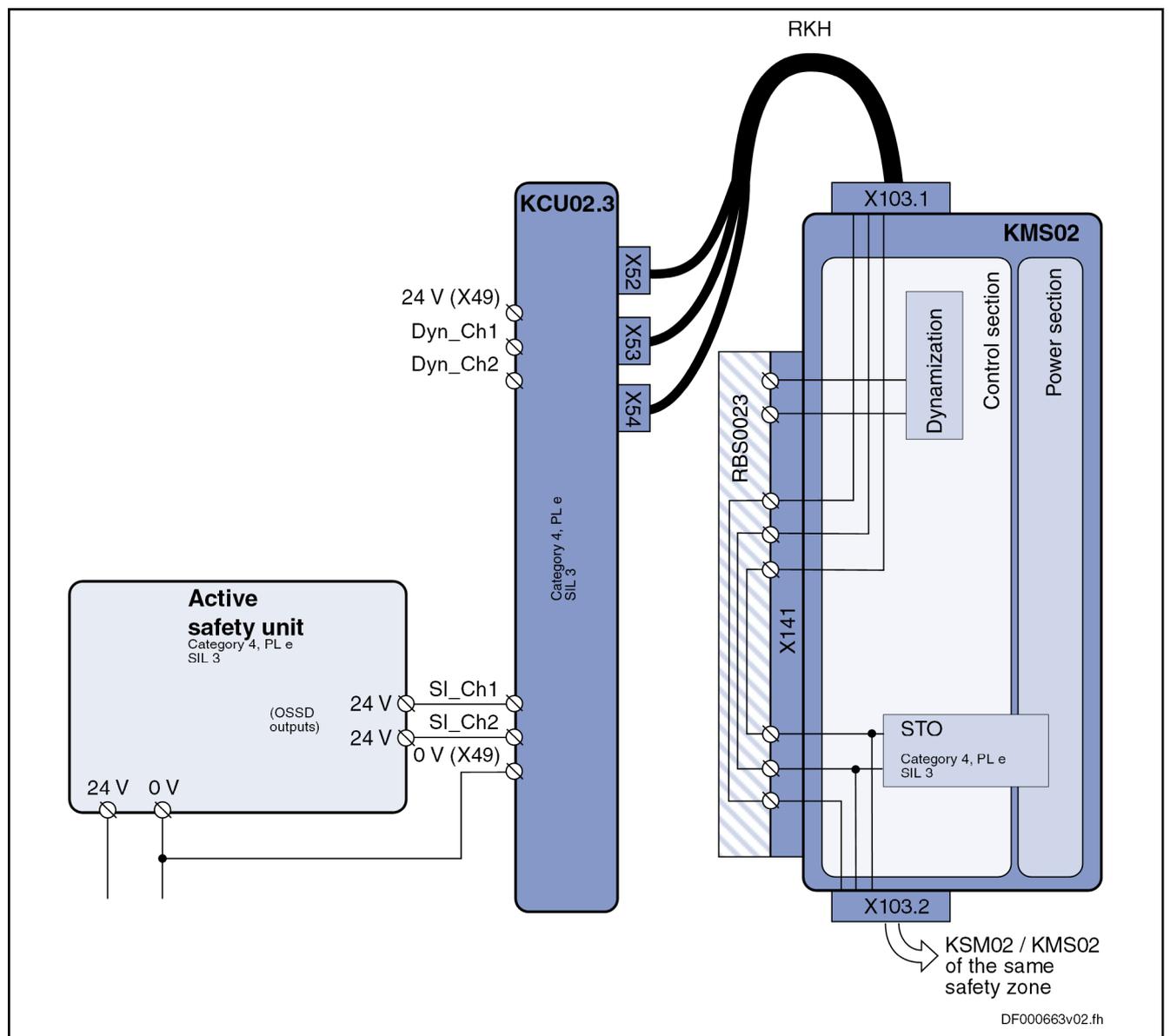
Fig. 7-11: KCU02 with *active* safety unit (plus-plus-switching outputs)

Plus-minus-switching safety unit

☞ It is also possible to connect an active safety unit to KMV03.

When the safety function is selected by means of a plus-minus-switching safety unit, the following errors have to be detected by the OSSD outputs:

• Short circuit of the plus-switching selection signal against 24 V
• Short circuit of the minus-switching selection signal against 0 V

Examples of application
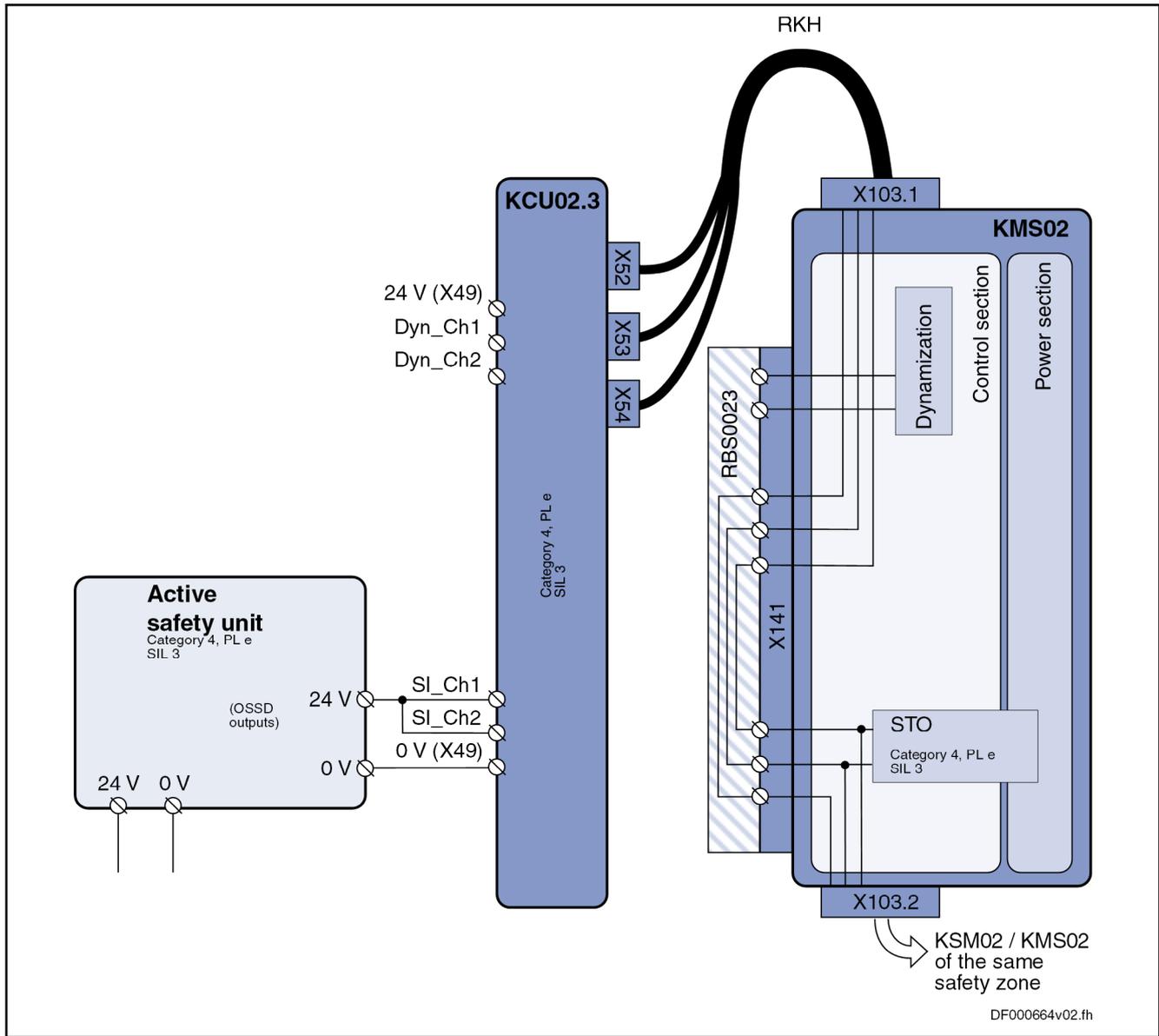
*Fig. 7-12:   KCU02 with **active** safety unit (plus-minus-switching outputs)*

"Safe stop 1 (Emergency stop)" function with "L3" option

Using the E-Stop function of the drive (or the NC stop of the control unit), the STO function can be extended to obtain the "Safe stop 1 (Emergency stop)" function. For this purpose, the selecting safety unit (active or passive) first has to shut down the drive by means of the E-Stop function (or the NC stop of the control unit) and select the STO function after a fixed time that has been set is over. The selection always has to take place after the time that has been set, independent of the axis state.

The figure below shows **KCU02 as a zone beginner**. The E-Stop signal is wired to X50 of KCU02 and is transmitted to the zone nodes via the hybrid cable.

☞ It is also possible to connect an active safety unit to KMV03. It is **not** possible to connect a passive safety unit to KMV03.
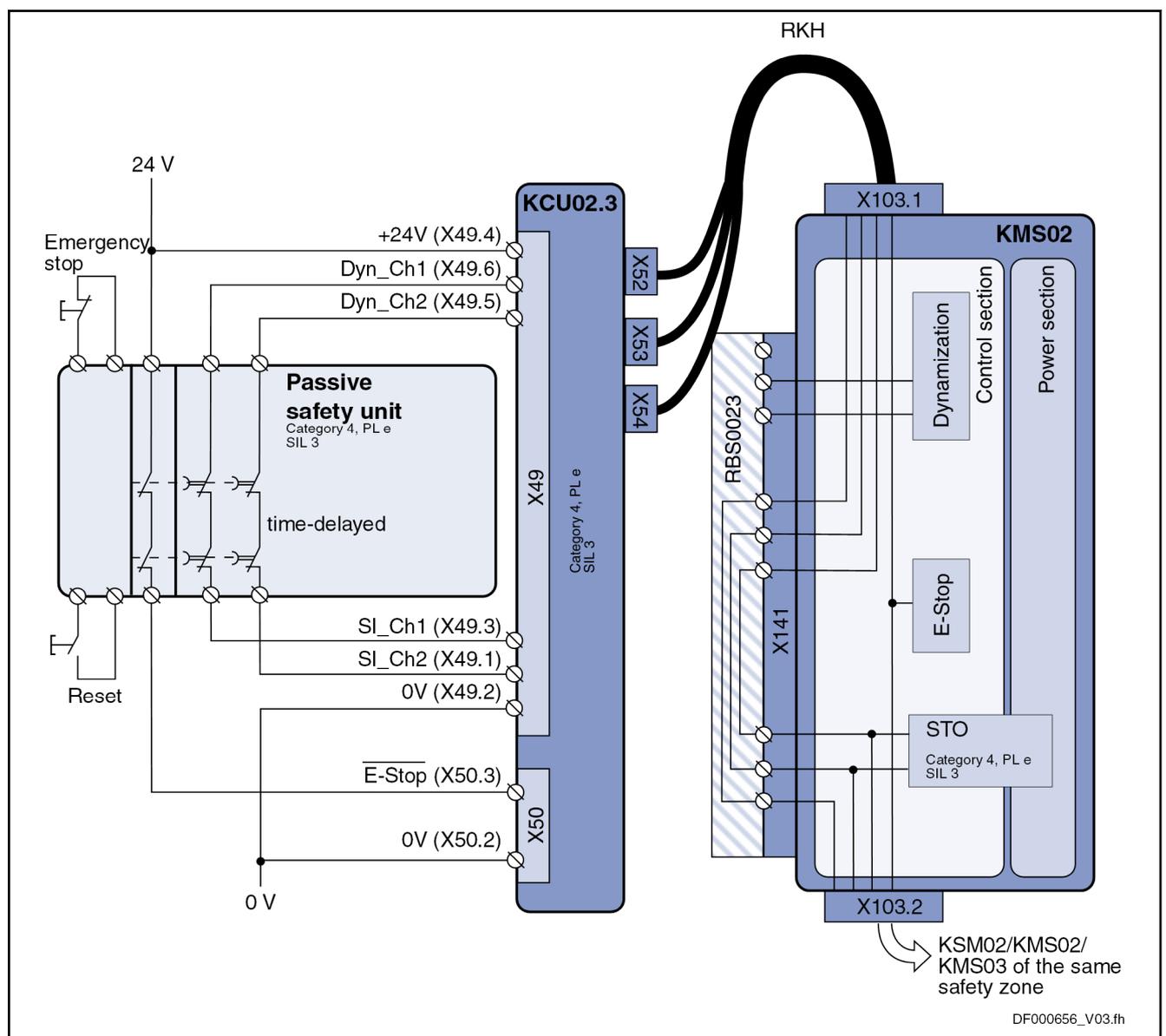

Fig. 7-13:   SS1 function via KCU02 with **dual-channel** wiring and **passive** safety unit

Examples of application

7.2.3   Distributed selection at KSM02/KMS02/KMS03

### Selection via the passive safety unit
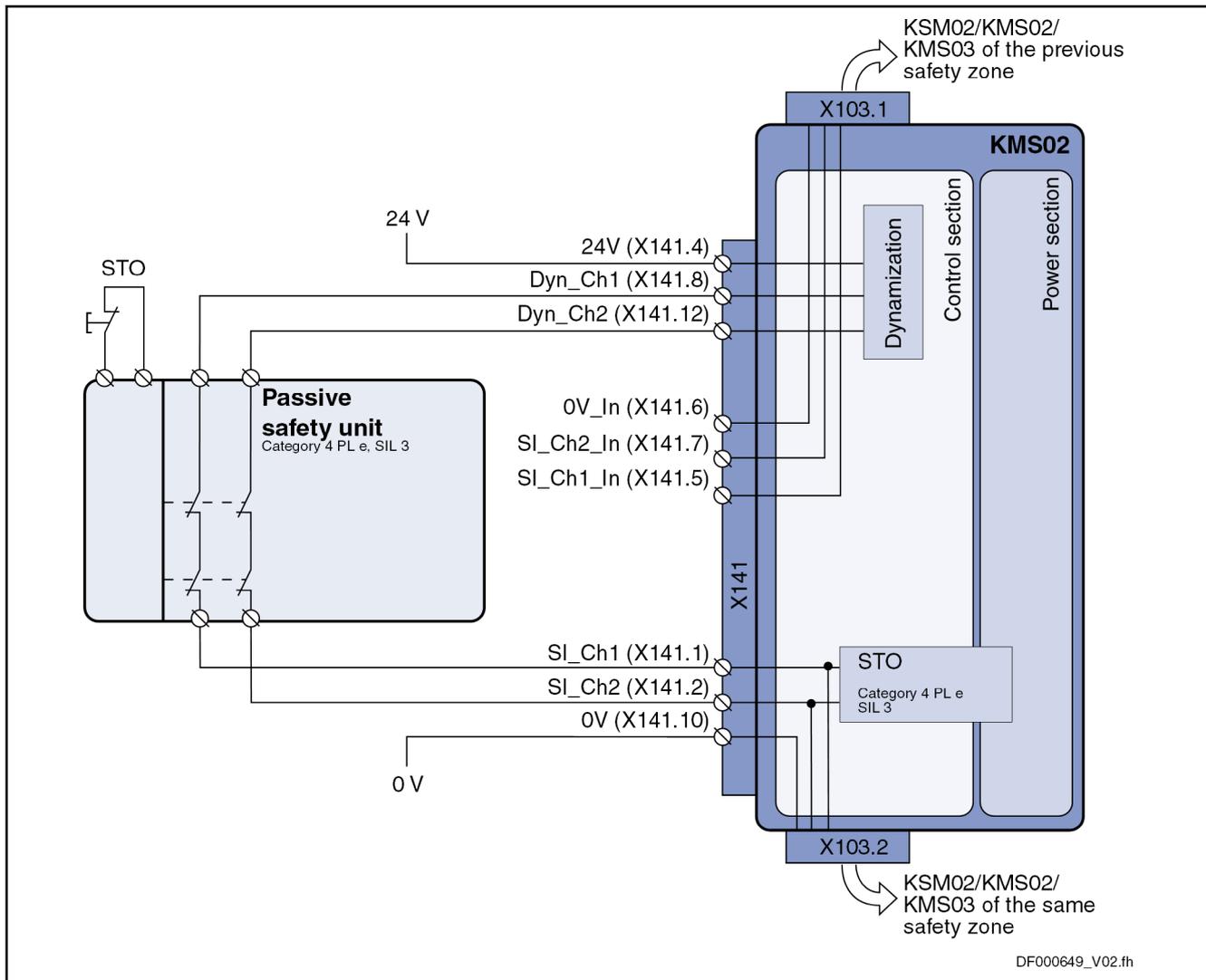
Fig. 7-14:   *KMS02 with* **dual-channel** *wiring and* **passive** *safety unit*

☞   The assignment of the dynamization signals can be selected as desired.

Selection via active safety units

Plus-minus-switching safety unit When the safety function is selected by means of a plus-minus-switching safety unit, the following errors have to be detected by the OSSD outputs:

- Short circuit of the selection signals with 24 V

- Short circuit of the selection signals with 0 V
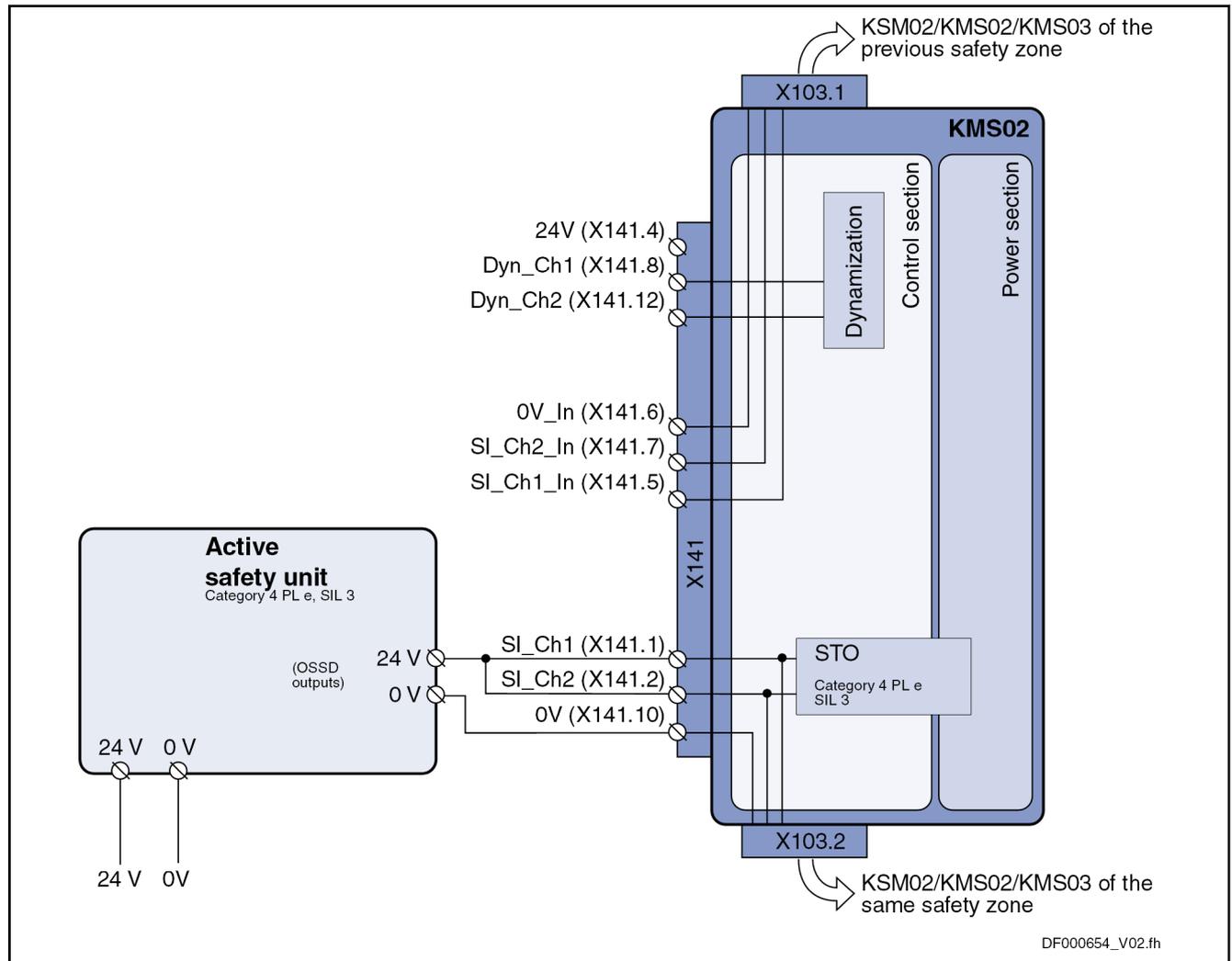
Fig. 7-15:   *KMS02 with **active** safety unit (**plus-minus-switching** outputs)*

Plus-plus-switching safety unit When the safety function is selected by means of a plus-plus-switching safety unit, the following errors have to be detected by the OSSD outputs:

- Short circuit of the selection signals with 24 V

- Short circuit between the two selection signals

Examples of application
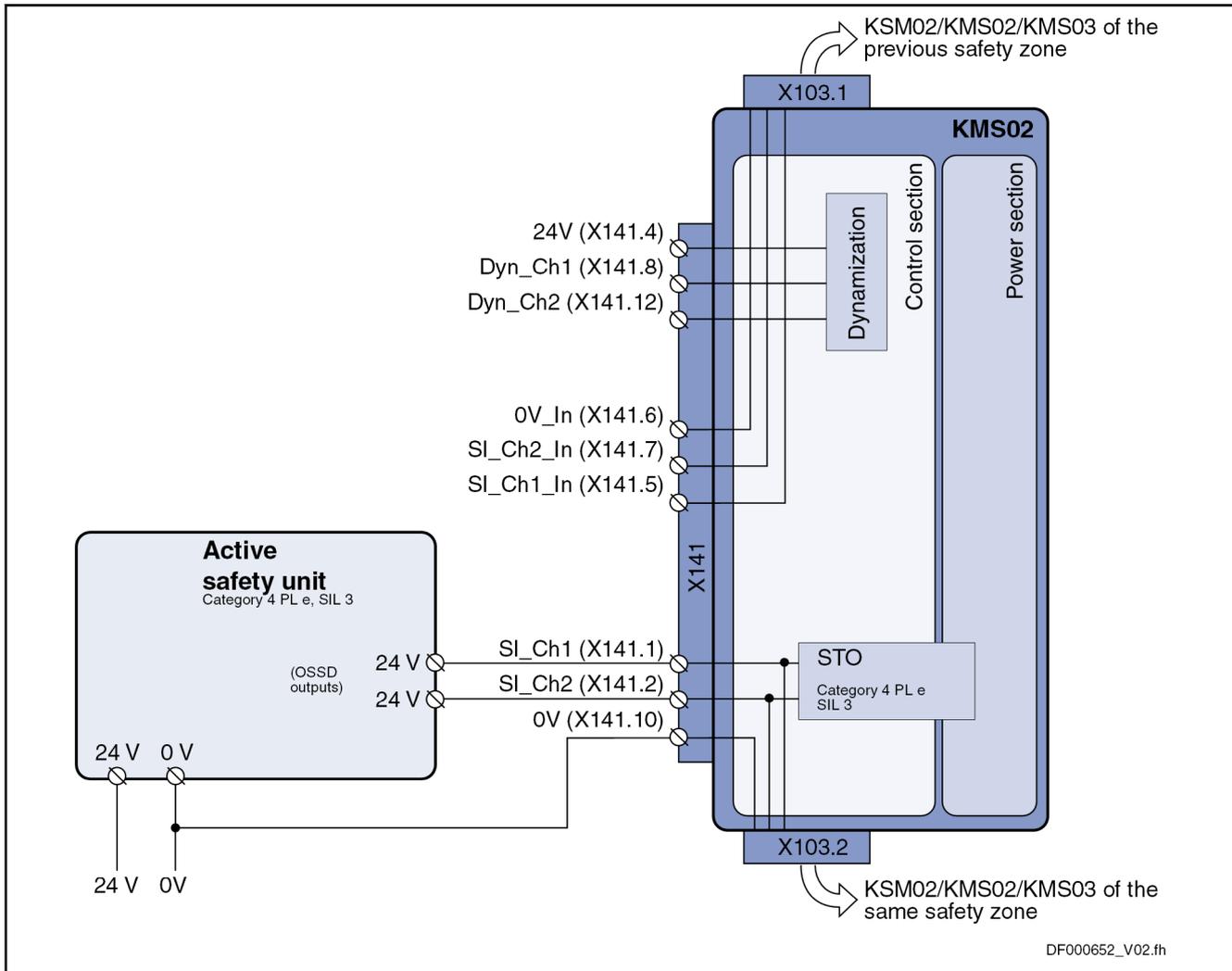
*Fig. 7-16:   KMS02 with **active** safety unit (**plus-plus-switching** outputs)*

"Safe stop 1 (Emergency stop)" function with "L3" option

Using the E-Stop function of the drive (or the NC stop of the control unit), the STO function can be extended to obtain the "Safe stop 1 (Emergency stop)" function. For this purpose, the selecting safety unit (active or passive) first has to shut down the drive by means of the E-Stop function (or the NC stop of the control unit) and select the STO function after a fixed time that has been set is over. The selection always has to take place after the time that has been set, independent of the axis state.

The figure below shows **KMS02 as a zone beginner**. The E-Stop signal is wired to a digital input [X37 (alternative: X38)] of KMS02 and can be transmitted to another node of the same safety zone via the hybrid cable.

Examples of application
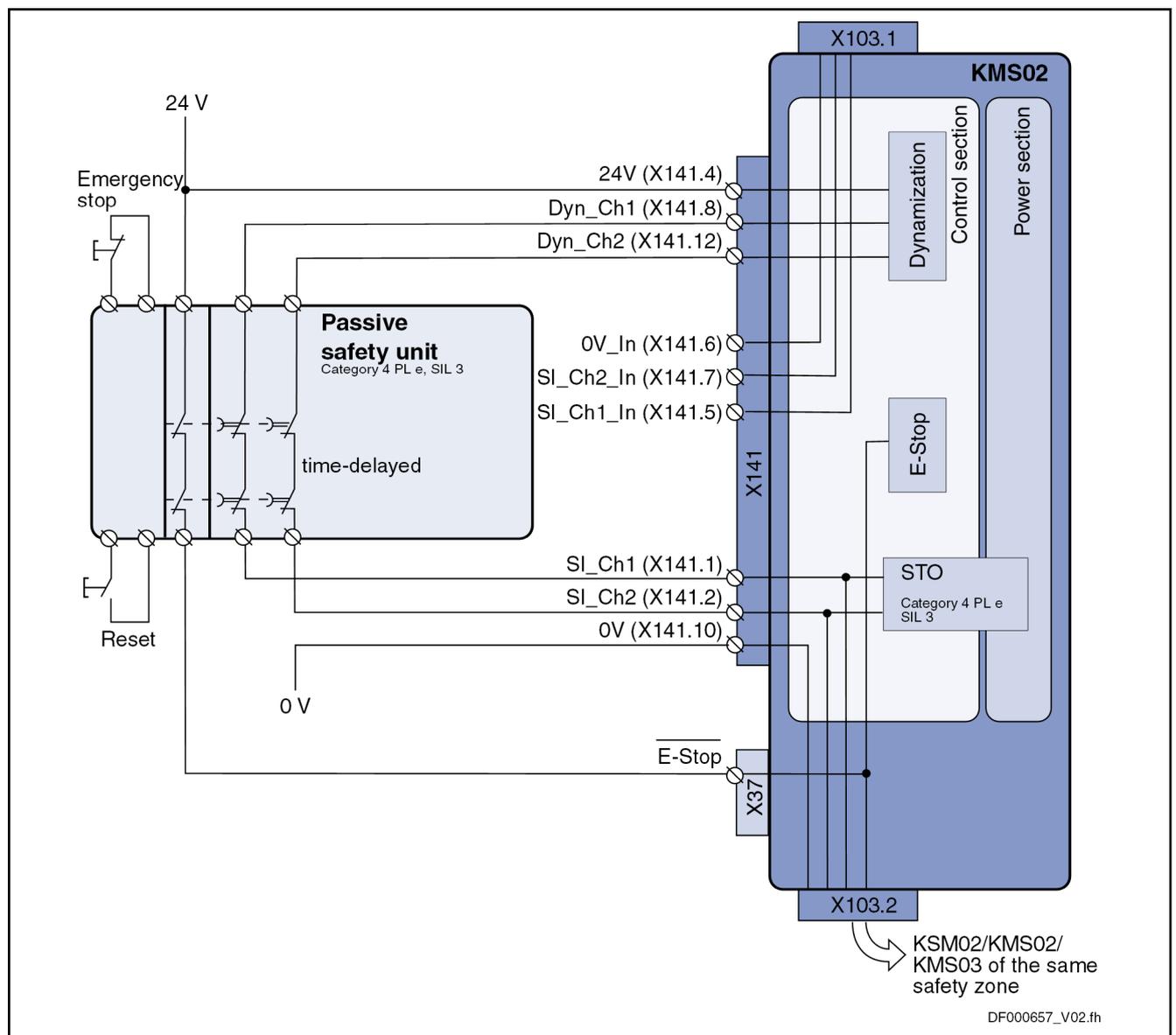
Fig. 7-17:   SS1 function via KMS02 with **dual-channel** wiring and **passive** safety unit

7.2.4   Zone setup

The figure below shows an exemplary zone setup with two safety zones.

Selection in **safety zone 1** is made via a passive safety unit at KCU02. The E-Stop function of the drive was used to extend the STO function to obtain the "Safe stop 1 (Emergency stop)" function. Drive 1 features L3 option; connector RBS0023 is plugged into X141 for transmitting the selection signals.

☞   Drive 2 does not feature L3 option. Connector RBS0023 at X141 is not required here because, in the case of devices of the KMS02/KSM02/KSM03 type without L3 option, X103.1 internally transmits the selection signals to X103.2.

Selection in **safety zone 2** is made via a passive safety unit at KMS02 (drive 3). The E-Stop function of the drive was used here as well to extend the STO

Examples of application

function to obtain the "Safe stop 1 (Emergency stop)" function. Drive 4 features L3 option.

☞   At devices of the KMS02/KSM02/KSM03 type, X141 is covered by a plastic hood in the condition as supplied. If these devices feature L3 option, X141 has to be connected:

- for transmitting the selection signals with connector RBS0023 or

- for transmitting new selection signals with cable RKB0033.

Connector RBS0023 and cable RKB0033 are described in the Appendix (see chapter 12.4 "Connectors and cables for safety technology" on page 131).
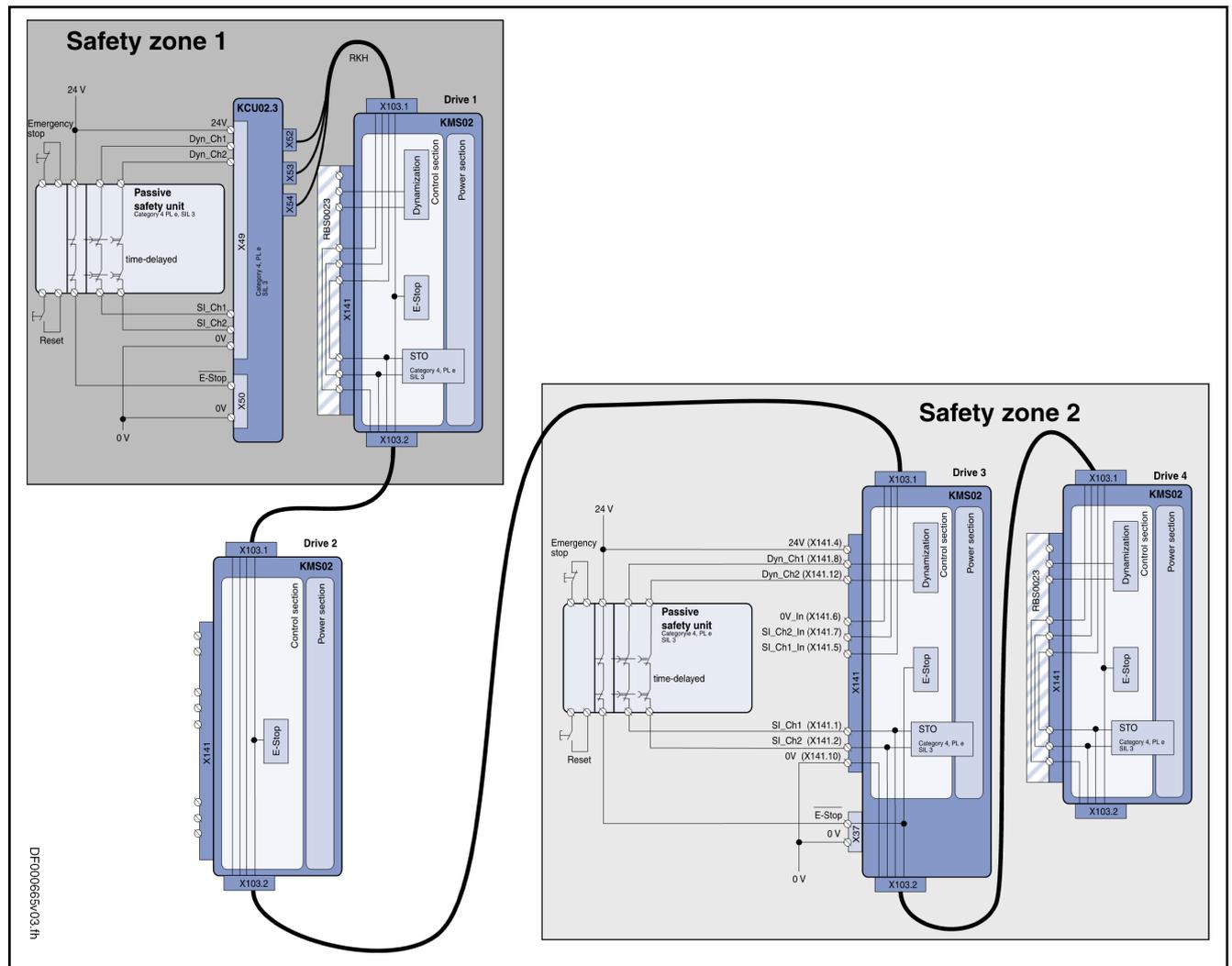
Drive 1	Selection of safety zone 1 via a passive safety unit at KCU; connector RBS0023 for transmitting the selection signals is plugged into X141
Drive 2	Without optional safety module
Drive 3	Selection of safety zone 2 via a passive safety unit
Drive 4	Node of safety zone 2; the selection signals are transmitted by drive 3 via connector RBS0023 at X141

Fig. 7-18:   Example of zone setup with two safety zones and E-Stop selection [the STO function is extended to obtain the "Safe stop 1 (Emergency stop)" function]

7.3   Mixed Operation of Optional Safety Technology Modules "L2" and "L3"/"L4"

7.3.1   Mixed Operation of Optional Safety Technology Modules "L2" and "L3"/"L4" at an Active Safety Unit

When a safety zone is to be implemented, in which drives with optional safety technology modules "L2" and "L3"/"L4" at an active safety unit are integrated, the axes must be interconnected as follows.

Examples of application
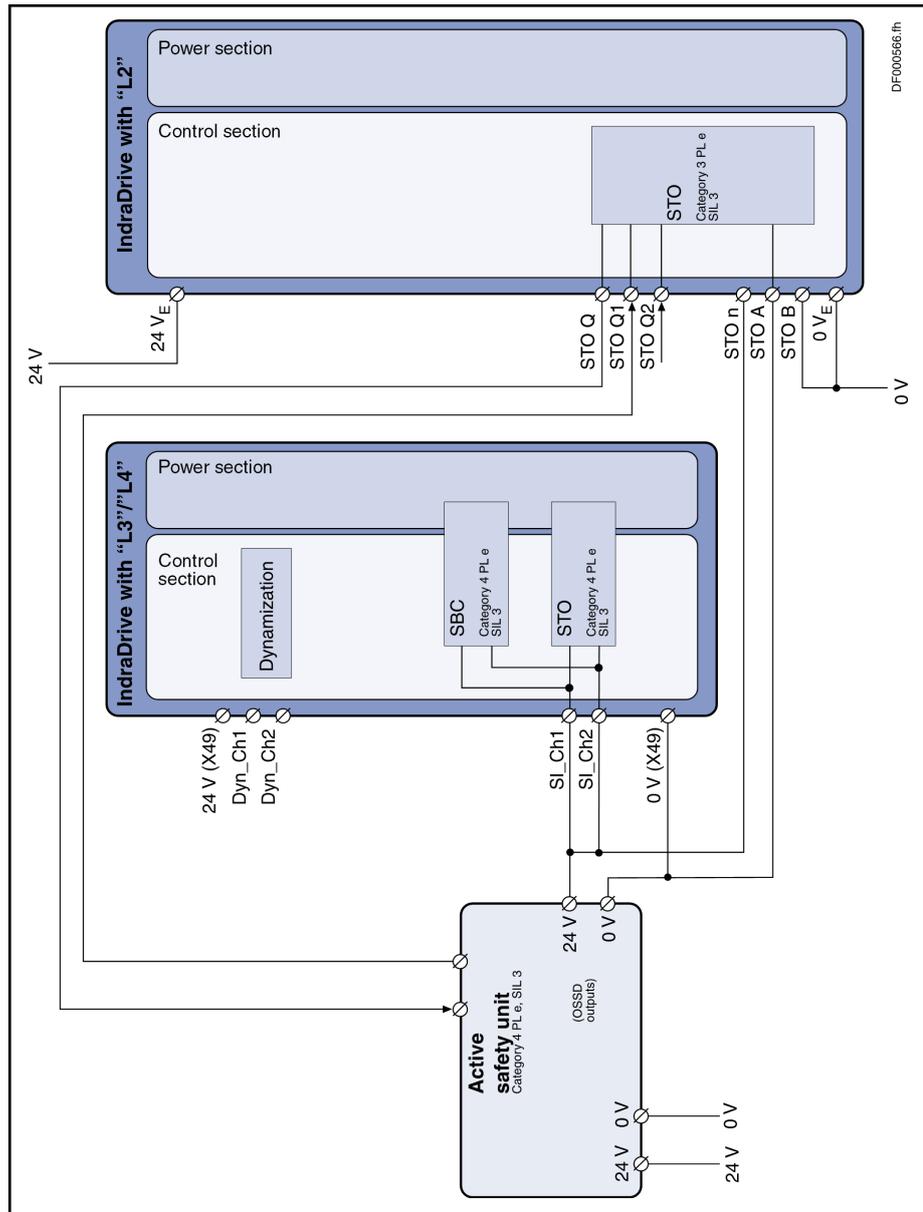
Fig. 7-19:   *Mixed Operation of Safety Options "L2" and "L3"/"L4" via an Active Safety Unit (Plus-Minus-Switching)*

The circuit illustrated above makes the following demands on the active safety unit which is used:

- Short circuits of the 0 V-switching output against 0 V/GND must be detected.

- Short circuits of the 24 V-switching output against a voltage >10 V must be detected.

- Test pulses in accordance with the requirement for optional safety technology modules "L3" or "L4" must be output.

- A cyclic test for optional safety technology modules "L2" must be made in accordance with the requirement.

- The outputs of the safety unit must be designed for the number of nodes of a safety zone.

7.3.2 Mixed Operation of Optional Safety Technology Modules "L2" and "L3"/"L4" at a Passive Safety Unit

Dual-Channel Selection of "L3"/"L4" Option

When a safety zone is to be implemented, in which drives with optional safety technology modules "L2" and "L3"/"L4" at a passive safety unit are integrated, the axes must be interconnected as follows; in this case, the dual-channel control of the "L3"/"L4" option must be used:
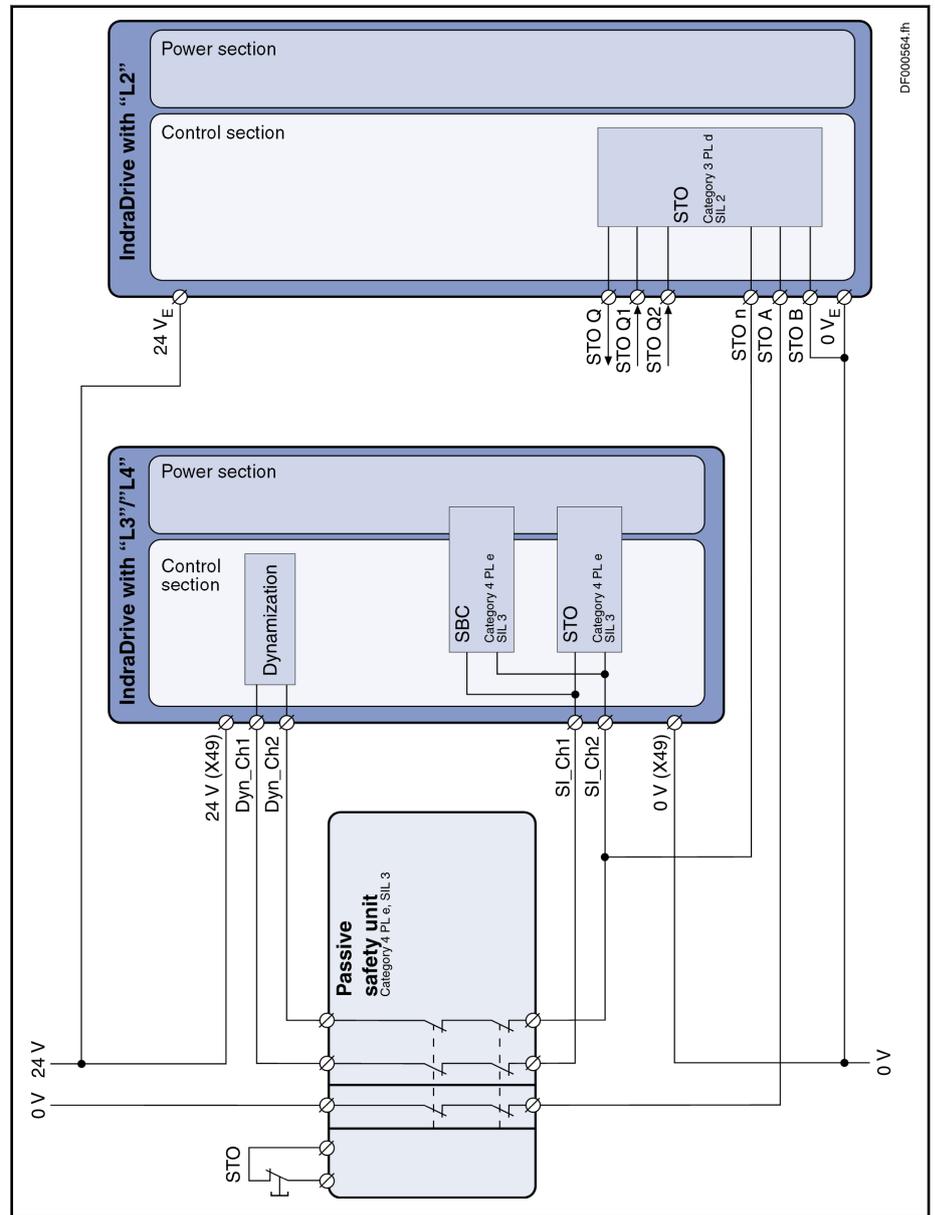

Fig. 7-20:   Mixed Operation of the Safety Options "L2" and "L3"/"L4" via Safety Switching Device (Passive Safety Unit)

The circuit illustrated above makes the following demands on the passive safety unit which is used:

- No more than 15 axes with the optional safety technology modules "L2"/"L3"/"L4" may be combined in a safety zone.

- The two outputs of the passive safety unit, which are used to control the "L3"/"L4" options, must meet the requirements of the SIL or Performance Level to be achieved.

Examples of application

- The two outputs of the passive safety unit, which are used to control the "L2" options, must meet the requirements of the SIL or Performance Level to be achieved.

- A cyclic test for optional safety technology modules "L2" must be made in accordance with the requirement.

Single-Channel Selection of the "L3"/"L4" Option

Setting up a safety zone with control via a passive safety unit, in which drives with the optional safety modules "L2" and "L3"/"L4" are integrated, and single-channel wiring of the "L3"/"L4" option are **not allowed**!
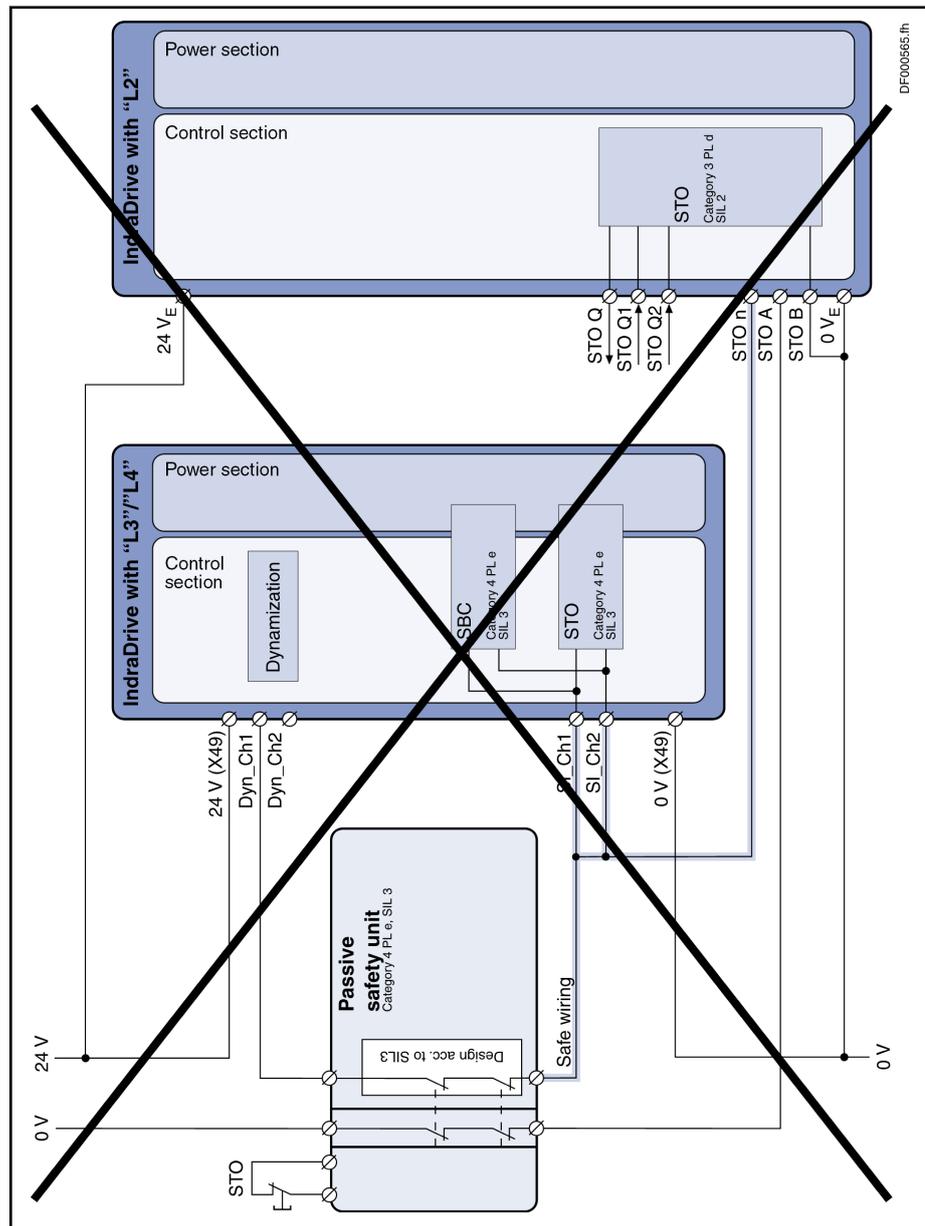

Fig. 7-21:   *Inadmissible* Mixed Operation of the Safety Options "L2" and "L3"/"L4" with Single-Channel Selection via Safety Switching Device (Passive Safety Unit)

8 Commissioning the safety technology

8.1 Safety instruction

> ⚠ **WARNING**   Dangerous movements! Danger to life, risk of injury, serious injury or property damage!
>
> **Do not commission the installation without having it checked by a qualified person!**
>
> Before an installation with integrated safety technology is commissioned for the first time, the installation must be checked and approved in documented form by a qualified person.
>
> **Check the danger zone!**
> - Before commissioning, make sure that nobody is staying in the danger zone.
> - Check the danger zone and secure it against access by persons (e.g., put up warning signs, install barriers or the like).
>
>   Observe the applicable laws and local regulations.

8.2 Prerequisites for using integrated safety technology

8.2.1 General information

The mechanical parts of power transmission, such as gear, motor, and those of the safety devices (brakes, fall-down protection, arresting device, ...) shall be designed to withstand the occurring static and dynamic stresses (e.g., dual weight of the load).

The safety factor and the dimensioning are application-specific and must be defined by the installation manufacturer or machine manufacturer.

For the maximum gear input torque, too, a safety factor in relation to the maximum motor torque must be taken into account. This, too, applies to motor-gearbox combinations by Bosch Rexroth. (See also documentation of the respective gearbox.)

> ⚠ **WARNING**   In the case of error, injury and property damage due to inadmissibly high voltage!
>
> For selection and the 24 V supply of devices with integrated safety technology, use a 24 V power supply unit with protection by **SELV**[1] in accordance with IEC 60950-1 or **PELV**[2] in accordance with IEC 60204-1.

8.2.2 Required drive firmware

The safety technology functions provided by the "L options" are functionalities only scalable by means of the hardware and do **not require any** additional **enabling of functional firmware packages**.

The integrated safety functions can be used with the following firmware versions:
- "Safe Torque Off" (L3):

[1] *Safety Extra Low Voltage*

[2] *Protective Extra Low Voltage*

Commissioning the safety technology

- – IndraDrive Cs (HCS01.1): MPx-17V06 and above
- – IndraDrive Mi (KSM02.x): MPB-17V08 and above
- – IndraDrive Mi (KMS02.x): MPB-17V10 and above
- – IndraDrive Mi (KMS03.x): MPB-20V02 and above
- – IndraDrive C (Cxx02.x control sections): MPx-18V06 and above
- – IndraDrive M (Cxx02.x control sections): MPx-18V06 and above
- – IndraDrive ML (Cxx02.5 control sections): MPx-19V02 and above

- "Safe Torque Off" **and** "Safe Brake Control" (L4) [(IndraDrive Cs (HCS01.1) only]: MPx-16V14 and above

See also Functional Description of firmware "Firmware types"

8.2.3   Required controller configuration

General information

To use the integrated safety technology of Rexroth IndraDrive controllers, the drive controller has to be configured/equipped with the corresponding optional safety technology module.

Optional safety technology module "L3"

Using the "Safe Torque Off" function requires the optional safety technology module "L3". The optional module can be ordered for the following controllers:

- IndraDrive Cs Basic (HCS01.1E-W00**-A0*-**B**)
- IndraDrive Cs Economy (HCS01.1E-W00**-A0*-**E**)
- IndraDrive Cs Advanced (HCS01.1E-W00**-A0*-**A**)
- Motor-integrated servo drive KSM**02**
- Near motor servo drive KMS**02**/KMS**03**

☞   Servo drives of the IndraDrive Mi type equipped with the optional safety module "L3" may only be operated at the drive connection box of the "KCU02.2"/"KCU02.3" or "KMV03" type.

- IndraDrive C (HCS02.1E-W00xx-A-03-xNN**N** and

  HCS03.1E-W0xxx-A-05-xxx**N**) with CSB**02** or CSH**02** control section
- IndraDrive M (HMS01, HMS02) with CSB**02** or CSH**02** control section
- IndraDrive M (HMD01) with CDB**02** control section

☞   All IndraDrive C and IndraDrive M power sections produced since 2007 can use the Cxx02 control sections. See power section type plate: "FD" has to be at least "07W01".

- IndraDrive ML (HMU05.1) with CSB**02.5** or CSH**02.5** control section

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☞   Parallel operation is only allowed for universal inverters (HMU05.1) of the same performance. Parallel operation of universal inverters (HMU05.1) with different performances is forbidden.

☞   For pin assignments and technical data of the optional safety technology module "L3", please refer to the Appendix: "X49, optional safety technology L3 or L4".

Commissioning the safety technology

Optional safety technology module "L4"

Using the "Safe Torque Off" and "Safe Brake Control" function requires the optional safety technology module "L4". The optional module can be ordered for the following controllers:

- IndraDrive Cs Basic (HCS01.1E-W00**-A0*-**B**)
- IndraDrive Cs Economy (HCS01.1E-W00**-A0*-**E**)
- IndraDrive Cs Advanced (HCS01.1E-W00**-A0*-**A**)

☞   For pin assignments and technical data of the optional safety technology module "L4", please refer to the Appendix: "X49, optional safety technology L3 or L4".

Commissioning the safety technology

8.2.4 Required motors and measuring systems

Rexroth Motors

The motor and the measuring system are not subject to any specific requirements in conjunction with the "L options" of safety technology.

For motors with integrated brake, observe the requirements mentioned in chapter "Allowed motor holding brakes".

Third-party motors / optional measuring systems

The motor and the measuring system are not subject to any specific requirements in conjunction with the "L options" of safety technology.

For motors with integrated brake, observe the requirements mentioned in chapter "Allowed motor holding brakes".

8.2.5 Allowed motor holding brakes

When a controller with an "L4 option" is used, the brake connected to the controller has to meet the following requirements:

- **Control:** When the "L4" option is used, the brake has to be designed in such a way that the holding torque of the brake takes effect in the de-energized state (e.g., electrically releasing friction surface brake).

- **Electrical connection:**
  – The electrical connections of the brake should not have ground reference.
  – The voltage range of the brake has to correspond to the supply voltage range.
  – The output voltage of the power supply has to stay within the range specified for the brake, even in the case of an error. The safety function does not provide any protection against overvoltage!
  – The brake current in the activated state has to be between 0.1 A and 1.25 A.

- **Mechanics:** When the "L4" option is used, only friction surface brakes are allowed as motor holding brakes. It is not allowed to operate form-fitting brakes as motor holding brakes. The static holding torque of the brake has to be dimensioned such that the maximum weight of the load of the axis can be safely held. If necessary, the brake has to be cyclically tested for proper functioning.

  For more detailed information on the dimensioning of the brake, please refer to the corresponding C-standard.

☞ In addition to the static holding torque of the brake, the required dynamic braking torque of the brake has to be considered. The dynamic braking torque of the brake has a direct influence on the behavior of the axis in the case of error and needs to be taken into account in the risk analysis.

- **Reliability:** The brake has to have been authorized for ambient temperatures from 0 to 40°C. Depending on the application, the brake has to cover a bigger temperature range.

- **Testing:** The brake has to tolerate test pulses (brake voltage switched off) ≤ 1 ms without switching.

Commissioning the safety technology

8.2.6 Required commissioning tools

One of the following tools is required for commissioning the optional safety technology modules "L3"/"L4":

- Any commissioning tool for visualizing and modifying parameters
- IndraWorks commissioning software
  - IndraDrive Cs and Mi: at least IndraWorks 12V04
  - IndraDrive C and M: at least IndraWorks version 13V04
  - IndraDrive ML: at least IndraWorks version 13V14

8.3 Checks before initial commissioning

The checks before the initial commissioning are meant to confirm the safety requirements stipulated in the national/international regulations (EC conformity), particularly in the Machinery Directive or the Use of Work Equipment Directive.

Check the protective equipment at the machine for effectiveness in all operation modes and functions which can be set at the machine.

Make sure that the operators - before they start working at the machine with integrated safety technology - are instructed by qualified staff of the company operating the machine. The operating company of the machine is responsible for the instruction.

8.4 Commissioning procedure

8.4.1 IndraDrive Cs/C/M/ML

Overview

The "Safe Torque Off" and "Safe Brake Control" functions are preferably commissioned using the IndraWorks commissioning software or manually.

☞ The following commissioning steps describe the commissioning procedure on the basis of IndraWorks 12V04. For commissioning with a different commissioning tool, the corresponding parameters which have to be set are listed.

⚠ DANGER	Lethal injury and/or property damage caused by unintended axis motion!

⇒ If external force influences, together with danger for persons or machines, are to be expected with the safety function "Safe Torque Off", e.g. due to the weight of the load in the case of a vertical axis, this motion must be safely prevented by additional measures, e.g. by a mechanical brake or a weight compensation.

⇒ In this case, all cases of operation occurring in the application must be taken into account, including mains failure and tripped fuses.

Commissioning the safety technology
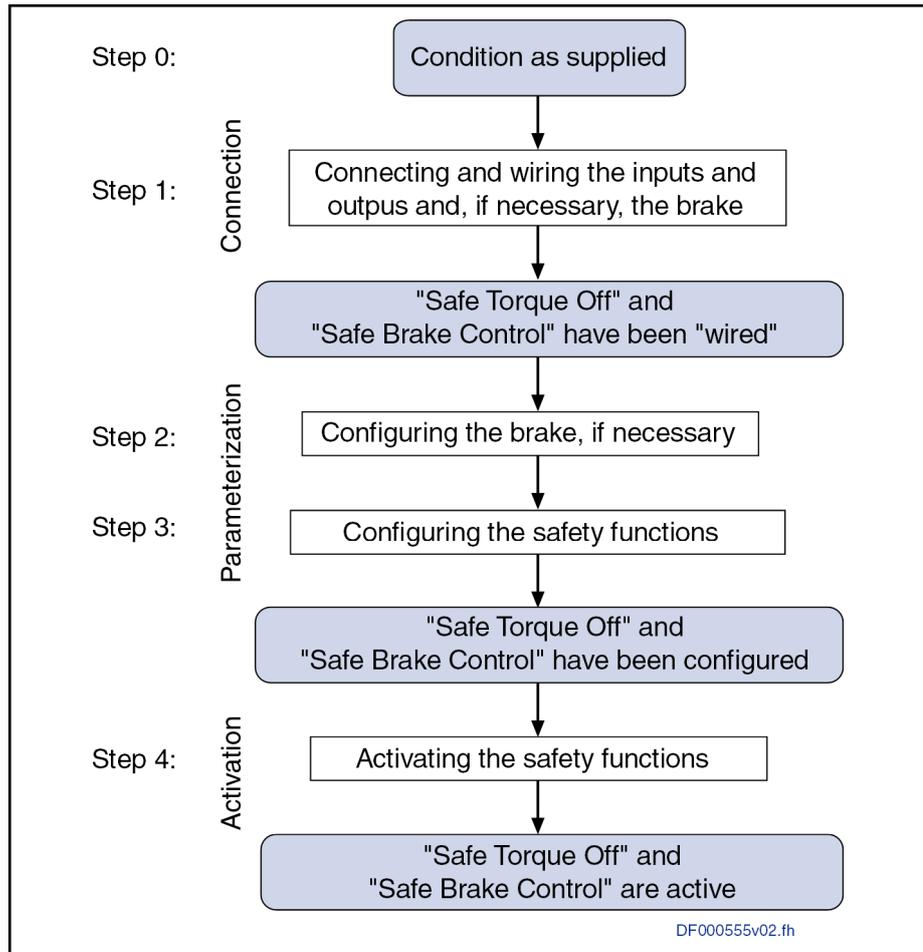
Fig. 8-1: *Overview - commissioning steps of the "Safe Torque Off" function*

Commissioning steps

Step 0: Condition as supplied and initialization

The "Safe Torque Off" and "Safe Brake Control" functions (L4 only) are always active and cannot be deactivated.

During the booting process, the drive system is in the "STO" and "SBC" operating states; i.e. the output stage and the brake (if available) have been switched off via two channels.

After the booting process, the safety functions "Safe Torque Off" and "Safe Brake Control" are active. When the drive is switched from **operating mode to parameter mode**, the functionality of the functions "Safe Torque Off" and "Safe Brake Control" is maintained, i.e. according to the selection, the functions "Safe Torque Off" and "Safe Brake Control" become active or not.

Step 1: Connecting and wiring the "Safe Torque Off" and "Safe Brake Control" function (L4 only)

The connection and wiring of the "Safe Torque Off" and "Safe Brake Control" function depends on the option used to make the selection at the drive. The "Examples of application" chapter shows the different options of selection and wiring.

The inputs and outputs at the connector X49 of the optional safety technology module have to be wired in accordance with the type of safety unit (active or passive) and on the wiring type (single-channel or dual-channel, plus-plus-switching or plus-minus-switching):

- The dynamization outputs Dyn_Ch1 (X49/6) and Dyn_Ch2 (X49/5) in the case of selection via a passive safety unit

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- The selection inputs SI_Ch1 (X49/3) and SI_Ch2 (X49/1) always
- The 24V supply of the X49 connector (X49/4) in the case of selection via a passive safety unit
- The 0V supply of the X49 connector (X49/2) always

Step 2: Configuring the brake When a holding brake is used, the brake connected to X6 has to be configured. (Call the IndraWorks dialog: **Motor, brake, measuring systems ▸ Brake**.)
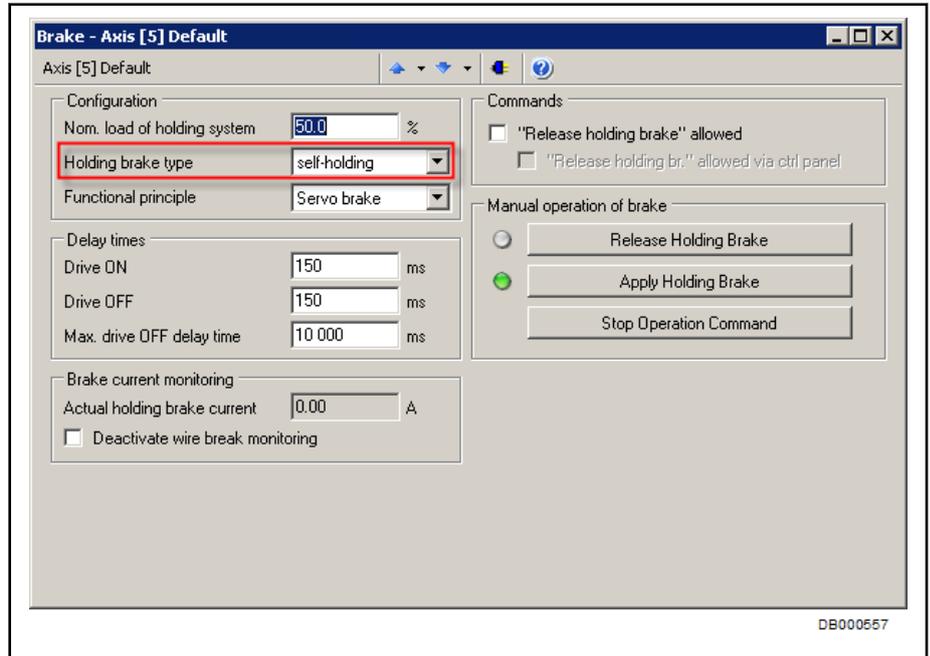

Fig. 8-2:   IndraWorks "Brake" dialog

Switch the drive to the parameter mode (phase 2 or PM) before starting the parameter setting. The "Configuration" field of the IndraWorks "Brake" dialog is used to parameterize the connected brake; in this dialog, configure "self-holding" as the holding brake type when using the optional safety technology module "L4", because only electrically releasing brakes are allowed with the optional module "L4". (P-0-0525, Holding brake control word).

Step 3: Configuring the safety function With MPx17V08 and above, it is possible to configure the diagnostic message output and the error reaction of the L options. The configuration can be made in IndraWorks. (Call the configuration dialog in IndraWorks: **Drive-integrated safety technology ▸ Configuration**.)

Commissioning the safety technology

Fig. 8-3:   *IndraWorks "Configuration" dialog*

- Switch the drive to the parameter mode (phase 2 or PM).

- Use the field "Reaction in special mode (...) when external drive enable already set" to select which diagnostic message the drive is to output when drive enable had been set when the special mode was selected.

> In the case of installations for which it is impossible to ensure that drive enable is removed before the special mode is selected (e.g., drive enable removed by opening the safety door), the "warning E8027" should be parameterized for "Reaction in special mode (...) when drive enable already set".

The corresponding parameter is "P-0-0101, Configuration STO/SBC".

- The "Diagnostic message output" field is used to limit the error output in the operating mode (OM), after the initialization of the axis and before drive enable is set for the first time.

> When the L option is selected by external components which output invalid selection states during initialization, "Limited diagnostic message" should be parameterized.

The corresponding parameter is "P-0-0101, Configuration STO/SBC".

Step 4: Activating / deactivating the safety function

> ☞ Before selecting the safety functions "Safe Torque Off" and "Safe Brake Control" (L4 only), shut down the drive system using the command value input and reset drive enable. There is no drive-controlled stopping process!

The safety functions "Safe Torque Off" and "Safe Brake Control" are automatically activated after the booting process. They cannot be deactivated.

8.4.2   IndraDrive Mi

Overview

The "Safe Torque Off" function can be commissioned for the IndraDrive Mi system, preferably via the IndraWorks commissioning software or manually.

☞   The following commissioning steps describe the commissioning procedure on the basis of IndraWorks 12V04. For commissioning with a different commissioning tool, the corresponding parameters which have to be set are listed.

⚠ **DANGER**	**Lethal injury and/or property damage caused by unintended axis motion!**

⇒ If external force influences, together with danger for persons or machines, are to be expected with the safety function "Safe Torque Off", e.g. due to the weight of the load in the case of a vertical axis, this motion must be safely prevented by additional measures, e.g. by a mechanical brake or a weight compensation.

⇒ In this case, all cases of operation occurring in the application must be taken into account, including mains failure and tripped fuses.


Fig. 8-4:   Overview - commissioning steps of the "Safe Torque Off" function

Commissioning the safety technology

Commissioning steps

Step 0: Condition as supplied and initialization

The "Safe Torque Off" function is always active and cannot be deactivated.

During the booting process, the drive system is in the "STO" operating status; i.e., the output stage has been switched off via two channels.

After the booting process, the safety function "Safe Torque Off" is active. When the drive is switched from **operating mode to parameter mode**, the functionality of the "Safe Torque Off" function is maintained, i.e. according to the selection, the "Safe Torque Off" function becomes active or not.

Step 1: Connecting and wiring the "Safe Torque Off" function

The connection and wiring of the "Safe Torque Off" function depends on the option used to make the selection at the drive, the drive connection box KCU02 or the distributed supply unit.

The "Examples of application for IndraDrive Mi" chapter shows the different options of selection and wiring.

The table below shows the dependancies of the optional safety technology module wiring:

		KCU02	KMV03	KSM02 / KMS02 / KMS03 as zone beginner	KSM02 / KMS02 / KMS03 as zone node
Selection via a passive safety unit	Dynamization outputs Dyn_Ch1 and Dyn_Ch2	X49/6 and X49/5	- (Selection via a passive safety unit not possible)	X141/8 and X141/12	Connector RBS0023 at X141 Hybrid cable at X103.1 / X103.2
	Selection inputs SI_Ch1 and SI_Ch2	X49/3 and X49/1		X141/1 and X141/2	
	24V supply	X49/4		X141/4	
	0V supply	X49/2		X141/10	
Selection via an active safety unit	Dynamization outputs Dyn_Ch1 and Dyn_Ch2	-	-	-	
	Selection inputs SI_Ch1 and SI_Ch2	X49/3 and X49/1	X141/1 and X141/2	X141/1 and X141/2	
	24V supply	-	-	-	
	0V supply	X49/2	X141/10	X141/10	

Step 3: Configuring the safety function

The diagnostic message output and the error reaction of the L options can be configured. The configuration can be made in IndraWorks. (Call the configuration dialog in IndraWorks: **Drive-integrated safety technology ▶ Configuration**.)

Commissioning the safety technology

Fig. 8-5:   *IndraWorks "Configuration" dialog*

- Switch the drive to the parameter mode (phase 2 or PM).

- Use the field "Reaction in special mode (...) when external drive enable already set" to select which diagnostic message the drive is to output when drive enable had been set when the special mode was selected.

> In the case of installations for which it is impossible to ensure that drive enable is removed before the special mode is selected (e.g., drive enable removed by opening the safety door), the "warning E8027" should be parameterized for "Reaction in special mode (...) when drive enable already set".

The corresponding parameter is "P-0-0101, Configuration STO/SBC".

- The "Diagnostic message output" field is used to limit the error output in the operating mode (OM), after the initialization of the axis and before drive enable is set for the first time; for this purpose, select "Limited diagnostic message".

> When the L option is selected by external components which output invalid selection states during initialization, "Limited diagnostic message" should be parameterized.

The corresponding parameter is "P-0-0101, Configuration STO/SBC".

Step 4: Activating / deactivating the safety function

☞ Before selecting the safety function "Safe Torque Off", shut down the drive system by means of the command value input and reset drive enable. There is no drive-controlled stopping process!

The safety function "Safe Torque Off" is automatically activated after the booting process. It cannot be deactivated.

Commissioning the safety technology

8.5   Control unit requirements

Optional safety technology modules "L3" and "L4"

The control unit is subject to the following requirements in conjunction with the optional safety technology modules "L3" and "L4":

- Before selecting the safety function, shut down the drive by means of the command value input and disable the drive torque.

- When the safety function is selected via the control unit, the selection has to comply at least with the required safety level of the application.

- When the safety function is selected via isolated selection contacts (passive safety unit), it has to be ensured that the test pulses described in chapter "Dynamization" are not inhibited.

  - or -

  The control unit features OSSD outputs (active safety unit) and has to monitor the wiring between the control unit and the safety option, as well as detect errors in the wiring.

9   Troubleshooting information

9.1   Introduction

For diagnostics (error messages, warnings and operating status messages) and servicing (firmware and hardware replacement), it is necessary to make oneself familiar with some of the functions/elements using the Functional Description of the firmware:

- Control panel and
- Parameter handling

The paragraphs below mainly explain the aspects relevant to integrated safety technology in detailed form.

The paragraphs are divided into:

- Overview of diagnostic system (e.g., logbook parameters and parameters containing information on the hardware configuration) ("Diagnostic system")
- Diagnostic messages of integrated safety technology

9.2   Diagnostic system

9.2.1   General information

The general diagnostic system of IndraDrive is explained in detail in the Functional Description of the firmware where you can read more about it, if required (see also index entry "Diagnostic system").

The following parameters are used in conjunction with the diagnostic system:

- S-0-0095, Diagnostic message
- S-0-0375, List of diagnostic numbers
- S-0-0390, Diagnostic message number
- P-0-0009, Error number (MPx18 and below)
- P-0-0478, Logbook event
- P-0-0479, Logbook time stamp

Axis or device configuration   A drive controller consists of several components (power section, control section, firmware,...); each of them has its own identifier in the form of a parameter (see also Functional Description of firmware "Device configuration").

Identifiers useful for the purpose of diagnostics and service are stored in the following parameters:

- S-0-0140, Controller type
- S-0-0141, Motor type
- S-0-0142, Application type
- P-0-1518, Module code of control section
- P-0-1519, Module code of power section
- P-0-1520, Control section type
- S-0-0030, Manufacturer version

Electronic type plate   With the firmware MPx-18 and above, the (electronic) type plate of a component is represented in the following parameters:

- S-0-1300.x.1, Component Name

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- S-0-1300.x.3, Vendor Code
- S-0-1300.x.4, Device Name
- S-0-1300.x.5, Vendor Device ID
- S-0-1300.x.8, Hardware version
- S-0-1300.x.9, Software version
- S-0-1300.x.11, Order Number
- S-0-1300.x.12, Serial Number

9.3   Diagnostic messages of integrated safety technology

9.3.1   Overview

For integrated safety technology, we distinguish operating states **normal operation** and **special mode**; in both operating states, the triggering of a monitoring function causes an error of category F3xxx or F8xxx.

Apart from the error and warning messages, the operating states of integrated safety technology are displayed in individual parameters (status messages).

9.3.2   Status information of integrated safety technology

For diagnostic purposes, the following pieces of status information are made available for integrated safety technology (the pieces of status information are **not** allowed for the safety-relevant evaluation):

- Parameter "P-0-0106, Operating status STO/SBC" provides binary status signals for online monitoring of the safety technology states. By means of this status word, the individual status signals can be optionally programmed to existing real-time bits of the master communication or hardware I/Os or I/O extensions.

- Description of the status display dialog in IndraWorks 13:

☞   The dialog described below is displayed for devices with optional safety technology module "L4". For devices with optional safety technology module "L3", only "STO" is displayed instead of "STO / SBC"; the information content (status information) is identical for both optional modules.

The "STO / SBC status" field of the IndraWorks dialog "Diagnostics" can be used to diagnose the following aspects (calling the Diagnostics dialog in IndraWorks: **Drive-integrated safety technology ▶ Diagnostics**):

- "STO / SBC in normal operation" is active (green), if the safety functions have not been selected or a safety technology error was detected.
- "STO / SBC in special mode" is active (green), if the safety functions have been selected and are active.
- "Output stage locked by STO / SBC" is active (red), if the safety technology has locked the output stage.
- "Error" is active (red), if a safety technology error was detected.
- "Limited diagnostic message" is active (green), unless the axis has been in control (AF) after the initialization. In this state, selection errors are not output so that external components for selection have enough time for initialization.

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– "Complete diagnostic message" is active (green), if the axis has been in control after the initialization. Safety technology error messages are not suppressed.
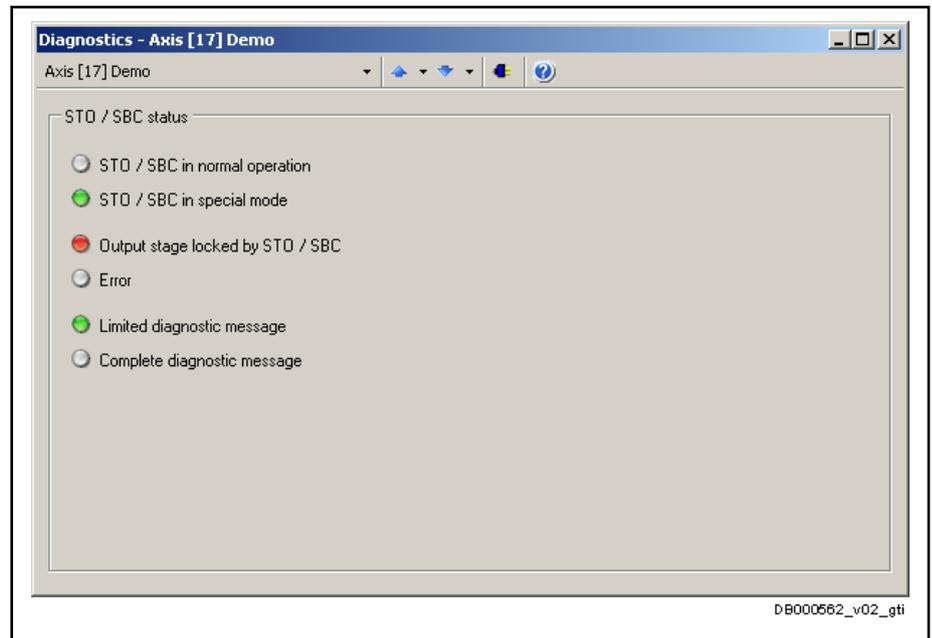

Fig. 9-1:   IndraWorks "Diagnostics" dialog

9.3.3   Behavior in the case of non-fatal safety technology errors (F3xxx)

If optional safety technology modules "STO" (L3) or "STO and SBC" (L4) are used, the behavior of the drive when non-fatal safety technology errors occur can be configured with "P-0-0119, Best possible deceleration" and "P-0-0117, Activation of NC reaction on error".

At the end of the error reaction, the drive goes torque-free (see also Functional Description of firmware "Error reaction").

Commissioning steps   The drive can only be put into operation again, if:

1. The error reaction has been completed, i.e. the drive has stopped (velocity="0"!).

2. The cause of the error was removed.

3. The error message has been cleared by the error clearing command (cf. "S-0-0099, C0500 Reset class 1 diagnostics").

4. The drive is in the operating mode again and power has been switched on ("Ab").

5. Drive enable has been switched on again (positive edge).

☞   In case non-fatal safety technology errors are occurring repeatedly, contact our service department as operating the drive then is no longer allowed.

9.3.4   Behavior in the Case of Fatal Errors (F8xxx)

Generally, there are 3 types of fatal errors (F8 errors):

• Fatal errors during initialization (e.g. F81xx)

• Fatal errors during operation (e.g. F80xx)

• Fatal safety technology errors (F83xx)

Troubleshooting information

Fatal Errors During Initialization (Initialization Errors)

Fatal initialization errors cannot be cleared but require that the drive be restarted.

💡 The drive can be restarted either by removing the 24-V supply or (as of MPx17V08) by starting the "Reboot command" (C6400).

Fatal Errors During Operation

When a fatal error occurs during operation, control (or U/f control) of the drive is no longer ensured; therefore, drive enable is immediately removed in case of these errors and the holding brake - if available - is switched on. Depending on the setting in "P-0-0119, Best possible deceleration", bit 8, D.C. braking can be additionally activated.

☞ With the corresponding setting in "P-0-0118, Power supply, configuration", the power supply is disconnected in the case of fatal errors.

Fatal Safety Technology Errors

When a fatal safety technology error occurs, the safety technology immediately locks the output stage via two channels (in the case of an error in the output stage interlock, possibly via one channel only) (STO) and - if available and configured - switches the holding brake on (SBC). D.C. braking (P-0-0119, bit 8) is no longer possible.

☞ With the corresponding setting in "P-0-0118, Power supply, configuration", the power supply is disconnected in the case of fatal safety technology errors.

See also Application Manual "Error Reactions"

Commissioning Steps

After a fatal error has occurred, the drive can only be put into operation again after the following steps were carried out:

1. The cause of the error must be recognized and removed; this possibly means that an entire component (e.g., motor or drive controller) must be replaced.

2. The error message must be cleared by the error clearing command [cf. "S-0-0099, C0500 Reset class 1 diagnostics"] (for this purpose, it might possibly be necessary to switch to the parameter mode or to switch the drive off completely).

3. The drive must be in the operating mode again and power must be switched on again ("Ab").

4. Drive enable must be switched on again (positive edge).

☞ In case fatal errors are occurring repeatedly, contact our service department as operating the drive then is no longer possible.

9.4 Removing malfunctions, maintenance measures, deactivating the motors

☞ When removing malfunctions, performing maintenance measures or deactivating the motors, observe the safety instructions in chapter "Safety instructions for electric drives and controls"!

In the case of malfunctions, maintenance measures or to deactivate the motors, proceed as follows:

● Observe the instructions contained in the machine documentation.

- Use the machine-side control commands to bring the drive to a controlled standstill.
- Switch off the power voltage and control voltage of the controller.
- Only for motors with fan unit: Switch off the motor circuit breaker for the fan unit.
- Switch off the main switch of the machine.
- Secure the machine against accidental movements and against unauthorized operation.
- Wait to allow the electric systems to discharge and then disconnect all electrical connections.
- Before dismounting them, secure the motor and, if necessary, the fan unit against falling or moving, before unfastening the mechanical connections.

9.5 Replacing drive components

9.5.1 General information

☞ When replacing drive components, observe the safety instructions in the chapter "Safety instructions for electric drives and controls"!

The following chapters only describe the replacement of drive components which ensure safe operation. The replacement of other drive components is described in the respective Project Planning Manuals.

9.5.2 Replacing the motor

⚠ **WARNING**   **Lethal electric shock by live parts with more than 50 V!**

The supply unit may only be replaced by qualified personnel which have been trained to perform the work on or with electrical devices.

☞ The motor should be replaced by a motor of identical type. Only by doing this is it ensured that all parameter settings can remain unchanged; in addition, it is not required in this case to repeat the acceptance test within the scope of the function "Integrated safety technology".

1. If necessary, write down last absolute value
2. Open main switch
3. Make sure main switch cannot be switched on again
4. Disconnect plug-in connectors

☞ When replacing the motor, cover the open mating sites of power lines with protective caps if sprinkling with cooling liquid/lubricant or pollution may occur (allowed pollution degree according to EN50178: 2).

5. Replace motor

☞ To mechanically replace the AC servo motor, observe the instructions of the machine manufacturer.

Troubleshooting information

6. Connect plug-in connectors
7. **WARNING!** Risk of accident caused by unwanted axis motion! Servo axes with indirect distance measuring system via the motor encoder will lose their position data reference when the motor is replaced!

   This position data reference to the machine coordinate system must therefore be reestablished after replacement.

9.5.3 Replacing the brake

| ⚠ WARNING | Dangerous movements! Danger to persons from falling or dropping axes! |

While the brake is replaced, secure the axis by a blocking device or by moving the axis to a safe end position.

☞ The same type of brake must be used after replacement.

9.5.4 Mounting and dismounting control sections and optional cards

| *NOTICE* | Risk of damage from improper handling! |

Only those trained by Rexroth for mounting and dismounting control sections and optional cards are allowed to perform these actions.

| *NOTICE* | Risk of damage and impairment to operational safety from electrostatic charges! |

Exposed conductive parts coming into contact with control sections and optional cards must be discharged beforehand through grounding.

Such exposed conductive parts include:
- The human body (grounding by touching a conductive, grounded object)
- Parts and tools (place them on a conductive surface)

Control sections and optional cards may only be stored or shipped in conductive packaging.

| *NOTICE* | Risk of damage from frequent mounting and dismounting! |

A control section or an optional card may only be mounted and dismounted a maximum of **20 times**.

How to proceed

1. Loosen the mounting screws of the control section, optional card or blank cover.
2. Carefully remove the control section or optional card from the slot.
3. Mounting is the reverse of dismounting.

9.5.5   Replacing the controller

Overview

A controller of the IndraDrive range consists of the components power section, control section and programming module / control panel (incl. firmware). The control section may be configured with additional components (e.g. optional safety technology module). The control section and power section are firmly connected to each other; only Rexroth service engineers or especially trained users are allowed to replace individual components. The paragraphs below describe how to replace the complete drive controller.

☞   The controller has to be replaced by a device of identical type. This is the only way to ensure that the originally configured functions can be used in unchanged form.

When using devices with integrated safety technology, make sure by organizational measures that only an authorized person replaces the device, e.g., by a lockable control cabinet. Also make sure that the device replacement is not carried out for several axes at a time to avoid accidentally interchanging the axes.

💡   A device intended for replacement that has already been in operation (thus is not in the factory-new condition as supplied), has to be brought to the condition as supplied again ["load defaults procedure (factory settings)", command C0750] before it is used.

The figure below illustrates the basically required individual steps.
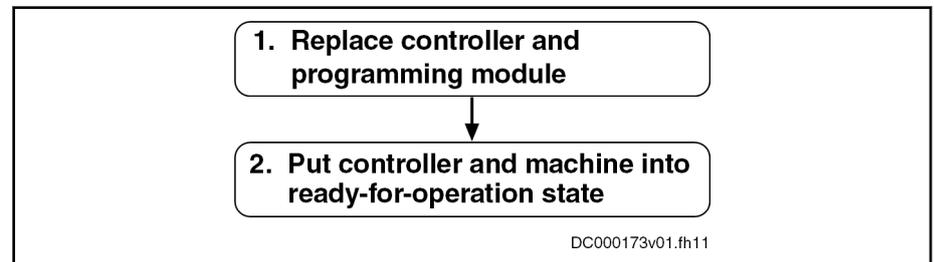
Fig. 9-2:   Sequence of drive controller replacement

☞   The "IndraDrive Service Tool (IDST)" allows accessing the drive system, e.g. for remote diagnostics. Besides, authorized users can handle different service cases with IDST, such as replacing drive components, loading parameters or updating/upgrading the drive firmware.

Further information on "IndraDrive Service Tool (IDST)" is described in the separate documentation „Rexroth IndraDrive Service Tools IMST/IDST" (DOK-IM*MLD-IMSTIDSTV13-RE**-EN-P; mat. no. R911342651).

How to proceed when replacing drive controllers

Replacing the drive controller and the programming module

1. Open the main switch
2. Make sure the main switch cannot be switched on again.
3. Make sure drive controller is de-energized.

Troubleshooting information

> **WARNING!** Lethal electric shock from live parts with more than 50 V! Before working on live parts: De-energize system and secure power switch against unintentional or unauthorized reconnection. Wait at least **30 minutes** after switching off the supply voltages to allow **discharging**. Make sure voltage has fallen below 50 V before touching live parts.

4. Separate connection lines from controller.

5. Dismount drive controller from control cabinet.

6. Dismount programming module / control panel

   - With IndraDrive C/M/Cs: Pull off programming module / control panel from defective device.

   - With IndraDrive Mi: Remove programming module (X107) from defective device, note down positions of address selector switches S4 and S5 (address selector switches below connections X103.1 and X103.2).

7. Mount programming module / control panel

   - With IndraDrive C/M/Cs: Plug programming module / control panel of defective device onto new controller.

   - With IndraDrive Mi:

     1. Set the address selector switches in the same way as for the defective device.

     2. Dismount cover above slot X107.

     3. Plug programming module of defective device onto replacement device.

     4. Mount cover above slot X107.

        NOTE: Damage to the programming module caused by penetrating dirt or moisture. When mounting the cover of X107, make sure that the sealing ring is undamaged and is seated correctly.

8. Mount new controller.

☞   The controller has to be replaced by a device of identical type. This is the only way to ensure that the originally configured functions can be used in unchanged form.

---

9. Connect device according to machine circuit diagram

Putting drive controller and machine into ready-for-operation state

1. Restore control voltage.

2. Put machine into ready-for-operation state again according to the machine manufacturer's instructions.

3. Activate safety technology (only with active Safe Motion with Sx-option)

   With single-axis devices, the following message appears on the display of the control panel during the booting process:

   "Load new Safety?"

   With double-axis devices, the following message appears on the display of the control panel during the booting process:

   ".1 Load new Safety?" for Axis 1 or **".2 Load new Safety?"** for Axis 2

   Pressing the "Enter" key at the control panel acknowledges the message. The safety technology parameters are now loaded from the control panel to memory of the optional safety technology module.

☞ IndraDrive Mi does not feature a control panel; this is why the parameter image of safety technology has to be activated by executing the command "P-0-3231.0.3, C8300 SMO: Command Activate parameter image", e.g., using IndraDrive Service Tool (IDST).

The error "F8330, SMO: Configuration data record has not been activated" generated during boot-up signals that the active image identifier on the programming module does not comply with the image identifier that was stored on the safety technology hardware. After the command C8300 has been successfully executed, the error must be cleared by the "clear error" command (C0500). The command execution is described in the Functional Description of the firmware, see chapter "Command processing".

4. Check functions of the drive.

5. Check safety technology parameters (only with active Safe Motion with Sx-option)

Completing the process, it is necessary to check, with activated safety technology, whether the correct safety technology parameters have been loaded for the drive.

The replacement of the device has to be recorded in the machine logbook. For this purpose, the data of the following safety technology parameters have to be accordingly documented and checked for correctness (these data can be queried via the control panel in the "SMO Info" menu; for IndraDrive Mi, the data have to be read, e.g. by means of the IndraDrive Service Tool (IDST), because IndraDrive Mi does not feature a control panel):

- P-0-3230, SMO: Password level
- P-0-3235.0.1, SMO: Active axis identifier
- P-0-3234.0.1, SMO: Configuration checksum
- P-0-3234.0.2, SMO: Operating hours at last change of configuration
- P-0-3234.0.3, SMO: Configuration change counter
- P-0-3234.0.4, SMO: Parameterization checksum
- P-0-3234.0.5, SMO: Operating hours at last change of parameterization
- P-0-3234.0.6, SMO: Parameterization change counter

Possible problems during controller replacement

Display defective or programming module defective   If the programming module / the display is defective, the parameter values saved after initial commissioning must be loaded.

NOTICE	The parameter values saved after initial commissioning are not generally suited for reestablishing the operatability of the drive after a device has been replaced!

Check actual position values and active target position before setting drive enable!

Troubleshooting information

When firmware and drive parameters are to be transmitted to the replacement controller, the required firmware and a parameter backup of the respective axis must be available.

1. Reestablish the control voltage supply of the controller.

2. Carry out firmware update, see also chapter "Firmware replacement"

3. Via the "IndraWorks" commissioning tool or the control master, load parameter file to controller:

   - "IndraWorks" commissioning tool

     Load parameter values saved after initial commissioning to controller.

   - "IDST" service tool

     Load parameter values saved after initial commissioning to controller.

   - Control master

     Load axis-specific parameter values saved after initial commissioning [according to list parameters "S-0-0192, IDN-list of all backup operation data" and "P-0-0195, IDN list of retain data (replacement of devices)"].

☞   With active Safe Motion, initial or serial commissioning of the drive controller is required after the programming module has been replaced!

            ℹ️ The steps necessary to do so are described in the documentation "Integrated safety technology"Safe Motion" (as of MPx-18)" under the keyword "Serial commissioning, copy of an axis".

☞   In the case of drives with absolute value encoder and modulo format, the position data reference has to be established again after having loaded the parameter values saved after initial commissioning, even if the actual position values are signaled to be valid via the parameter "S-0-0403, Position feedback value status"!

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10   Decommissioning Drive Components

Before the drive or a component is decommissioned, an impact and hazard analysis must be prepared. This analysis must assess how the decommissioning affects the safety of the installation.

Furthermore, the impact and hazard analysis must contain a risk assessment of the process of decommissioning.

On the basis of this impact and hazard analysis, decommission the drive or component (see also IEC 61508-1:2010, 7.17).

11   Declarations of conformity

Declarations of conformity

11.1   IndraDrive Cs (HCS01)

The "HCS01" drive controller of the "IndraDrive Cs" range complies with the protection goals of the Low-Voltage Directive 2006/95/EC.

We declare conformity with the Machinery Directive for the optional safety technology modules "L4" [STO (Safe Torque Off) and SBC (Safe Brake Control)] and "L3" [STO (Safe Torque Off)].

Rexroth
Bosch Group

EG-Konformitätserklärung - *Original*

Dok.-Nr.: DCTC-30124-001
Datum: 2016-08-31

☒ nach Maschinenrichtlinie 2006/42/EG
☐ nach Niederspannungsrichtlinie 2014/35/EU
☐ nach EMV-Richtlinie 2014/30/EU
☐ nach ATEX-Richtlinie 2014/34/EU

Hiermit erklärt der Hersteller, Bosch Rexroth AG, Bürgermeister-Dr.-Nebel-Straße 2, 97816 Lohr am Main/Germany, dass die nachstehenden Produkte

| Bezeichnung: | Sicherheitstechnik-Optionsmodul L4 mit den Sicherheitsfunktionen STO und SBC für das elektrischen Antriebssystem „IndraDrive Cs" |
| Typen: | HCS01.1E-W0...-L4-... |

| Bezeichnung: | Sicherheitstechnik-Optionsmodul L3 mit der Sicherheitsfunktion STO für das elektrischen Antriebssystem „IndraDrive Cs" |
| Typen: | HCS01.1E-W0...-L3-... |

Ab Herstelldatum: 2016-08-31

in Übereinstimmung mit der oben genannten EU-Richtlinie entwickelt, konstruiert und gefertigt wurden.

Angewandte harmonisierte Normen:

Norm	Titel	Ausgabe
EN ISO 13849-1 (ISO 13849-1)	Sicherheit von Maschinen – Sicherheitsbezogene Teile von Steuerungen – Teil 1: Allgemeine Gestaltungsleitsätze	2015 (2015)
EN 62061 (IEC 62061)	Sicherheit von Maschinen – Funktionale Sicherheit sicherheitsbezogener elektrischer, elektronischer und programmierbarer elektronischer Steuerungssysteme	2005 + Cor.:2010 + A1:2013 + A2:2015 (2005 + A1:2012 + A2:2015)
EN 61800-5-2 (IEC 61800-5-2)	Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl – Teil 5-2: Anforderungen an die Sicherheit – Funktionale Sicherheit	2007 (2007)
EN 60204-1 (IEC 60204-1)	Sicherheit von Maschinen – Elektrische Ausrüstung von Maschinen – Teil 1: Allgemeine Anforderungen	2006 + A1:2009 (2005 + A1:2008)

Benannte Stelle, die das EG-Baumusterprüfverfahren nach oben genannter Richtlinie durchgeführt hat:
Name, Anschrift, Kennnummer: TÜV Rheinland Industrie Service GmbH, Alboinstr. 56, 12103 Berlin/Germany, 0035
EG-Baumusterprüfbescheinigungs-Nr.:   01/205/5155.01/16

Nachfolgende Person ist bevollmächtigt, die relevanten technischen Unterlagen zusammenstellen:
Name, Anschrift: Christian Russo, DC-IA/EDY4, Bürgermeister-Dr.-Nebel-Str. 2, 97816 Lohr am Main / Germany

Weitere Erläuterungen:
Die Optionsmodule L3 und L4 sind entsprechend SIL 3 nach EN 62061 / EN 61800-5-2 und Kategorie 4 und PL e nach EN ISO 13849-1 ausgeführt.

Lohr am Main , den   2016-08-31   ppa. _[signature]_   i.V. _[signature]_
       Ort   Datum   Joachim Hennig   Eberhard Schemm
                                                Werkleitung LoP2   Entwicklungsbereichsleiter Antriebe
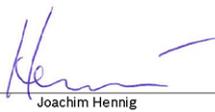
Änderungen im Inhalt der EG-Konformitätserklärung sind vorbehalten. Derzeit gültige Ausgabe auf Anfrage.

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DCTC-30124-001_KOE_N_DE_2016-08-31.docx

Fig. 11-1:   Declaration of conformity for the optional safety technology modules "L4" [STO (Safe Torque Off) and SBC (Safe Brake Control)] and "L3" [STO (Safe Torque Off)]

Declarations of conformity

EC declaration of conformity
(Translation of the original Declaration of Conformity)

Doc. No.: DCTC-30124-001
Date: 2016-08-31

☒   in accordance with Machinery Directive 2006/42/EC
☐   in accordance with Low Voltage Directive 2014/35/EU
☐   in accordance with EMC Directive 2014/30/EU
☐   in accordance with ATEX Directive 2014/34/EU

The manufacturer, Bosch Rexroth AG, Bürgermeister-Dr.-Nebel-Straße 2, 97816 Lohr am Main/Germany hereby declares that the products below

Name: Optional safety technology module L4 with safety functions STO and SBC for electric drive system "IndraDrive Cs"
Types: HCS01.1E-W0...-L4-...

Name: Optional safety technology module L4 with safety function STO for electric drive system "IndraDrive Cs"
Types: HCS01.1E-W0...-L3-...
From date of
manufacture: 2016-08-31

were developed, designed and manufactured in compliance with the above-mentioned EU directive.

Harmonized standards applied:

Standard	Title	Edition
EN ISO 13849-1 (ISO 13849-1)	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design	2015 (2015)
EN 62061 (IEC 62061)	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems	2005 + Cor.:2010 + A1:2013 + A2:2015 (2005 + A1:2012 + A2:2015)
EN 61800-5-2 (IEC 61800-5-2)	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional	2007 (2007)
EN 60204-1 (IEC 60204-1)	Safety of machinery – Electrical equipment of machines – Part 1: General requirements	2006 + A1:2009 (2005 + A1:2008)

Notified body that has conducted the EC type-examination procedure in accordance with the above-mentioned directive
Name, address, identification number: TÜV Rheinland Industrie Service GmbH, Alboinstr. 56, 12103 Berlin/Germany, 0035
No. of EC type-examination certificate: 01/205/5155.01/16

The individual below is authorized to compile the relevant technical files:
Name, address: Christian Russo, DC-IA/EDY4, Bürgermeister-Dr.-Nebel-Str. 2, 97816 Lohr am Main / Germany

Further explanations:
The optional safety function modules L3 and L4 fulfill the requirements of SIL 3 according to EN 61800-5-2 / EN 62061 and Category 4 / PL e according to EN ISO 13489-1.

Place/date/signature as indicated in the original declaration.

We reserve the right to make changes to the content of the EC Declaration of Conformity. Current issue on request.

Page 1 / 1

Fig. 11-2:   *Translation of the original declaration of conformity for the optional safety technology modules "L4" [STO (Safe Torque Off) and SBC (Safe Brake Control)] and "L3" [STO (Safe Torque Off)]*

The declaration of conformity is also available with signatures in the English language.

If you have access to the Bosch Rexroth Intranet, please download the declaration of conformity here. Otherwise, please contact our sales representative.

Declarations of conformity

11.2   IndraDrive M / IndraDrive C (HCS, HMS)

The "HCS" / "HMS" controllers of the "IndraDrive M" / "IndraDrive C" ranges comply with the protection goals of the Low-Voltage Directive 2006/95/EC.

We declare conformity with the Machinery Directive for the optional safety technology module "L3" [STO (Safe Torque Off)].

Fig. 11-3:   *Declaration of conformity for the optional safety technology module "L3" [STO (Safe Torque Off)]*

Declarations of conformity

Electric Drives and Controls | Hydraulics | Linear Motion and Assembly Technologies | Pneumatics | Service

Rexroth
Bosch Group

EC Declaration of Conformity

(Translation of the original EC Declaration of Conformity)

Doc. No.:   TC30122-2

Date: 2013-05-06

☒ in accordance with Machinery Directive 2006/42/EC
☐ in accordance with Low Voltage Directive 2006/95/EC
☐ in accordance with EMC Directive 2004/108/EC
☐ in accordance with Pressure Equipment Directive 97/23/EC
☐ in accordance with ATEX Directive 94/9/EC

The manufacturer

Bosch Rexroth AG
Bürgermeister-Dr.-Nebel-Straße 2
97816 Lohr a. Main / Germany

hereby declares that the products below

Name: Optional module "Safe Torque Off (STO)"
Type: CSB02.1*-**-**-**-L3-**-**-**
    CSH02.1*-**-**-**-L3-**-**-**
    CDB02.1*-**-**-**-**-L3-L3-**-**-**

From date of manufacture: 2013-05-06

were developed, designed and manufactured in compliance with the above-mentioned EU directive.

Harmonized Standards applied:

Standard	Title	Edition
EN ISO 13849-1	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design	2008+AC:2009
EN 62061	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems	2005+AC:2010
EN 61800-5-2	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional	2007
EN 60204-1	Safety of machinery – Electrical equipment of machines – Part 1: General requirements	2006+A1:2009

Notified body that has conducted the EC type-examination procedure in accordance with the above-mentioned directive:

Name: TÜV Rheinland Industrie Service GmbH
Address: Alboinstr. 56, 12103 Berlin / Germany
Identification number: 0035
No of EC type-examination certificate: 01/205/5319/13

The individual below is authorized to compile the relevant technical files:

Name: Christian Russo, Department DC-IA/EDY4
Address: Bürgermeister-Dr.-Nebel-Str. 2, 97816 Lohr am Main / Germany

Further explanations:
The optional module "Safe Torque Off (STO)" has been implemented in accordance with SIL 3 according to EN 62061 / EN 61800-5-2 and Category 3 and PL e according to EN ISO 13489-1.

Place/date/signature as indicated in the original EC Declaration of Conformity.

We reserve the right to make changes to the content of the EC Declaration of Conformity. Current issue on request.

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Fig. 11-4:   Translation of the original declaration of conformity for the optional safety technology module "L3" [STO (Safe Torque Off)]

The declaration of conformity is also available with signatures in the English language.

If you have access to the Bosch Rexroth Intranet, please download the declaration of conformity here. Otherwise, please contact our sales representative.

Declarations of conformity

11.3   IndraDrive Mi

11.3.1   KSM02, KMS02

The distributed servo drive "KSM02" and the distributed drive controller "KMS02" of the "IndraDrive Mi" range comply with the protection goals of the Low-Voltage Directive 2006/95/EC.

We declare conformity with the Machinery Directive for the optional safety technology module "L3" [STO (Safe Torque Off)].

Rexroth
Bosch Group

EG-Konformitätserklärung - *Original*

Dok.-Nr.: DCTC-30129-001

Datum: 2017-05-05

☒   nach Maschinenrichtlinie 2006/42/EG
☐   nach Niederspannungsrichtlinie 2014/35/EU
☐   nach EMV-Richtlinie 2014/30/EU

Hiermit erklärt der Hersteller,
Bosch Rexroth AG, Bürgermeister-Dr.-Nebel-Straße 2, 97816 Lohr am Main / Germany,

dass die nachstehenden Produkte

Bezeichnung:	Sicherheitstechnik-Optionsmodul L3 [„Safe Torque Off" (STO)] für das elektrische Antriebssystem „IndraDrive Mi"	
Typen:	KSM02.1B-*-*-*-*-ET-L3-D7-*-FW	KCU02.2-N-ET-ET*-025
	KMS02.1B-A018-P-D7-ET-*-L3-*-FW	KMV03.1*
Ab Herstelldatum:	2017-05-05	

in Übereinstimmung mit der oben genannten EU-Richtlinie entwickelt, konstruiert und gefertigt wurden.

Angewandte harmonisierte Normen:

Norm	Titel	Ausgabe
EN ISO 13849-1 (ISO 13849-1)	Sicherheit von Maschinen – Sicherheitsbezogene Teile von Steuerungen – Teil 1: Allgemeine Gestaltungsleitsätze	2015 (2015)
EN 62061 (IEC 62061)	Sicherheit von Maschinen – Funktionale Sicherheit sicherheitsbezogener elektrischer, elektronischer und programmierbarer elektronischer Steuerungssysteme	2005 + A1: 2013 + A2:2015 (2005 + A1:2012 + A2:2015)
EN 61800-5-2 (IEC 61800-5-2)	Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl – Teil 5-2: Anforderungen an die Sicherheit – Funktionale Sicherheit	2007 (2007)
EN 60204-1 (IEC 60204-1)	Sicherheit von Maschinen – Elektrische Ausrüstung von Maschinen – Teil 1: Allgemeine Anforderungen	2006 + A1:2009 (2005 + A1:2008)

Benannte Stelle, die das EG-Baumusterprüfverfahren nach oben genannter Richtlinie durchgeführt hat:
Name, Anschrift, Kennnummer: TÜV Rheinland Industrie Service GmbH, Alboinstr. 56, 12103 Berlin / Germany, 0035
EG-Baumusterprüfbescheinigungs-Nr.:   01/205/5220.01/17

Nachfolgende Person ist bevollmächtigt, die relevanten technischen Unterlagen zusammenstellen:
Name, Anschrift: Christian Russo, DC-AE/EPI2, Bürgermeister-Dr.-Nebel-Str. 2, 97816 Lohr am Main / Germany

Weitere Erläuterungen:
Das Sicherheitstechnik-Optionsmodul L3 mit der Sicherheitsfunktion „Safe Torque Off (STO)" ist ausgeführt entsprechend SIL 3 nach EN 62061 / EN 61800-5-2 und Kategorie 4 / PL e für KMV03.1 und Kategorie 3 / PL e für KCU02.2 nach EN ISO 13849-1.

Lohr am Main	, den	2017-05-05	ppa.		i.V.	
Ort		Datum		Joachim Hennig Werkleitung LoP2		Thomas Laux Entwicklungsbereichsleiter Antriebe
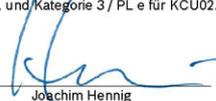
Änderungen im Inhalt der EG-Konformitätserklärung sind vorbehalten. Derzeit gültige Ausgabe auf Anfrage.

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Fig. 11-5:   Declaration of conformity for the optional safety technology module "L3" [STO (Safe Torque Off)] in the distributed servo drives KSM02 and the distributed drive controllers KMS02

Declarations of conformity

EC declaration of conformity

(Translation of the original Declaration of Conformity)

Doc. No.: DCTC-30129-001
Date: 2017-05-05

☒ in accordance with Machinery Directive 2006/42/EC
☐ in accordance with Low Voltage Directive 2014/35/EU
☐ in accordance with EMC Directive 2014/30/EU

The manufacturer,
Bosch Rexroth AG, Bürgermeister-Dr.-Nebel-Straße 2, 97816 Lohr am Main / Germany

hereby declares that the products below

Name:	Optional safety function module L3 ["Safe Torque Off" (STO)] for the electric drive system "IndraDrive Mi"	
Types:	KSM02.1B-*-*-*-*-ET-L3-D7-*-FW	KCU02.2-N-ET-ET*-025
	KMS02.1B-A018-P-D7-ET-*-L3-*-FW	KMV03.1*
From the date of manufacture:	2017-05-05	

were developed, designed and manufactured in compliance with the above-mentioned EU directive.

Harmonized standards applied:

Standard	Title	Edition
EN ISO 13849-1 (ISO 13849-1)	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design	2015 (2015)
EN 62061 (IEC 62061)	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems	2005 + A1: 2013 + A2:2015 (2005 + A1:2012 + A2:2015)
EN 61800-5-2 (IEC 61800-5-2)	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional	2007 (2007)
EN 60204-1 (IEC 60204-1)	Safety of machinery – Electrical equipment of machines – Part 1: General requirements	2006 + A1:2009 (2005 + A1:2008)

Notified body that has conducted the EC type-examination procedure in accordance with the above-mentioned directive
Name, address, identification number: TÜV Rheinland Industrie Service GmbH, Alboinstr. 56, 12103 Berlin / Germany, 0035
No. of EC type-examination certificate: 01/205/5220.01/17

The individual below is authorized to compile the relevant technical files:
Name, address: Christian Russo, DC-AE/EPI2, Bürgermeister-Dr.-Nebel-Str. 2, 97816 Lohr am Main / Germany

Further explanations:
The optional safety function module L3 (Safe Torque Off (STO)) fulfils the requirements of SIL 3 according to EN 61800-5-2 / EN 62061 / IEC 61508 and Category 4 / PL e for KMV03.1 and Category 3 / PL e for KCU02.2 according to EN ISO 13489-1.

Place/date/signature as indicated in the original declaration.

We reserve the right to make changes to the content of the EC Declaration of Conformity. Current issue on request.

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DCTC-30129-001_KOE_N_EN_22017-05-05.docx

Fig. 11-6:   Translation of the original declaration of conformity for the optional safety technology module "L3" [STO (Safe Torque Off)] in the distributed servo drives KSM02 and the distributed drive controllers KMS02

The declaration of conformity is also available with signatures in the English language.

If you have access to the Bosch Rexroth Intranet, please download the declaration of conformity here. Otherwise, please contact our sales representative.

Declarations of conformity

11.3.2   KMV03 / KMS03

The distributed supply unit "KMV03" and the distributed drive controller "KMS03" of the "IndraDrive Mi" range comply with the protection goals of the Low-Voltage Directive 2006/95/EC.

We declare conformity with the Machinery Directive for the optional safety technology module "L3" [STO (Safe Torque Off)].

Rexroth
Bosch Group

EG-Konformitätserklärung - Original

Dok.-Nr.: DCTC-30129-003
Datum: 2016-02-11

☒ nach Maschinenrichtlinie 2006/42/EG
☐ nach Niederspannungsrichtlinie 2014/35/EU
☐ nach EMV-Richtlinie 2014/30/EU
☐ nach ATEX-Richtlinie 2014/34/EU

Hiermit erklärt der Hersteller, Bosch Rexroth AG, Bürgermeister-Dr.-Nebel-Straße 2, 97816 Lohr am Main / Germany,

dass die nachstehenden Produkte

Bezeichnung: Sicherheitstechnik-Optionsmodul L3 [„Safe Torque Off" (STO)]
                    für das elektrische Antriebssystem „IndraDrive Mi"

Typ: KMS03.1*...-L3-...
                    KMV03.1*...

Ab Herstelldatum: 2016-02-11

in Übereinstimmung mit der oben genannten EU-Richtlinie entwickelt, konstruiert und gefertigt wurden.

Angewandte harmonisierte Normen:

Norm	Titel	Ausgabe
EN ISO 13849-1 (ISO 13849-1)	Sicherheit von Maschinen – Sicherheitsbezogene Teile von Steuerungen – Teil 1: Allgemeine Gestaltungsleitsätze	2015 (2015)
EN 62061 (IEC 62061)	Sicherheit von Maschinen – Funktionale Sicherheit sicherheitsbezogener elektrischer, elektronischer und progammierbarer elektronischer Steuerungssysteme	2005 + Cor.:2010 + A1:2013 + A2:2015 (2005 + A1:2013 + A2:2015)
EN 61800-5-2 (IEC 61800-5-2)	Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl – Teil 5-2: Anforderungen an die Sicherheit – Funktionale Sicherheit	2007 (2007)
EN 60204-1 (IEC 60204-1)	Sicherheit von Maschinen – Elektrische Ausrüstung von Maschinen – Teil 1: Allgemeine Anforderungen	2006 + A1:2009 (2005 + A1:2008)

Benannte Stelle, die das EG-Baumusterprüfverfahren nach oben genannter Richtlinie durchgeführt hat:
Name, Anschrift: TÜV Rheinland Industrie Service GmbH, Alboinstr. 56, 12103 Berlin / Germany
Kennnummer: 0035
EG-Baumusterprüfbescheinigungs-Nr.:   01/205/5501.00/16

Nachfolgende Person ist bevollmächtigt, die relevanten technischen Unterlagen zusammenstellen:
Name, Anschrift: Christian Russo, DC-IA/EDY4, Bürgermeister-Dr.-Nebel-Str. 2, 97816 Lohr am Main / Germany

Weitere Erläuterungen:
Das Optionsmodul L3 ist entsprechend SIL 3 nach EN 62061 / EN 61800-5-2 und Kategorie 4 und PL e nach EN ISO 13849-1 ausgeführt.

Lohr am Main , den   2016-02-11   ppa.   i.V.
Ort   Datum   Joachim Hennig   Eberhard Schemm
                                           Werkleitung LoP2   Entwicklungsbereichsleiter Antriebe

Änderungen im Inhalt der EG-Konformitätserklärung sind vorbehalten. Derzeit gültige Ausgabe auf Anfrage.

Seite 1 / 1

(margin: © Bosch Rexroth AG 2016)
(margin: DCTC-30129-003_KOE_N_DE_2016-02-11.docx)

Fig. 11-7:   Declaration of conformity for the optional safety technology module "L3" [STO (Safe Torque Off)] in the distributed drive controller "KMS03" of the "IndraDrive Mi" range

Declarations of conformity

Rexroth
Bosch Group

EC declaration of conformity
(Translation of the original Declaration of Conformity)

Doc. No.: DCTC-30129-003
Date: 2016-02-11

☒   in accordance with Machinery Directive 2006/42/EC
☐   in accordance with Low Voltage Directive 2014/35/EU
☐   in accordance with EMC Directive 2014/30/EU
☐   in accordance with ATEX Directive 2014/34/EU

The manufacturer, Bosch Rexroth AG, Bürgermeister-Dr.-Nebel-Straße 2, 97816 Lohr am Main / Germany

hereby declares that the products below

Name: Optional safety technology module L3 ["Safe Torque Off" (STO)]
                     for electric drive system "IndraDrive Mi"

Type: KMS03.1*...-L3-...
                     KMV03.1*...

From date of manufacture: 2016-02-11

were developed, designed and manufactured in compliance with the above-mentioned EU directive.

Harmonized standards applied:

Standard	Title	Edition
EN ISO 13849-1 (ISO 13849-1)	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design	2015 (2015)
EN 62061 (IEC 62061)	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems	2005 + Cor.:2010 + A1:2013 + A2:2015 (2005 + A1:2013 + A2:2015)
EN 61800-5-2 (IEC 61800-5-2)	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional	2007 (2007)
EN 60204-1 (IEC 60204-1)	Safety of machinery – Electrical equipment of machines – Part 1: General requirements	2006 + A1:2009 (2005 + A1:2008)

Notified body that has conducted the EC type-examination procedure in accordance with the above-mentioned directive
Name, address, identification number: TÜV Rheinland Industrie Service GmbH, Alboinstr. 56, 12103 Berlin / Germany, 0035
No. of EC type-examination certificate: 01/205/5501.00/16

The individual below is authorized to compile the relevant technical files:
Name, address: Christian Russo, DC-IA/EDY4, Bürgermeister-Dr.-Nebel-Str. 2, 97816 Lohr am Main / Germany

Further explanations:
The optional safety function module L3 fulfils the requirements of SIL 3 according to EN 61800-5-2 / EN 62061 / IEC 61508 and Category 4 / PL e according to EN ISO 13489-1.

Place/date/signature as indicated in the original declaration

We reserve the right to make changes to the content of the EC Declaration of Conformity. Current issue on request.

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DCTC-30129-003_KOE_N_EN_2016-02-11.docx

Fig. 11-8:   Translation of the original declaration of conformity for the optional safety technology module "L3" [STO (Safe Torque Off)]

💡 The declaration of conformity is also available with signatures in the English language.

If you have access to the Bosch Rexroth Intranet, please download the declaration of conformity here. Otherwise, please contact our sales representative.

11.4   IndraDrive ML (HMU05)

The "HMU05" drive controller of the "IndraDrive ML" range complies with the protection goals of the Low-Voltage Directive 2006/95/EC.

We declare conformity with the Machinery Directive for the optional safety technology module "L3" [STO (Safe Torque Off)].

Fig. 11-9:   Declaration of conformity for the optional safety technology module "L3" [STO (Safe Torque Off)] in the "HMU05" drive controllers of the "IndraDrive ML" range

Declarations of conformity

Rexroth
Bosch Group

EC declaration of conformity

(Translation of the original Declaration of Conformity)

Doc. No.: DCTC-30133-001

Date: 2017-03-01

☒   in accordance with Machinery Directive 2006/42/EC
☐   in accordance with Low Voltage Directive 2014/35/EU
☐   in accordance with EMC Directive 2014/30/EU

The manufacturer,
Bosch Rexroth AG, Bürgermeister-Dr.-Nebel-Straße 2, 97816 Lohr am Main / Germany
hereby declares that the products below

Name:	Optional safety function module L3 ["Safe Torque Off" (STO)] for the electric drive system "IndraDrive CL/ML"	
Types:	CSB02.5*...-L3-...	CSH02.5*...-L3-...
	HMU05.1*...-A4-D7-Pxx-Nxxx	HMU05.1*...-A4-D7-N1N-Nxxx
	HMU05.1*...-A4-D7-Pxx-Mxxx	HMU05.1*...-A4-D7-N1N-Mxxx
	HMU05.1*...-A5-11-Pxx-Mxxx	HMU05.1*...-A5-11-N1N-Mxxx
	HPC01.1-MN002	HPC01.1-P001
From the date of manufacture:	2017-03-01	

were developed, designed and manufactured in compliance with the above-mentioned EU directive.

Harmonized standards applied:

Standard	Title	Edition
EN ISO 13849-1 (ISO 13849-1)	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design	2015 (2015)
EN 62061 (IEC 62061)	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems	2005 + A1: 2013 + A2:2015 (2005 + A1:2012 + A2:2015)
EN 61800-5-2 (IEC 61800-5-2)	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional	2007 (2007)
EN 60204-1 (IEC 60204-1)	Safety of machinery – Electrical equipment of machines – Part 1: General requirements	2006 + A1:2009 (2005 + A1:2008)

Notified body that has conducted the EC type-examination procedure in accordance with the above-mentioned directive
Name, address, identification number: TÜV Rheinland Industrie Service GmbH, Alboinstr. 56, 12103 Berlin / Germany, 0035
No. of EC type-examination certificate: 01/205/5427.02/17

The individual below is authorized to compile the relevant technical files:
Name, address: Christian Russo, DC-AE/EPI2, Bürgermeister-Dr.-Nebel-Str. 2, 97816 Lohr am Main / Germany

Further explanations:
The optional safety function module L3 (Safe Torque Off (STO)) fulfils the requirements of SIL 3 according to EN 61800-5-2 / EN 62061 / IEC 61508 and Category 4 / PL e according to EN ISO 13489-1.

Place/date/signature as indicated in the original declaration.

We reserve the right to make changes to the content of the EC Declaration of Conformity. Current issue on request.

(left margin: © Bosch Rexroth AG 2017   DCTC-30133-001_KOE_N_EN_2017-03-01.docx)

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Fig. 11-10:   *Translation of the original declaration of conformity for the optional safety technology module "L3" [STO (Safe Torque Off)] in the "HMU05" drive controllers of the "IndraDrive ML" range*

💡   The declaration of conformity is also available with signatures in the English language.

If you have access to the Bosch Rexroth Intranet, please download the declaration of conformity here. Otherwise, please contact our sales representative.

12   Project planning

This chapter describes the interfaces, connectors and cables relevant to the safety technology.

	IndraDrive Cs	IndraDrive C/ IndraDrive M	IndraDrive ML	IndraDrive Mi		
				KMS/KSM	KMV03	KCU
X6 Motor temperature monitoring and motor holding brake	✓[1]	–	–	–	–	–
X49 Optional safety technology Safe Torque Off	✓	✓	✓	–	–	✓
X141 Safety technology Safe Torque Off and "release brake" service input	–	–	–	✓	✓	–

[1]   Only if optional safety module "L4" configured

Tab. 12-1:   STO/SBC, relevant interfaces

In addition, this chapter describes the E-Stop function, the setting up of safety zones and the technical data of the inputs and outputs.

12.1   X6, Motor Temperature Monitoring and Motor Holding Brake

> ⚠ **WARNING**   Dangerous movements! Danger to persons from falling or dropping axes!
>
> The standard motor holding brake provided or an external motor holding brake controlled directly by the drive controller are not sufficient on their own to guarantee personal safety!
>
> Personal safety must be achieved using higher-level, fail-safe measures:
>
> - Block off danger zones with safety fences or safety guards
> - Additionally secure vertical axes against falling or dropping after switching off the motor power by, for example,
>   - mechanically securing the vertical axes
>   - adding external braking/arrester/clamping mechanisms
>   - ensuring sufficient equilibration of the vertical axes

> ⚠ **WARNING**   Lethal electric shock by live parts with more than 50 V!
>
> The input of the motor temperature evaluation is **not** galvanically isolated from the housing. If the voltage applied to the input is impermissibly high (e.g. because of a flashover of the motor winding voltage), this voltage may come into contact with the housing. Ensure that the temperature sensor of the connected motor has a **double** isolation against the motor winding.

Project planning

NOTICE	Excessive voltage at the input of the motor temperature evaluation may cause damage to the device!

The voltage allowed at the input of the motor temperature evaluation must correspond to the allowed control voltage of the device. If the voltage applied to the input is impermissibly high, the device may be damaged.

Function Connection point X6 contains the connections for

- monitoring the motor temperature
- controlling the motor holding brake

☞ Via an integrated contact element (BR), the power section switches the voltage of the **external** 24-V supply to the output for controlling the motor holding brake.
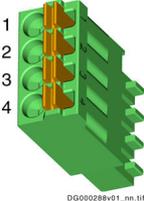
View	Connection	Signal name	Function
	1	MotTemp+	Motor temperature evaluation input
	2	MotTemp-	
	3	+24VBr	Output for controlling the motor holding brake
	4	0VBr	

Spring terminal (connector)	Unit	Min.	Max.
Connection cable	mm^2	0,25	1,5
Stranded wire	AWG	24	16
Stripped length	mm	10	
Current carrying capacity of outputs X6	A	-	1,25
Time constant of load	ms	-	50
Number of switching operations at maximum time constant of load		Wear-free electronic contact	
Switching frequency	Hz	-	0,5
Short circuit protection		X6.3 against X6.4 (output for controlling the motor holding brake)	
Overload protection		X6.3 against X6.4 (output for controlling the motor holding brake)	

Tab. 12-2:   *Function, pin assignment*

Motor holding brake: selection Maximum current carrying capacity of outputs X6: 1.25 A

$\Rightarrow R_{br\,(min)} = U_{br\,(max)} / 1.25\,A$

$R_{br\,(min)}$: Minimum allowed resistance of the motor holding brake

$U_{br\,(max)}$: Maximum supply voltage of the motor holding brake

If $U_{br\,(max)}$ = 24 V +5% = 25.2 V, this results in:

Project planning

$$R_{br\,(min)} = 20.16\ \Omega\ \text{(applicable to all operating and ambient conditions)}$$

Motor holding brake: installation instructions

Make sure the **power supply** for the motor holding brake at the motor is sufficient. You have to take into account that voltage drops on the supply line. Use connection lines with the highest possible cross section of the single strands.

Use an **external contact element in accordance with the required safety category**, if you wish to supply motor holding brakes with higher currents than the allowed current load at X6. Make sure to comply with the required minimum current consumption of 100 mA when using the external contact element. Otherwise, the brake current monitoring unit signals an error.

Connection diagram
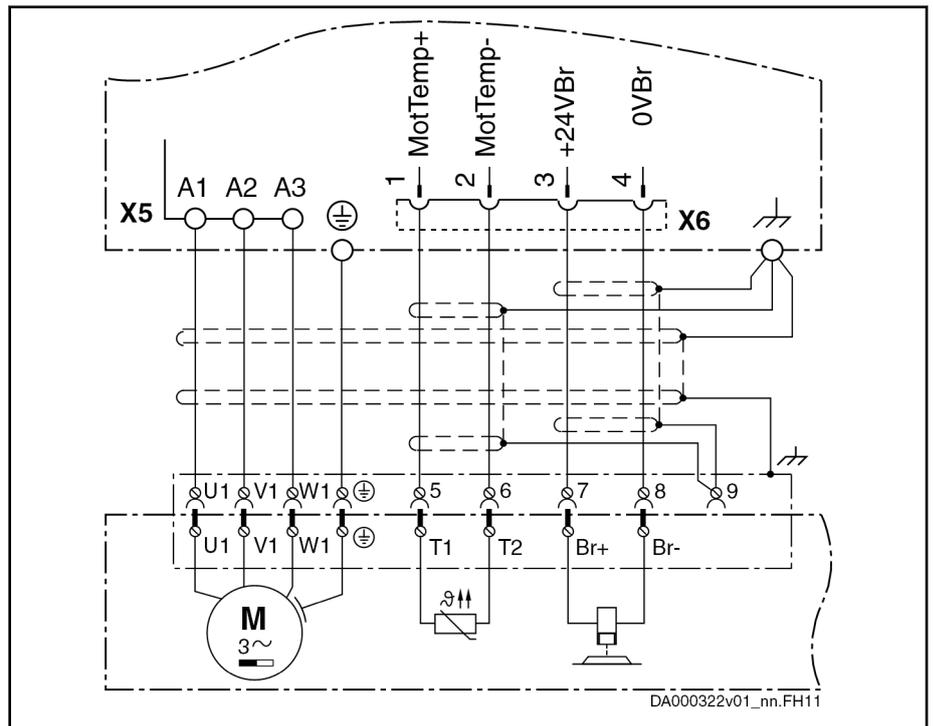
Fig. 12-1:   Connection of motor temperature monitoring and motor holding brake

12.2   X49, optional safety technology Safe Torque Off

View	Connection	Signal name	Function
SI_Ch2 1 0V 2 SI_Ch1 3 +24V 4 Dyn_Ch2 5 Dyn_Ch1 6	1	SI_Ch2	Input for selection of channel 2
	2	0V	GND reference of inputs and outputs
	3	SI_Ch1	Input for selection of channel 1
	4	+24V	Dynamization outputs power supply
	5	Dyn_Ch2	Channel 2 dynamization output
	6	Dyn_Ch1	Channel 1 dynamization output

Spring terminal (connector)	Unit	min.	max.

Project planning

Connection cable	mm²	1	1.5
Stranded wire	AWG	16	16
Stripped length	mm	-	8

Tab. 12-3:   *X49, optional safety technology Safe Torque Off*

☞   When the dynamization outputs do not work, check the power supply connection. The polarity might possibly have been reversed.

12.3   X141, Safe Torque Off safety technology and "release brake" service input
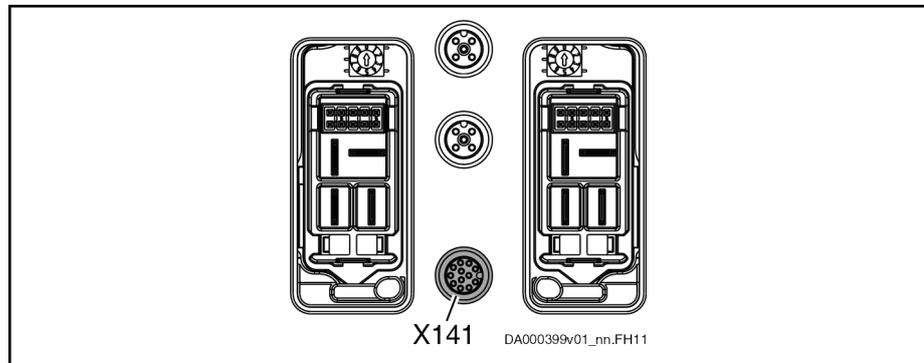
Fig. 12-2:   *X141*

View	Connection	Signal name Devices with safety technology	Signal name Devices without safety technology [1]	Function
DA000400v01_nn.FH11 **Female connector M12 (12-pin, D-coded)**	1	SI_Ch1	n. c.	Input for selection of channel 1 (connected to X103.2.10)
	2	SI_Ch2	n. c.	Input for selection of channel 2 (connected to X103.2.8)

	3	Zone_Br	Zone_Br	For the desired function, X141.3 has to be accordingly controlled:
				• Safety zone beginner:
				  Input not connected
				• Safety zone node:
				  Short circuit to X141.11
				  (input voltage: 0 … 6 V)
				• "Release brake":
				  Short circuit to X141.9
				  (input voltage: 24 V ±20%)

	4	24V	n. c.	Dynamization outputs power supply
	5	SI_Ch1_In	n. c.	Input for selection of channel 1, preceding axis (connected to X103.1.10)
	6	0V_In	0V [2]	0V selection, preceding axis (connected to X103.1.9)
	7	SI_Ch2_In	n. c.	Input for selection of channel 2, preceding axis (connected to X103.1.8)
	8	Dyn_Ch1	n. c.	Channel 1 dynamization output [3]
	9	24V_ZBr	24V_Br	Internal interface only; 24 V for "release brake" function
	10	0V	0V [2]	Inputs and outputs power supply (connected to X103.2.9)
	11	GND_Zone	GND	For "safety zone node" function
	12	Dyn_Ch2	n. c.	Channel 2 dynamization output [3]

Project planning

Ready-made connection cable	RKB0033
Connector for safety zone node	RBS0023
	When a KSM/KMS with optional safety technology is to be a safety zone node within a safety zone, X141 has to be equipped with the connector RBS0023.
	At X141, the connector RBS0023 jumpers the following connections:
	• 5 ↔ 1
	• 7 ↔ 2
	• 6 ↔ 10
	• 11 ↔ 3

1) KSM/KMS without optional safety technology can be operated within a safety zone, because the signals are transmitted to the next safety zone node via X103.1 and X103.2. KSM/KMS without optional safety technology do not react to safety technology signals.
2) X141.6 connected to X141.10
3) When the two outputs are used for different functions, short circuit between the two signal wirings has to be excluded.

Tab. 12-4: *Function, pin assignment, properties*

Technical data

Function	Signal	Connection	Technical data
Channel 1 selection	SI_Ch1	1	chapter 12.7.1 "Digital inputs (safety technology L options)" on page 137
Channel 2 selection	SI_Ch2	2	
Channel 1 dynamization output	Dyn_Ch1	8	chapter 12.7.2 "Digital Outputs (Safety Technology L Options)" on page 138
Channel 2 dynamization output	Dyn_Ch2	12	
Power supply of **isolated** inputs and outputs	+24V	4	DC 19.2 … 30 V
	0V	10	max. 700 mA

Tab. 12-5: *Technical data*

12.4 Connectors and cables for safety technology

12.4.1 RBS0023, connector for safety zone node
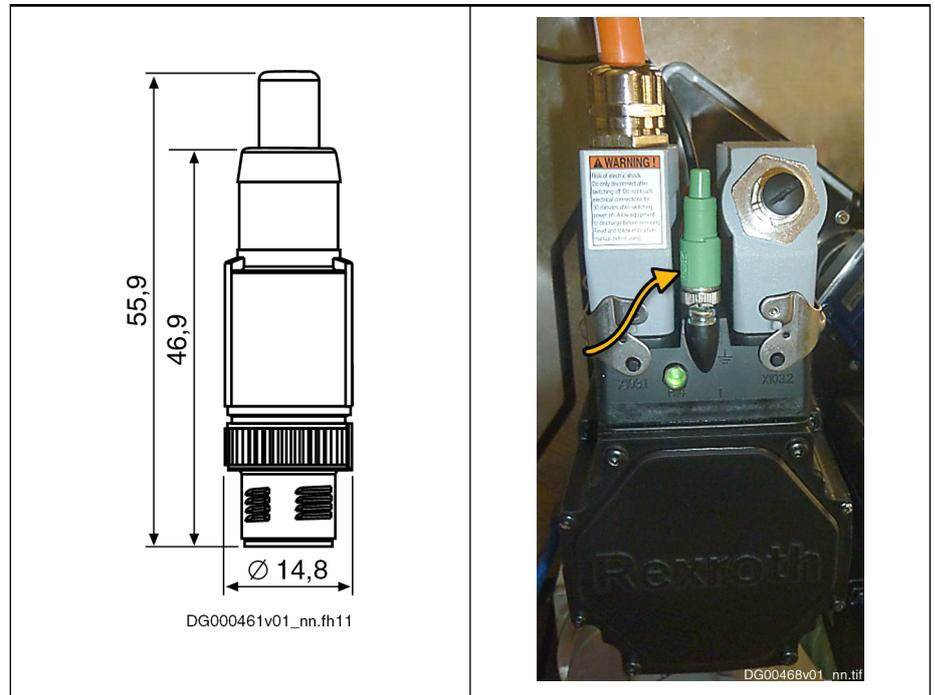
Tab. 12-6:   Connector RBS0023

RBS0023 Connector M12, 12-pin, A-coded; mat. no.: R911335348	Connection	Connected to connection	Function
 DA000437v01_nn.fh11 A: Coding	1	5	When a KSM/KMS with optional safety technology is to be a safety zone node within a safety zone, the connection point X141 must be equipped with the connector RBS0023. The connector RBS0023 jumpers the following connections: • 5 ↔ 1 • 7 ↔ 2 • 6 ↔ 10 • 11 ↔ 3 KSM/KMS without optional safety technology can be operated within a safety zone without the connector RBS0023, because the signals are directly transmitted to the next safety zone node via X103.1 and X103.2.
	2	7	
	3	11	
	4	n. c.	
	5	1	
	6	10	
	7	2	
	8	n. c.	
	9	n. c.	
	10	6	
	11	3	
	12	n. c.	

Tab. 12-7:   Function, pin assignment, properties

Project planning

12.4.2   RKB0033, cable for safety technology
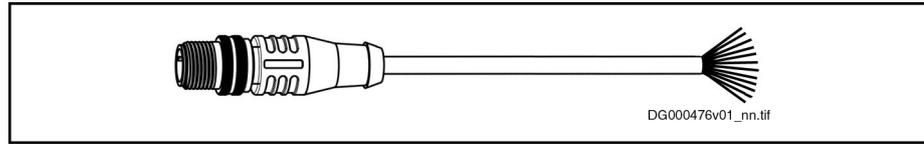
Fig. 12-3:   RKB0033

Assignment   For devices with safety option L3. The cable can be used to form a new safety zone within a drive line in a distributed manner.

Length that can be ordered, order code

Length	Order code	Material number
1.5 m	RKB0033 / 001,5	R911334865
10 m	RKB0033 / 010,0	R911335718

Tab. 12-8:   RKB0033

RKB0033

Plug-in connector	Bulk cable	Plug-in connector
M12, 12-pin	Bus cable	Open ends

Interconnection diagram
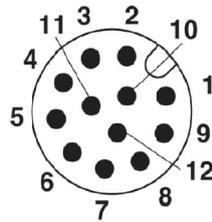
1	SI_Ch1	BN
3	Zone_Br	WH
6	SI_0V_In	YE
4	+24V	GN
5	SI_Ch1_In	PK
8	Dyn_Ch1	GY
7	SI_Ch2_In	BK
10	SI_0V	VT
9	24V_Br	RD
2	SI_Ch2	BU
11	GND	GYPK
12	Dyn_Ch2	RDBU

DG000428v01_nn.fh11

Use instruction: only fixed lengths

Tab. 12-9:   RKB0033 parts

12.5   E-Stop function

With KCU: The E-Stop function is wired at KCU and transmitted to KSM/KMS via the hybrid cable.

In this case, the E-Stop signal is input to the safety zone via an isolated 24V contact (X50.3) at KCU. The reference potential of the E-Stop signal within the safety zone is X53.1 (output of the DC-DC converter in KCU).

With KMV: The E-Stop function is wired at KMV (X141) and transmitted to KSM/KMS via the hybrid cable.

The E-Stop signal is amplified in each KSM/KMS.

Assigning and transmitting E-Stop signals

- If a KSM/KMS/KMV has been configured as a **safety zone beginner** (X141.3 = n. c., P-0-0249 = 2) and an **E-Stop signal has been assigned** to this KSM/KMS/KMV via an I/O (X37/X38; with KMV: X37.4/X38.4), this E-Stop signal is transmitted to the subsequent KSM/KMS (pertinent parameters: P-0-0223, P-0-0300).

  When a new safety zone begins, a new E-Stop zone can be begun via a local I/O (X37.4/X38.4).

- If a KSM/KMS/KMV has been configured as a **safety zone beginner** (X141.3 = n. c., P-0-0249 = 2) and **no E-Stop signal has been assigned** to this KSM/KMS/KMV, the E-Stop signal of the preceding safety zone is transmitted.

Project planning
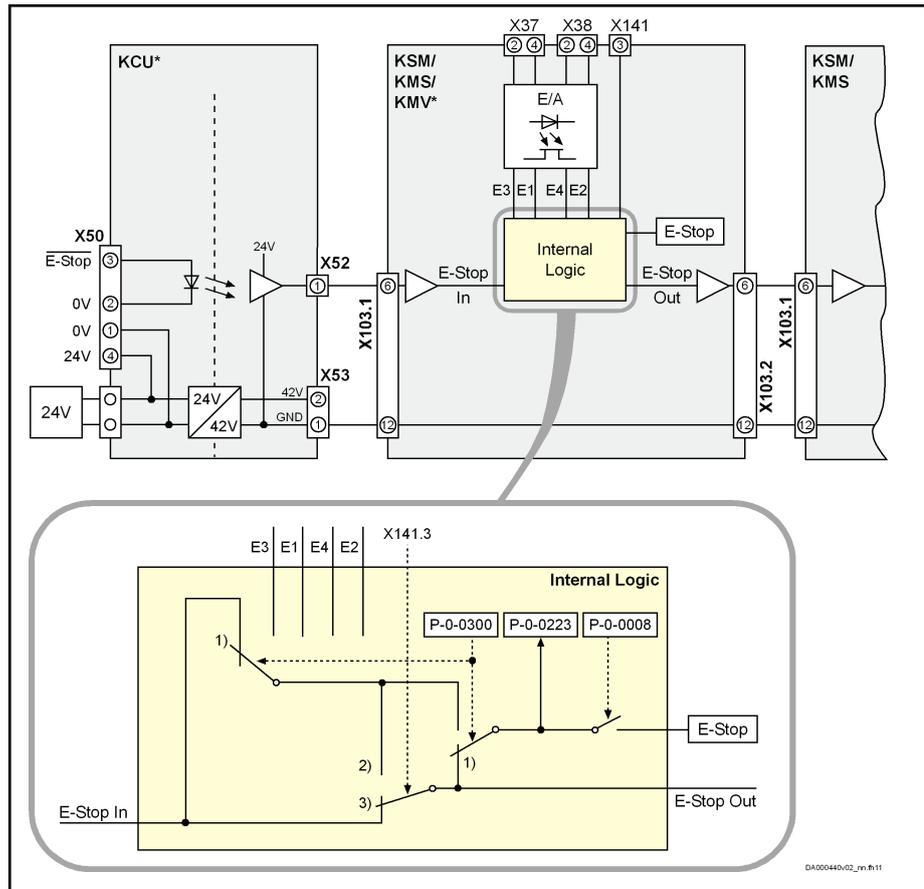
* KCU/KMV	KCU control module is not required when using a KMV supply unit
E1, E2, E3, E4	Digital inputs
P-0-0300	Digital inputs, assignment list
P-0-0223	E-Stop input
P-0-0008	Activation E-Stop function
1)	Position of switch if P-0-0223 (E-Stop input) not entered in any element of P-0-0300 (default state)
2)	Position of switch if X141 equipped with RKB0033 cable or open; P-0-0249 = 2 (zone beginner)
3)	Position of switch if X141 equipped with RBS0023 connector; P-0-0249 = 1 (zone node)

Fig. 12-4:   *E-Stop zone setup*

☞   The E-Stop zone setup is independent of whether a safety technology option L3 is available or not.
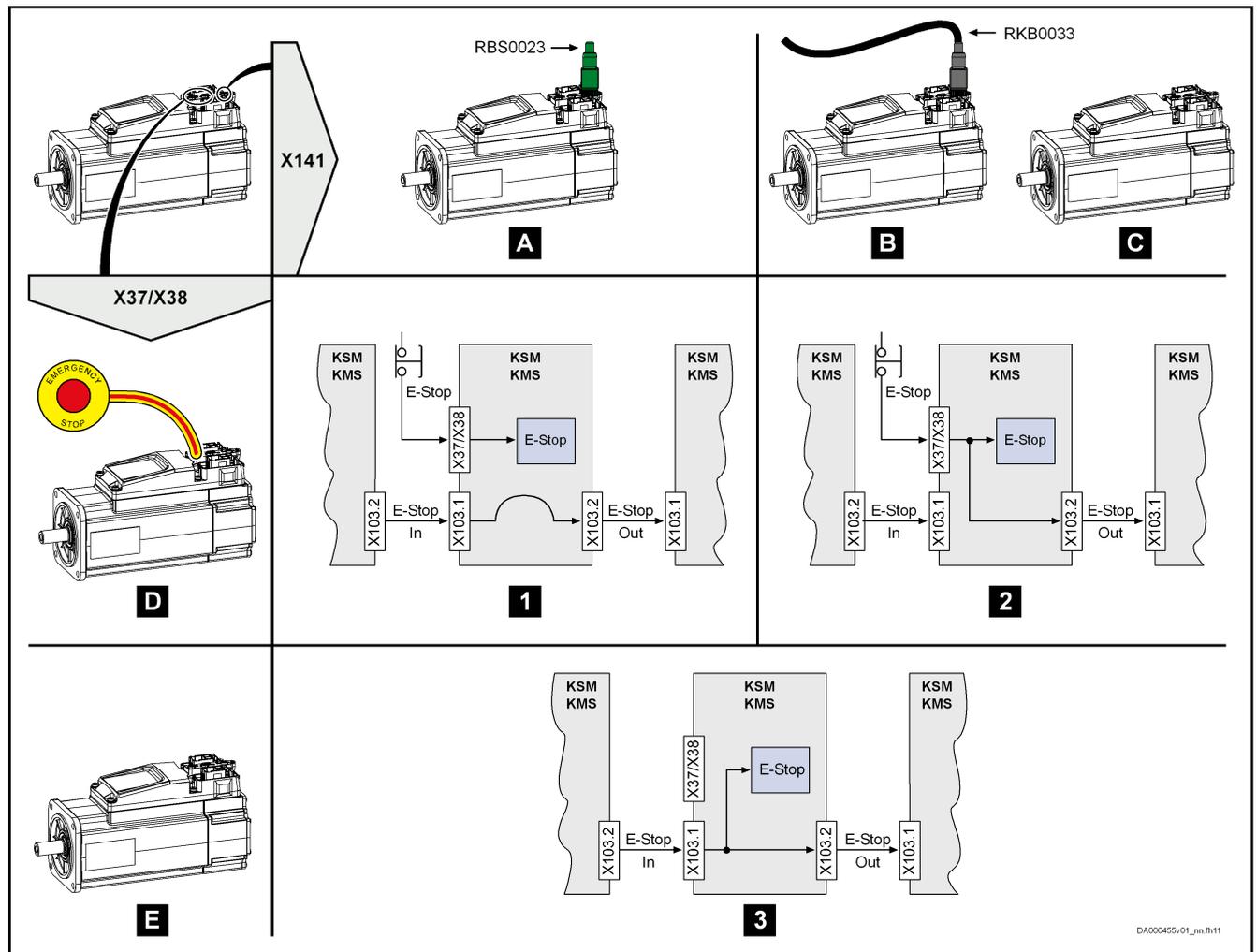
A	RBS0023 at X141
B	RKB0033 at X141
C	X141 not connected
D	E-Stop wired at X37/X38 and configured in P-0-0300
E	E-Stop not wired at X37/X38 and/or not configured in P-0-0300
1	Not an E-Stop zone node, local E-Stop takes effect
2	E-Stop zone beginner
3	E-Stop zone node

Fig. 12-5: *Logic table of E-Stop zone setup*

📖 See also Functional Description of firmware "E-Stop function".

12.6 Safety zones

Safety zone   A **safety zone** consists of a **safety zone beginner** and one or several **safety zone nodes**. The example shows a drive system with 2 safety zones.

Project planning
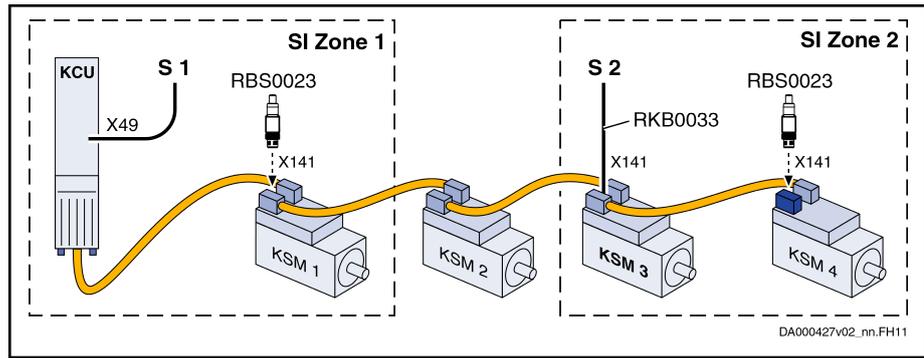
KCU, KSM 3	Safety zone beginner; alternative for KCU: KMV (S1 signal via X141 at KSM 1; KMV is not a safety zone node)
KSM 1, KSM 4	Safety zone node
KSM 2	KSM without optional safety technology ⇒ not a safety zone node
RBS0023	Connector for safety zone node at connection point X141 (only required for KSM/KMS with optional safety technology)
RKB0033	Cable for transmitting the safety-related signals
S 1, S 2	Signals of the individual safety zones
SI Zone 1, SI Zone 2	Safety zones
X49, X141	Connection points of safety technology

Fig. 12-6:   Safety zones

Safety zone beginner KCU
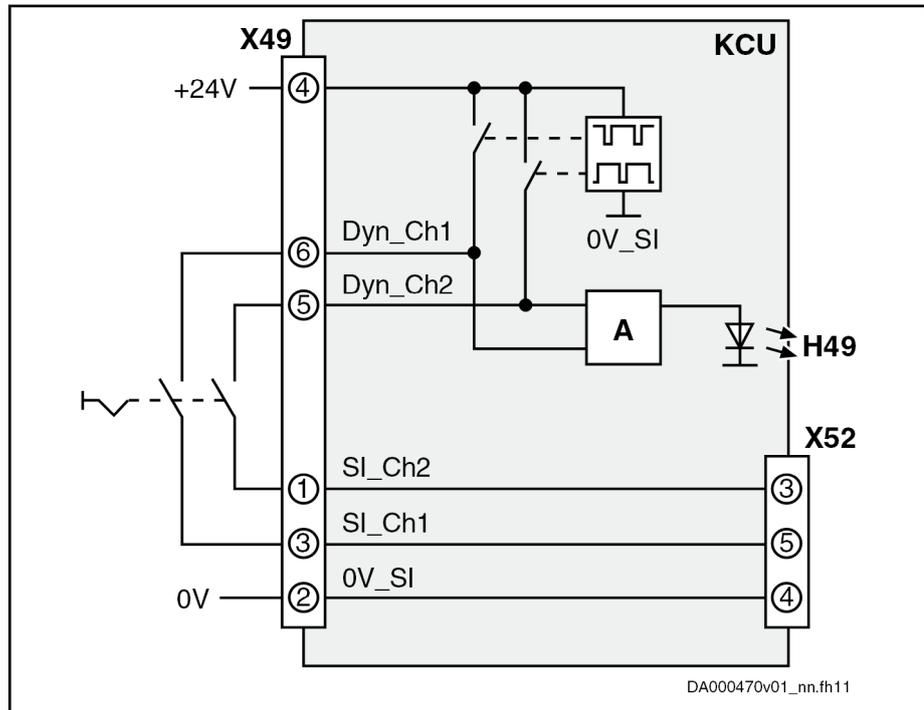
| A | Monitoring electronics in KCU |
| H49 | Diagnostic display for safety technology signals |

Fig. 12-7:   Safety zone beginner KCU

Two options for signal input:

- Passive safety unit with internal dynamization pulses in conjunction with external safety technology contacts and an external 24V power supply unit
- Active safety unit via a safety PLC

Passive safety unit	Active safety unit

int. Dyn: Dynamization pulses are internally generated
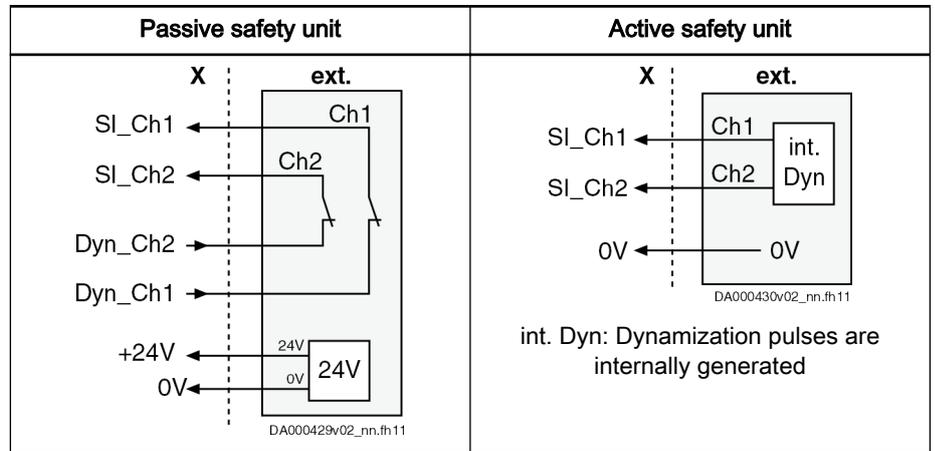
ext.   External safety unit for a safety zone
X   Connection point of the safety zone beginner

Tab. 12-10:   Signal input

Safety zone node

When a KSM/KMS **with** optional safety technology is to be a safety zone node within a safety zone, X141 has to be equipped with the connector RBS0023.

KSM/KMS **without** optional safety technology do not require the connector, because for these devices the signals are directly transmitted to the next safety zone node via X103.1 and X103.2. KSM/KMS without optional safety technology are not safety zone nodes and do not react to safety technology signals.

12.7   Technical data of inputs and outputs

12.7.1   Digital inputs (safety technology L options)

The digital inputs correspond to IEC 61131, type 2.

DX000037v01_nn.fh11
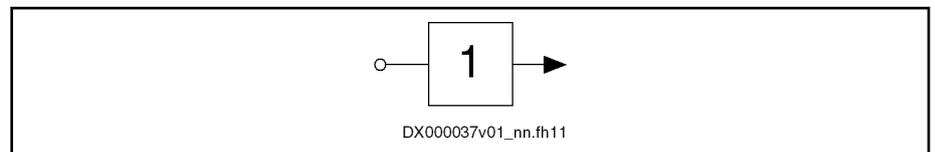
Fig. 12-8:   Symbol

Data	Unit	Min.	Max.
Allowed input voltage	V	-3	30
High	V	11	30

Project planning

Data	Unit	Min.	Max.
Low	V	-3	5
Current consumption [1]	mA	7	15

1)   For KCU02, the specified values must be multiplied with the number of zone nodes of the drive line.

Tab. 12-11:   *Digital inputs (safety technology L options)*

12.7.2   Digital Outputs (Safety Technology L Options)

The digital outputs are compatible with digital inputs of types 1, 2 and 3 (IEC 61131).

DX000038v01_nn.fh11
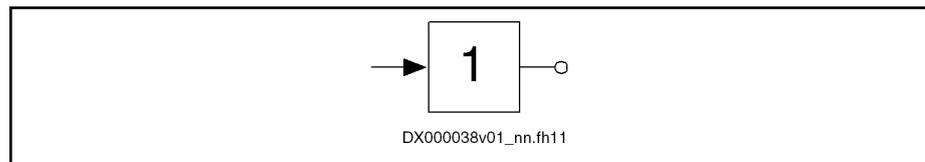
Fig. 12-9:   *Symbol*

Data	Unit	Min.	Max.
Supply voltage (U_{ext})	V	19,2	30
Current consumption (I_{ext})	mA		700
Output voltage ON	V	18,2	30
Output voltage OFF	V		5
Output current ON	mA		350
Allowed energy content of connected inductive loads, e.g. relay coils; only allowed as single pulse	mJ		400
Short circuit protection		Available	
Overload protection		Available	

Tab. 12-12:   *Digital Outputs (Safety Technology L Options)*

13   Service and support

Our worldwide service network provides an optimized and efficient support. Our experts offer you advice and assistance should you have any queries. You can contact us **24/7**.

Service Germany

Our technology-oriented Competence Center in Lohr, Germany, is responsible for all your service-related queries for electric drive and controls.

Contact the **Service Hotline** and **Service Helpdesk** under:

Phone:	**+49 9352 40 5060**
Fax:	**+49 9352 18 4941**
E-mail:	service.svc@boschrexroth.de
Internet:	http://www.boschrexroth.com/

Additional information on service, repair (e.g. delivery addresses) and training can be found on our internet sites.

Service worldwide

Outside Germany, please contact your local service office first. For hotline numbers, refer to the sales office addresses on the internet.

Preparing information

To be able to help you more quickly and efficiently, please have the following information ready:

- Detailed description of malfunction and circumstances
- Type plate specifications of the affected products, in particular type codes and serial numbers
- Your contact data (phone and fax number as well as your e-mail address)

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Notes

R911332634

DOK-INDRV*-SI3-**VRS**-AP08-EN-P