

Rexroth IndraDrive Integrated Safety Technology

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Edition 06

Functional and Application Description



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Purpose of Documentation	This documentation is used to <ul style="list-style-type: none"> • make oneself familiar with the subject of "Integrated Safety Technology", • get to know the IndraDrive system with integrated safety technology, employ and commission application-related safety functions, • enable you to recognize and fix errors and • enable you to replace the hardware and update the firmware.

Record of Revision	Edition	Release Date	Notes
	DOK-INDRV*-SI*-**VRS**-FK01-EN-P to DOK-INDRV*-SI*-**VRS**-FK06-EN-P	2004-03-16 to 2008-04-03	See chapter "About This Documentation", marginal note "Editions of This Documentation"

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1 Introduction

1.1 About This Documentation

Editions of This Documentation

Edition	Release date	Notes
DOK-INDRV*-SI*-**VRS**-FK01-EN-P	2004-03-16	First edition
DOK-INDRV*-SI*-**VRS**-FK02-EN-P	2004-07-21	Designation of safety functions corrected; declarations of conformity and type-examination certificates updated; description for "Safety related homing procedure (dual-channel)" corrected; fields of application corrected
DOK-INDRV*-SI*-**VRS**-FK03-EN-P	2005-05-04	<ul style="list-style-type: none"> • Documentation structure modified • New safety technology functions (introduced with MPx03) included • Description of PROFIsafe • Note in "Appropriate Use" regarding realization of safety-relevant machine control acc. to IEC EN 62061 when using safety technology with PROFIBUS interface (PROFIsafe) • Notes regarding option L1/S1 included in Brief Description of the functions • Parameter setting of P-0-3222=0 (switches off monitoring of activation time) described in all safety functions in special mode "Safety related motion" and under "Setting the System Behavior" • "Firmware Update and Controller Replacement" replaced by "Diagnosis and Service" • Error corrections • Certificates updated due to PROFIsafe • Chapter "Commissioning" extended
DOK-INDRV*-SI*-**VRS**-FK04-EN-P	2006-03-08	<ul style="list-style-type: none"> • New safety technology functions (introduced with MPx04) included • Description of firmware update supplemented • Certificates updated
DOK-INDRV*-SI*-**VRS**-FK05-EN-P	2008-01-19	Description of complete scope of functions of MPx05; new: <ul style="list-style-type: none"> • Safety function "safety related braking and holding system" • Auxiliary function "safety related brake check" • Command for enabling special mode without valid brake status • Extension of function "safety related monitored stopping process"
DOK-INDRV*-SI*-**VRS**-FK06-EN-P	2008-04-03	Chapter "Replacing the Controller" updated

Fig. 1-1: Record of revisions

Means of Representation in This Documentation

To make the reading of this documentation easier for you, the table below contains the means of representation and notations of recurring terms.

Introduction

What?	How?	For example...
Important facts which are to be highlighted in continuous text	Boldface	With the safety function "safety related parking axis" the following monitoring functions are de-activated : ...
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".

Fig. 1-2: Conventions of notation

All important notes are highlighted. A symbol tells you what kind of note is used in the text. The symbols have the following significances:



DANGER

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



WARNING

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



CAUTION

...
CAUTION indicates a potentially hazardous situation which, if not avoided, may result in injury or property damage.



This box contains important information which you should take into consideration.



This symbol highlights useful tips and tricks.

Structure of Documentation

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

- **Functional and Application Description** for Rexroth IndraDrive, **Integrated Safety Technology** (this documentation)
- **Project Planning Manual of Rexroth IndraDrive control sections**
Assists with electrical design and installation of the drive system
- **Parameter Description** for Rexroth IndraDrive
Apart from the safety-technology-specific parameters, all other drive parameters are documented in the Parameter Description
- **Troubleshooting Guide** for Rexroth IndraDrive
Apart from the safety-technology-specific diagnostic messages, all other diagnostic drive messages are documented in the Troubleshooting Guide



For an overview of reference documentations, see: [chapter 1.2 "Reference Documentations" on page 3](#)

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:

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We need the following information to handle your feedback:

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

1.2 Reference Documentations

1.2.1 Drive Systems, System Components

Title Rexroth IndraDrive ...	Kind of documentation	Document typecode ¹⁾ DOK-INDRV*-...	Part no. R911...
Drive System	Project Planning Manual	SYSTEM*****-PRxx-EN-P	309636
Mi Drive Systems	Project Planning Manual	KCU+KSM****-PRxx-EN-P	320924
Supply Units and Power Sections	Project Planning Manual	HMV-S-D+HCS-PRxx-EN-P	318790
Drive Controllers Control Sections	Project Planning Manual	CSH*****-PRxx-EN-P	295012
Additional Components	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)

Fig. 1-3: Documentations – drive systems, system components

1.2.2 Motors

Title Rexroth IndraDyn ...	Kind of documentation	Document typecode ¹⁾ DOK-MOTOR*-...	Part no. R911...
A Series Asynchronous Motors MAD/MAF	Project Planning Manual	MAD/MAF****-PRxx-EN-P	295781
H Frameless Synchronous Spindle Motors	Project Planning Manual	MBS-H*****-PRxx-EN-P	297895
L Synchronous Linear Motors	Project Planning Manual	MLF*****-PRxx-EN-P	293635
S MSK Synchronous Motors	Project Planning Manual	MSK*****-PRxx-EN-P	296289
T Synchronous Torque Motors	Project Planning Manual	MBT*****-PRxx-EN-P	298798

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)

Fig. 1-4: Documentations – motors

1.2.3 Cables

Title	Kind of documentation	Document typecode ¹⁾ DOK-...	Part no. R911...
Rexroth Connection Cables	Selection Data	CONNEX-CABLE*STAND-AUxx-EN-P	282688

1) In the document typecodes, "xx" is a wild card for the current edition of the documentation (example: AU03 is the third edition of the documentation "Selection Data")

Fig. 1-5: Documentations – cables

Introduction

1.2.4 Firmware

Title	Kind of documentation	Document typecode ¹⁾	Part no.
Rexroth IndraDrive ...		DOK-INDRV*-...	R911...
Firmware for Drive Controllers	Functional Description	MP*-02VRS**-FKxx-EN-P	299223
Firmware for Drive Controllers	Functional Description	MP*-03VRS**-FKxx-EN-P	308329
Firmware for Drive Controllers	Functional Description	MP*-04VRS**-FKxx-EN-P	315485
Firmware for Drive Controllers	Parameter Description	GEN-**VRS**-PAxx-EN-P	297317
Firmware for Drive Controllers	Troubleshooting Guide	GEN-**VRS**-WAxx-EN-P	297319
Integrated Safety Technology	Functional and Application Description	SI**-**VRS**-FKxx-EN-P	297838
Rexroth IndraMotion MLD	Application Manual	MLD-**VRS**-AWxx-EN-P	306084
Rexroth IndraMotion MLD Library	Library Description	MLD-SYSLIB*-FKxx-EN-P	309224

1) In the document typecodes, "xx" is a wild card for the current edition of the documentation (example: PA02 is the second edition of a Parameter Description)

Fig. 1-6: Documentations – firmware

2 System Overview

2.1 Introduction

2.1.1 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 **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 distinguished by the following features:

- Complies with valid standards
- Simplified system structure (e.g. use of PROFIBUS for communication and safety)
- Increased system performance
- Reduced system costs
- Easy understanding of complex subjects
- Improved diagnoses
- Simplified certification
- Easy commissioning
- Independent of control units

Safety Related Braking and Holding System

Machine setup, trouble shooting or process optimization: During operation of machines and installations, it is necessary for persons to work in the processing area of machines. With gravity-loaded axes in the area of access, particular precaution is required. Whereas horizontal axes are not subject to gravitational force, vertical or inclined axes can move down accidentally and thereby cause danger, even when they have been de-energized. This can occur, for example, by soiling, mechanical wear or when holding brakes get oiled-up and thereby lose their nominal holding torques.

The Information Sheet no. 5 ("Gravity-loaded axes (Vertical axes)", issue 02/2004) of the "Fachausschuss Maschinenbau, Fertigungssysteme, Stahlbau" (Committee of experts for mechanical engineering, manufacturing systems, structural steel engineering) of the institution for statutory accident insurance and prevention ("Berufsgenossenschaft Metall Süd") contains the presently valid "state-of-the-art" concerning fall-down protection of vertical axes. This Information Sheet reflects the experience gained by manufacturers and users of industrial robots and handling systems, as well as machine tool manufacturers, as regards the handling of gravity-loaded axes which move down accidentally. Depending on the hazardous situation, technical and organizational protective measures are described to prevent the axes from moving down due to errors and minimize the hazards. If the intended use allows, for example,

System Overview

a machine operator to stay under the vertical axis with the whole body, the Information Sheet recommends a redundant device for fall-down protection according to DIN EN 954-1, category 3, both for automatic operation and for a longer stay in the setting-up mode. According to the Information Sheet, this is fulfilled, for example, by a holding brake in combination with a second brake.

In the majority of cases, the machine manufacturer cannot manage to build up a safety related braking and holding system according to EN 954-1, category 3 on his own. An error mustn't cause the safety function to fail and the error must be detected, such are the requirements of category 3. This means that it is not sufficient to use two brakes, the control of the two brakes must additionally take place via different channels. The error detection of all possible errors in both channels must be verified by an FMEA, i.e. failure mode and effects analysis.

With the safety related braking and holding system in the drive, Rexroth does this work for the machine manufacturers and as a drive manufacturer provides an integrated system solution which has been certified according to EN 954-1, category 3. The safety functions already available in the drive are usefully complemented for the use of gravity-loaded axes.

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 operating modes with a maximum of safety (short reaction times).

The following components of conventional safety technology are not included in drive and control systems with integrated safety technology:

- Motor zero-speed relay for monitoring safety related standstill
- Speed monitor for monitoring safety related reduced speeds
- Power contactors between controllers and motors
- Limit switches or position cams for detection of range



The integrated safety technology is **not** destined to replace conventional safety technology, such as emergency stop switching 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 in diversitary (manifold) design. Master communication (SERCOS interface, PROFIBUS, CANopen, etc.) can be used for transmission of a channel.

2.1.2 Conceptual Overview

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

The integrated safety technology is realized by the interaction of the hardware and firmware components.

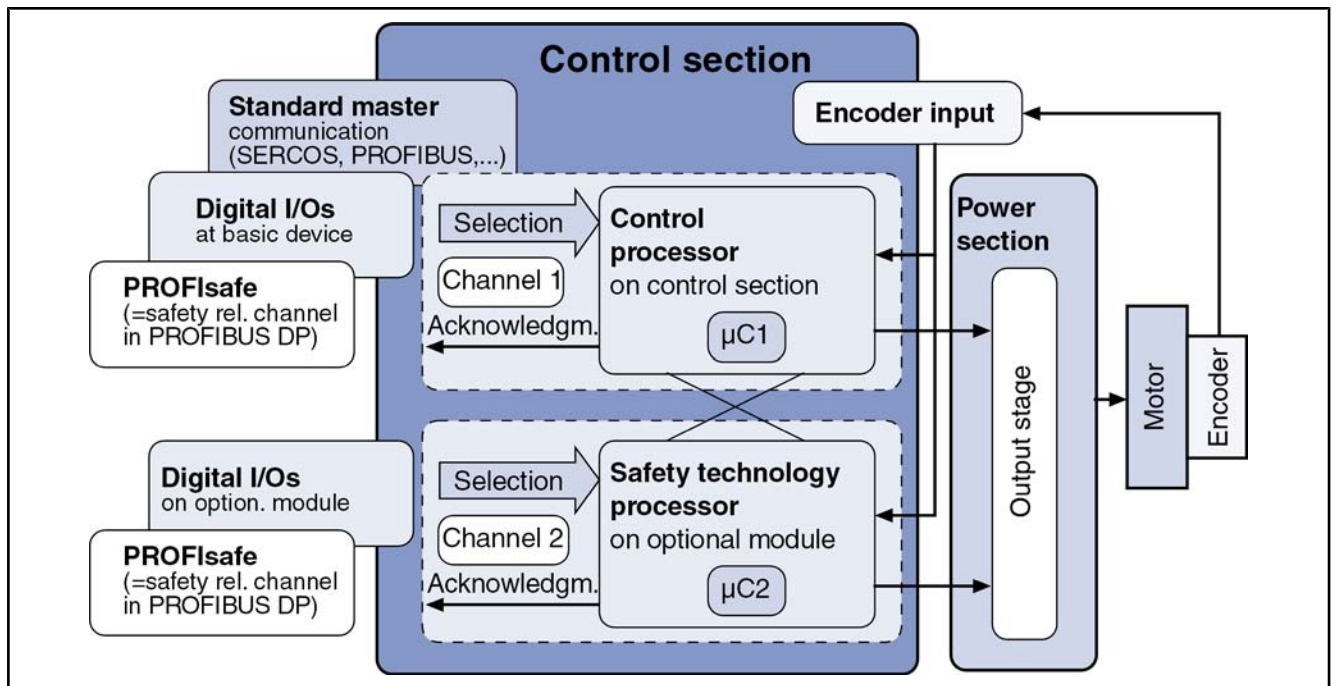


Figure name DF000308

Fig.2-1: Schematic diagram of IndraDrive with integrated safety technology

The above diagram contains all 3 variants of control of integrated safety technology:

- Safety Technology I/O
- Safety technology I/O and master communication
- PROFIsafe (as of MP*03VRS; PROFIBUS as master communication is the prerequisite for using PROFIsafe)

See also "[Interfaces for Selection and Acknowledgment](#)"



Using only one motor encoder is sufficient.



Under "[Required Motors and Measuring Systems](#)", the allowed encoder types (measuring systems) are mentioned.

2.1.3 Risk Analysis

Before he is allowed to put a machine into circulation, the manufacturer of the machine has to carry out a risk analysis according to Machinery Directive 98/37/EWG in order to determine the hazards associated with the use of the machine.

The risk analysis is a multilevel, iterative process. The procedure is described in detail in EN 1050 [4] – Principles for risk assessment. This documentation can only give you a very short overview on the subject of risk analysis; users of integrated safety technology are obliged to intensively study the respective standards and legal status.

The risk analysis carried out provides you the requirements for determining the category for safety-related control units according to EN 954 1 the safety-relevant parts of the machine control have to comply with.

System Overview



For more detailed information on the categories, see EN 954 1 and the Z-document of "Certification Authority SIBE Schweiz" (<http://www.sibe.ch> or e-mail to nsbiv@sibe.ch), "Klassifizierung von Steuerungen, Erläuterungen zu Risikobeurteilung und EN 954-1" ("Classification of Controls, Explanations Regarding Risk Assessment and EN 954-1") Z9714dVers03.

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 of the following simplifications:

- The safety-related components of the IndraDrive range with the option "integrated safety technology" correspond to category 3 of EN 954-1. This means that functions realized with the optional safety technology modules of the IndraDrive range comply with category 3 of EN 954-1.
- The safety functions integrated in IndraDrive were certified by the accredited "Certification Authority SIBE Schweiz"; this guarantees the user that the solution complies with the state-of-the-art / the conformity of the components according to Machinery Directive 98/37/EG is ensured.

Category 1)	Summary of the requirements	System behavior 2)	Principles for obtaining safety
B	The safety-related parts of control units and/or their protective devices, as well as their components, must be designed, constructed, selected, assembled and combined, according to the respective standards, in such a way that they can resist the influences to be expected.	An error occurring can cause the safety function to be lost.	Predominantly characterized by selection of components.
1	Requirements of category B must be fulfilled. Proved components and proved safety principles must be used.	An error occurring can cause the safety function to be lost, but it is less probable that an error occurs than in category B.	Predominantly characterized by selection of proved components.
2	The requirements of B and the use of proved safety principles must be fulfilled. In appropriate intervals, the safety function must be checked by the machine control unit.	An error occurring can cause the safety function to be lost between the points of time the safety function is checked. The loss of the safety function is recognized by the check.	Predominantly characterized by selection of proved components and check of safety functions by the control unit. The check may be initiated automatically or manually.

System Overview

Category 1)	Summary of the requirements	System behavior 2)	Principles for obtaining safety
3	The requirements of B and the use of proved safety principles must be fulfilled. Safety-related parts must be designed in such a way that a single error in each of those parts does not cause the safety function to be lost and that single errors are recognized whenever this can be realized in an appropriate way.	When a single error occurs the safety function is always maintained. Some but not all errors are recognized. An accumulation of unrecognized errors can cause the safety function to be lost.	Predominantly characterized by the structure. An accumulation of unrecognized errors can cause the safety function to be lost.
4	The requirements of B and the use of proved safety principles must be fulfilled. Safety-related parts must be designed in such a way that an individual error in each of those parts does not cause the safety function to be lost and that the individual error is recognized at or before the next requirement of the safety function. If this is impossible an accumulation of errors mustn't cause the safety function to be lost.	When errors occur the safety function is always maintained. The errors are recognized in time in order to prevent the safety function from being lost.	Predominantly characterized by the structure. All errors are recognized in time, no accumulation of unrecognized errors.

1) The categories are not destined to be used in any given sequence or hierarchical order with regard to the safety-related requirements.

2) The risk assessment will show whether the total or partial loss of the safety function(s) due to errors can be accepted.

Fig.2-2: Summary of requirements for safety categories (excerpt from EN 60954-1: 1996, section 6)

2.2 Safety-Relevant Standards and Regulations

2.2.1 General Information



Standard documents and sheets are subject to copyright protection and Bosch Rexroth mustn't pass them on. If required, contact the authorized sales agencies; in Germany directly contact BEUTH Verlag GmbH (<http://www.din.de/beuth>).

Below the user will find a short overview of the relevant standards for the use of safety-related control units. As regards the relevant standards, this documentation does not claim completeness.

2.2.2 Standards Relevant to Components

Product group	Standard	Title	Date of issue
Electric drives	IEC 61800-5-2	Adjustable speed electrical power drive systems, part 5-2: Functional safety requirements	2007
Simple controls	EN 954-1	Safety of machinery, Safety-related parts of control systems	1996
Complex controls	IEC 61508-1 to IEC 61508-7	Functional safety Safety systems	1998 to 2000

Fig.2-3: Standards relevant to components

System Overview

2.2.3 Standards Relevant to Machinery

Standard	Title	Date of issue
EN 60204-1	Safety of machinery, Electric equipment of machines	2007
EN ISO 12100-1/ -2	Safety of machinery; Basic concepts, general principles for design	2000
EN ISO 14121	Safety of machinery, Principles for risk assessment	1996
EN 954-1	Safety of machinery, Safety-related parts of control systems	1996
EN 1921	Safety of integrated manufacturing systems	1996
EN 775	Manipulating industrial robots; Safety	1993
EN 1037	Safety of machinery, Prevention of unexpected start-up	1995
EN 12415	Safety of Machine tools – Small numerically controlled turning machines and turning centres	2000
EN 12417	Machine tools – Safety –Machining centres	2001
EN 1010-1	Safety of machinery, Safety requirements for the design and construction of printing and paper converting machines	1993
IEC 62061	Safety of machinery, Functional safety of electrical, electronic and programmable control systems for machinery	2004
DIN EN 848-3	Safety of woodworking machines	2007
EN 999	Safety of machinery, The positioning of protective equipment in respect of approach speed of parts of the human body	1998
EN 1088	Safety of machinery, Interlocking devices associated with guards - Principles for design and selection	1995
DIN EN ISO 13849-1	Safety of machinery, Safety-related parts of control systems	2007

Fig.2-4: Standards relevant to machinery

2.2.4 Overview of the Required Safety Categories in C-Standards

Below you find an overview of the required safety categories for safety-related parts of control units in C-standards.

	EN 12417 Machining centres	EN 12415 Turning centres	EN 1010 Printing and paper converting machines	EN 775 Industrial robots	EN 1921 Automated manufacturing systems	prEN 848-3 Woodworking machines
Enabling control	Category 3	Category 3	-	Category 3	Category 3	Category 3
Speed reduction, incl. protection against unexpected start-up (n=0)	Category 3	Category 3	Category 3	Category 3	Category 3	Category 3
	Category B and enabling control device				Category B and enabling control device	Category B and enabling control device
Locking of protective equipment	Category 3	Category 3	Category 3	Category 3	Category 3	Category 3 (electronic)
					Category 1 for maintenance doors	Category 1 (with contacts)

	EN 12417 Ma- chining centres	EN 12415 Turn- ing centres	EN 1010 Printing and paper con- verting machines	EN 775 Industri- al robots	EN 1921 Auto- mated manufac- turing systems	prEN 848-3 Woodworking machines
Limitation of end positions	-	-		Category 3	Category 3	-
Emergency halt	Category 1 (with contacts)	Category 1 (with contacts)		According to EN 60204-1	According to EN 60204-1	Category 1 (with contacts)
	Category 3 (elec- tronic)	Category 3 (electronic)	Category 3			Category 3 (electronic)

Fig.2-5: Requirements for safety-related control units in C-standards



The standards EN 775 and EN 1921 do not contain any direct reference to EN 954-1; their requirements, however, can be compared to those of EN 954-1.

2.2.5 Standards and Regulations for PROFIBUS / PROFI-safe

Subject	Standard	Title	Date of issue
PROFIBUS	IEC 61158	Digital data communication for measurement and control - Fieldbus for use in industrial control systems	
PROFI-safe	PNO Order No: 3.092	Profile for Safety Technology, Version 1.30	June 2004
PROFI-safe	PNO Order No: 3.232	Requirements for Installation, Immunity and electrical Safety, Version 1.0	February 2003

Fig.2-6: Standards and regulations for PROFIBUS / PROFI-safe

2.3 Product Presentation

2.3.1 What is "Integrated Safety Technology"?

The control sections of the IndraDrive range can be equipped with

- an optional module "starting lockout" ("L1") or
- an optional module "safety technology I/O" ("S1")

IndraDrive is thereby equipped with integrated safety technology which provides the user with an electronic starting lockout, as well as with universally programmable safety related motion and standstill monitoring.

Definition "Integrated safety technology" refers to application-related safety functions that are applicable for personal protection at machines in accordance with EN 954-1 category 3.

Selecting the Function The safety functions can be alternatively selected via

- 24 V inputs at the drive controller or
- 24 V inputs at the drive controller and master communication (one channel each) or
- the safety related channel in PROFIBUS (PROFI-safe)

Certification The safety technology was tested and certified by an EU type examination of "Certification Authority SIBE Schweiz" (<http://www.sibe.ch>). (On demand, you can get copies of the declarations of conformity and of the mark certificates from our Bosch Rexroth sales representative [see "Service and Support"]).

System Overview

In addition, safety technology was certified by TÜV Rheinland and has been listed by TÜV Rheinland of North America (NRTL listing) (see (<http://www.tuv.com/de/index.html> or <http://www.us.tuv.com/> under "ID-Zertifikate" or "ID-Certificate") [US+Canada NRTL-Certificate, certificate no. 72071176 (L1) and certificate no. 72071177 (S1)]. "NRTL" means **N**ationally **R**ecognized **T**esting **L**aboratory; products listed by such a testing laboratory may be used in the US in the appropriate way (according to NFPA79).

Requirements That Can Be Realized

The integrated safety technology is independent of the kind of master communication, the higher-level control unit and the supply modules. It is available as an optional module for the standard drive system. The following requirements can be realized in the machine or installation:

- Measures according to EN 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 in accordance with EN 954-1 category 3, as stipulated in EN 1010-1 (printing and paper converting machines), EN 12415 (turning machines) and EN 12417 (machining centres).
- Control functions in the case of error according to EN 60204-1 (see "Using diversity" in EN 60204-1).

2.3.2 Integrated Safety Technology as IndraDrive Platform Solution

The different characteristics (e.g. PROFIsafe, I/O, ...) require different hardware:

Control section type	Designation	Characteristics of integrated safety technology		
		Starting lockout (opt. module "L1")	Safety On Board	
			Safety technology I/O (optional module "S1")	PROFIsafe
CSH01.1C	ADVANCED	X	X	X
CSH01.2C	ADVANCED	X	X	X
CSB01.1C	BASIC UNIVERSAL (single-axis)	X		
CDB01.1C	BASIC UNIVERSAL (double-axis)	X	X	X
CSB01.1N-FC	BASIC OPENLOOP	X		
CSB01.1N-AN	BASIC ANALOG	X		
CSB01.1N-SE	BASIC SERCOS	X		
CSB01.1N-PB	BASIC PROFIBUS	X		

Fig.2-7: Overview of hardware requirements for integrated safety technology



Apart from the optional module "S1", using PROFIsafe requires the master communication module "PROFIBUS" (PB) and the corresponding firmware version (as of MP*03VRS)!

2.3.3 Characteristics and Classification of Safety Technology

Functionality Levels

The available integrated safety functions can be divided into 2 levels:

- Level 1: purely hardware-based safety technology, starting lockout is part of it (optional safety technology module "L1" required)

Characteristics Regarding the Interfaces

- Level 2: extensive integrated safety technology including all other safety functions, such as safety related reduced speed, safety related limited absolute position, ... (optional safety technology module "S1" required)

Apart from the classification of the safety functions, we distinguish the kinds of control (e.g. digital I/Os or PROFIBUS). The firmware MP*03VRS supports the following characteristics:

- Safety technology I/O
- PROFIsafe

2.4 Overview of Functions and Characteristics

2.4.1 Characteristics of Integrated Safety Technology

Introduction

Presently there are 3 different characteristics of integrated safety technology which differ as regards complexity and functionality.

- Starting lockout [pure hardware solution (optional safety technology module "L1")]
- Safety technology I/O [hardware solution (optional safety technology module "S1") and firmware solution]
- PROFIsafe [hardware solution (optional safety technology module "S1" and PROFIBUS master communication) and firmware solution]

The paragraphs below briefly explain the differences of the characteristics of integrated safety technology to allow you distinguishing them.



For detailed information on the characteristics of integrated safety technology and the functions they provide, see chapter "Integrated Safety Functions".

Drive System With Safety Related Starting Lockout

On the optional safety technology module "starting lockout" ("L1"), there are 24 V inputs available for dual-channel selection and a floating changeover contact for dual-channel feedback (all 3 connections can be accessed).

By means of the optional safety technology module "starting lockout", the drive can be protected against accidental restart and thereby be kept in a safety related status.

Drive System With Integrated "Safety Technology I/O"

On the optional safety technology module "safety technology I/O" ("S1"), there are the 24 V inputs of channel 2 available for selecting the application-related safety functions. The inputs of channel 1 can be connected either via the master communication or via the standard inputs of the drive controller. In addition, 24 V outputs for acknowledgment of safety are available on the optional module.

By means of the optional safety technology module "safety technology I/O", it is possible to realize application-related safety functions of safety related halt and safety related motion in the drive.

Drive System With Integrated Safety Technology "PROFIsafe"

For a drive system with integrated safety technology "PROFIsafe", the optional safety technology module "safety technology I/O" ("S1") and PROFIBUS as master communication have to be available in the drive. Of the optional module inputs it is only the home switch that is used for this characteristic, as the safety

System Overview

function selection and the acknowledgment take place via the safety related PROFIsafe protocol of the master communication.

By means of PROFIsafe, it is possible to realize application-related safety functions of safety related halt and safety related motion in the drive via PROFIBUS.

2.4.2 Supported Safety Technology Functions

Introduction

The safety technology functions can be divided into the following categories:

- Normal operation and special mode
- "Safety related halt"
- "Safety related motion"
- Auxiliary functions
- "Safety related feedback"

Safety Related Halt

The category "**safety related halt**" includes the individual functions:

- Starting lockout
- Safety related standstill
- Safety related operational stop
- Safety related drive interlock
- Safety related braking and holding system



The functions "safety related standstill", "safety related operational stop" and "safety related drive interlock" contain the safety related monitored stopping process (category of auxiliary functions).

Safety Related Motion

The category "safety related motion" includes the individual functions:

- Safety related maximum speed
- Safety related reduced speed
- Safety related direction of motion
- Safety related monitored deceleration ramp
- Safety related limited increment
- Safety related limited absolute position
- Safety related limited absolute end position



The special mode "safety related motion" contains the safety related monitored stopping process (category of auxiliary functions).

Safety Related Feedback

The category "**safety related feedback**" includes the individual functions:

- Safety related diagnostic outputs
- Safety related I/Os
- Safety related control of a door locking device

Auxiliary Functions

- Safety related monitored stopping process
- Safety related homing procedure (required for "safety related limited absolute position" and "safety related limited absolute end position")
- Safety related parking axis
- Safety related brake check (required for "safety related braking and holding system")

Overviews

Safety technology function category	Safety technology function
Safety related halt	Safety related starting lockout

Fig.2-8: Safety technology function with optional module "starting lockout" ("L1")

Safety technology function category	Safety technology function	Availability ⁽¹⁾
Normal operation and special mode	Safety related maximum speed	As of MP*02VRS
Normal operation and special mode	Safety related direction of motion	As of MP*05VRS
Normal operation and special mode	Safety related limited absolute end position	As of MP*04VRS
Safety related halt	Safety related drive interlock	As of MP*02VRS
Safety related halt	Safety related standstill	As of MP*02VRS
Safety related halt	Safety related operational stop	As of MP*02VRS
Safety related halt	Safety related braking and holding system	As of MP*05VRS
Safety related motion	Safety related reduced speed	As of MP*02VRS
Safety related motion	Safety related direction of motion	As of MP*02VRS
Safety related motion	Safety related limited increment	As of MP*02VRS
Safety related motion	Safety related limited absolute position	As of MP*02VRS
Safety related feedback	Safety related diagnostic outputs	As of MP*02VRS
Safety related feedback	Safety related control of a door locking device	As of MP*02VRS
Safety related feedback	Safety related I/Os	As of MP*04VRS ⁽²⁾
Auxiliary functions	Safety related monitored stopping process	As of MP*04VRS
Auxiliary functions	Safety related homing procedure	As of MP*02VRS
Auxiliary functions	Safety related parking axis	As of MP*04VRS
Auxiliary functions	Safety related brake check	As of MP*05VRS

(1) As of MP*03 also via master communication "PROFIBUS" (PROFIsafe)

(2) Only available via master communication PROFIBUS" (PROFIsafe)

Fig.2-9: Overview of available safety technology functions with optional module "safety technology I/O"

2.4.3 Performance

Time Response and Reaction Times

The performance of integrated safety technology for control via the digital I/Os of the optional safety technology module ("S1") is as follows:

- Internal safety functions processed in 2 ms clock
- System control runs in 1 ms clock
- Error reaction takes place in 1 ms clock

System Overview

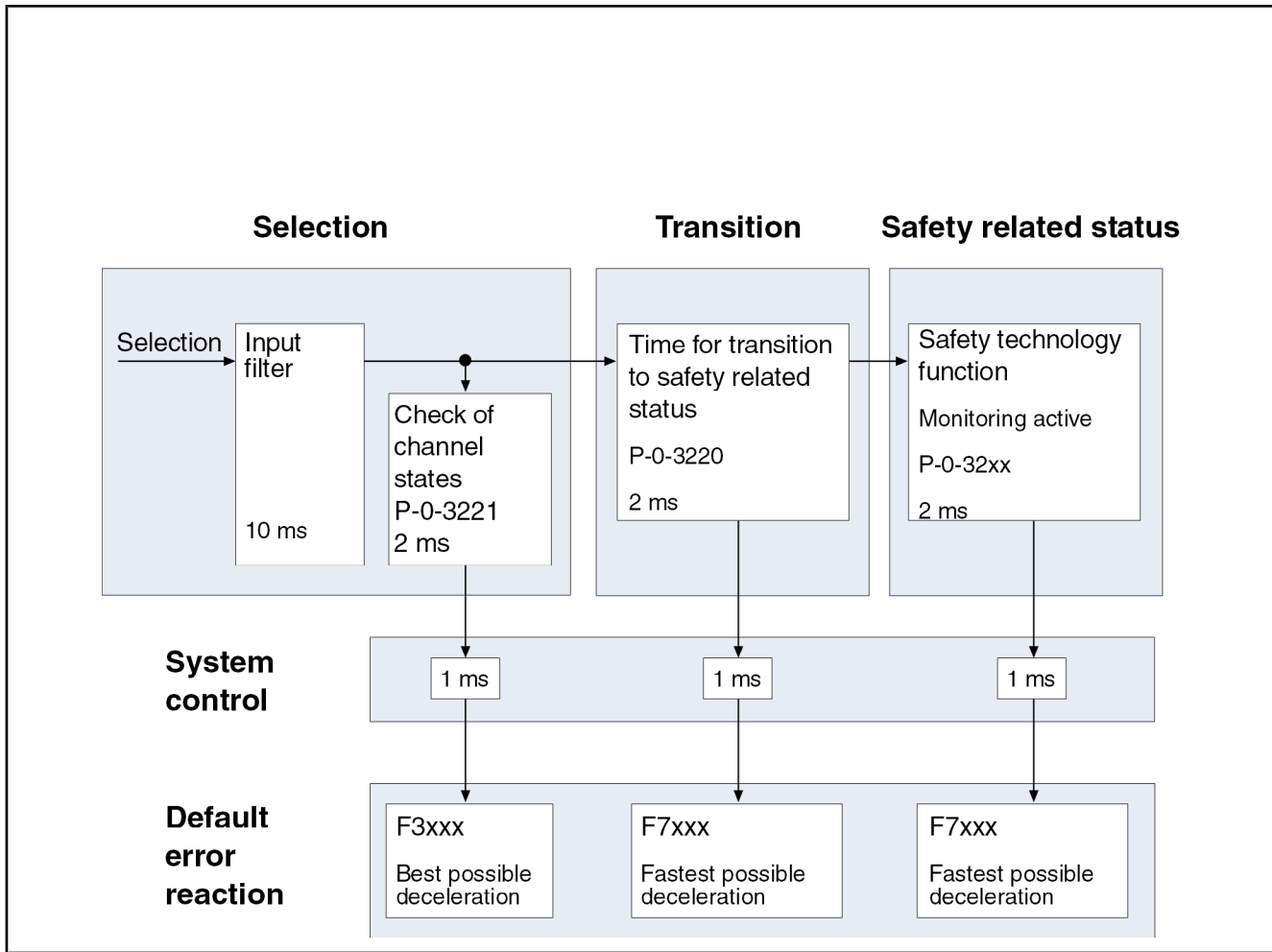


Figure name DF000093
 Fig.2-10: Reaction times I/O (optional module S1)

3 Important Directions for Use

3.1 Appropriate Use

3.1.1 Introduction

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



Personal injury and property damage caused by incorrect use of the products!

The products have been designed for use in the industrial field and may only be used in the manner that is defined as appropriate. If they are used in an inappropriate manner, then situations can develop that may lead to property damage or injury to personnel.



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 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 mount damaged or faulty products or use them in operation.
- Make sure that the products have been installed in the manner described in the relevant documentation.

3.1.2 Areas of Use and Application

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

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



The drive controllers may only be used with the accessories and parts specified in this document. 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, making it possible for the motor to execute the specific functions of an application.

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

To ensure application-specific use, the Drive controllers are available with different drive power and different interfaces.

Important Directions for Use

Typical applications of the drive controllers include:

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

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.).

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

4 Safety Instructions for Electric Drives and Controls

4.1 Safety Instructions - General Information

4.1.1 Using the Safety Instructions and Passing them on to Others

Do not attempt to install or commission this device without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with the device. If you do not have the user documentation for the device, contact your responsible Bosch Rexroth sales representative. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the device.

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



Improper use of these devices, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, may result in material damage, bodily harm, electric shock or even death!

Observe the safety instructions!

4.1.2 How to Employ the Safety Instructions

Read these instructions before initial commissioning of the equipment in order to eliminate the risk of bodily harm and/or material damage. Follow these safety instructions at all times.

- Bosch Rexroth AG is not liable for damages resulting from failure to observe the warnings provided in this documentation.
- Read the operating, maintenance and safety instructions in your language before commissioning the machine. If you find that you cannot completely understand the documentation for your product, please ask your supplier to clarify.
- Proper and correct transport, storage, assembly and installation, as well as care in operation and maintenance, are prerequisites for optimal and safe operation of this device.
- Only assign trained and qualified persons to work with electrical installations:
 - Only persons who are trained and qualified for the use and operation of the device may work on this device or within its proximity. The persons are qualified if they have sufficient knowledge of the assembly, installation and operation of the product, as well as an understanding of all warnings and precautionary measures noted in these instructions.
 - Furthermore, they must be trained, instructed and qualified to switch electrical circuits and devices on and off in accordance with technical safety regulations, to ground them and to mark them according to the requirements of safe work practices. They must have adequate safety equipment and be trained in first aid.
- Only use spare parts and accessories approved by the manufacturer.

Safety Instructions for Electric Drives and Controls

- Follow all safety regulations and requirements for the specific application as practiced in the country of use.
- The devices have been designed for installation in industrial machinery.
- The ambient conditions given in the product documentation must be observed.
- Only use safety-relevant applications that are clearly and explicitly approved in the Project Planning Manual. If this is not the case, they are excluded. Safety-relevant are all such applications which can cause danger to persons and material damage.
- The information given in the documentation of the product with regard to the use of the delivered components contains only examples of applications and suggestions.

The machine and installation manufacturer must

- make sure that the delivered components are suited for his individual application and check the information given in this documentation with regard to the use of the components,
- make sure that his 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 permitted once it is sure that the machine or installation in which they are installed complies with the national regulations, safety specifications and standards of the application.
- Operation is only permitted 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 documentation (Project Planning Manuals of components and system).
The machine or installation manufacturer is responsible for compliance with the limiting values as prescribed in the national regulations.
- Technical data, connection and installation conditions are specified in the product documentation and must be followed at all times.

National regulations which the user must take into account

- European countries: according to 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)

4.1.3 Explanation of Warning Symbols and Degrees of Hazard Seriousness

The safety instructions describe the following degrees of hazard seriousness. The degree of hazard seriousness informs about the consequences resulting from non-compliance with the safety instructions:

Safety Instructions for Electric Drives and Controls




Warning symbol	Signal word	Degree of hazard seriousness acc. to ANSI Z 535.4-2002
	Danger	Death or severe bodily harm will occur.
	Warning	Death or severe bodily harm may occur.
	Caution	Minor or moderate bodily harm or material damage may occur.

Fig. 4-1: Hazard classification (according to ANSI Z 535)

4.1.4 Hazards by Improper Use

 DANGER	High electric voltage and high working current! Risk of death or severe bodily injury by electric shock! Observe the safety instructions!
 DANGER	Dangerous movements! Danger to life, severe bodily harm or material damage by unintentional motor movements! Observe the safety instructions!
 WARNING	High electric voltage because of incorrect connection! Risk of death or bodily injury by electric shock! Observe the safety instructions!
 WARNING	Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment! Observe the safety instructions!
 CAUTION	Hot surfaces on device housing! Danger of injury! Danger of burns! Observe the safety instructions!
 CAUTION	Risk of injury by improper handling! Risk of bodily injury by bruising, shearing, cutting, hitting or improper handling of pressurized lines! Observe the safety instructions!

**CAUTION****Risk of injury by improper handling of batteries!**

Observe the safety instructions!

4.2 Instructions with Regard to Specific Dangers

4.2.1 Protection Against Contact with Electrical Parts and Housings



This section concerns devices and drive components with voltages of **more than 50 Volt**.

Contact with parts conducting voltages above 50 Volts can cause personal danger and electric shock. When operating electrical equipment, it is unavoidable that some parts of the devices conduct dangerous voltage.

**DANGER****High electrical voltage! Danger to life, electric shock and severe bodily injury!**

- Only those trained and qualified to work with or on electrical equipment are permitted to operate, maintain and repair this equipment.
- Follow general construction and safety regulations when working on power installations.
- Before switching on the device, the equipment grounding conductor must have been non-detachably connected to all electrical equipment in accordance with the connection diagram.
- Do not operate electrical equipment at any time, even for brief measurements or tests, if the equipment grounding conductor is not permanently connected to the mounting points of the components provided for this purpose.
- Before working with electrical parts with voltage potentials higher than 50 V, the device must be disconnected from the mains voltage or power supply unit. Provide a safeguard to prevent reconnection.
- With electrical drive and filter components, observe the following:
Wait **30 minutes** after switching off power to allow capacitors to discharge before beginning to work. Measure the electric voltage on the capacitors before beginning to work to make sure that the equipment is safe to touch.
- Never touch the electrical connection points of a component while power is turned on. Do not remove or plug in connectors when the component has been powered.
- Install the covers and guards provided with the equipment properly before switching the device on. Before switching the equipment on, cover and safeguard live parts safely to prevent contact with those parts.
- A residual-current-operated circuit-breaker or r.c.d. cannot be used for electric drives! Indirect contact must be prevented by other means, for example, by an overcurrent protective device according to the relevant standards.
- Secure built-in devices from direct touching of electrical parts by providing an external housing, for example a control cabinet.

Safety Instructions for Electric Drives and Controls



For electrical drive and filter components with voltages of **more than 50 volts**, observe the following additional safety instructions.

**High housing voltage and high leakage current! Risk of death or bodily injury by electric shock!**

- Before switching on, the housings of all electrical equipment and motors must be connected or grounded with the equipment grounding conductor to the grounding points. This is also applicable before short tests.
- The equipment grounding conductor of the electrical equipment and the devices must be non-detachably and permanently connected to the power supply unit at all times. The leakage current is greater than 3.5 mA.
- Over the total length, use copper wire of a cross section of a minimum of 10 mm² for this equipment grounding connection!
- Before commissioning, also in trial runs, always attach the equipment grounding conductor or connect to the ground wire. Otherwise, high voltages may occur at the housing causing electric shock.

4.2.2 Protection Against Electric Shock by Protective Extra-Low Voltage

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

All connections and terminals with voltages between 5 and 50 volts at Rexroth products are PELV systems. ¹⁾ It is therefore allowed to connect devices equipped with basic insulation (such as programming devices, PCs, notebooks, display units) to these connections and terminals.

**High electric voltage by incorrect connection! Risk of death or bodily injury by electric shock!**

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. ²⁾

4.2.3 Protection Against Dangerous Movements

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

- improper or wrong wiring of cable connections
- incorrect operation of the equipment components
- wrong input of parameters before operation
- malfunction of sensors, encoders and monitoring devices
- defective components
- software or firmware errors

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

¹⁾ "Protective Extra-Low Voltage"

²⁾ "Protective Extra-Low Voltage"

Safety Instructions for Electric Drives and Controls

The monitoring in the drive components will normally be sufficient to avoid faulty operation in the connected drives. Regarding personal safety, especially the danger of bodily harm and material 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, severe bodily harm or material damage!

- Ensure personal safety by means of qualified and tested higher-level monitoring devices or measures integrated in the installation.

These measures have to be provided for by the user according to the specific conditions within the installation and a hazard and fault analysis. The safety regulations applicable for the installation have to be taken into consideration. Unintended machine motion or other malfunction is possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, bodily harm and/or material damage:

- Keep free and clear of the machine's range of motion and moving parts. Possible measures to prevent people from accidentally entering the machine's range of motion:
 - use safety fences
 - use safety guards
 - use protective coverings
 - install light curtains or light barriers
- Fences and coverings must be strong enough to resist maximum possible momentum.
- Mount the emergency stop switch in the immediate reach of the operator. Verify that the emergency stop works before startup. Don't operate the device if the emergency stop is not working.
- Isolate the drive power connection by means of an emergency stop circuit or use a safety related starting lockout to prevent unintentional start.
- Make sure that the drives are brought to a 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 equilibration of the vertical axes.
- The standard equipment motor brake or an external brake controlled directly by the drive controller are **not sufficient to guarantee personal safety!**
- Disconnect electrical power to the equipment using a master switch and secure the switch against reconnection 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 electronics circuits and supply leads. If the use of such devices cannot be avoided, verify the system and the installation for possible malfunctions in all possible positions of normal use before initial startup. If necessary, perform a special electromagnetic compatibility (EMC) test on the installation.

4.2.4 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated by current-carrying conductors and permanent magnets in motors represent a serious personal danger to those with heart pacemakers, metal implants and hearing aids.



WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

- Persons with heart pacemakers and metal implants are not permitted to enter following areas:
 - Areas in which electrical equipment and parts are mounted, being operated or commissioned.
 - Areas in which parts of motors with permanent magnets are being stored, repaired or mounted.
- If it is necessary for somebody with a pacemaker to enter such an area, a doctor must be consulted prior to doing so. The noise immunity of present or future implanted heart pacemakers differs greatly so that no general rules can be given.
- Those with metal implants or metal pieces, as well as with hearing aids, must consult a doctor before they enter the areas described above. Otherwise health hazards may occur.

4.2.5 Protection Against Contact with Hot Parts



CAUTION

Hot surfaces at motor housings, on drive controllers or chokes! Danger of injury! Danger of burns!

- Do not touch surfaces of device housings and chokes in the proximity of heat sources! Danger of burns!
- Do not touch housing surfaces of motors! Danger of burns!
- According to the operating conditions, temperatures can be **higher than 60 °C, 140°F** during or after operation.
- Before accessing motors after having switched them off, let them cool down for a sufficiently long time. Cooling down can require **up to 140 minutes!** Roughly estimated, the time required for cooling down is five times the thermal time constant specified in the Technical Data.
- After switching drive controllers or chokes 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, the manufacturer of the end product, machine or installation, according to the respective safety regulations, has to take measures to avoid injuries caused by burns in the end application. These measures can be, for example: warnings, guards (shielding or barrier), technical documentation.

4.2.6 Protection During Handling and Mounting

In unfavorable conditions, handling and mounting certain parts and components in an improper way can cause injuries.

**CAUTION****Risk of injury by improper handling! Bodily injury by bruising, shearing, cutting, hitting!**

- Observe the general construction and safety regulations on handling and mounting.
- Use suitable devices for mounting and transport.
- Avoid jamming and bruising by appropriate measures.
- Always use suitable tools. Use special tools if specified.
- Use lifting equipment and tools in the correct manner.
- If necessary, use suitable protective equipment (for example safety goggles, safety shoes, safety gloves).
- Do not stand under hanging loads.
- Immediately clean up any spilled liquids because of the danger of skidding.

4.2.7 Battery Safety

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

**CAUTION****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 recharge the batteries as this may cause leakage or explosion.
- Do not throw batteries into open flames.
- Do not dismantle batteries.
- When replacing the battery/batteries do not damage electrical parts installed in the devices.
- Only use the battery types specified by the manufacturer.



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 separate from other waste. Observe the local regulations in the country of assembly.

4.2.8 Protection Against Pressurized Systems

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

Safety Instructions for Electric Drives and Controls



CAUTION

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 (for example safety goggles, safety shoes, safety gloves).
 - Immediately clean up any spilled liquids from the floor.
-



Environmental protection and disposal! The agents used to operate the product might not be economically friendly. Dispose of ecologically harmful agents separately from other waste. Observe the local regulations in the country of assembly.

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 components or materials, failures in the system. Incorrect drive motion – even if the errors only occur for a short time and occasionally – can endanger persons staying in the danger zone of the drive motion.

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

During operation, the safety functions are monitored by the drive system. For this purpose, three principles for detecting static error states, so-called "sleeping errors", were realized in the system:

- **Dual-channel data processing** with diversitary structure
- **Cross comparison** of the safety-relevant data
- **Dynamization** of static states

These measures guarantee that a single error cannot cause the safety functions to get lost.

The installation or machine manufacturer has to determine in how far this is sufficient for an existing installation or machine by a risk analysis according to annex I of Directive 98/37/EG.

The schematic diagram below illustrates the basic functions and functional principles explained in this section:

Functional Principle of Integrated Safety Technology

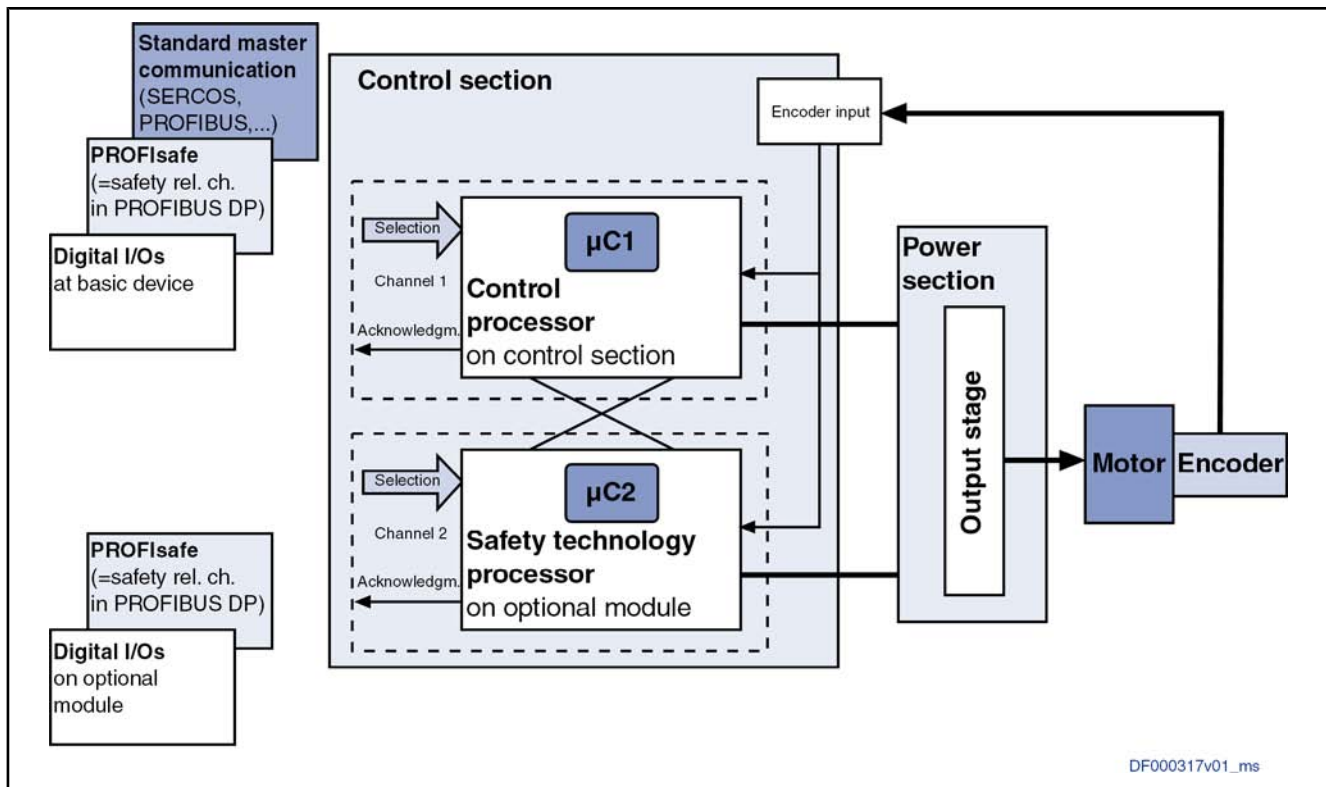


Fig.5-1: Schematic diagram of IndraDrive with integrated safety technology

5.1.2 Dual-Channel Structure

All safety-relevant data are transmitted and processed by two independent channels.

- **Channel 1:** The drive µC (basic control unit) is the first monitoring channel.
- **Channel 2:** The additional safety technology µC on the optional safety technology module "S1" is the second channel.

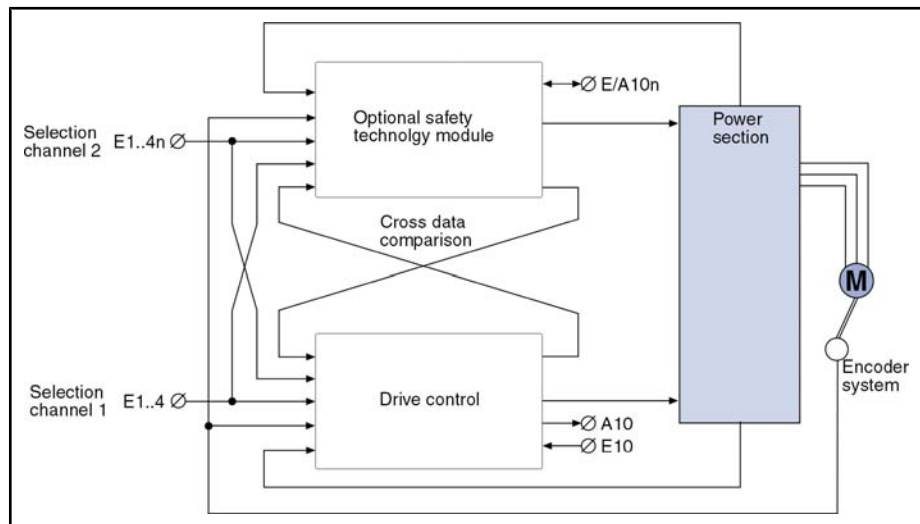


Figure name DF0016

Fig.5-2: Schematic diagram of the dual-channel structure by the example of I/O connection

5.1.3 Cross Data Comparison

Brief Description

The respective monitoring functions for displaying the safety functions are processed independently in the basic drive (basic control unit) and on the optional safety technology module (safety control unit).

To make sure that the safety functions work with correct (identical) limit values, a cross data comparison is required. If a deviation of the monitored parameters is detected in one of the two channels, this causes the respective error reaction and the drive system goes to the safety related status.

Functioning of Cyclic Cross Data Comparison

The cross data comparison is started with the "run up" of the drive. As soon as the operating mode ("phase 4") has been reached, the cross data comparison starts.

If the safety parameters of both channels are not identical during operation,

- "E3104 Safety parameters validation error" is generated in normal operation
- the error message "F3140 Safety parameters validation error" or "F7040 Validation error parameterized - effective threshold" is generated in special mode.



When one or several safety functions are activated, an additional cross data comparison is carried out by means of safety function selection.

Errors Detected by Cross Data Comparison

The following errors are detected by cross data comparison:

- Safety function only activated on one system
- Wrong safety function activated
- Different monitoring parameters used
- Safety function does not work (lifecounter)
- Accidental hardware errors
- Accidental software errors

5.1.4 Dynamization

Brief Description

Dynamization is to detect static error states, so-called "sleeping errors", in the safety-relevant circuits. Dynamization takes place, in certain time intervals, automatically in the background without having an effect on the safety function.

Functional Principle of Dynamization



In the case of safety function selection via PROFIsafe, dynamization does not take place because in this case it is impossible to parameterize selection signals via I/Os and selection via PROFIsafe is safety related.

A safety function is selected via an N/C-N/O combination so that one channel of a safety function is always selected (the function is activated/deactivated by the switching).

Drive-internally the active channel (N/O) is cyclically checked.

Functional Principle of Integrated Safety Technology

Common Dynamization of the Inputs

A dynamization master automatically carries out dynamization for all selected inputs (via A30). Synchronization of dynamization has to take place via E30.



Due to hardware restrictions, a maximum of 25 drives (including the dynamization master) can be dynamized by a dynamization master!

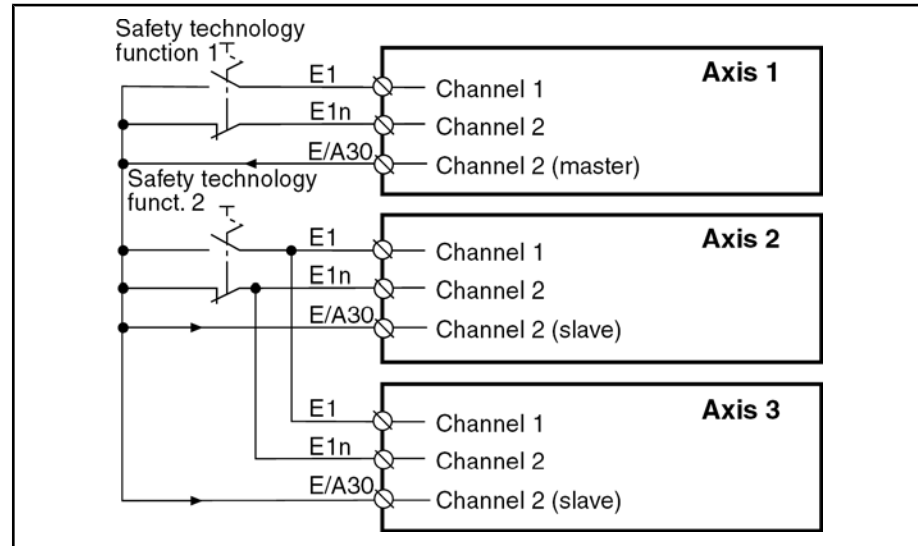


Figure name DF0044

Fig. 5-3: Common dynamization of the inputs via I/O

Separate Dynamization for Inputs for Channel 1 via Master Communication

When channel 1 is selected via the master communication, separate dynamization for channel 1 and 2 can be parameterized in the drive.

Dynamization of channel 1 and channel 2 takes place via the higher-level control unit. Synchronization of dynamization has to take place via E30 and substitute for E30 ("P-0-3212, Safety technology control word, channel 1" or "P-0-3212, Safety technology signal control word, channel 1").

Dynamization of Interrupting Circuits

Both the control section in standard design and the optional module "safety technology I/O" have their own interrupting circuits.

Drive-internally, the activation of an interrupting circuit is cyclically checked.

5.2 State Machine of Integrated Safety Technology

5.2.1 Safety Technology Operating States

Overview

We distinguish the following safety technology operating states:

- Normal operation (corresponds to normal operation of the drive as a servo positioning axis, for example)
- Special mode "safety related halt"
- Special mode "safety related motion"
- Drive interlock

The status diagram below illustrates how the different operating states can be selected with the three activation devices (mode selector, enabling control device, drive interlock switch).

Functional Principle of Integrated Safety Technology

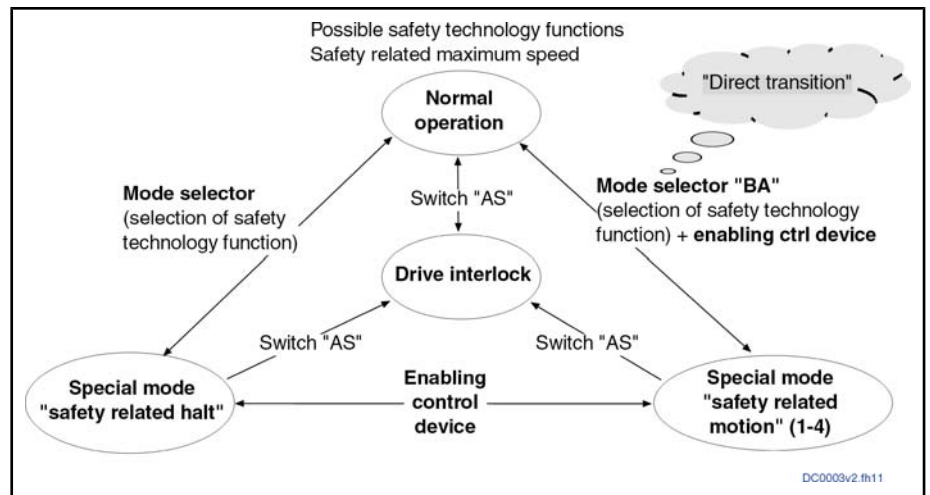


Fig. 5-4: Status diagram



"Direct transition" is the direct change from normal operation to the special mode "safety related motion" while leaving out the special mode "safety related halt". The safety function is selected by simultaneously activating the mode selector and the enabling control device.

Change of Safety Technology Operating States

Changing between the safety technology operating states takes place by means of the mode selector, the enabling control device and the drive interlock switch.

Selecting Drive Interlock

Drive interlock can be selected by means of the drive interlock switch. This selection is independent of the position of the mode selector and the enabling control.

Selecting Operating States by Means of Mode Selector

The safety technology operating states "normal operation" and "special mode" can be selected by means of the mode selector.

Changing States in Special Mode by Means of Enabling Control

In the special mode, it is possible to switch between the following safety operating states by means of an enabling control:

- **Special mode "safety related halt"**
The following safety functions can be configured in the special mode "safety related halt" (Note: Selection takes place via mode selector):
 - "Safety related standstill"
 - "Safety related operational stop"
- **Special mode "safety related motion"**
The following safety functions can be configured in the special mode "safety related motion" (Note: Selection takes place via enabling control in special mode):
 - "Safety related reduced speed"
 - "Safety related direction of motion"
 - "Safety related limited increment"
 - "Safety related limited absolute position"

By means of the safety switches "S1" and "S2", four operating states can be selected in the special mode "safety related motion".

Functional Principle of Integrated Safety Technology

Overview of the Safety Technology Functions in the Individual Operating States

The table below shows useful combinations of safety function selection in the respective safety technology operating states.

Safety functions	Control elements for selecting/deselecting safety functions						Home switch Available
	Mode selector Position	Enabling control Position	Safety switch 1 Position	Safety switch 2 Position	Drive interlock Position		
Normal operation	Safety related maximum speed	-	-	-	-	-	-
	Safety related limited abs. end position	-	-	-	-	-	Yes
Special mode with halt	Drive interlock	-	-	-	-	-	-
	Safety related halt	SO	Off	-	-	Off	-
Special mode with motion "SBB"	SG1 + SD1 + SM1	SO	On	Off	<input type="checkbox"/>	Off	<input type="checkbox"/>
	SG2 + SD2 + SM2	SO	On	On	<input type="checkbox"/>	Off	<input type="checkbox"/>
	SG1 + SD1 + SM1 + SL1	SO	On	Off	<input type="checkbox"/>	Off	Yes
	SG2 + SD2 + SM2 + SL2	SO	On	On	<input type="checkbox"/>	Off	Yes
	SG3 + SD3 + SM3	SO	On	Off	On	<input type="checkbox"/>	<input type="checkbox"/>
	SG4 + SD4 + SM4	SO	On	On	On	<input type="checkbox"/>	<input type="checkbox"/>
	Safety related limited max. speed	-	-	-	-	Off	-
	Safety related limited abs. end position	-	-	-	-	Off	Yes
Safety rel. monit. stopping proc. for SH / SBH	SO	Off	-	-	Off	-	
Safety rel. mon. stopping proc. for drive interl.	-	-	-	-	On	-	
Safety rel. monit. stopping process for SBB	SO	On	-	-	Off	-	

NO: Normal operation
 SO: Special mode
 SH: Safety related standstill (no torque)
 SBH: Safety rel. operational stop (control loops are active)
 SG: Safety related reduced speed
 SD: Safety related direction of motion
 SM: Safety related limited increment
 SL: Safety related limited absolute position
 Input for control element for SBB
 No input for control element available (max. 4 inputs)

DL00014 0511

Fig.5-5: Combination of safety functions in the respective status when selected via I/Os

Functional Principle of Integrated Safety Technology



The restriction to 4 inputs is abolished when you use PROFIsafe; i.e. more functions can be configured accordingly.

Notes on Application

Observe the following points for handling the safety technology operating states:

- If the enabling control is activated in normal operation, the reduction of the command value input can take effect. Switching to the special mode internally activates the monitoring functions for safety related motion after the end of the transition times.
- Before the safety function "safety related limited absolute position" is selected, the "safety related homing procedure" has to be carried out. The safety related homing procedure requires an input on the optional safety technology module. Only one input will then be available, for example for switching two instead of four operating states in the special mode "safety related motion".

5.2.2 Transition to Safety Related Status**Brief Description**

When selecting a safety related status, you have to adjust the command value system for the drive accordingly. This adjustment takes place in the transition to the safety related status. We distinguish the following kinds of transition:

- Transition from normal operation to special mode
- Transition from one special mode to another special mode

Transition can be controlled by the drive or the control unit.

Functional Principle

The kind of transition to the special mode (controlled by drive or control unit) has to be parameterized in "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word".

The transition process is started immediately after the safety related operating mode has been selected.

According to parameter setting (controlled by drive or control unit) and selected safety related status ("safety related halt" or "safety related motion"), the transition can be terminated by different events:

- Tolerance time for transition is over (P-0-3220 or P-0-3225)
- Drive enable is reset
- Higher-level control unit gives feedback in "P-0-3212, Safety technology control word, channel 1" or "P-0-3212, Safety technology signal control word, channel 1" that it has adjusted the command value system of the drive

Tolerance Time for Transition

The tolerance time is monitored during each transition to the special mode. For transition from normal operation / special mode to the safety related status, there is one programmable time available for each kind of transition:

- P-0-3220, Tolerance time transition from normal operation
- P-0-3225, Tolerance time transition from safety rel. oper.

Drive-Controlled Transition

Drive-controlled transition to the safety related operational stop takes place by activating the function "Drive Halt". The drive is shut down with the acceleration and jerk parameterized for this purpose.

Functional Principle of Integrated Safety Technology

For transition to safety related standstill or drive interlock, the drive is shut down according to the best possible deceleration (P-0-0119) that was parameterized. Subsequently, drive enable is removed.



Transition to the special mode "safety related motion" always is controlled by the NC, independent of the setting in parameter "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word".

The selected special mode becomes active when the actual velocity of the drive, after stopping process has been completed, is lower than "P-0-3233, Velocity threshold for safety related halt".

If the actual velocity is not lower than "P-0-3233, Velocity threshold for safety related halt" or the parameterized tolerance time for transition (P-0-3220 or P-0-3225) is over, the error "F7050 Time for stopping process exceeded" is generated.

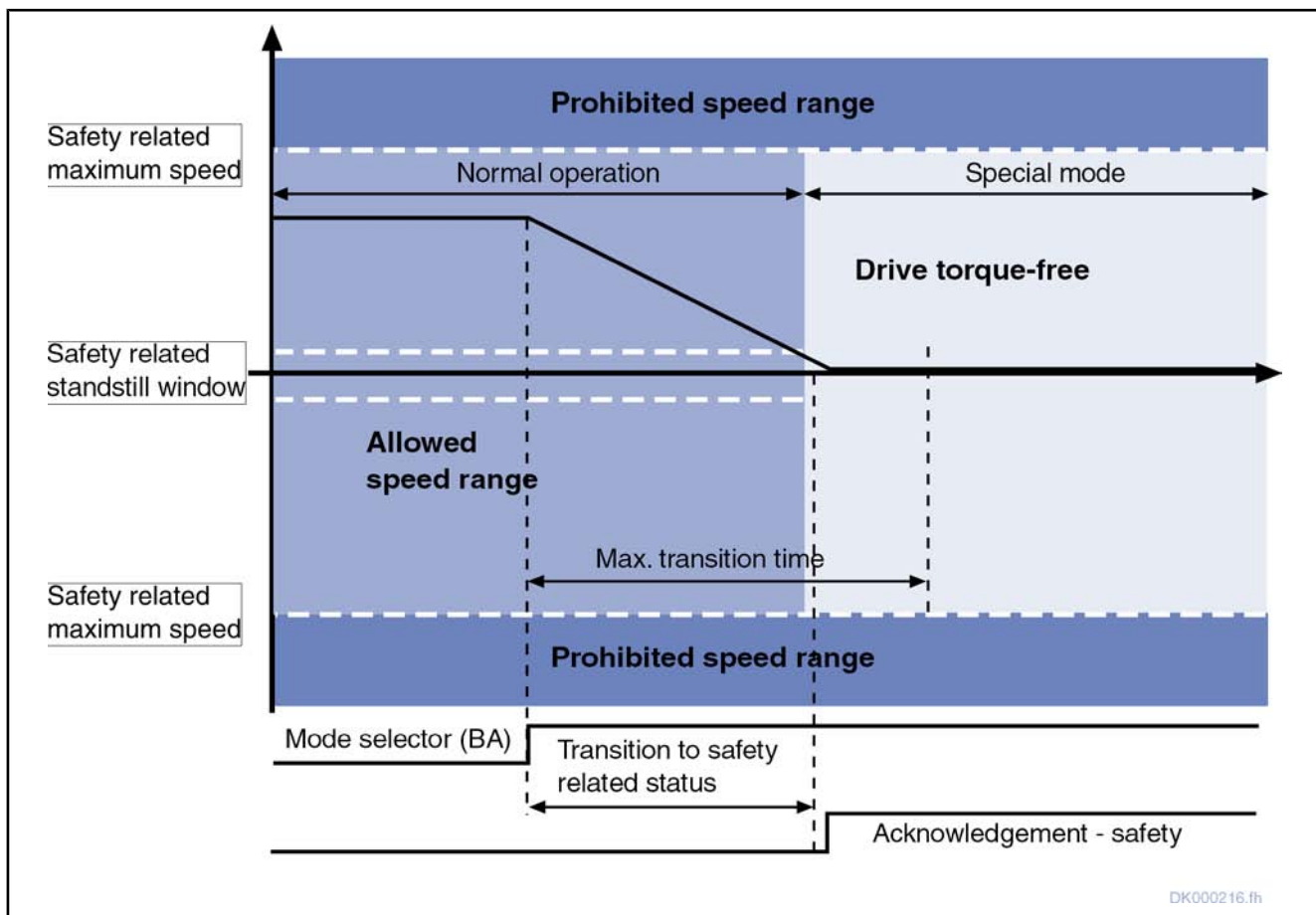


Fig.5-6: Drive-controlled transition to safety related standstill from normal operation

NC-Controlled Transition

For NC-controlled transition, the higher-level control unit has to bring the drive to the new command value system.

The selected special mode is only activated after the tolerance time for transition (P-0-3220 or P-0-3225) is over.

When the special mode "safety related halt" has been selected, a check is run to find out whether the actual velocity of the drive is smaller than "P-0-3233, Velocity threshold for safety related halt"; if this is not the case, the error "F7050 Time for stopping process exceeded" is generated.

Functional Principle of Integrated Safety Technology

When the special mode "safety related motion" has been selected, direct switching to the special mode "safety related motion" takes place after the parameterized transition time is over and the monitoring functions valid in this mode become active. The corresponding error is generated in case the monitors trigger.

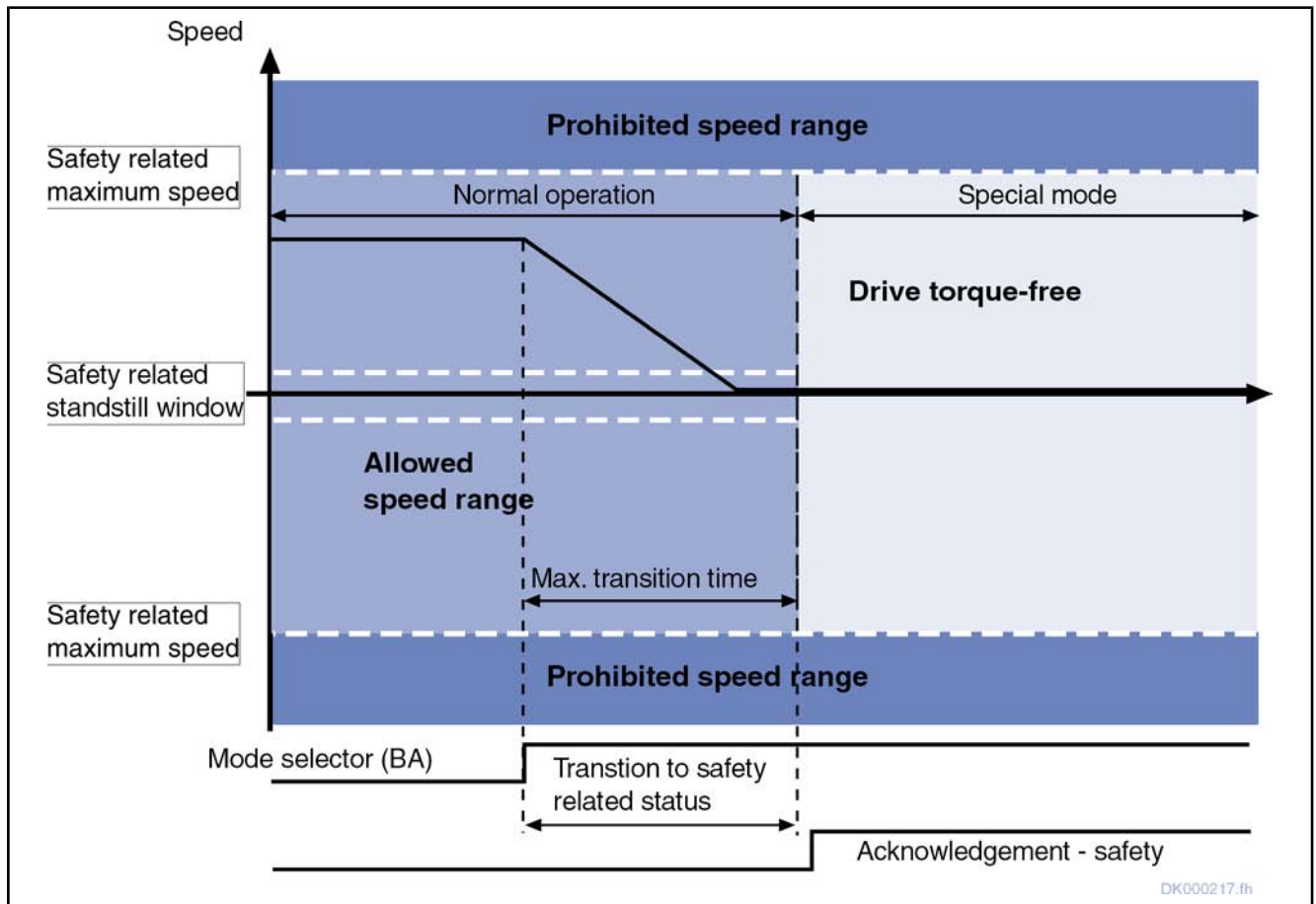
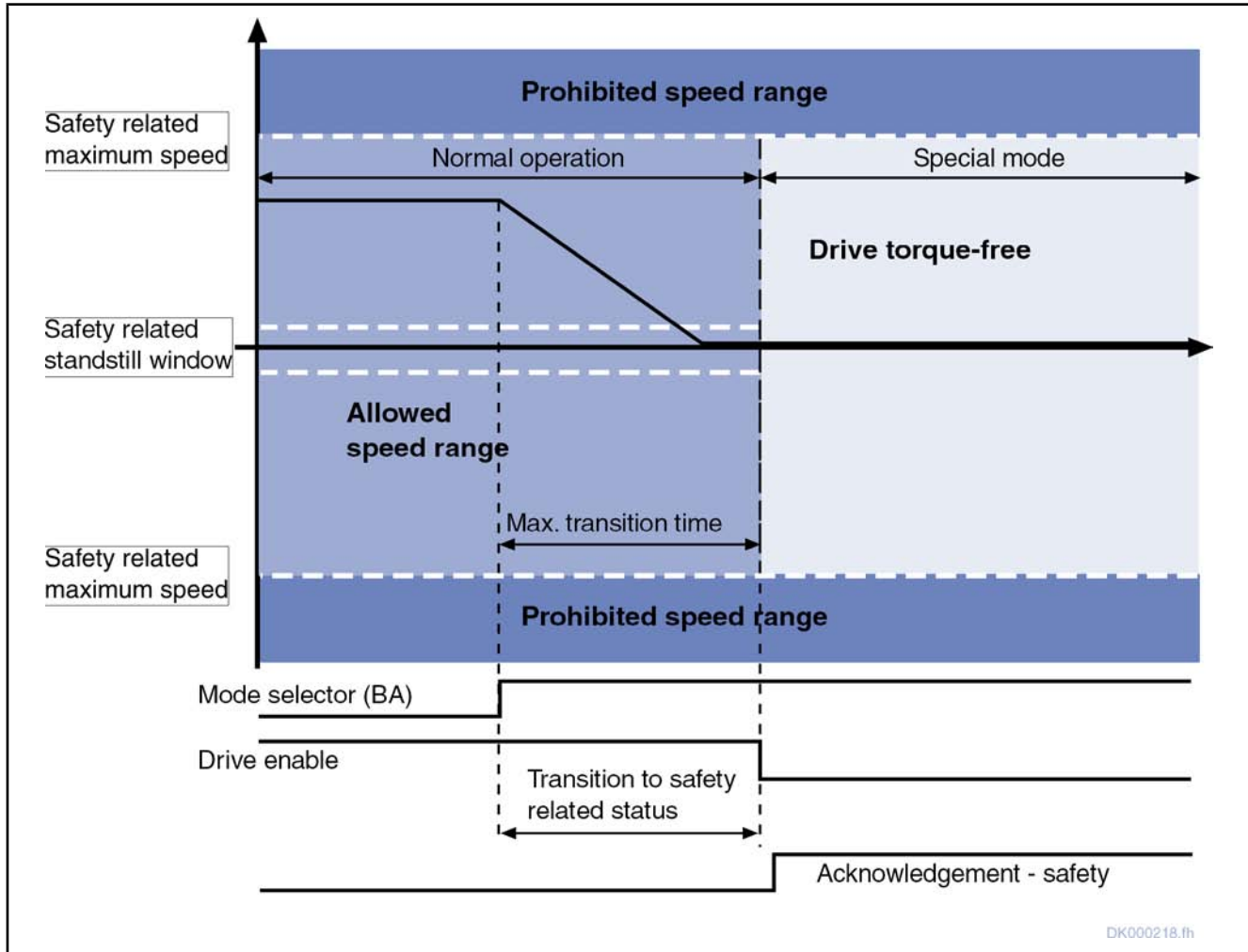


Fig.5-7: NC-controlled transition to safety related standstill from normal operation

To avoid unnecessary waiting times, the selected safety technology operating status is activated in the case of all transitions, as soon as

- drive enable has not been set and
- the actual velocity of the drive is lower than "P-0-3233, Velocity threshold for safety related halt" (only with special mode "safety related halt" selected).

Functional Principle of Integrated Safety Technology



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Fig.5-8: NC-controlled transition to safety related standstill from normal operation, with drive enable removed

Via bit 11 (NC-Ready) in "P-0-3212, Safety technology control word, channel 1" or "P-0-3212, Safety technology signal control word, channel 1", the control unit can signal to the drive that the adjustment of the command value system has been completed. By this signal the control unit can reduce the transition time. The bit has to be reset when the selected safety technology operating status is active or after some constant time which depends on the application.

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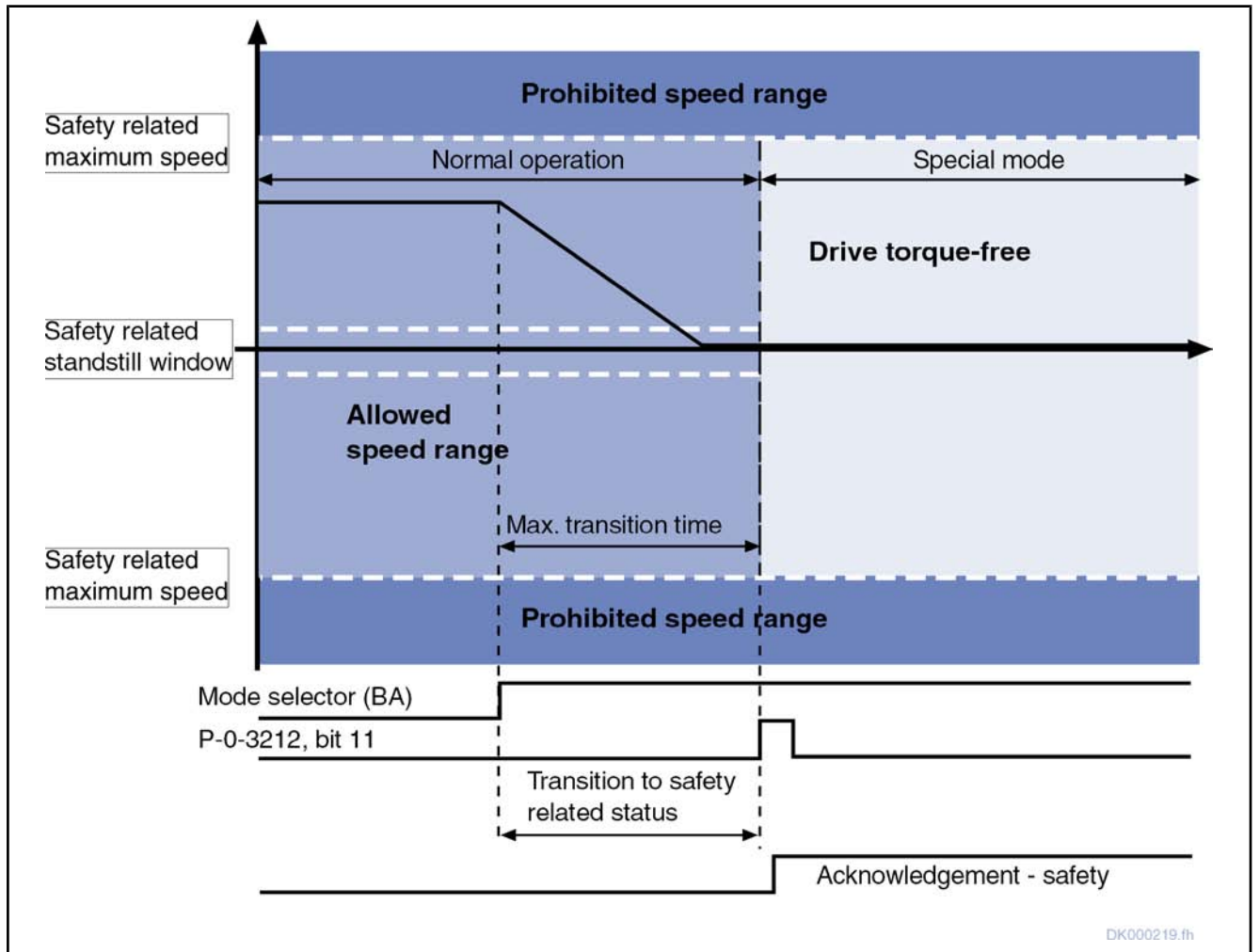


Fig.5-9: NC-controlled transition from normal operation to safety related standstill with "NC-Ready" bit

Functional Principle of Integrated Safety Technology

Selected safety technology operating status	Safety technology operating mode transitions	
	NC-controlled	Drive-controlled
Safety function "safety related standstill", "drive interlock"	NC-controlled stopping process, - NC removes drive enable, - When t = P-0-3220 or P-0-3225 or P-0-3212/"NC-Ready" bit = 1 and actual velocity < P-0-3233 the safety function "safety related standstill" or "drive interlock" is activated	Drive-controlled stopping process is initiated according to P-0-0119; at end of stopping process, drive enable is removed - As soon as actual velocity < P-0-3233 the safety function "safety related standstill" or "drive interlock" is activated, even if t < P-0-3220 or P-0-3225
Safety function "safety related operational stop"	NC-controlled stopping process - When t = P-0-3220 or P-0-3225 or no drive enable or P-0-3212/"NC-Ready" bit = 1 and actual velocity < P-0-3233 the safety function "safety related operational stop" is activated	Drive-controlled stopping process by means of internally activated "Drive Halt", - As soon as actual velocity < P-0-3233 the safety function "safety related operational stop" is activated, even if t < P-0-3220 or P-0-3225
Special mode "safety related motion"	NC-controlled transition - When t = P-0-3220 or P-0-3225 or no drive enable or P-0-3212/"NC-Ready" bit = 1 the special mode "safety related motion" is activated	NC-controlled operating mode transition is carried out

Fig.5-10: Actions during the transitions between safety operating states

5.3 Interfaces for Selection and Acknowledgment

5.3.1 General

General Information

As a basic principle, safety-relevant selection and acknowledgment takes place via two channels (EN 954-1, category 3); the firmware supports the following possibilities:

- Safety technology I/O
- Safety technology I/O and master communication

Functional Principle of Integrated Safety Technology

- PROFIsafe (as of MP*03VRS)

Overview of Interfaces

The safety technology operating states can be selected and acknowledged via the following interfaces (via two channels):

- Safety technology I/Os (channel 1 and channel 2) (as of MP*02VRS)
- Safety technology I/Os (channel 2) and master communication (channel 1) (as of MP*02VRS)
- PROFIsafe (channel 1 and channel 2) (as of MP*03VRS)

Note: With PORFIsafe, I/O evaluation does not take place - except for the reference cam!



The available safety functions are independent of the interface used; depending on the firmware version, different scopes of functions can be available.

Connection System

The interfaces are connected via different terminal connectors (plug-in connectors):

- X41 on optional safety technology module: D-Sub, 9-pin
- X31 on control section: Phoenix connector
- X10 on digital I/O extension: D-Sub, 25-pin
- For master communication
 - SERCOS: fiber optic cable connections at X20 / X21
 - PROFIBUS: D-Sub, 9-pin at X30



If you use drive controllers with PROFIBUS master communication, make sure not to confound the 9-pin D-Sub connectors for master communication and the ones for the optional safety technology module!

5.3.2 Safety Technology I/O

Brief Description

According to the available dual-channel inputs, configurable combinations of safety functions can be selected via two channels via digital I/Os (N/C-N/O combination) on the optional safety technology module (X41) and the control section (X31 / X32 and digital I/O extension).

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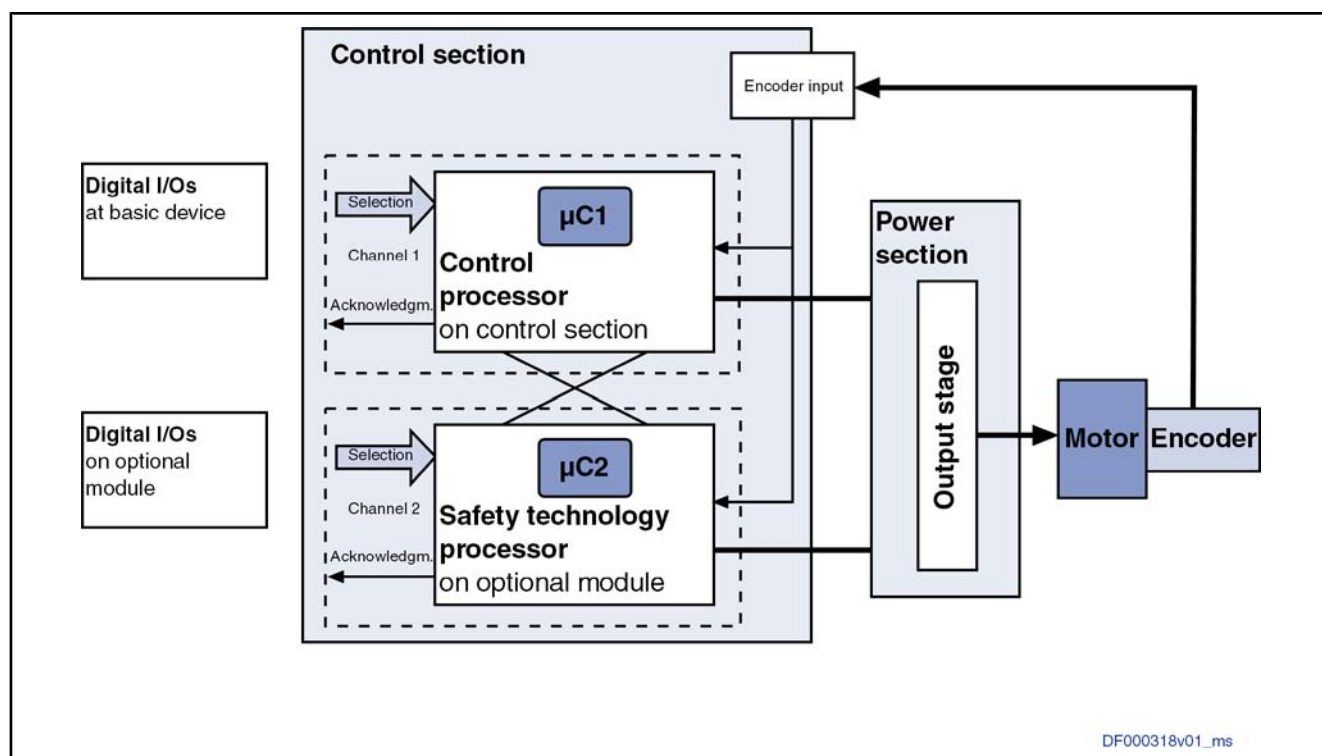


Fig.5-11: Control via digital I/Os for channel 2 (X41) and channel 1 (X31 / X32 and digital I/O extension) directly at the drive

Features The digital inputs/outputs used for selection and acknowledgment have the following features:

- All I/Os are symbolically named "E1" to "E4", "E1n" to "E4n", "A10", "E10", "E/A10n", "E/A20" and "E/A30".
- The freely configurable digital inputs/outputs (24 V) for channel 1 can be realized in the following way:
 - Using digital I/Os at the control section of the single-axis device (e.g. CSH01.1) at terminal connector X31 / X32
 - Using digital I/Os at the control section of the double-axis device (CDB01.1) at terminal connector X31 / X32 / X33 / X34
 - Using digital I/Os at an I/O extension (MD1) at terminal connector X10
- The digital inputs/outputs (24 V) for channel 2 are situated on the optional safety technology module ("S1") at terminal connector X41.

Pertinent Parameters The following parameters are used in conjunction with the function:

- P-0-0300, Digital I/Os, assignment list
- P-0-0301, Digital I/Os, bit numbers
- P-0-0302, Digital I/Os, direction
- P-0-0303, Digital I/Os, status display
- P-0-0304, Digital I/Os, outputs
- P-0-0681, Assignment IDN -> parallel output 1
- P-0-0682, Assignment parallel input 1 -> IDN
- "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word"

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- "P-0-3211, Safety technology I/O configuration list, channel 2" or "P-0-3211, Safety technology I/O control word, channel 2"
- "P-0-3212, Safety technology control word, channel 1" or "P-0-3212, Safety technology signal control word, channel 1"
- "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status"
- "P-0-3214, Safety technology status word, channel 1" or "P-0-3214, Safety technology signal status word, channel 1"
- "P-0-3215, Selected safety technology operating status" or "P-0-3215, Selected safety technology mode"
- P-0-3216, Active safety technology signals
- P-0-3217, I/O status channel 2 (optional safety technology module)

Configuring the I/Os

The digital I/Os of the drive controller which are used have to be accordingly configured during safety technology commissioning:

- Digital I/Os on the control section or an I/O extension (channel 1) have to be configured - like all other digital I/Os in the drive - via the following parameters:
 - P-0-0300, Digital I/Os, assignment list,
 - "P-0-0301, Digital I/Os, bit numbers" and "P-0-0302, Digital I/Os, direction" or
 - "P-0-0681, Assignment IDN -> parallel output 1" and "P-0-0682, Assignment parallel input 1 -> IDN"

See also Functional Description of firmware "Digital Inputs/Outputs"

- The digital I/Os situated on the optional safety technology module have to be configured by means of "P-0-3211, Safety technology I/O configuration list, channel 2" or "P-0-3211, Safety technology I/O control word, channel 2".



To simplify commissioning, the commissioning software DriveTop or IndraWorks provides a safety technology wizard.

Functional Principle

The safety technology operating states can be selected and acknowledged via digital I/Os directly at the drive controller.

The figure below shows the pertinent parameters and the basic function:

Functional Principle of Integrated Safety Technology

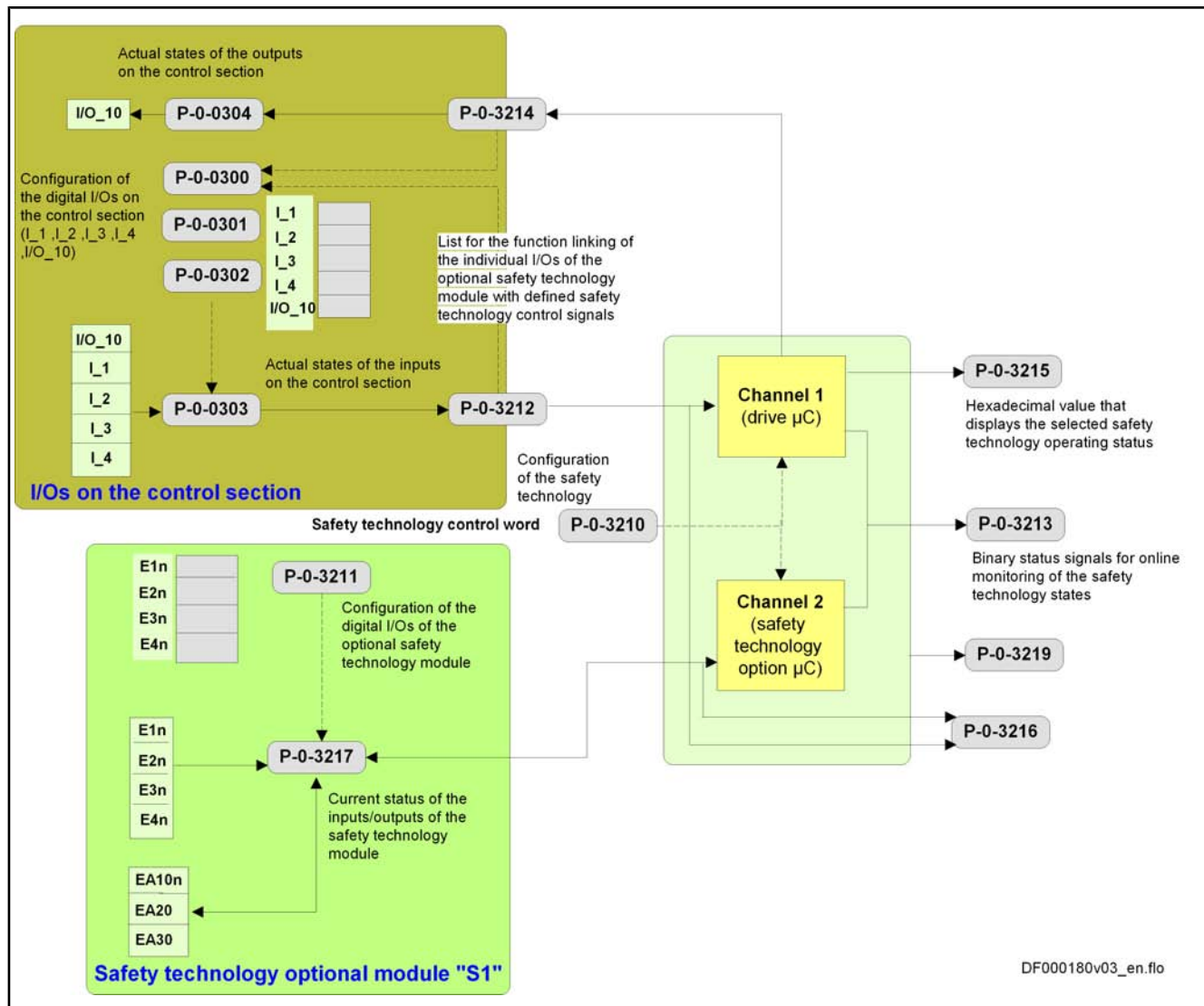


Fig.5-12: Communication via safety technology I/O

The figure below illustrates the selection of operating states via 24 V inputs at the drive controller.

Functional Principle of Integrated Safety Technology

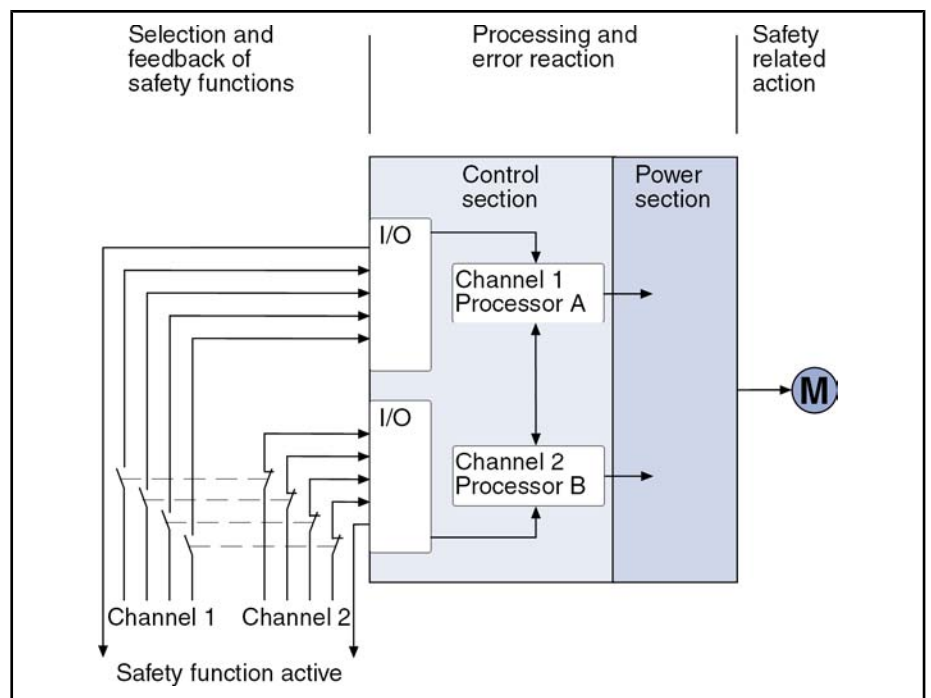


Fig.5-13: Direct selection of both channels at the drive controller

5.3.3 Safety Technology I/O in Conjunction With a Master Communication

Brief Description

According to the available dual-channel inputs, configurable combinations of safety functions can be selected via two channels via digital I/Os (N/C-N/O combination) on the optional safety technology module (X41) and the master communication (e.g. SERCOS, PROFIBUS).

Functional Principle of Integrated Safety Technology

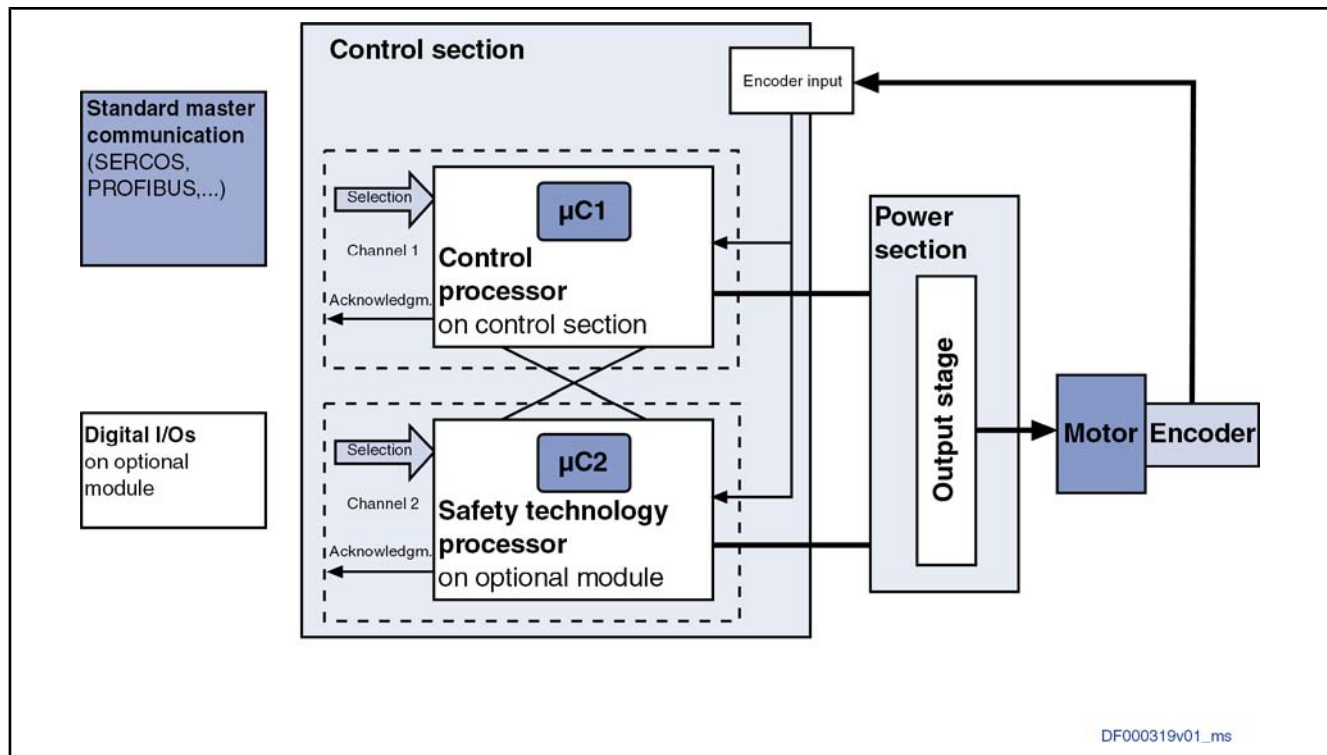


Fig.5-14: Control via digital I/Os for channel 2 (X41) and master communication channel 1 directly at the drive

Features The inputs/outputs used for selection and acknowledgment have the following features:

- All I/Os are symbolically named "E1" to "E4", "E1n" to "E4n", "A10", "E10", "E/A10n", "E/A20" and "E/A30".
- The inputs/outputs for channel 1 can be realized using digital I/Os of a control unit which are transmitted to the drive via the non-safety-related standard field bus or SERCOS interface.
- The digital inputs/outputs (24 V) for channel 2 are situated on the optional safety technology module ("S1") at terminal connector X41.

Pertinent Parameters The following parameters are used for communication via safety technology I/O and master communication:

- "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word"
- "P-0-3211, Safety technology I/O configuration list, channel 2" or "P-0-3211, Safety technology I/O control word, channel 2"
- "P-0-3212, Safety technology control word, channel 1" or "P-0-3212, Safety technology signal control word, channel 1"
- "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status"
- "P-0-3214, Safety technology status word, channel 1" or "P-0-3214, Safety technology signal status word, channel 1"
- "P-0-3215, Selected safety technology operating status" or "P-0-3215, Selected safety technology mode"
- P-0-3216, Active safety technology signals
- P-0-3217, I/O status channel 2 (optional safety technology module)

Configuring the I/Os

The digital I/Os of the drive controller and of the control unit which are used have to be accordingly configured during safety technology commissioning:

- **Digital inputs** of the control unit (channel 1) have to be transmitted to the drive via the master communication. For this purpose, "P-0-3212, Safety technology control word, channel 1" or "P-0-3212, Safety technology signal control word, channel 1" has to be configured in the cyclic **command value channel** of SERCOS (cf. S-0-0024) or the field bus (cf. P-0-4081).
- **Digital outputs** of the control unit (channel 1) have to be transmitted from the drive to the control unit via the master communication. For this purpose, "P-0-3214, Safety technology status word, channel 1" or "P-0-3214, Safety technology signal status word, channel 1" has to be configured in the cyclic **actual value channel** of SERCOS (cf. S-0-0016) or the field bus (cf. P-0-4080).

See also Functional Description of firmware "Master Communication"

- The digital inputs situated on the optional safety technology module have to be configured by means of "P-0-3211, Safety technology I/O configuration list, channel 2" or "P-0-3211, Safety technology I/O control word, channel 2".



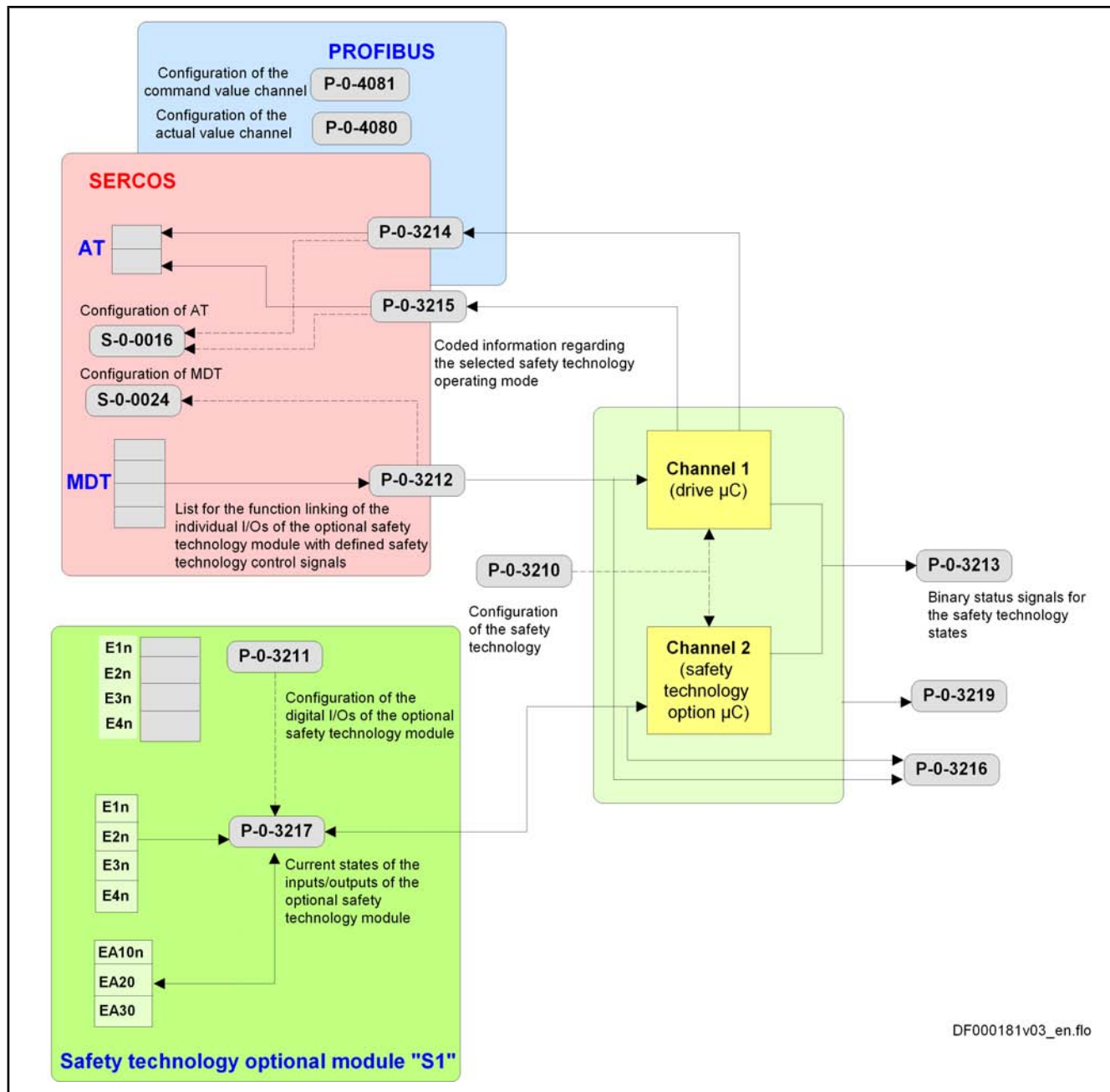
To simplify commissioning, the commissioning software DriveTop or IndraWorks provides a safety technology wizard.

Functional Principle

The safety technology operating states are selected and acknowledged via digital I/Os of the optional safety technology module and digital I/Os of the control unit which are transmitted to the drive via the master communication.

The figure below shows the pertinent parameters and the basic function:

Functional Principle of Integrated Safety Technology



->: Channel 1 is indirectly activated via the master communication interface of the control unit (CNC; PLC)
 ->: Channel 2 is directly activated via the input interface of the drive controller
 Fig.5-15: Communication via safety technology I/O and master communication

Functional Principle of Integrated Safety Technology

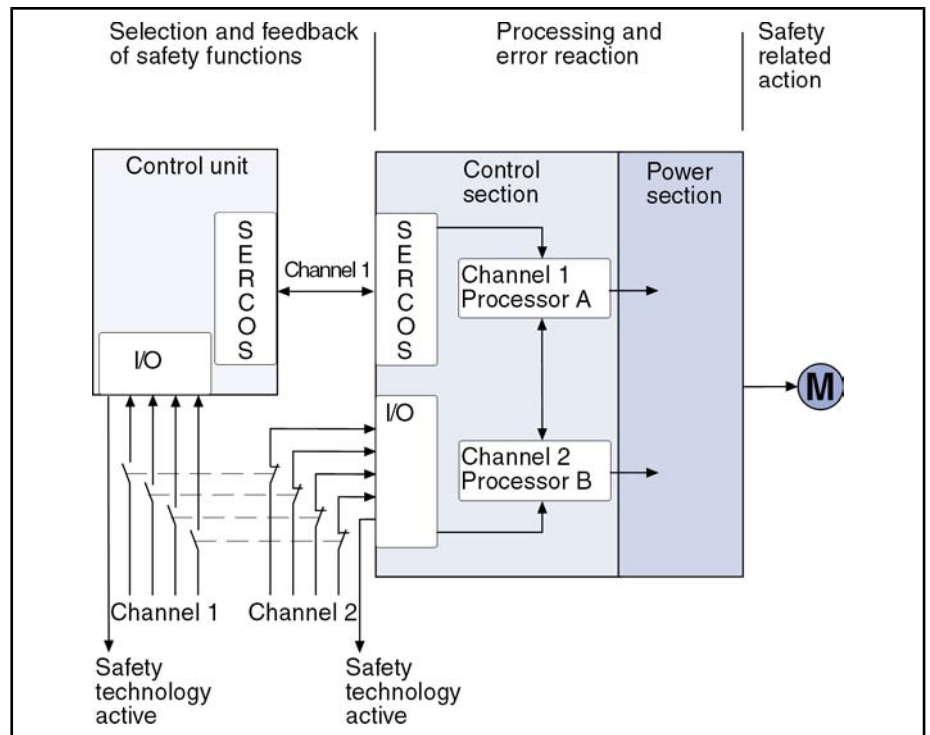


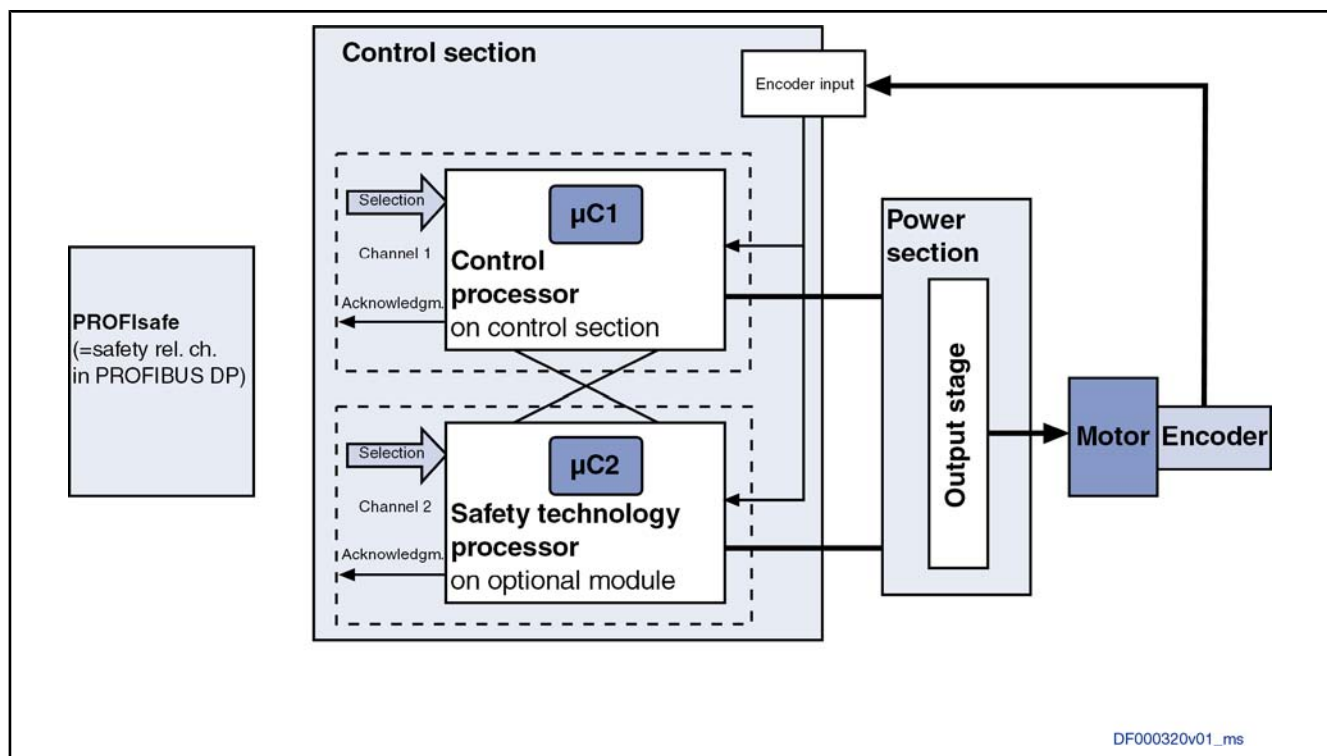
Fig.5-16: Direct and indirect selection of the channels at the drive controller

5.3.4 PROFIsafe

Brief Description

The safety functions can also be selected via a safety related channel (PROFIsafe). For this purpose, the PROFIBUS standard protocol was extended by a safety related protocol so that, apart from PROFIBUS standard communication, operating mode selection and acknowledgment for integrated safety technology (channel 1 and channel 2) can take place.

Functional Principle of Integrated Safety Technology



DF000320v01_ms

Fig.5-17: Control via safety related channel "PROFIsafe" in PROFIBUS DP

Pertinent Parameters

The following parameters are used in conjunction with PROFIsafe:

- "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word"
- "P-0-3211, Safety technology I/O configuration list, channel 2" or "P-0-3211, Safety technology I/O control word, channel 2"
- "P-0-3212, Safety technology control word, channel 1" or "P-0-3212, Safety technology signal control word, channel 1"
- "P-0-3213, Safety technology status" or "P-0-3213, Safety technology operating status"
- "P-0-3214, Safety technology status word, channel 1" or "P-0-3214, Safety technology signal status word, channel 1"
- "P-0-3215, Selected safety technology operating status" or "P-0-3215, Selected safety technology mode"
- P-0-3216, Active safety technology signals
- P-0-3217, I/O status channel 2 (optional safety technology module)
- P-0-3290, PROFIsafe: F_Destination_Address
- P-0-3291, PROFIsafe: F_Source_Address
- P-0-3292, PROFIsafe: F_Parameters

Configuring PROFIsafe

When you use PROFIsafe, there are the following functional differences compared to the function "safety technology I/O":

- No dynamization of the safety related control bits.
- Only the home switch can be defined as input on the optional safety technology module, all other signals are preset by PROFIsafe via the safety related control bits.

Functional Principle of Integrated Safety Technology

Configuring the Digital I/Os in the Drive

With PROFIsafe it is not necessary to configure any I/Os in the drive controller, because channel 1 and channel 2 are transmitted in a safety related PROFIBUS channel (PROFIsafe). Only if you need a reference cam for safety related homing procedure, do you have to configure this cam via "P-0-3211, Safety technology I/O configuration list, channel 2" or "P-0-3211, Safety technology I/O control word, channel 2".

Activating PROFIsafe

To use the safety related channel in PROFIBUS (=PROFIsafe), make the following parameter setting in the drive:

- "P-0-3290, PROFIsafe: F_Destination_Address": Enter target address under which the axis is administrated in the safety PLC.



P-0-3290="0" deactivates PROFIsafe!

- "P-0-3291 PROFIsafe: F_Source_Address": Enter the source address stored in the safety PLC.
- "P-0-3292, PROFIsafe: F_Parameters" contains all PROFIsafe parameters that are set via the PLC configuration and is used for display.

Configuring PROFIBUS

Configuring the drive requires a so-called device data sheet:

Firmware version	Device data sheet
MPx-04VRS	RX030107.GSD
MPx-05VRS	RX050107.GSD

Fig. 5-18: Device data sheet depending on the firmware version used

See also Functional Description of firmware "PROFIBUS-DP"



All configuration programs supporting at least GSD revision 3 only allow such modules for the slot which may be configured in these programs.

Functional Principle

Control and feedback of the integrated safety technology via PROFIsafe takes place via the F-modules of PROFIBUS (=safety related data containers within the PROFIBUS protocol).

The figure below shows the pertinent parameters of PROFIsafe communication and the basic function:

Functional Principle of Integrated Safety Technology

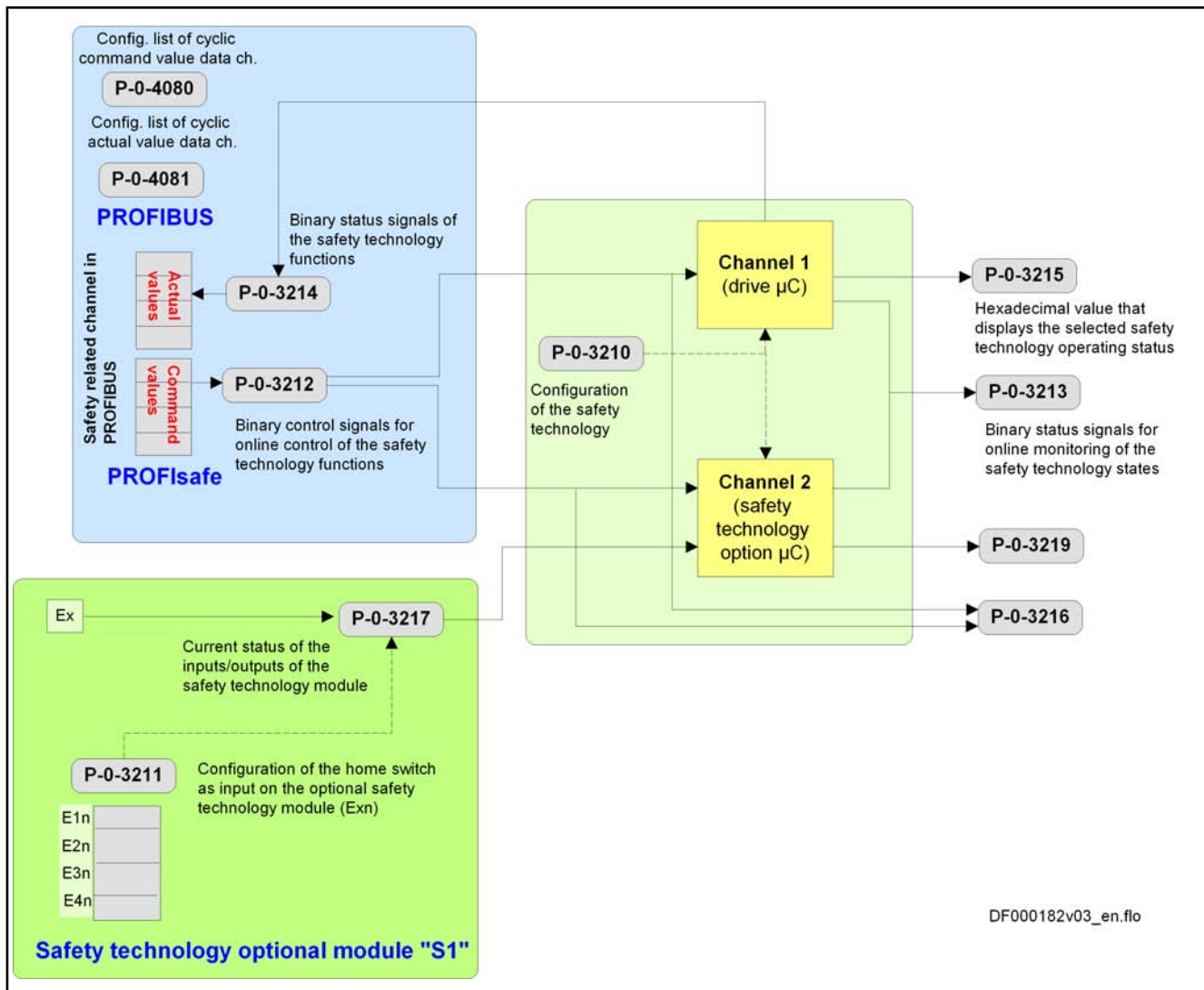


Fig.5-19: Communication via safety related channel "PROFIsafe" in PROFIBUS DP

Command Value Channel for Selecting Safety Technology Operating Modes

In the command value channel, a 16-bit control word is transmitted from master to slave (drive) which is divided into 2 control bytes:

- F control byte 1: low byte (bit 0...7)
- F control byte 2: high byte (bit 8...15)



At present, only the lowest 8 bits of the 16-bit control word (bit 0...7 in low byte) are used.

Bit	Designation/function
0	Mode selector ("BA") 0 = Select safety related operation ("BA") 1 = Deselect safety related operation ("BA")
1	Drive interlock ("ASP") 0 = Select drive interlock ("ASP") 1 = Deselect drive interlock ("ASP")

Functional Principle of Integrated Safety Technology

Bit	Designation/function
2	Enabling control ("ZT") 0 = Select enabling control ("ZT") 1 = Deselect enabling control ("ZT")
3	Safety switch 1 ("S1") 0 = Select safety switch 1 ("S1") 1 = Deselect safety switch 1 ("S1")
4	Safety switch 2 ("S2") 0 = Select safety switch 2 ("S2") 1 = Deselect safety switch 2 ("S2")
7	Control of safety related output 0 = Output not active (safety related status) 1 = Output active
15-5	Reserved

Fig. 5-20: Safety technology control bits in PROFIsafe (channel 1+2)



The control bits received by the drive are displayed in "P-0-3212, Safety technology control word, channel 1" or "P-0-3212, Safety technology signal control word, channel 1".

Actual Value Channel for Acknowledging Safety

In the actual value channel, a 16-bit status word is transmitted from slave (drive) to master which is divided into 2 control bytes:

- F status byte 1: low byte (bit 0...7)
- F status byte 2: high byte (bit 8...15)



At present, only the lowest 8 bits of the 16-bit control word (bit 0...7 in low byte) are used.

Bit	Designation/function
0	Safety technology status output of controller 0 = Drive is in non-safety-related status (default value!) 1 = Drive has established safety
1	Safety technology status output of drive interlock 0 = Drive interlock not active 1 = Drive interlock active
4	Status safety related input 1 0 = Input not active (safety related status) 1 = Input active
5	Status safety related input 2 0 = Input not active (safety related status) 1 = Input active
6	Status safety related input 3 0 = Input not active (safety related status) 1 = Input active

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Bit	Designation/function
7	Status safety related input 4 0 = Input not active (safety related status) 1 = Input active
15-1	Reserved

Fig.5-21: Safety technology status bits in PROFIsafe (channel 1+2)



The safety technology status acknowledged by the drive is displayed in "P-0-3214, Safety technology status word, channel 1" or "P-0-3214, Safety technology signal status word, channel 1".

F Actual Position Value (32 Bits); Safety Related Image of S-0-0051

In addition to the status word, the drive can, if required, provide a safety related actual position value which is transmitted subsequent to the two status bytes.



The default value of the transmitted actual position value is the maximum position: "0x7FFF FFFF".

According to the PROFIsafe configuration, the drive supports 2 variants regarding data exchange via PROFIsafe:

- Module 10: F-Module I/O
- Module 12: F-Module I/O Real



In the following paragraphs, the data transmitted from master to slave are described as "output data" and the data from slave to master as "input data".

Module 10: F-Module I/O

With the configuration "module 10: F-module I/O", the telegram structure is as follows:

Byte no.	User data	PROFIsafe protocol
O (n)	F control byte 1	F process data
O (n+1)	F control byte 2	(User data)
O (n+2)		Control byte
O (n+3)		Consecutive number
O (n+4)		CRC2 (16 bit)
O (n+5)		

Fig.5-22: Output telegram structure with "module 10: F-module I/O", 6 bytes telegram length

Byte no.	User data	PROFIsafe protocol
I (n)	F status byte 1	F process data
I (n+1)	F status byte 2	(User data)
I (n+2)		Status byte
I (n+3)		Consecutive number
I (n+4)		CRC2 (16 bit)
I (n+5)		

Fig.5-23: Input telegram structure with "module 10: F-module I/O", 6 bytes telegram length

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Module 12: F-Module I/O Real

With the configuration "module 12: F-module I/O Real", the telegram structure is as follows:

Byte no.	User data	PROFIsafe protocol
O (n)	F control byte 1	F process data
O (n+1)	F control byte 2	(User data)
O (n+2)		Control byte
O (n+3)		Consecutive number
O (n+4)		CRC2 (16 bit)
O (n+5)		

Fig. 5-24: Output telegram structure with "module 12: F-module I/O Real", 6 bytes telegram length

Byte no.	User data	PROFIsafe protocol
I (n)	F status byte 1	F process data
I (n+1)	F status byte 2	(User data)
I (n+2)	F actual position value	
I (n+3)		
I (n+4)		
I (n+5)		
I (n+6)		Status byte
I (n+7)		Consecutive number
I (n+8)		CRC2 (16 bit)
I (n+9)		

Fig. 5-25: Input telegram structure with "module 12: F-module I/O Real", 10 bytes telegram length

5.4 Feedback of Safety Technology Operating States to the Peripherals

5.4.1 General

Safety-relevant feedback is basically transmitted via two channels (EN 954-1, category 3), whereas feedback for diagnostic purposes can be transmitted via one channel.

The integrated safety technology of IndraDrive provides the following variants which have to be selected and configured or wired according to the application:

- Safety related feedback to a safety PLC
- Safety related control of a door locking device (not with PROFIsafe)

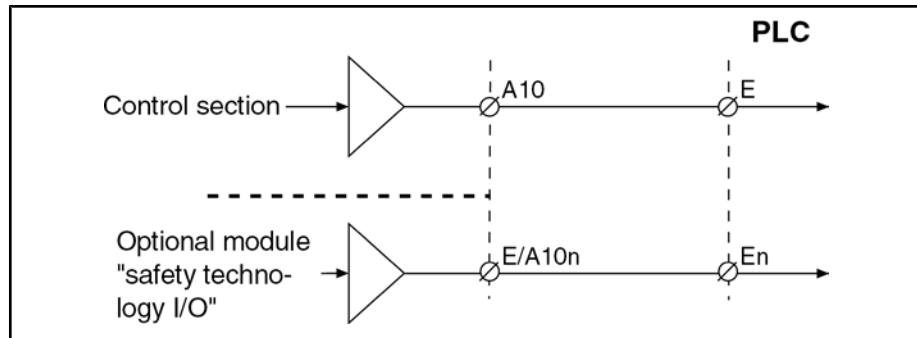


For feedback of the second channel, a 24 V driver or a relay contact is available on the optional safety technology module ("S1") (one relay point is internally assigned to 0 V).

Chapter "[Interfaces for Selection and Acknowledgment](#)" describes the interface-dependent differences regarding the configuration and the functions that can be used!

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5.4.2 Safety Related Feedback via Digital I/Os to a Safety PLC



Channel 1: A10 (control section)
 Channel 2: E/A10n (A10, 24 V driver is active on optional module "safety technology I/O")

Figure name DA0002

Fig.5-26: Safety related status message to a safety PLC



The two outputs **A10** and **E/A10n** work in inverted form!

Drive status	A10	E/A10n
Drive safety related	High	Low
Drive not safety related	Low	High
Parameter mode (diagnostic/acknowledgment master)	Low	High
Parameter mode (diagnostic/acknowledgment slave)	Last status in phase 4	Last status in phase 4

Fig.5-27: Output signals for controlling a PLC

5.4.3 Safety Related Door Locking Device via Digital I/Os



With PROFIsafe, dynamization of acknowledgment does not take place and there aren't any functions for door locking!

Apart from the feedback to a safety PLC, it is possible to directly control a door locking device in a safety related way. For this purpose, the drive has to be configured as "diagnostic master" (cf. "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word").



Lethal injury caused by axes / spindles coasting to stop in a torque-free way due to an error!

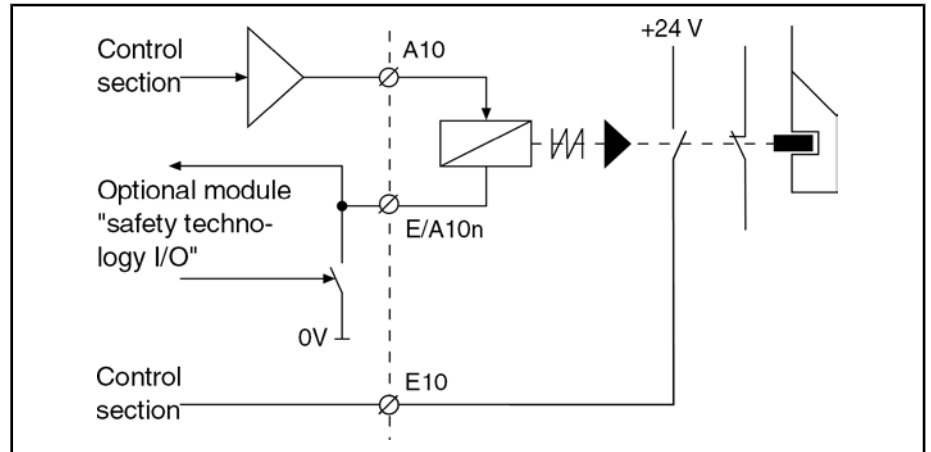
⇒ Provide an interlocking guard with guard locking that only allows unlocking the guard when standstill has been reached (see EN 1088).

If the guard is unlocked without standstill having been reached, coasting to stop in a torque-free way has to be prevented by additional measures [e.g. by using a motor holding brake (to be used only in the case of an emergency), an emergency braking resistor or a service brake] or the guard has to be positioned in such a way that spindles / axes have stopped before they can be reached (see EN 999).

The safety related status is signaled via the safety technology status output. This output is a dual-channel output (A10, E/A10n). The output A10 can be

Functional Principle of Integrated Safety Technology

output at the basic device or at the control unit (P-0-3214 transmitted by the drive via master communication). The output E/A10n switches internally to 0 V. For monitoring the interlocking device, a second input (E10) has to be used at the basic device or at a control unit. This input has to be transmitted to the drive via the master communication.



Channel 1: A10, E10 (control section or P-0-3214 via master communication)
 Channel 2: E/A10n (24 V input and driver for relay contact are active on optional module "safety technology I/O")

Figure name DA0001

Fig.5-28: Control of a door locking device

Drive status	A10	E/A10n
Drive safety related	High	Low
Drive not safety related	Low	High-resistance
Parameter mode	Last status in phase 4	Last status in phase 4

Fig.5-29: Output signals for controlling a safety door



In the case of an encoder error in the drive, it is impossible to signal a safety related status. If the safety technology status (acknowledgment signal of integrated safety technology) is used for direct control of a safety door, the manual safety door unlocking device has to be activated for the corresponding axis (see "P-0-3218, C3700 Manually unlocking the safety door").



Lethal injury caused by axes / spindles coasting to stop in a torque-free way due to an error!

⇒ When the safety door is manually unlocked, it is not ensured that the faulty axis is in standstill. This is why you have to wait until the axis has coasted to stop and come to standstill before accessing the protection zone.

5.4.4 Setting Up a Safety Zone

General Information

If there are several axes in a danger zone, it is useful to combine them in a safety zone. For this purpose, one drive in the safety zone is configured as "diagnostic master" and all others as "diagnostic slaves" (cf. "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word").

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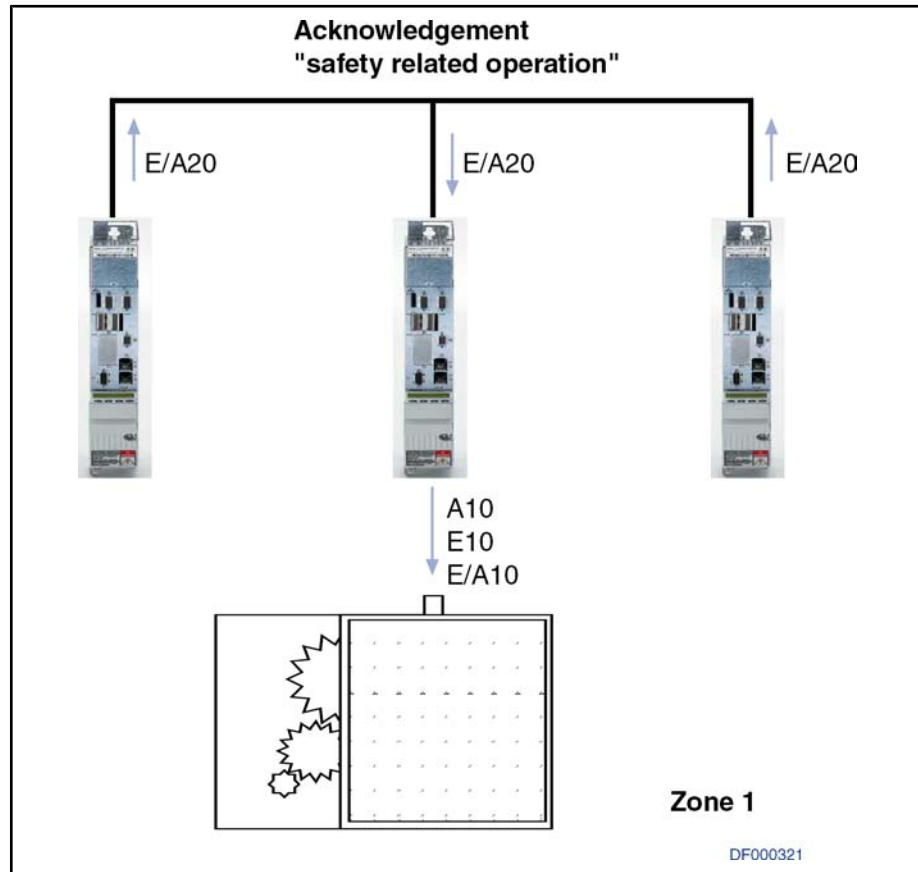


One diagnostic master has to be available for each safety zone!

Functional Principle

All axes of a danger zone (=safety zone) have to be interconnected via E/A20 via bus.

The diagnostic master addresses the diagnostic slaves via E/A20 and expects the feedback/acknowledgment "safety related operation" in order to enable the safety door.



Channel 1: A10, E10 (control section or master communication)

Channel 2: E/A10n (24 V input and driver for relay contact are active on optional module "safety technology I/O")

Fig. 5-30: Safety zone with control of a door locking device



Due to hardware restrictions, a maximum of 25 drives can be combined in a safety zone!

Notes on Commissioning

All axes of a safety zone must have been completely configured for commissioning. In addition, safety technology must have been activated in all axes.



If safety technology has not been activated in a diagnostic slave, the error "F3131 Error when checking acknowledgment signal" appears in the diagnostic master.

Diagnostic Master

The so-called "diagnostic master" recognizes the "safety related status" of its own drive and other drives which are interconnected via E/A20.

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All axes have to acknowledge having reached the safety related status before the diagnostic master controls the common safety technology status output (e.g. for a door locking device).



In the case of an encoder error in a drive, it is impossible to signal the safety related status. If the safety technology status (acknowledgment signal of integrated safety technology) is used for direct control of a safety door, the manual safety door unlocking device has to be activated for the corresponding axis (see "P-0-3218, C3700 Manually unlocking the safety door").



DANGER

Lethal injury caused by axes / spindles coasting to stop in a torque-free way due to an error!

⇒ When the safety door is manually unlocked, it is not ensured that the faulty axis is in standstill. This is why you have to wait until the axis has coasted to stop and come to standstill before accessing the protection zone.

Special Case: "Starting Lockout and Safety Technology I/O in One Safety Zone"

When setting up safety zones, take the following special case into account:

- This application cannot recognize the status of an axis equipped with the optional module "starting lockout".
- When the optional modules "starting lockout" (option "L1") and safety technology I/O" (option "S1") are used in a common danger zone, the control of the magnet for the locking device has to be connected via the relay contact "ASQ"/"ASQ1" of the starting lockout!

5.4.5 Safety Related Feedback via PROFIsafe to the Safety PLC

General Information

For diagnostic purposes, the transmitted F-data are displayed in the drive in the corresponding parameters. The figure below contains an overview of how the individual parameters interact:

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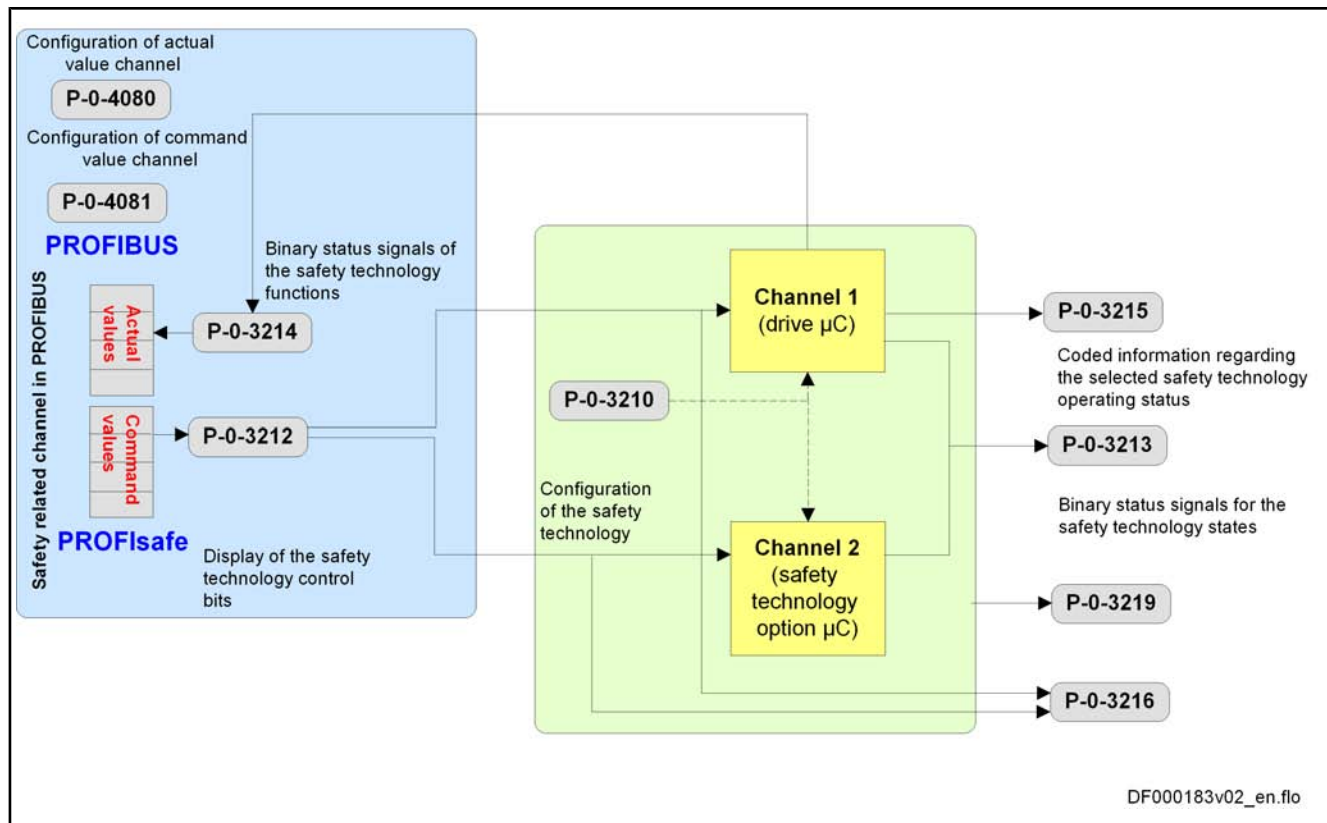


Fig.5-31: Status parameters and diagnostic parameters with PROFIsafe

Control Bits

The control bits of the two channels that are used can be read via the following diagnostic parameters / display parameters:

- "P-0-3216, Active safety technology signals": Displays the current states of the signals applied via "P-0-3214, Safety technology status word, channel 1" or "P-0-3214, Safety technology signal status word, channel 1"
- "P-0-3215, Selected safety technology operating status" or "P-0-3215, Selected safety technology mode": Makes available a hexadecimal value that displays the selected safety technology operating status
- "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status": Makes available binary status signals for online monitoring of the safety technology states

Status Bits

The status bits of the two channels that are used can be read via the following diagnostic parameters / display parameters:

- "P-0-3214, Safety technology status word, channel 1" or "P-0-3214, Safety technology signal status word, channel 1": Makes available binary status signals of the safety technology functions of channel 1

5.5 Advanced Settings

5.5.1 Scaling / Mechanical Axis System

Motor-Related Scaling

For certain applications, it is necessary to set the safety threshold value parameters for velocity, acceleration and relative position in the motor-related format, independent of the drive scaling system. Such applications, for example, are the use of parameter set switching (load gear switching) or gear switching in parameter mode.

Features The functionality "motor-related scaling" has the following features:

- Functionality available as of MPx03
- Using the safety function "safety related limited absolute position" or "safety related limited absolute end position" is not possible in conjunction with "motor-related scaling".
- The safety parameters for velocity, acceleration and relative position must be input in motor-related format.

Pertinent Parameters The following parameters are used in conjunction with motor-related scaling:

- S-0-0278, Maximum travel range
- P-0-0129, Internal position data format
- P-0-3210, Safety technology configuration
- P-0-3230, Monitoring window for safety related operational stop
- "P-0-3232, Monitoring window for safety related direction of motion" or "P-0-3232, Standstill window for safety related direction of motion"
- P-0-3233, Velocity threshold for safety related halt
- P-0-3234, Safety related maximum speed
- P-0-3243, Safety related limited increment 1
- P-0-3244, Safety related reduced speed 1
- P-0-3253, Safety related limited increment 2
- P-0-3254, Safety related reduced speed 2
- P-0-3263, Safety related limited increment 3
- P-0-3264, Safety related reduced speed 3
- P-0-3273, Safety related limited increment 4
- P-0-3274, Safety related reduced speed 4
- P-0-3282, Safety related monitored deceleration

Functional Principle Motor-related scaling must be activated by the corresponding setting in parameter "P-0-3210, Safety technology configuration". When this was done, the following safety parameters always must be parameterized with relation to the motor shaft when safety technology is commissioned:

- **Velocity thresholds:**
 - P-0-3233, Velocity threshold for safety related halt
 - P-0-3234, Safety related maximum speed
 - P-0-3244, Safety related reduced speed 1
 - P-0-3254, Safety related reduced speed 2
 - P-0-3264, Safety related reduced speed 3
 - P-0-3274, Safety related reduced speed 4
- **Acceleration thresholds:**

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- P-0-3282, Safety related monitored deceleration
- **Position thresholds (relative):**
 - P-0-3229, Tolerance window for safety related homing procedure
 - P-0-3230, Monitoring window for safety related operational stop
 - "P-0-3232, Monitoring window for safety related direction of motion" or "P-0-3232, Standstill window for safety related direction of motion"
 - P-0-3243, Safety related limited increment 1
 - P-0-3253, Safety related limited increment 2
 - P-0-3263, Safety related limited increment 3
 - P-0-3273, Safety related limited increment 4



For general parameterization of the axis, make sure that the setting of "P-0-0129, Internal position data format" remains the same for all parameter sets or gear ratios which are used. Adjust "S-0-0278, Maximum travel range", if necessary.

In case "P-0-0129, Internal position data format" is changed with safety technology active, the error "F3140 Safety parameters validation error" or "F7040 Validation error parameterized - effective threshold" is generated.

Gear Independence With Safety Technology Encoder Mounted on the Load Side

According to the application, it can be necessary to mount the encoder relevant to safety technology on the load side. This provides the advantage that the velocity and position information required for safety technology are detected directly where the dangerous movement occurs. If the power transmission between motor and load has a modifiable gear ratio (e.g. switchable gear), the signal detection and evaluation of the safety technology encoder mounted on the load side must be independent of gear switching. Such an independence can be achieved with the functionality "gear independence with safety technology encoder mounted on the load side".

Features The functionality "gear independence with safety technology encoder mounted on the load side" has the following features:

- Functionality available as of MPx05.
- The axis must have been scaled on the load side.
- The acceleration and velocity data must have rotary scaling.
- The functionality cannot be used in conjunction with the safety related braking and holding system.
- The functionality cannot be used in conjunction with the safety related limited absolute position or the safety related limited absolute end position.

Pertinent Parameters The following parameters are used in conjunction with the functionality "gear independence with safety technology encoder mounted on the load side":

- S-0-0044, Velocity data scaling type
- S-0-0076, Position data scaling type
- S-0-0086, Torque/force data scaling type
- S-0-0160, Acceleration data scaling type
- P-0-3210, Safety technology configuration
- P-0-3240, Configuration of safety related motion 1
- P-0-3250, Configuration of safety related motion 2
- P-0-3260, Configuration of safety related motion 3

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- P-0-3270, Configuration of safety related motion 4
- P-0-3239, Configuration of global safety technology functions

Functional Principle

The gear independence with safety technology encoder mounted on the load side must be activated by the corresponding setting in parameter "P-0-3210, Safety technology configuration".

During every switching process to the operating mode, the following configurations are checked:

- The axis must have been scaled on the load side (S-0-0044, S-0-0076, S-0-0086, S-0-0160).
- The acceleration and velocity data (S-0-0044, S-0-0160) must have rotary scaling.
- The safety related braking and holding system (P-0-3300) mustn't have been activated.
- The safety related limited absolute end position (P-0-3239) mustn't have been configured.
- The safety related limited absolute position (P-0-3240, P-0-3250, P-0-3260, P-0-3270) mustn't have been configured.

In the case of deviations from these configurations, the transition command error "C0256 Safety technology configuration error" is generated.

6 Integrated Safety Functions

6.1 Overview of Safety Functions

6.1.1 General Information

Application-related safety functions are realized for personal protection in accordance with EN 954-1 category 3.



When a safety function is selected, transition to the corresponding status has to take place for the drive system by means of command value input.

6.1.2 Classification of Safety Functions

The safety functions can be divided into the following categories:

1. Safety functions in normal operation and in special mode with the functions
 - Safety related maximum speed
 - Safety related limited absolute end position (as of MP*04VRS)
 - Safety related direction of motion (as of MP*05VRS)
2. Safety functions in special mode "safety related halt" with the functions
 - Safety related starting lockout
 - Safety related standstill*¹
 - Safety related operational stop*¹
 - Safety related drive interlock*¹
 - Safety related braking and holding system (as of MP*05VRS)
3. Safety functions in special mode "safety related motion" with the functions
 - Safety related reduced speed
 - Safety related direction of motion
 - Safety related limited increment
 - Safety related limited absolute position
4. Additional or auxiliary functions
 - Safety related homing procedure
 - Safety related monitored stopping process
 - Safety related brake check (as of MP*05VRS)
5. Safety related feedback
 - Safety related diagnostic outputs (acknowledgment)
 - Safety related control of a door locking device



Safety related control of a safety door is not possible in conjunction with PROFIsafe.



*¹The functions "safety related standstill", "safety related operational stop" and "safety related drive interlock" contain "safety related monitored stopping process".

Integrated Safety Functions

6.2 Safety Functions in Normal Operation and in Special Mode

6.2.1 Safety Related Maximum Speed

Brief Description

In the case of the safety function "safety related maximum speed", the dual-channel monitoring prevents the drive from exceeding the preset velocity limit value ("P-0-3234, Safety related maximum speed").



Using the function "safety related maximum speed" requires the optional safety technology module ("S1") which can be selected as configuration for the control sections CSH01.1 or CSH01.2 (ADVANCED) and CDB01.1 (BASIC).

Features	<p>The safety function "safety related maximum speed" has the following features:</p> <ul style="list-style-type: none"> • Has been realized for personal protection in accordance with EN 954-1 category 3. • Closed-loop controlled operation is monitored with regard to the exceeding of a defined velocity limit value (cf. "P-0-3234, Safety related maximum speed"). • The safety function "safety related maximum speed" is active in normal operation and in special mode. • Selection/deselection of the safety function <ul style="list-style-type: none"> – MPx02 and MPx03: The safety function cannot be directly selected or deselected; only a high value in "P-0-3234, Safety related maximum speed" can prevent the monitor from triggering. – As of MPx04: The safety function "safety related maximum speed" is selected via the parameter "P-0-3239, Configuration of global safety technology functions" when safety technology is commissioned. • When a monitor is triggered, this causes an error reaction which shuts down the drive system. The corresponding error message is "F7020 Safety related maximum speed exceeded".
Pertinent Parameters	<p>The following parameters are used in conjunction with the safety function "safety related maximum speed":</p> <ul style="list-style-type: none"> • P-0-3234, Safety related maximum speed • P-0-3239, Configuration of global safety technology functions (as of MPx04)
Pertinent Diagnostic Messages	<p>The following diagnostic messages can be generated in conjunction with the safety function "safety related maximum speed":</p> <ul style="list-style-type: none"> • F7020 Safety related maximum speed exceeded • With the safety function "safety related maximum speed" activated, there is no separate message shown on the display of the IndraDrive control panel, but the standard diagnostic message (e.g. "AF") appears.

Safety Function

Selecting the Function	<p>MPx02 and MPx03: The safety function cannot be directly selected or deselected; only a high value in "P-0-3234, Safety related maximum speed" (as a maximum "S-0-0113, Maximum motor speed") can prevent the monitor from triggering.</p> <p>As of MPx04: The safety function "safety related maximum speed" is selected after safety technology has been activated. Is carried out via the parameter</p>
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Integrated Safety Functions

"P-0-3239, Configuration of global safety technology functions" when safety technology is commissioned.



After safety technology has been activated, "P-0-3234, Safety related maximum speed" is write-protected with "P-0-3206, Safety technology password" and cannot be changed by unauthorized persons.

The status of the safety technology password can be seen in "P-0-3207, Safety technology password level".

Monitoring Functions

In the case of the safety function "safety related maximum speed", the dual-channel monitoring prevents the drive from exceeding the preset velocity threshold ("P-0-3234, Safety related maximum speed").

Monitoring of the safety related maximum speed (cf. P-0-3234) is active in each safety technology operating status.

When the actual velocity is outside of the limit value (P-0-3234), the fatal safety technology error "F7020 Safety related maximum speed exceeded" is generated by the drive and the drive is shut down.

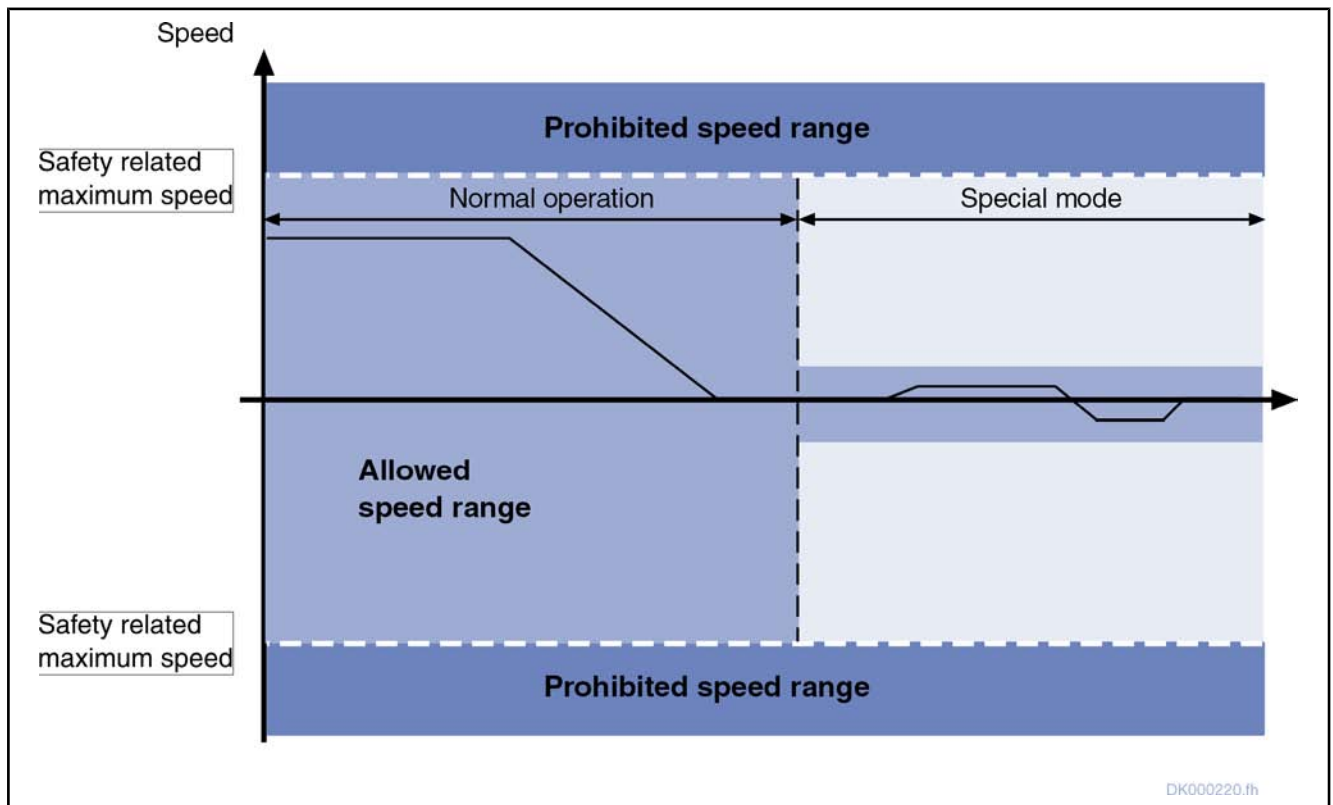


Fig. 6-1: $|V_{act}| < P-0-3234$, Safety related maximum speed

6.2.2 Safety Related Direction of Motion

Brief Description



The safety function "safety related direction of motion" can be parameterized either for the special mode "safety related motion" or for normal operation **and** special mode (as of MPx05). This chapter describes the function for normal operation and special mode.

In the case of the safety function "safety related direction of motion", dual-channel monitoring guarantees that motion is only possible in one direction.

Integrated Safety Functions



Using the function "safety related direction of motion" requires the optional safety technology module ("S1") which can be selected as configuration for the control sections **CSH01.1** or **CSH01.2** (ADVANCED) and CDB01.1 (BASIC).

The safety function "safety related direction of motion" for normal operation and special mode is available as of firmware version MPx05.

Features The safety function "safety related direction of motion" for normal operation and special mode has the following features:

- The safety function "safety related direction of motion" has been realized for personal protection in accordance with EN 954-1 category 3.
- In the operating mode, monitoring takes place with regard to the direction of motion (cf. "P-0-3232, Standstill window for safety related direction of motion").
- The safety function "safety related direction of motion" is active in normal operation and in special mode.
- When the monitor for the direction of motion is triggered, this causes an error reaction which shuts down the drive system. The corresponding error message is "F7031 Incorrect direction of motion".
- The safety function "safety related direction of motion" is configured for normal operation and special mode via the parameter "P-0-3239, Configuration of global safety technology functions" when safety technology is commissioned and afterwards is automatically active in the operating mode (no selection required).

Pertinent Parameters The following parameters are used in conjunction with the safety function "safety related direction of motion" for normal operation and special mode:

- P-0-3239, Configuration of global safety technology functions
- P-0-3232, Standstill window for safety related direction of motion

Pertinent Diagnostic Messages The following diagnostic messages can be generated in conjunction with the safety function "safety related direction of motion":

- F7031 Incorrect direction of motion
- F7040 Validation error parameterized - effective threshold

Safety Function

Selecting the Function The safety function "safety related direction of motion" for normal operation and special mode is active after the function has been parameterized and safety technology has been activated; it is not necessary to explicitly select it in addition.

Monitoring Function In the case of the safety function "safety related direction of motion" for normal operation and special mode, dual-channel monitoring takes place to make sure that the drive only moves in the enabled direction of motion (cf. P-0-3239) or, when moving in the non-enabled direction of motion, that it does not exceed P-0-3232; otherwise, the error "F7031 Incorrect direction of motion" is generated and the drive is shut down.

Monitoring of the safety related direction of motion for normal operation and special mode takes place independent of the safety technology operating status

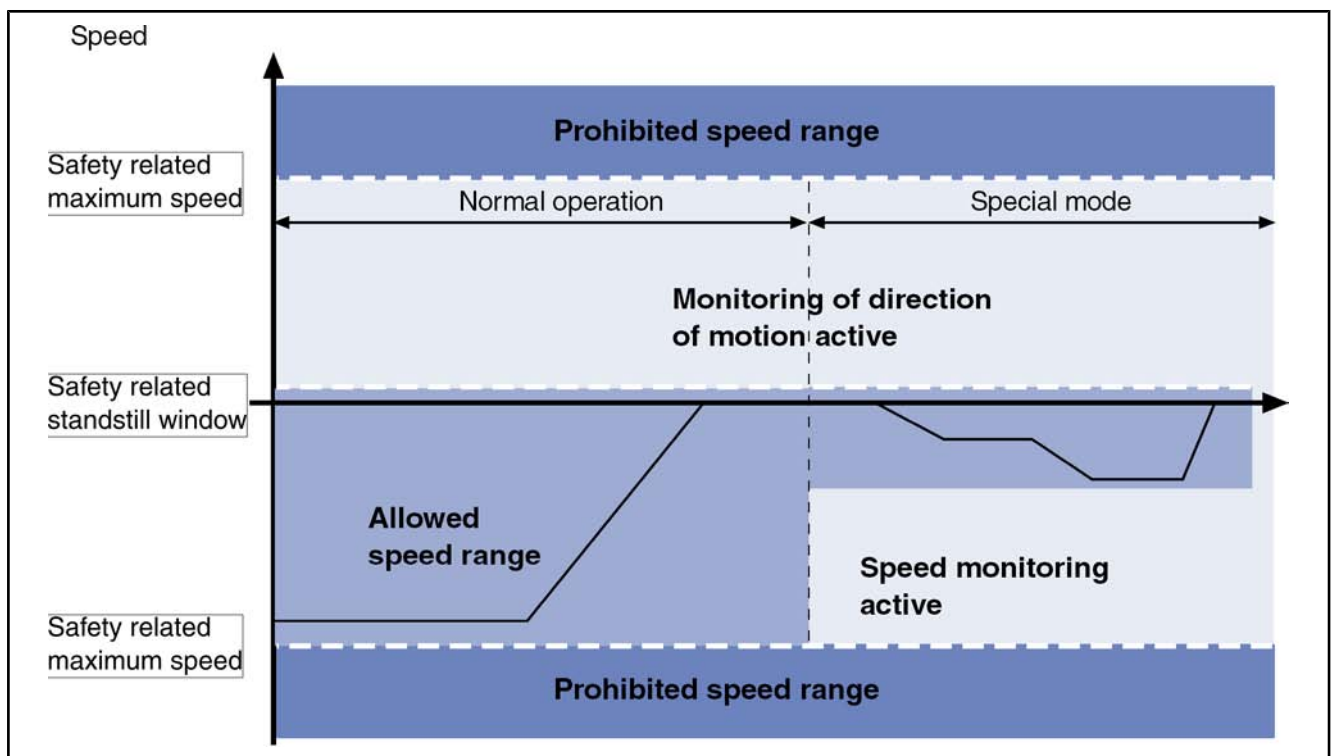


Fig. 6-2: Safety related direction of motion for normal operation and special mode

6.2.3 Safety Related Limited Absolute End Position

Brief Description

In the case of the safety function "safety related limited absolute end position", dual-channel monitoring prevents the drive from leaving the preset position range ("P-0-3235, Safety related end position, positive"; "P-0-3236, Safety related end position, negative").



Using the safety function "safety related limited absolute end position" requires the optional safety technology module ("S1") which can be selected as configuration for the control sections CSH01.1 or CSH01.2 (ADVANCED) and CDB01.1 (BASIC).



The safety function "safety related limited absolute end position" is available as of firmware version MPx04.

Features

The safety function "safety related limited absolute end position" has the following features:

- Has been realized for personal protection in accordance with EN 954-1 category 3.
- Closed-loop controlled operation is monitored with regard to the exceeding of the defined end positions (cf. "P-0-3235, Safety related end position, positive"; "P-0-3236, Safety related end position, negative").
- The safety function "safety related limited absolute end position" is active in normal operation and in special mode.
- The safety function "safety related limited absolute end position" is **selected** via the parameter "P-0-3239, Configuration of global safety technology functions" when safety technology is commissioned.

Integrated Safety Functions

	<ul style="list-style-type: none"> When a monitor is triggered, this causes an error reaction which shuts down the drive system. The corresponding error message is "F7021 Safety related end position exceeded".
Notes on Utilization	<ul style="list-style-type: none"> For the safety function "safety related limited absolute end position", the drive must have been safely homed. When the safety function "safety related limited absolute end position" is used and the parameter setting of the error reaction for F7xx errors is torque disable, it is no longer possible to ensure that the axis does not leave the allowed position range in case the monitors trigger. This, too, must be taken into account for the machine manufacturer's risk analysis.
Pertinent Parameters	<p>The following parameters are used in conjunction with the safety function "safety related limited absolute end position":</p> <ul style="list-style-type: none"> "P-0-3232, Monitoring window for safety related direction of motion" or "P-0-3232, Standstill window for safety related direction of motion" P-0-3235, Safety related end position, positive P-0-3236, Safety related end position, negative P-0-3239, Configuration of global safety technology functions P-0-3282, Safety related monitored deceleration
Pertinent Diagnostic Messages	<p>The following diagnostic messages can be generated in conjunction with the safety function "safety related limited absolute end position":</p> <ul style="list-style-type: none"> E3107 Safety related reference missing F3112 Safety related reference missing F7021 Safety related end position exceeded With "safety related limited absolute end position" activated, there is no separate message shown on the display of the IndraDrive control panel, but the standard diagnostic message (e.g. "AF") appears.

Safety Function

Selecting the Function To use the safety function "safety related limited absolute end position" it must be activated in parameter "P-0-3239, Configuration of global safety technology functions"; the safety function is always active after safety technology has been commissioned.



Before the safety function "safety related limited absolute end position" is selected, the "safety related homing procedure" has to be carried out.

Monitoring Functions In the case of the safety function "safety related limited absolute end position", dual-channel monitoring makes sure that the drive...

- ...only receives such command values (position or velocity) which do not cause the safety related end position positive or negative ("P-0-3235, Safety related end position, positive"; "P-0-3236, Safety related end position, negative") to be exceeded. If the command values are incorrect, the drive generates the error "F7021 Safety related end position exceeded".
- ...with the current actual velocity and the parameterized deceleration "P-0-3282, Safety related monitored deceleration", can still be stopped within the safety related end positions. If the actual velocity is too high, the error "F7021 Safety related end position exceeded" is generated.

$$\text{Braking distance} = \frac{\text{Actual velocity}^2}{2 \cdot \text{P-0-3282}}$$

$$\text{Braking distance} < |\text{P-0-3235 (or P-0-3236)} - \text{Act. position value}|$$

P-0-3235	Safety related end position, positive
P-0-3236	Safety related end position, negative
P-0-3282	Safety related monitored deceleration

Fig. 6-3: Calculating the braking distance for monitoring of safety function "safety related limited absolute end position"



The deceleration ramp defined in parameter "P-0-3282, Safety related monitored deceleration" should be set such that the drive has the deceleration capacity to come to standstill before the safety related end positions set in "P-0-3235, Safety related end position, positive" or "P-0-3236, Safety related end position, negative" are reached.

- ...is homed in a safety-related way after having reached the operating mode. As long as "safety related reference" has not been established, the warning "E3107 Safety related reference missing" is output. After the warning has occurred, the drive can be operated for 15 minutes without "safety related reference", then the error "F3112 Safety related reference missing" will be generated.

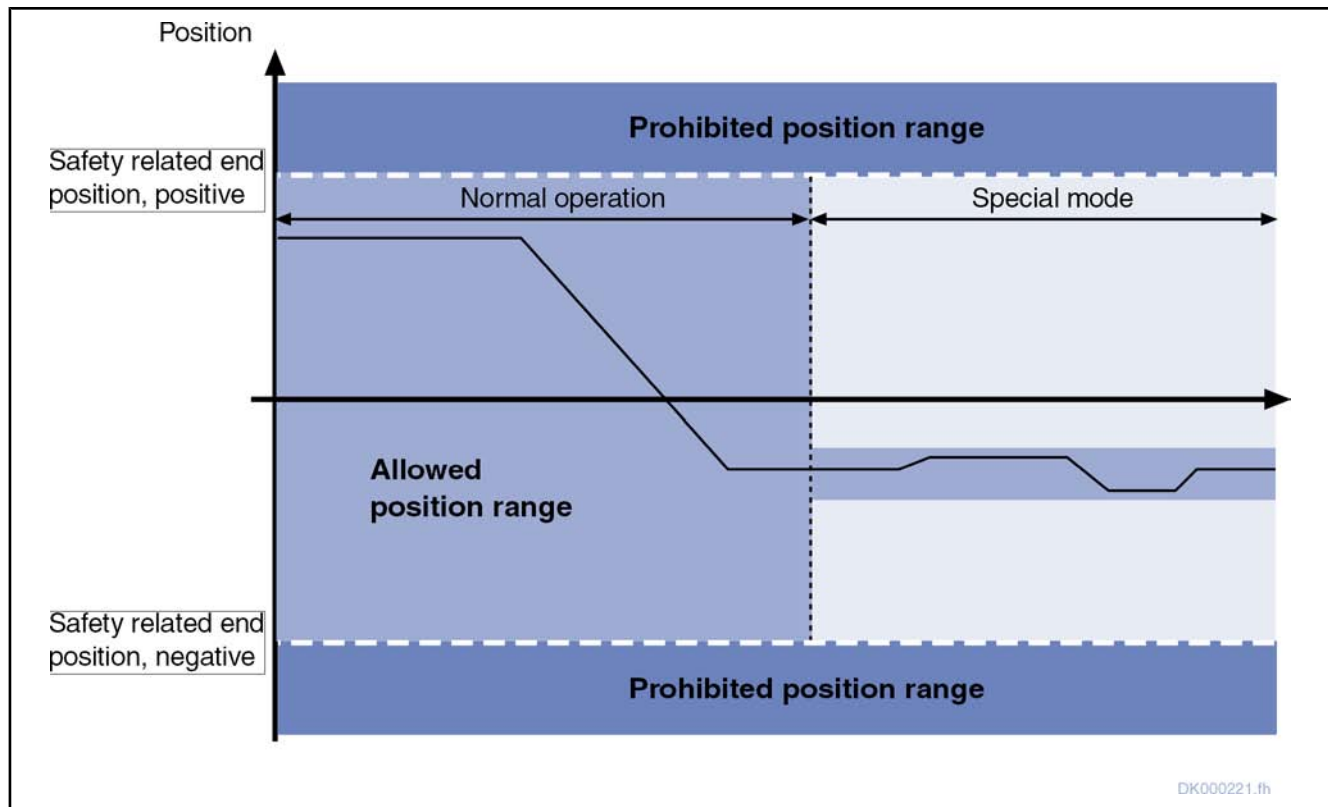


DANGER

Lethal injury / property damage caused by drive operation without reference, as the safety related end positions (positive / negative) can be exceeded!

⇒ Establish safety related reference

Integrated Safety Functions



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Fig.6-4: Safety related limited absolute end position

Return Motion to Allowed Position Range

When the axis is outside of the allowed position range, the error "F7021 Safety related end position exceeded" is generated. This error can be reset by executing the command "S-0-0009, C0500 Reset class 1 diagnostics". Afterwards it is possible to move the axis back to the allowed position range; when this is done the drive only allows motion in the direction of the allowed position range. Motion in the other direction is only possible within the tolerance window ("P-0-3232, Monitoring window for safety related direction of motion" or "P-0-3232, Standstill window for safety related direction of motion"), otherwise the error "F7021 Safety related end position exceeded" is immediately generated again.

6.3 Safety Functions in Special Mode "Safety Related Halt"

6.3.1 Safety Related Starting Lockout ("AS")

Brief Description



Using the function "safety related starting lockout" requires the optional safety technology module ("L1").

In the case of the safety function "safety related starting lockout", the energy supply to the drive is safely interrupted. The drive cannot produce any torque/any force and therefore no dangerous movements.



Before starting lockout is selected, the drive system has to be shut down by means of command value input; drive-controlled shutdown dose not take place!

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

⇒ If external force influences are to be expected with the safety function "safety related starting lockout", 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 weight compensation.

- Features** The safety function "safety related starting lockout" has the following features:
- Corresponds to stop category 0 according to EN 60204-1.
 - Has been realized for **personal protection in accordance with EN 954-1 category 3**.
 - The energy supply to the motor is safely interrupted via two channels.
 - The **selection** is made via two channels using either an N/C-N/O or an N/C-N/C combination.
 - The safety related status is **acknowledged** by an N/C-N/O contact.
 - For **dynamization of the safety function selection**, the function must be activated at least every 168 hours. For this reason, the operating hours of the power section, at which the safety function "safety related starting lockout" was selected the last time, are stored in parameter "P-0-0102, Oper. hours power section at last activat. of start. lockout".
 - Validation monitoring of selection: 100 ms after selection was changed.
 - The time intervals for activating the starting lockout have to be set via "P-0-0103, Time interval of forced dynamization".
 - The history of the time intervals that were set is displayed in parameter "P-0-0104, Change history time interval of forced dynamization".
 - The status of starting lockout is displayed via the parameter "P-0-0106, Operating status of starting lockout" (as of firmware MPx04V14).

- Pertinent Parameters** The following parameters are used in conjunction with the safety function "safety related starting lockout":
- P-0-0101, Configuration for starting lockout selector
 - P-0-0102, Oper. hours power section at last activat. of start. lockout
 - P-0-0103, Time interval of forced dynamization
 - P-0-0104, Change history time interval of forced dynamization
 - P-0-0106, Operating status of starting lockout (as of firmware MPx04V14)

- Pertinent Diagnostic Messages** The following diagnostic messages can be generated in conjunction with the safety function "safety related starting lockout":
- F8027 Safety related standstill while drive enabled
 - F7043 Error of output stage interlock
 - F3130 Error when checking input signals
 - F3131 Error when checking acknowledgment signal
 - E3110 Time interval for forced dynamization exceeded
 - E8027 Safety related standstill while drive enabled (as of firmware MPx03V24 or MPx04V14)
 - With starting lockout activated, "AS" is shown on the display of the Indra-Drive control panel.

Integrated Safety Functions

Safety Function

On the optional safety technology module ("L1"), there are 24 V inputs available for dual-channel selection and a floating changeover contact for dual-channel feedback (all 3 connections can be accessed).



For pin assignments and technical data of the optional module, please see the Project Planning Manual for the control section.

The safety related starting lockout can be divided into the topics

- forced dynamization,
- selection of starting lockout and
- command value input

which are described in detail below.

Forced Dynamization

Forced dynamization is to detect static error states, so-called "sleeping errors", during safety function selection and in the interrupting circuits. Both the control section in standard design and the optional safety technology module "L1" have their own interrupting circuits.



After drive enable has been set and within, for example, 8 hours, manual dynamization is required (activate starting lockout) which is initiated by removing drive enable.

Setting drive enable starts the lifecounter which runs as long as the drive is in control. When drive enable is reset, the lifecounter is stopped and the current value is stored. The lifecounter is only reset when starting lockout is selected.

"P-0-0103, Time interval of forced dynamization" is used to set the time interval for the lifecounter. When the time interval is exceeded, the drive generates the warning "E3110 Time interval of forced dynamization exceeded" and thereby signals that forced dynamization has to be carried out. This is done by simple selection of starting lockout.

The operating hours of the power section, for which the "starting lockout" function was selected the last time, are saved in parameter "P-0-0102, Oper. hours power section at last activat. of start. lockout".

A history of the time intervals set by the user in "P-0-0103, Time interval of forced dynamization" is stored in parameter "P-0-0104, Change history time interval of forced dynamization".

Requirements on the Command Value Input

Before starting lockout is selected, the drive system has to be shut down by means of command value input; drive-controlled shutdown dose not take place!



The "safety related starting lockout" corresponds to stop category 0 according to EN 60204-1.

When drive enable has been set and starting lockout is selected at the same time, the drive generates the error "F8027 Safety related standstill while drive enabled", because the drive first has to be shut down before it is allowed to activate the starting lockout.

Via parameter "P-0-0101, Configuration for starting lockout selector", the displayed diagnostic message can be changed from the fatal error "F8027 Safety related standstill while drive enabled" to the fatal warning "E8027 Safety related standstill while drive enabled" (as of firmware MPx03V24 or MPx04V14). The

warning is automatically cleared, when drive enable is removed. In the diagnostic message memory, however, the fatal warning remains entered.



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

⇒ When starting lockout 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 safety related!

Selecting Starting Lockout

Starting lockout is selected via two channels, either by means of a switch with two N/C contacts or one N/C-N/O contact, each at the 9-pin D-Sub connector on the optional module "L1".

See also "Project Planning Manual for control sections" or "[X41, Connection Point Safety Technology S1](#)"

With parameter "P-0-0101, Configuration for starting lockout selector", it is possible to configure the selection via N/C contacts or N/C-N/O contacts.

The firmware checks the selection signals for validation. In the case of states which are not allowed, the drive generates the error "F3130 Error when checking input signals".

As of firmware MPx04V14, the status of starting lockout and the validation of the selection signals can be read via the parameter "P-0-0106, Operating status of starting lockout".



The tolerance time for different selection of channel 1 and channel 2 is 100 ms; the parameter setting of the tolerance time cannot be changed.

One channel of the switch can be connected via PLC I/O, the second channel then should be directly connected to the optional safety technology module.

Both channels of the switch can be connected via I/Os of a safety PLC.

Both channels can be connected via the safety contacts of a door monitoring device. For feedback to the monitoring device, there is a floating contact available.



For applications of category 3 according to EN 954-1, it is not allowed to connect both channels via a standard PLC!

Integrated Safety Functions

Notes on Commissioning

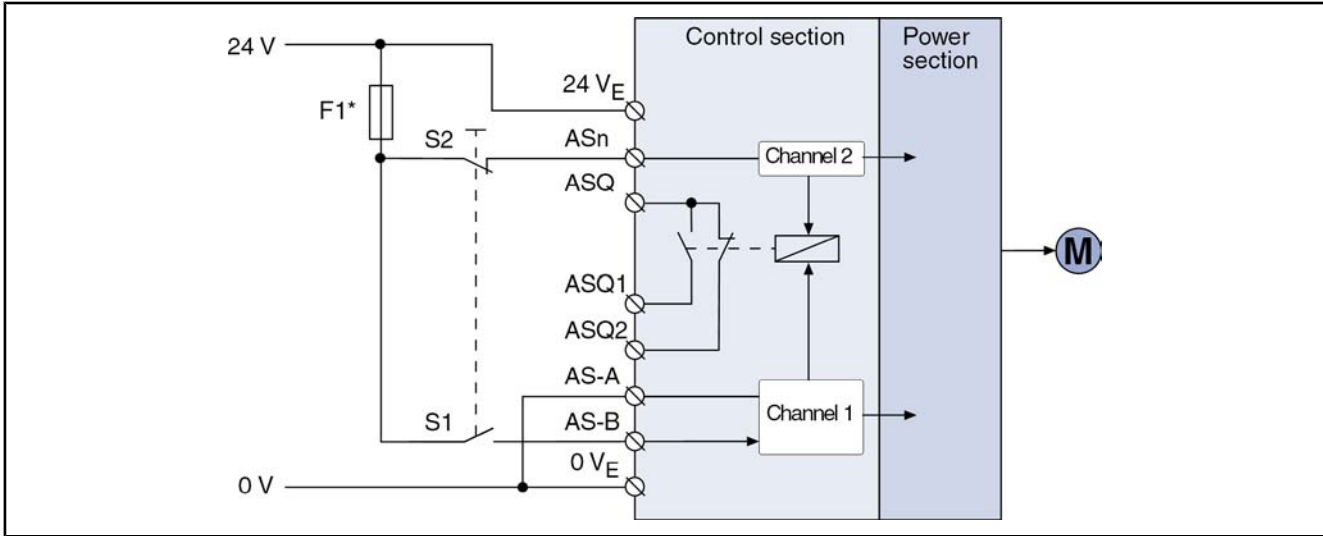


Fig.6-5: Data for F1*, see switch contacts S1/S2
 Selecting starting lockout via switch with N/C-N/O contacts

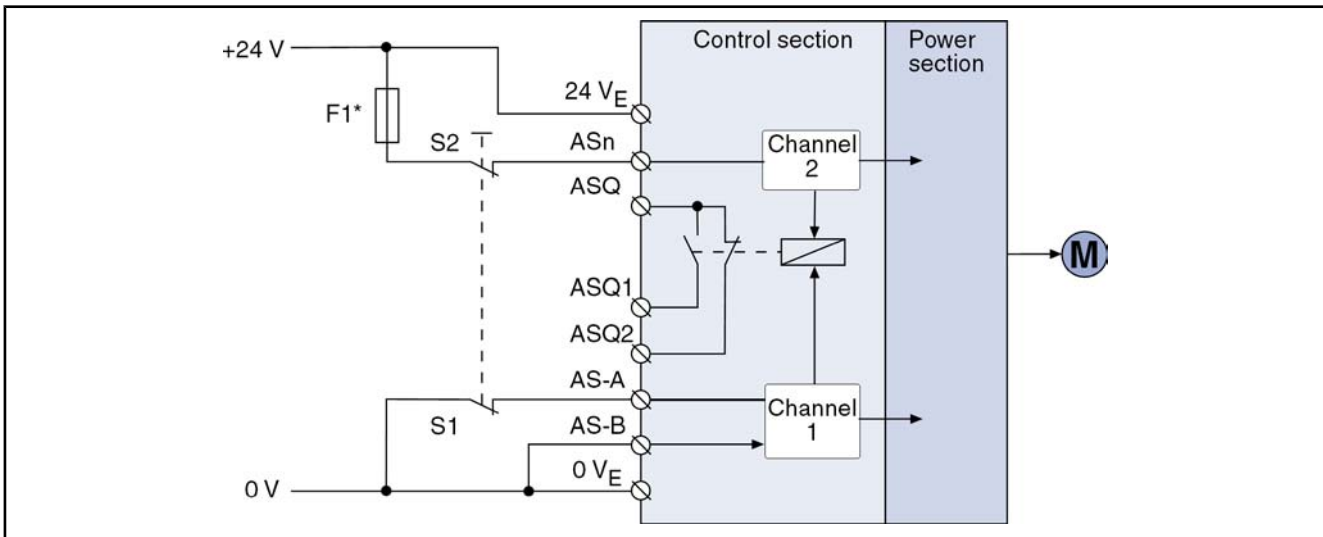


Fig.6-6: Data for F1*, see switch contacts S1/S2
 Selecting starting lockout via switch with two N/C contacts

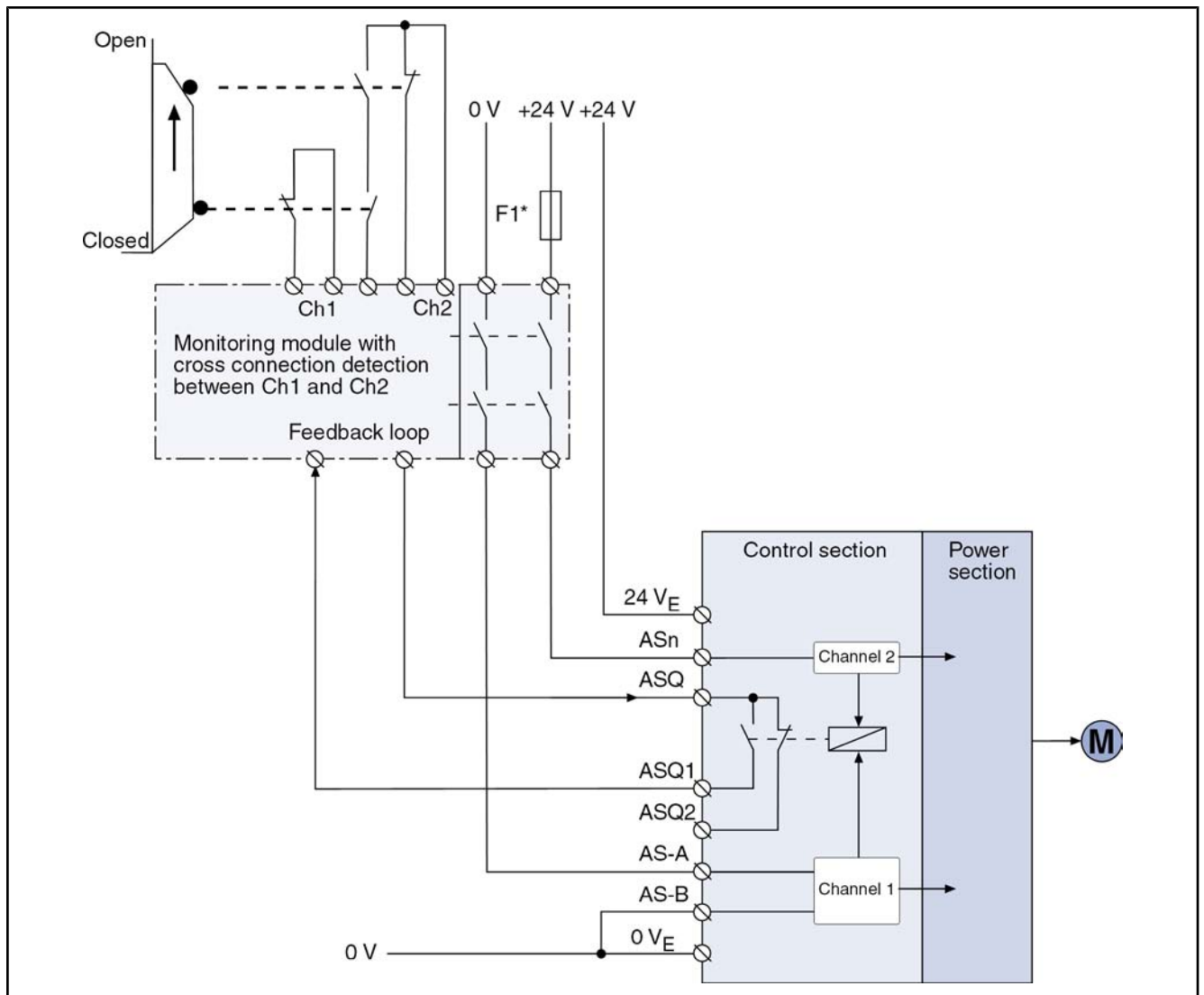


Fig.6-7: Data for F1*, see switch contacts of safety device
Selecting starting lockout by means of safety device



In terms of EN 954-1, the signal processing of a standard PLC has to be regarded as single-channel, the circuit illustrated below therefore is not allowed!

Integrated Safety Functions

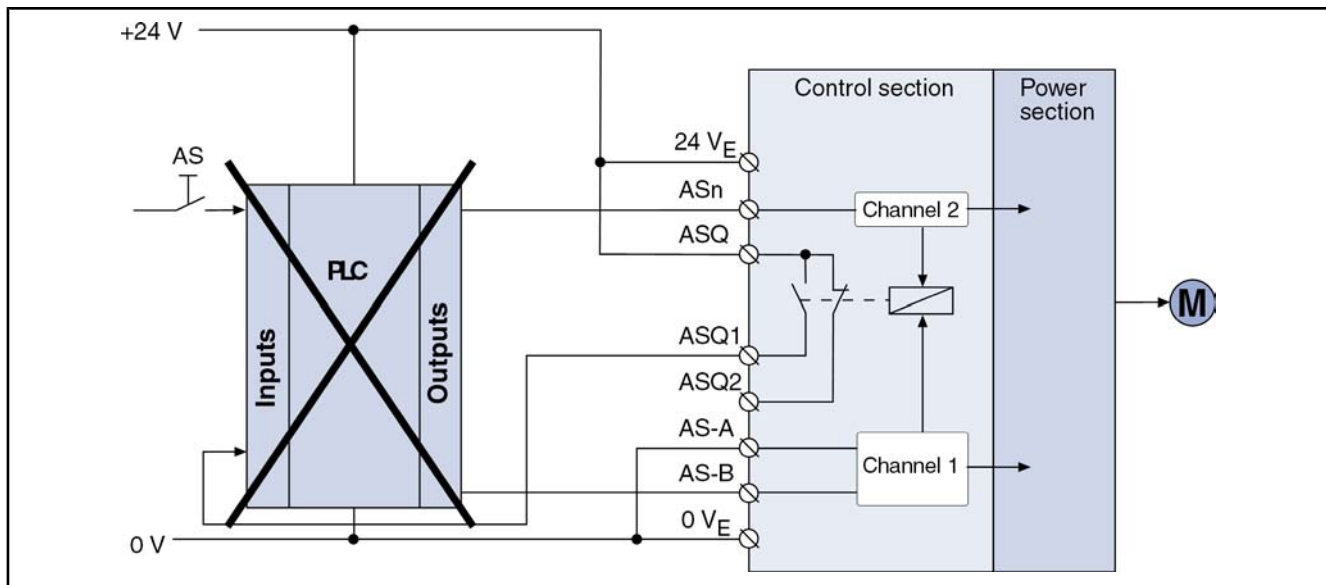


Fig.6-8: Selecting starting lockout via standard PLC (negative example)

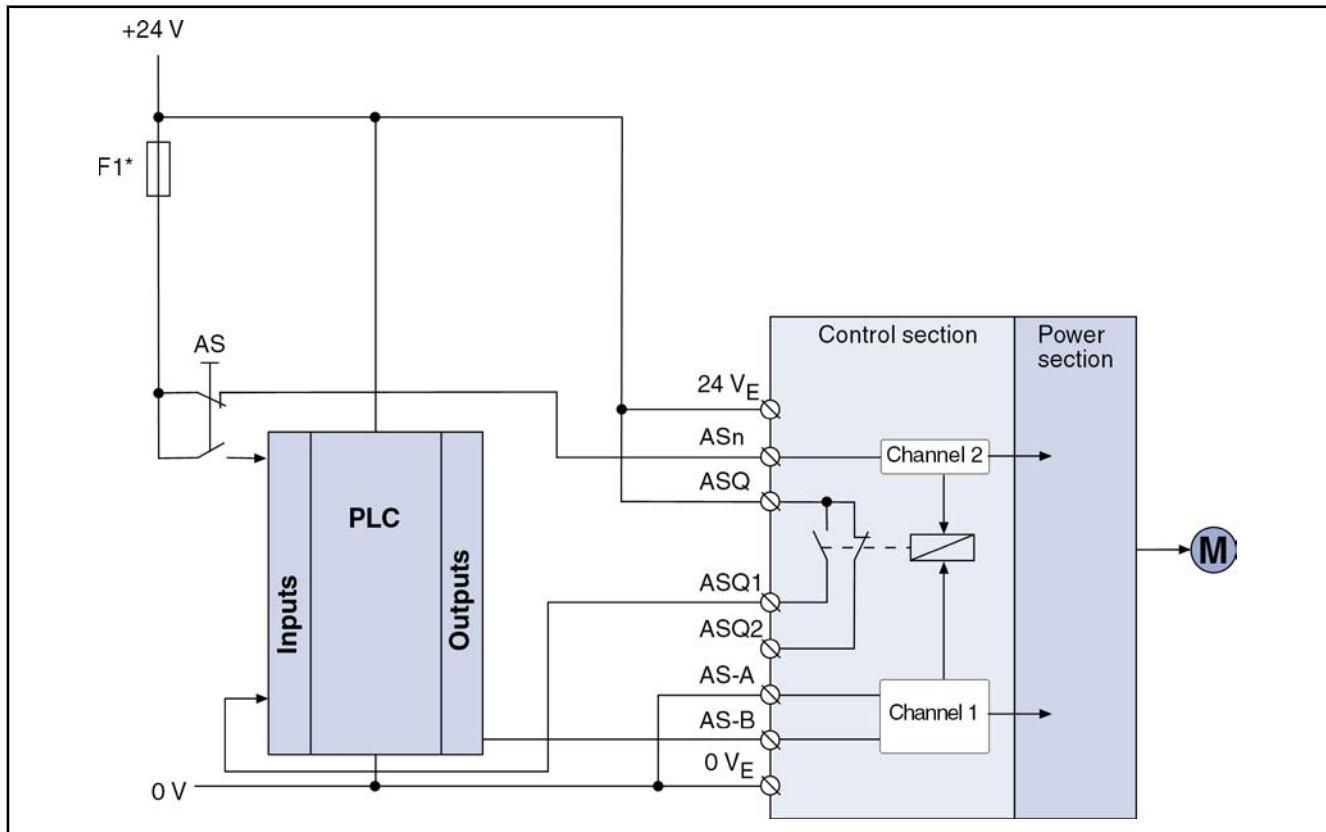


Fig.6-9: Data for F1*, see switch contacts starting lockout
 Selecting starting lockout via switch with N/C-N/O contacts standard PLC

6.3.2 Safety Related Standstill ("SH")

Brief Description

In the case of safety related standstill, the energy supply to the motor is safely interrupted. The motor cannot generate any torque/any force and therefore no dangerous movements.



Using the function "safety related standstill" requires the optional safety technology module ("S1") which can be selected as configuration for the control sections CSH01.1 or CSH01.2 (ADVANCED) and CDB01.1 (BASIC).

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

⇒ Please observe the warnings in section "Notes on Commissioning".



The function "safety related standstill" is deselected by selecting "safety related drive interlock" or actuating the enabling control or by deselecting the mode selector!

Features

The function has the following features:

- Corresponds to stop category 1 according to EN 60204-1.
- Has been realized for personal protection in accordance with EN 954-1 category 3.
- The energy supply to the motor is safely interrupted via two channels.
- The duration of the transition to safety related standstill is monitored (cf. "P-0-3220, Tolerance time transition from normal operation" or "P-0-3225, Tolerance time transition from safety rel. oper.").
- There aren't any monitoring functions active in safety related standstill.

Pertinent Parameters

The following parameters are used in conjunction with the safety function "safety related standstill":

- "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word"
- "P-0-3212, Safety technology control word, channel 1" or "P-0-3212, Safety technology signal control word, channel 1"
- P-0-3220, Tolerance time transition from normal operation
- P-0-3225, Tolerance time transition from safety rel. oper.
- P-0-3233, Velocity threshold for safety related halt

Pertinent Diagnostic Messages

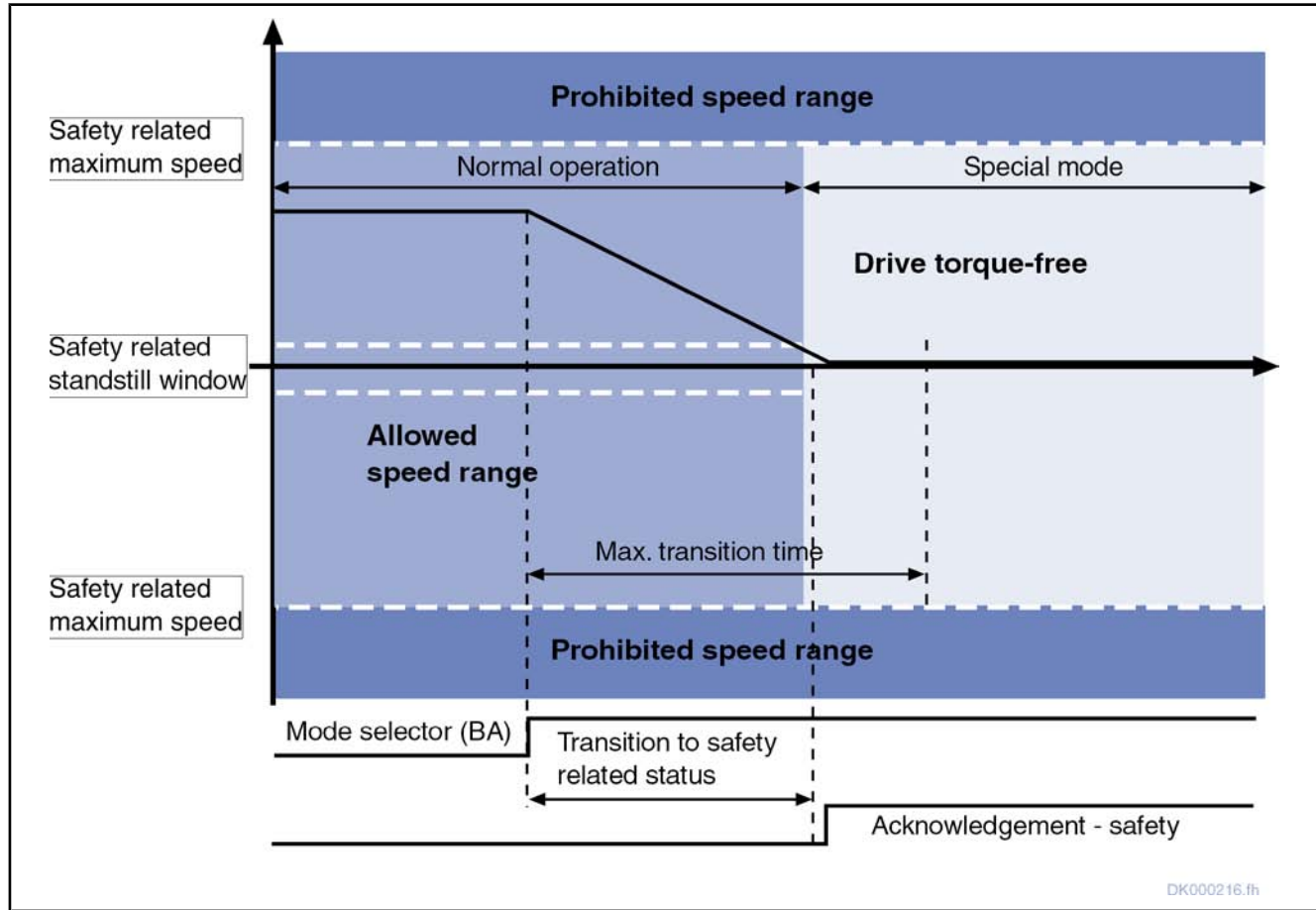
The following diagnostic messages can be generated in conjunction with the safety function "safety related standstill":

- F7040 Validation error parameterized - effective threshold
- F7050 Time for stopping process exceeded
- F8027 Safety related standstill while drive enabled
- With safety related standstill activated, "SH" is shown on the display of the IndraDrive control panel.

Safety Function**Transition to Safety Related Status**

The kind of transition to the safety related status can be set in parameter "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration". You can select either "drive-controlled safety technology operating mode transitions" and "NC-controlled operating mode transitions" (see "[Transition to Safety Related Status](#)"). In both cases the safety function "safety related monitored stopping process" becomes active for transition (see "[Safety Related Monitored Stopping Process](#)").

Integrated Safety Functions



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Fig.6-10: Drive-controlled transition to safety related standstill from normal operation

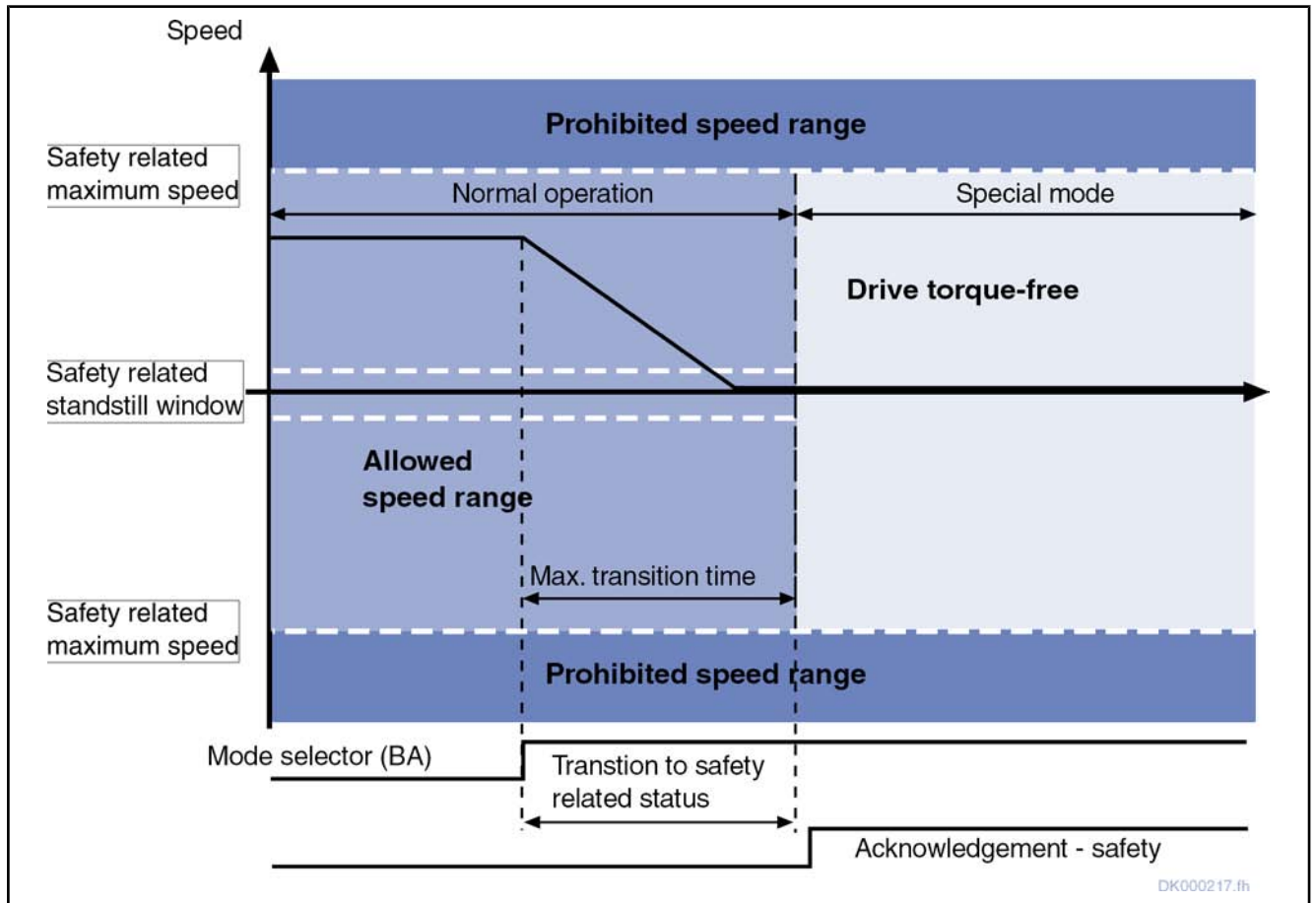


Fig.6-11: NC-controlled transition to safety related standstill from normal operation



DANGER

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

⇒ In safety related standstill, the drive cannot generate any torque/any force and therefore no dangerous movements which has to be taken into account above all for vertical axes. Please observe the warnings in section "Notes on Commissioning".

Monitoring Functions

If the safety function "safety related standstill" has been activated and drive enable is set, the error "F8027 Safety related standstill while drive enabled" is generated.

Terminating Safety Related Standstill

The function "safety related standstill" is deselected by selecting "safety related drive interlock" or actuating the enabling control or by deselecting the mode selector!

Notes on Project Planning

When projecting the safety function "safety related standstill", you absolutely have to observe the following warnings:



DANGER

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

⇒ If external force influences are to be expected with the safety function "safety related standstill", 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 weight compensation; for such axes, Bosch Rexroth recommends that you use the safety related braking and holding system.

Integrated Safety Functions

**WARNING****Injury and/or material 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 three errors are occurring simultaneously in the power section with the voltage DC bus being active:

- Breakdown of a power semiconductor
- Breakdown of another semiconductor
- In this case, two of six semiconductors are affected in such a way that the motor shaft is aligning

Example synchronous motor: For a 6-pole synchronous motor, the motion can be a maximum of 30 degrees. For a directly driven ballscrew, 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.

6.3.3 Safety Related Operational Stop ("SBH")

Brief Description

In the case of the safety function "safety related operational stop", the drive is in controlled standstill, i.e. all control functions between the electronic control unit and the drive are maintained. The dual-channel monitoring prevents the drive from carrying out dangerous movements due to errors although the energy supply is not interrupted.



Using the function "safety related operational stop" requires the optional safety technology module ("S1") which can be selected as configuration for the control sections CSH01.1 or CSH01.2 (ADVANCED) and CDB01.1 (BASIC).

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

⇒ Please observe the warnings in section "Notes on Commissioning".

- Features** The safety function "safety related operational stop" has the following features:
- Corresponds to stop category 2 according to EN 60204-1.
 - Has been realized for personal protection in accordance with EN 954-1 category 3.
 - The energy supply to the motor is **not** interrupted.
 - Closed-loop controlled operation in standstill is monitored (cf. "P-0-3230, Monitoring window for safety related operational stop").
 - The duration of the transition to safety related operational stop is monitored (cf. "P-0-3220, Tolerance time transition from normal operation" or "P-0-3225, Tolerance time transition from safety rel. oper.>").
 - When a monitor is triggered, this causes an error reaction which shuts down the drive system. The corresponding error message is "F7030 Pos. window for safety rel. operational stop exceeded".

Integrated Safety Functions

- Pertinent Parameters** The following parameters are used in conjunction with the safety function "safety related operational stop":
- "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word"
 - "P-0-3212, Safety technology control word, channel 1" or "P-0-3212, Safety technology signal control word, channel 1"
 - P-0-3220, Tolerance time transition from normal operation
 - P-0-3225, Tolerance time transition from safety rel. oper.
 - P-0-3230, Monitoring window for safety related operational stop
 - P-0-3233, Velocity threshold for safety related halt

- Pertinent Diagnostic Messages** The following diagnostic messages can be generated in conjunction with the safety function "safety related operational stop":
- F7030 Pos. window for safety rel. operational stop exceeded
 - F7040 Validation error parameterized - effective threshold
 - F7050 Time for stopping process exceeded
 - With safety related operational stop activated, "SBH" is shown on the display of the IndraDrive control panel.

Safety Function

- Basic Principle** In the case of the safety function "safety related operational stop", the drive is in controlled standstill, i.e. all control functions between the electronic control unit and the drive are maintained. The drive, however, cannot generate any dangerous movement although the energy supply is not interrupted.



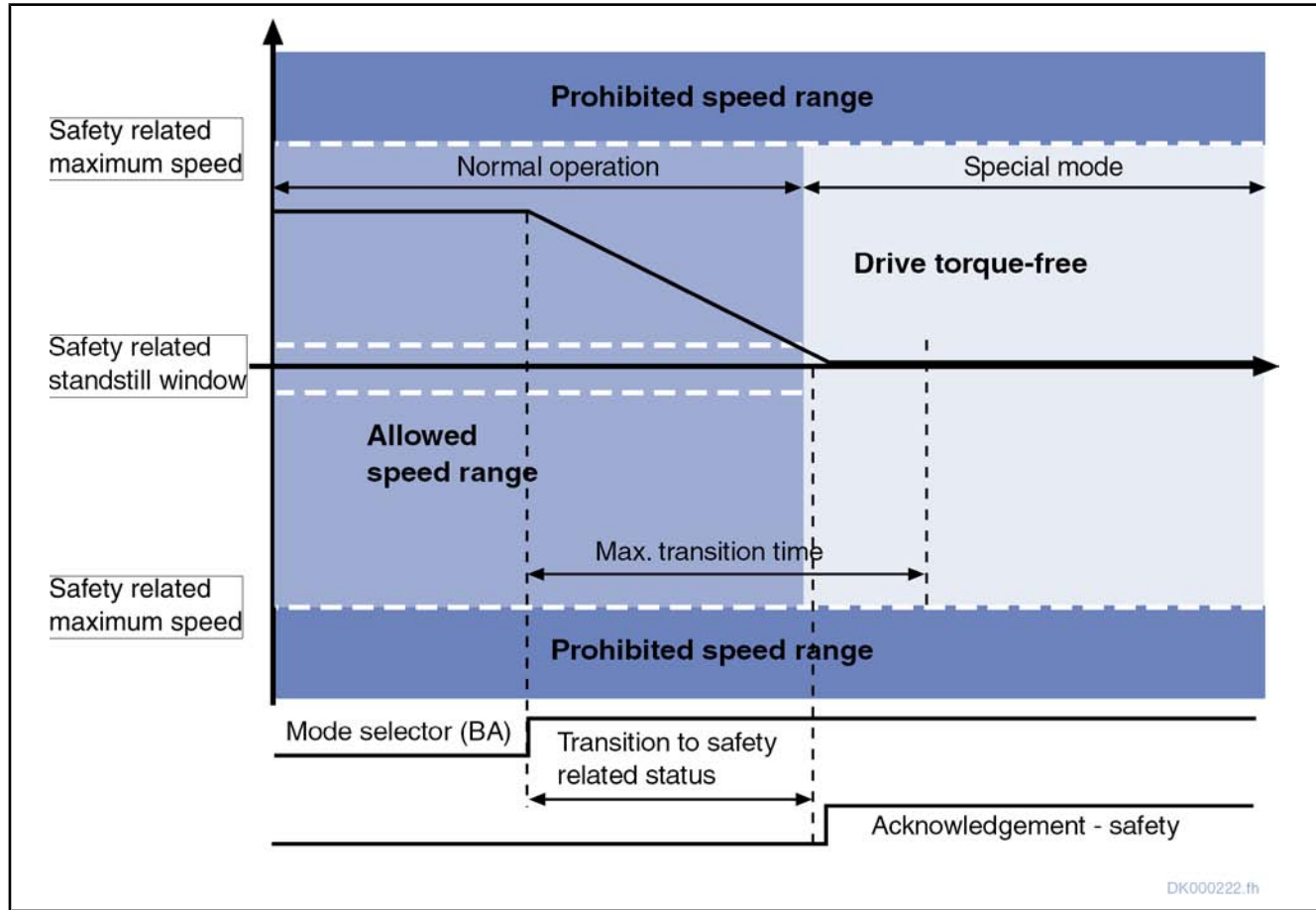
When the safety function "safety related operational stop" has been selected, the control unit can reset drive enable and set it again. The monitoring of the standstill position always remains active.

- Transition to Safety Related Status** The kind of transition to the safety related status can be set with "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration". You can select either "drive-controlled safety technology operating mode transitions" and "NC-controlled operating mode transitions" (see "[Transition to Safety Related Status](#)"). In both cases the safety function "safety related monitored stopping process" becomes active for transition (see "[Safety Related Monitored Stopping Process](#)").

For transition to the safety related status, there is a programmable time (P-0-3220 from normal operation and P-0-3225 from special mode) available. After the time is over, the drive is shut down with velocity command value reset and energy supply is safely (i.e. via two channels) interrupted. The error "F7050 Time for stopping process exceeded" is generated.

In safety related operational stop, the energy supply is not interrupted; all control functions between the electronic control unit and the drive are maintained.

Integrated Safety Functions



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Fig.6-12: Drive-controlled transition to safety related operational stop from normal operation

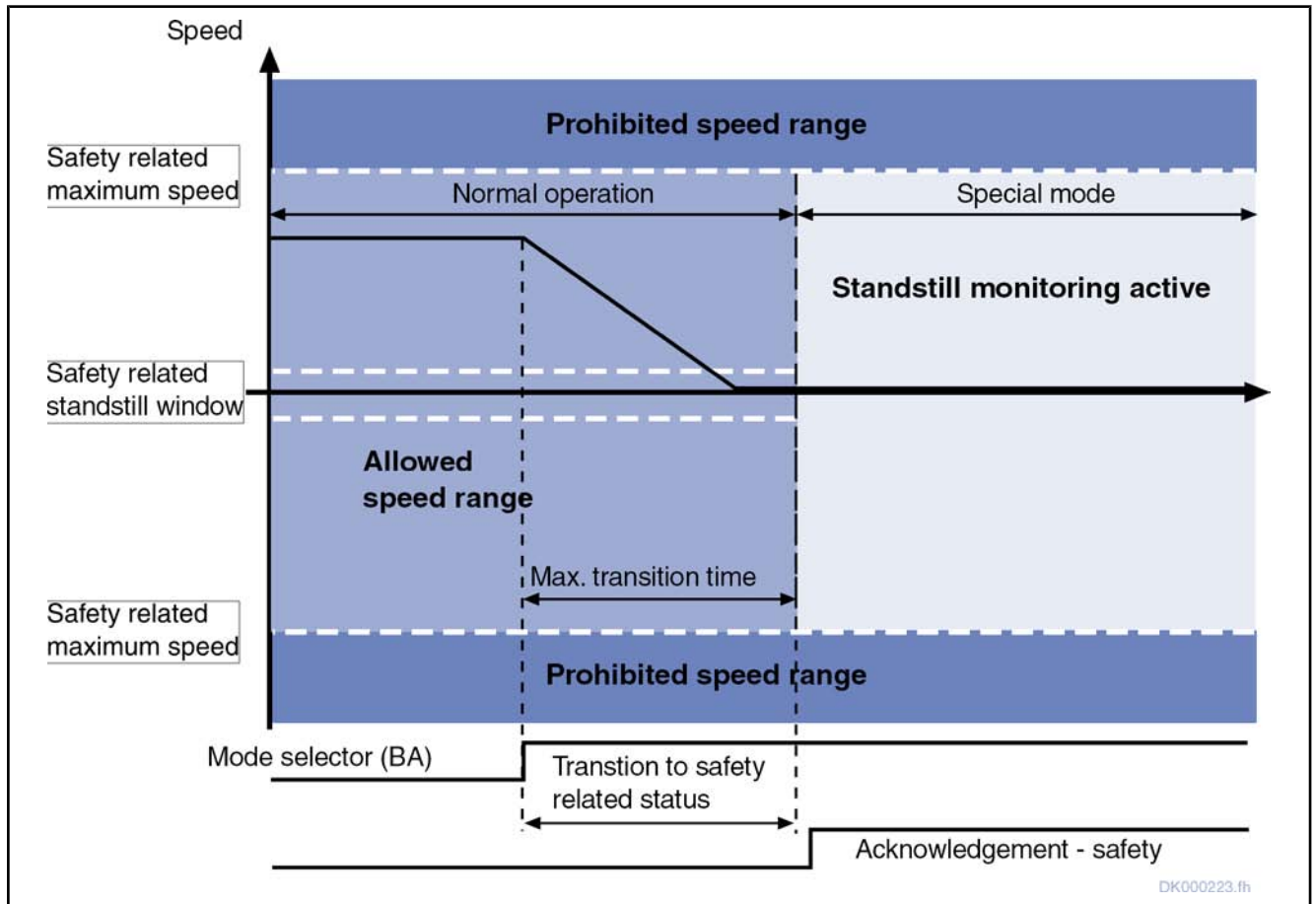


Fig.6-13: NC-controlled transition to safety related operational stop from normal operation

Monitoring Functions

In the case of active safety function "safety related operational stop", dual-channel monitoring of the actual position or the travel distance prevents the drive from carrying out dangerous movements due to errors.

In addition, monitoring makes sure that there aren't any command values preset for the drive during safety related operational stop which would cause the drive to leave the monitoring window for safety related operational stop (P-0-3230).

When the travel distance is greater than the value parameterized in "P-0-3230, Monitoring window for safety related operational stop", the drive generates the error "F7030 Pos. window for safety rel. operational stop exceeded" and is shut down.



After safety technology has been activated, "P-0-3230, Monitoring window for safety related operational stop" is write-protected with "P-0-3206, Safety technology password" and cannot be changed by unauthorized persons.

The status of the safety technology password can be seen in "P-0-3207, Safety technology password level".

Terminating Safety Related Operational Stop

After removing the safety related operational stop, e.g. by closing a protective device and executing the start command, the working motion of a drive can be immediately continued at the point of interruption.

The function "safety related operational stop" is deselected by selecting "safety related drive interlock" or actuating the enabling control or by deselecting the mode selector!

Integrated Safety Functions

Notes on Utilization

When using the safety function "safety related operational stop", you absolutely have to observe the following warnings:



DANGER

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

⇒ If external force influences are to be expected with the safety function "safety related operational stop", 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 weight compensation.



WARNING

Injury and/or material damage caused by deviation from standstill position!

⇒ When using the safety related operational stop for axes with external force influences, error situations (e.g. mains failure, controller defect) can occur in which the drive controller can no longer keep the axis in position. In this case, the axis must be kept in position by additional measures (e.g. mechanical brake). In the time between the occurrence of the error and the triggering of the "additional holding device", axis motion can occur. This has to be taken into account for the risk assessment of the installation.

For such axes, Bosch Rexroth recommends that you use the safety related braking and holding system.

Make sure that the value parameterized in "P-0-3233, Velocity threshold for safety related halt" is sufficiently small, because during transition to the safety related status the standstill monitor ("P-0-3230, Monitoring window for safety related operational stop") becomes active immediately after the velocity has fallen below this value and the drive then must have come to standstill.

6.3.4 Safety Related Drive Interlock ("ASP")

Brief Description

The safety function "safety related drive interlock" corresponds to "safety related standstill", but it is not disabled by actuating an enabling control.



Using the function "safety related drive interlock" requires the optional safety technology module ("S1") which can be selected as configuration for the control sections CSH01.1 or CSH01.2 (ADVANCED) and CDB01.1 (BASIC).



The selection of the function "safety related drive interlock" takes effect in normal operation, too.

Features

The safety function "safety related drive interlock" has the following features:

- Corresponds to stop category 1 according to EN 60204-1.
- Has been realized for personal protection in accordance with EN 954-1 category 3.
- The energy supply to the motor is safely interrupted.
- The duration of the transition to safety related drive interlock is monitored (cf. "P-0-3220, Tolerance time transition from normal operation" or "P-0-3225, Tolerance time transition from safety rel. oper.").

Examples of Application

The safety function "safety related drive interlock" can be used, for example, for manual tool change in the case of spindle drives or handling axes which are to be manually moved.

Integrated Safety Functions

According to EN 60204-1, purely electrical devices (such as the safety function "safety related drive interlock") are allowed for emergency halt in addition to electromechanical devices.

**WARNING****Death or severe bodily harm might possibly be caused by restart!**

If an electrical device is used for emergency halt, restart must be prevented via an emergency halt device.

Pertinent Parameters

The following parameters are used in conjunction with the safety function "safety related drive interlock":

- "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration"
- "P-0-3212, Safety technology control word, channel 1" or "P-0-3212, Safety technology signal control word, channel 1"
- P-0-3220, Tolerance time transition from normal operation
- P-0-3225, Tolerance time transition from safety rel. oper.
- P-0-3233, Velocity threshold for safety related halt

Pertinent Diagnostic Messages

The following diagnostic messages can be generated in conjunction with the safety function "safety related drive interlock":

- F7040 Validation error parameterized - effective threshold
- F7050 Time for stopping process exceeded
- F8027 Safety related standstill while drive enabled
- With drive interlock activated, "ASP" is shown on the display of the IndraDrive control panel.

Safety Function**Basic Principle**

With the safety function "safety related drive interlock", the energy supply to the motor is safely interrupted. The motor cannot generate any torque/any force and therefore no dangerous movements.

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

⇒ Please observe the warnings in section "Notes on Commissioning".

Transition to Safety Related Status

The kind of transition to the safety related status can be set with "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration". You can select either "drive-controlled safety technology operating mode transitions" and "NC-controlled operating mode transitions" (see "[Transition to Safety Related Status](#)"). In both cases the safety function "safety related monitored stopping process" becomes active for transition.



After successful transition to the safety related drive interlock, safety is only acknowledged if "control of a PLC" has been projected for the diagnostic output.

After successful transition to the safety related drive interlock and with parameterization "control of a safety door", the safety door is only controlled if the mode selector is additionally actuated.

Integrated Safety Functions

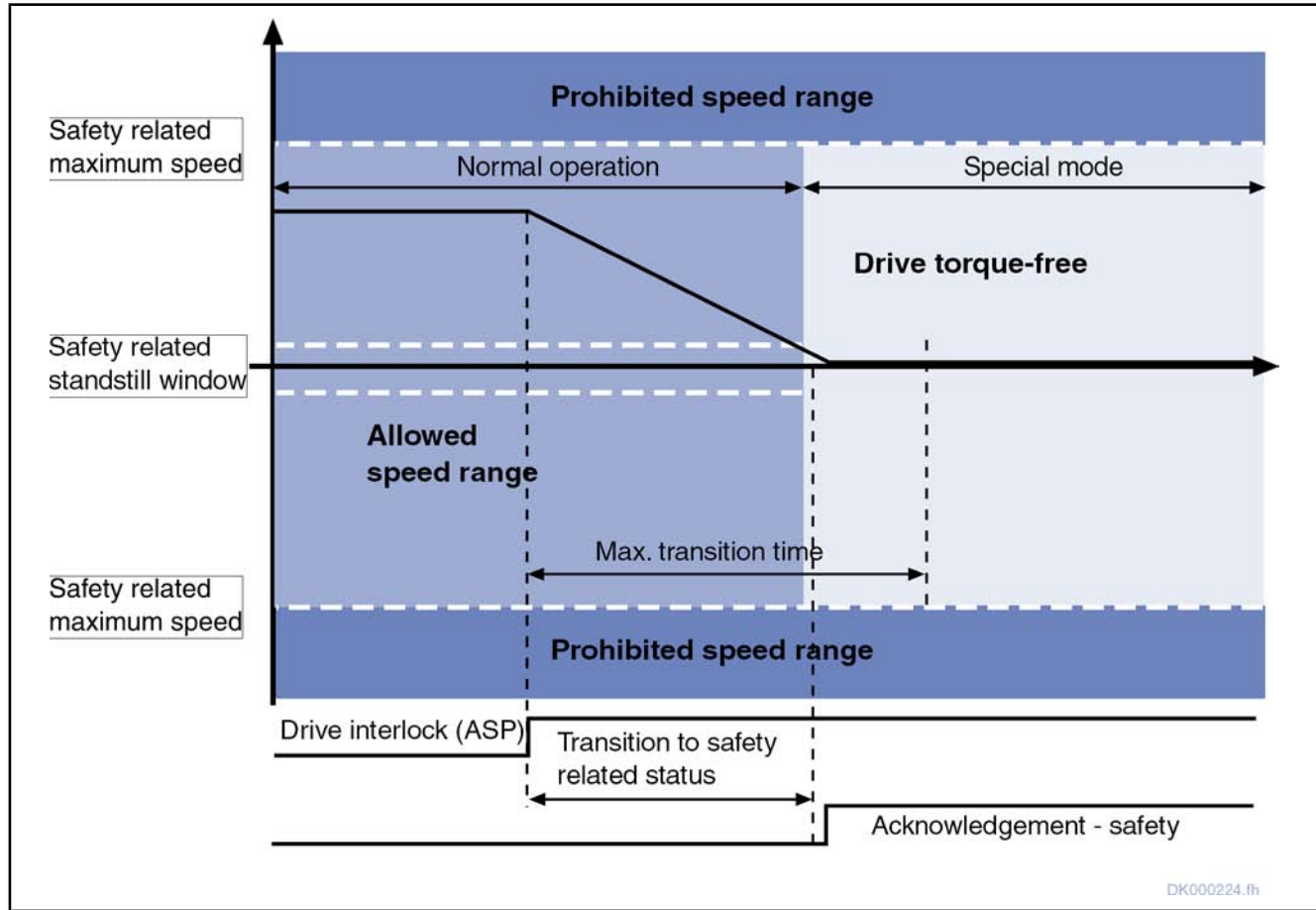


Fig.6-14: Drive-controlled transition to safety related drive interlock from normal operation

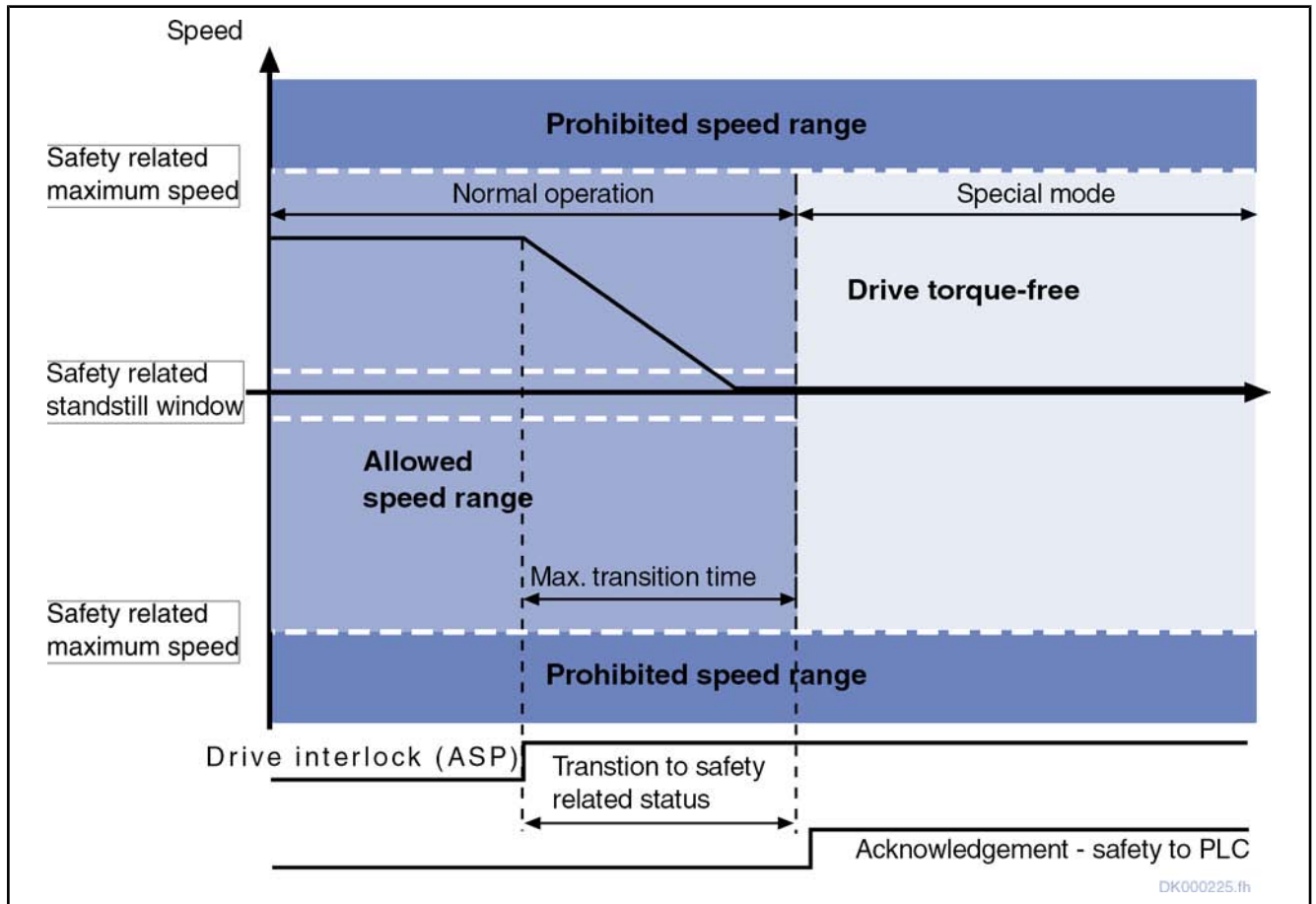


Fig. 6-15: NC-controlled transition to safety related drive interlock from normal operation



DANGER

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

⇒ In safety related drive interlock, the drive cannot generate any torque/any force and therefore no dangerous movements which has to be taken into account above all for vertical axes. Please observe the warnings in section "Notes on Commissioning".

Monitoring Functions

When drive enable is set with safety related drive interlock having been activated, the error "F8027 Safety related standstill while drive enabled" is generated.

Terminating Safety Related Drive Interlock

The safety function "safety related drive interlock" can only be deselected by resetting the drive interlock selection.

Notes on Utilization

When using the safety function "safety related drive interlock", you absolutely have to observe the following warnings:



DANGER

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

⇒ If external force influences are to be expected with the safety function "safety related standstill", 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 weight compensation.

For such axes, Bosch Rexroth recommends that you use the safety related braking and holding system.

Integrated Safety Functions

**WARNING****Injury and/or material 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 three errors are occurring simultaneously in the power section with the voltage DC bus being active:

- Breakdown of a power semiconductor
- Breakdown of another semiconductor
- In this case, two of six semiconductors are affected in such a way that the motor shaft is aligning

Example synchronous motor: For a 6-pole synchronous motor, the motion can be a maximum of 30 degrees. For a directly driven ballscrew, 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.

6.3.5 Safety Related Braking and Holding System

Brief Description

The "safety related braking and holding system" safely prevents unintended axis motion (e.g. of vertical axes), even if the drive is not in control. The safety related holding of the axis is realized by two brakes which can be controlled independently of each other.

The function of the brakes is cyclically checked.

**WARNING****Severe bodily harm caused by possible errors in the brake system during safety related operation!**

⇒ The drive system resets the acknowledgment of safety of the axes. The user must take appropriate measures for personal protection.

Features

The safety function "safety related braking and holding system" has the following features:

- Has been realized for personal protection in accordance with EN 954-1 category 3
- The safety related braking and holding system consists of two brakes which take effect independently of each other:
 - Brake 1: Only electrically releasing friction surface brakes allowed, such as the motor holding brake
 - Brake 2: Redundant holding brake, designed either as external electrically releasing friction surface brake or as external electrically releasing, toothed brake
- Redundant holding brake controlled via "control module (HAT)"
- Redundant holding of the axis also present after energy has been switched off (emergency halt, emergency stop)
- Quick reaction on error: escalation strategy with a total of three channels for deceleration
- Command "C5900 Command Resurfacing of redundant holding brake" is not accepted or executed when using a toothed brake

Integrated Safety Functions

Pertinent Parameters The following parameters are used in conjunction with the safety function "safety related braking and holding system":

- P-0-0525, Holding brake control word
- P-0-0539, Holding brake status word
- P-0-0540, Torque of motor holding brake
- P-0-0541, C2100 Command Holding system check
- P-0-0542, C2000 Command Release motor holding brake
- P-0-0543, C3800 Command Apply motor holding brake
- P-0-0544, C3900 Command Resurfacing of motor holding brake
- P-0-0545, Test torque for releasing motor holding brake
- P-0-0546, Starting torque for releasing motor holding brake
- P-0-0547, Nominal load of holding system
- P-0-0549, Oper. hours control section at last successful brake check
- P-0-0550, Time interval brake check
- P-0-0551, Current load torque
- P-0-3211, Safety technology I/O configuration list, channel 2
- P-0-3218, C3700 Command Manually unlocking the safety door
- P-0-3300, Redundant holding brake: configuration
- P-0-3301, Redundant holding brake: status word
- P-0-3302, Safety related holding system: time interval brake check
- P-0-3303, Safety related holding system: nominal load
- P-0-3304, Safety related holding system: torque/force constant
- P-0-3306, Delay time motor holding brake
- P-0-3307, Safety technology - drive off delay time
- P-0-3310, Safety related holding system: travel range brake check
- P-0-3311, Safety rel. hold. sys.: dur. test torque injection br. check
- P-0-3314, C5900 Command Resurfacing of redundant holding brake
- P-0-3315, C6200 Comm. Enabling special mode without valid brake status

Pertinent Diagnostic Messages The following diagnostic messages can be generated in conjunction with the safety function "safety related braking and holding system":

- E3115 Prewarning, end of brake check time interval
- F3115 Error, brake check time interval exceeded
- E3116 Nominal load torque of holding system reached
- F3116 Nominal load torque of holding system exceeded
- F3122 Safety related holding system: system error
- F3123 Safety related holding system: brake check missing
- F7051 Safety related deceleration exceeded
- F8134 Safety related holding system: fatal error
- C0256 Safety technology configuration error
- C2000 Command Release motor holding brake
- C2001 Command not enabled
- C2100 Command Holding system check
- C2101 Holding system check only possible with drive enable

Integrated Safety Functions

- C2103 Motor holding brake: torque too low
- C2104 Command execution impossible
- C2105 Load of holding system > test torque
- C2106 Test torque of holding system not reached
- C2107 Redundant holding brake: torque too low
- C2108 Error when releasing the holding system
- C2109 Safety related holding system: test torque invalid
- C3700 Command Manually unlocking the safety door
- C3800 Command Apply motor holding brake
- C3900 Command Brake resurfacing
- C3901 Resurfacing of brake only possible with drive enable
- C3902 Error during resurfacing of brake
- C3903 Command execution impossible
- C5800 Command Apply redundant holding brake
- C5801 Command Apply redundant holding brake not possible
- C5900 Command Resurfacing of redundant holding brake
- C5901 Comm. Resurfacing of red. holding brake only possible AF
- C5902 Comm. Error when resurfacing redundant holding brake
- C5903 Command execution impossible
- C6200 Command Enabling special mode without valid brake status
- C6201 Command execution impossible

Functional Description

General Information

The "safety related braking and holding system" consists of the motor holding brake, an external holding brake, called "redundant holding brake" in the following chapters, a control module for the redundant holding brake and the drive controller with the corresponding firmware.



24V loss causes the brake systems to be immediately applied. To avoid this, it is strongly recommended that you use an independent power supply (UPS) for voltage buffering, especially for toothed brakes.

Integrated Safety Functions

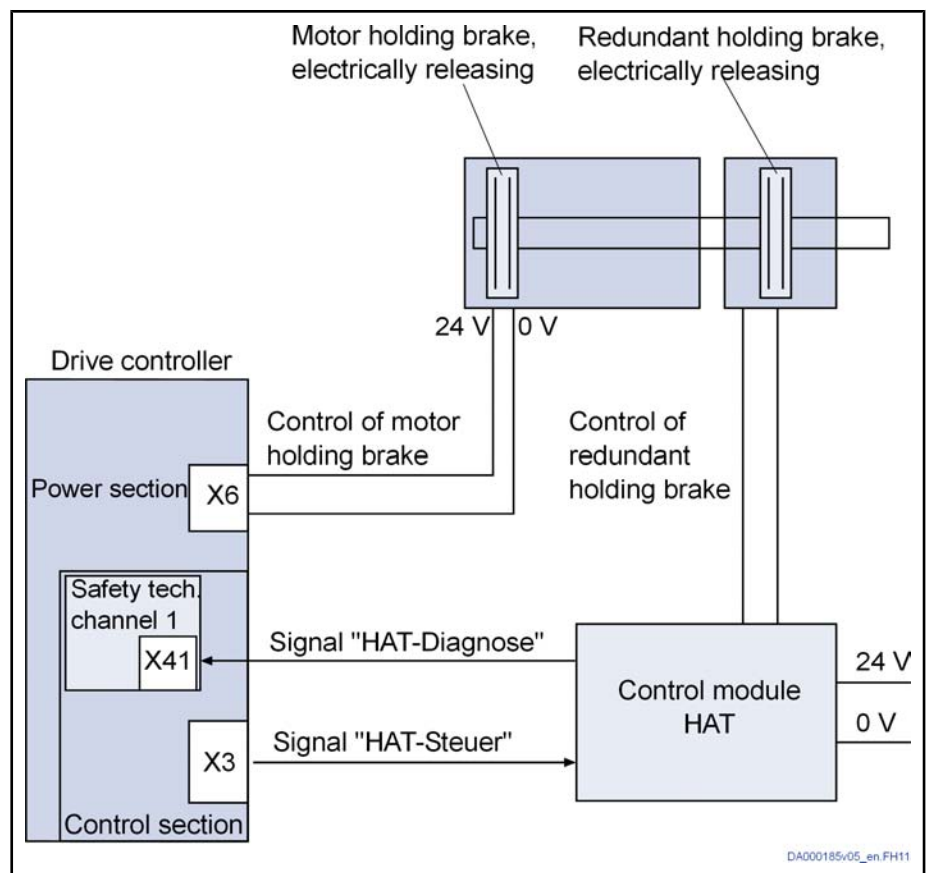


Fig. 6-16: System overview of the "safety related braking and holding system"

As motor holding brake, only an electrically releasing friction surface brake is allowed; it is controlled like a standard motor brake and can be designed as an **external** or as a **motor-integrated holding brake**.

Two designs are allowed for the redundant holding brake:

- External electrically releasing toothed brakes
- External electrically releasing friction surface brakes

The **redundant holding brake** can be mounted either on the motor side or on the load side. If the mounting position of the redundant holding brake is arbitrary, load-side mounting is preferred, as the remaining risk due to errors in the transmission path from motor to load is reduced in the case of load-side mounting. Control does not take place directly via the controller, but via the corresponding control module (HAT01.1-002-NNN-NN).

An **external brake** must at least comply with the specifications of the motor holding brake. Each of the two holding brakes must have been **dimensioned such** that it can safely hold **the maximum weight of the load of the axis** (P-0-0547). For a basis of dimensioning, see, for example, the Information Sheet 5 of the "Fachausschuss Maschinenbau, Fertigungssysteme, Stahlbau" (Committee of experts for mechanical engineering, manufacturing systems, structural steel engineering) of the institution for statutory accident insurance and prevention ("Berufsgenossenschaft Metall Süd") ["Gravity-loaded axes (Vertical axes)", issue 02/2004]. The Information Sheet contains the following specification for the dimensioning of the brakes:

"The mechanical parts of power transmission and those of the safety devices shall be at least designed to withstand the occurring static and dynamic stresses at dual weight of the load."

Integrated Safety Functions

There are the following possible combinations of the two brakes:

- The motor holding brake and the redundant holding brake are designed as electrically releasing friction surface brakes.
- The motor brake is designed as electrically releasing friction surface brake and the redundant holding brake is designed as electrically releasing, toothed brake.

Two operating states change by the use of the "safety related braking and holding system":

- The safety operating status "safety related standstill" (SH) becomes "safety related braked standstill" (SGH).
- The operating status "halt" (AH) becomes "braked standstill" (GH).

Safety Related Braked Standstill

When the "safety related braking and holding system" is used, the axis is in the safety operating status "safety related braked standstill" (SGH), when

- the "status of holding brake check" of both holding brakes, P-0-0539 and P-0-3301, is "carried out successfully",
- the special mode "safety related halt" has been selected,
- the holding torques of both holding brakes take effect,
- standstill is detected,
- the feedback of the redundant holding brake is available and
- restart is successfully prevented.

In this status, the axis acknowledges safety.

In the parameter mode, the drive is in "SGH-Parameterization" and in the case of error in "SGH-Error". The acknowledgment of safety depends on several conditions (see "[Monitoring of the Brake Status](#)").

Braked Standstill

In normal operation, the holding torques of both holding brakes also take effect to increase the machine safety. When the safety related braking and holding system is used, this status is called "braked standstill (GH)". In this status, the axis does not acknowledge safety.



The safety related braking and holding system is always controlled in the case of error, independent of whether the axis is in normal operation or in special mode.

In this case, an escalation strategy is carried out (see "[Safety Technology Error Reaction](#)").

Measures to Avoid States of Torque Disable

The user has to carry out or take into account the following measures to increase the availability or independence of drive control as "service braking device":

- Suppression of "torque disable without delay" by the bit "drive enable" in one of the following control words:
 - P-0-0116, Device control: control word
 - S-0-0134, Master control word
 - P-0-4028, Device control word
 - P-0-4068, Field bus: control word IO
 - P-0-4077, Field bus: control word
- Suppression of application-side torque limitations (except for "P-0-0109, Torque/force peak limit"):
 - S-0-0082, Torque/force limit value positive
 - S-0-0083, Torque/force limit value negative

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- S-0-0092, Bipolar torque/force limit value

Risk Analysis

For the risk analysis of an installation in which the safety related braking and holding system is used, it is necessary to know how far the corresponding axis moves as a maximum in the case of error.

The greatest axis motion occurs, when

- the axis is in special mode motion ("SBB") with downward travel direction and an F8xxx error occurs during this axis motion **and**
- the motor holding brake has been applied and no brake torque is generated **and**
- the redundant holding brake is applied and the axis decelerates until standstill has been reached.

The traveled distance is divided into two steps. In the first step, the axis falls down in a torque-free way (x_{free}) and in the second step, the axis is decelerated by the redundant holding brake (x_{decel}).

For the following calculations, we assume that the axis is a vertical axis with recirculating ball screw and directly connected motor. The friction which is present in the system is not taken into account, as it cannot be considered as being constant over the service life of such a mechanical system. Existing friction has a positive effect on the braking distance, i.e. the travel distance calculated below will in reality be shorter due to the existing friction.

$$\begin{aligned}
 t_{\text{errorreaction}} &= t_{\text{free}} + t_{\text{decel}} \\
 t_{\text{free}} &= P-0-3306 + t_{\text{clamp,red}} + t_{\text{system}} \\
 t &= - \left(\frac{M \cdot t_{\text{free}}}{M_L - M_{\text{red}}} + \frac{2\pi \cdot J \cdot \frac{v_{\text{SBB}}}{h}}{M_L - M_{\text{red}}} \right) \\
 &= \frac{M_L \cdot t_{\text{free}} + 2\pi \cdot J \cdot \frac{v_{\text{SBB}}}{h}}{M_{\text{red}} - M_L}
 \end{aligned}$$

$t_{\text{errorreaction}}$	Total time of error reaction
t_{free}	Time during which axis is torque-free
t_{decel}	Deceleration time of axis
$t_{\text{clamp,red}}$	Clamping delay of redundant holding brake
t_{system}	Internal processing time of drive (typically 49 ms)
M_L	Load torque
M_{red}	Brake torque of redundant holding brake
J	Total inertia with relation to the motor shaft
h	Spindle lead
v_{SBB}	Parameterized velocity threshold for SBBx

Fig. 6-17: Calculating the error reaction time

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$$\begin{aligned}
 x_{\text{errorreaction}} &= x_{\text{free}} + x_{\text{decel}} \\
 &= \left(v_{\text{SBB}} + \frac{M_L \cdot h \cdot t_{\text{free}}}{4\pi \cdot J} \right) \cdot t_{\text{free}} + \frac{1}{2} \cdot \left(v_{\text{SBB}} + \frac{M_L \cdot h \cdot t_{\text{free}}}{2\pi \cdot J} \right) \cdot t_{\text{decel}} \\
 &= \left(t_{\text{free}} + \frac{t_{\text{decel}}}{2} \right) \cdot v_{\text{SBB}} + (t_{\text{free}} + t_{\text{decel}}) \cdot \frac{M_L \cdot h \cdot t_{\text{free}}}{4\pi \cdot J}
 \end{aligned}$$

$x_{\text{errorreaction}}$	Traveled distance of axis during error reaction
x_{free}	Traveled distance of axis while it is torque-free
x_{decel}	Traveled distance of axis while holding torque of the redundant holding brake takes effect
t_{free}	Time during which axis is torque-free
t_{decel}	Deceleration time of axis
M_L	Load torque
J	Total inertia with relation to the motor shaft
h	Spindle lead
v_{SBB}	Parameterized velocity threshold for SBBx

Fig.6-18: Calculating the error reaction distance

Example:

When you use a Rexroth motor with the order code MSK071D-300-NN-M1-UG2-NNNN, a spindle (40 mm diameter, 20 mm lead) and a redundant brake (26 Nm holding torque, 26 ms clamping delay), the error reaction distance is calculated as follows:

$$\begin{aligned}
 d &= 40 \text{ mm} \\
 h &= 20 \text{ mm} \\
 m_L &= 340 \text{ kg} \rightarrow M_L = 10.6 \text{ Nm} \\
 M_{\text{red}} &= 26 \text{ Nm} \\
 t_{\text{clamp,red}} &= 26 \text{ ms} \\
 J &= 0.011 \text{ kgm}^2 \\
 v_{\text{SBB}} &= 2.0 \frac{\text{m}}{\text{min}} \\
 P-0-3306 &= 35 \text{ ms} \\
 t_{\text{system}} &= 49 \text{ ms}
 \end{aligned}$$

Fig.6-19: Data for exemplary calculation

$$\begin{aligned}
 t_{\text{free}} &= P-0-3306 + t_{\text{clamp,red}} + t_{\text{system}} \\
 &= 110 \text{ ms} \\
 t_{\text{decel}} &= \frac{M_L \cdot t_{\text{free}} + 2\pi \cdot J \cdot \frac{v_{\text{SBB}}}{h}}{M_{\text{red}} - M_L} \\
 &= 8,8 \text{ ms} \\
 x_{\text{errorreaction}} &= \left(t_{\text{free}} + \frac{t_{\text{decel}}}{2} \right) \cdot v_{\text{SBB}} + \left(t_{\text{free}} + t_{\text{decel}} \right) \cdot \frac{M_L \cdot h \cdot t_{\text{free}}}{4\pi \cdot J} \\
 &= 4,15 \text{ mm}
 \end{aligned}$$

Fig. 6-20: Exemplary calculation of the error reaction distance

This means that after an error was detected, the axis moves by a maximum of 4.15 mm before it has been shut down.

Monitoring Functions

The following monitoring functions are active with the safety related braking and holding system:

- Monitoring of configuration errors
- Monitoring of the actual load torque
- Monitoring of the brake status

Monitoring of Configuration Errors

With active safety function "safety related braking and holding system", the following configuration restrictions are monitored via two channels at every change to the operating mode (OM):

- Torque disable mustn't have been configured as best possible deceleration (P-0-0119), because otherwise control would be deactivated regardless of the brake delay time.
- Torque disable mustn't have been configured as error reaction to F7 errors (P-0-3210), because otherwise control would be deactivated regardless of the brake delay time.
- NC or MLD error reaction mustn't be configured in P-0-0117.
- The motor holding brake mustn't have been configured as main spindle brake (P-0-0525), because in this case the brake is only applied at an actual velocity <10 rpm.

In the case of incorrect configuration setting, the command error "C0256 Safety technology configuration error" is generated.

Monitoring of the Actual Load Torque

To exclude overload of the safety related braking and holding system, the load torque of the axis is monitored via two channels during operation.

The prerequisites for monitoring are:

- Monitoring was not deactivated in P-0-3300.

Integrated Safety Functions



WARNING

Possible injury and property damage caused by overload of axis and brakes!

⇒ By deactivating the load torque monitoring, it is no longer possible to detect overload of axis, holding brake and mechanical system.

- The drive is in control.
- Standstill is detected, i.e. the actual velocity is smaller than 5 to 20 rpm (depending on the encoder which is used).

The currently determined load torque is displayed in P-0-0551. Both safety technology channels monitor this value. If the value of P-0-0551 is above the parameterized nominal load of the holding system (P-0-3303), the warning "E3116 Nominal load torque of holding system reached" is generated. If the parameterized value of P-0-3303 is exceeded by the 1.3-fold value, the error "F3116 Nominal load torque of holding system exceeded" is generated.

Monitoring of the Brake Status

As long as the "status of holding brake check" (P-0-0539, P-0-3301) of one of the two brakes is "carried out without success", the axis does not acknowledge safety. The selection of the special mode is acknowledged with the error message "F3123 Safety related holding system: brake check missing".



If such states can occur at the installation in which the axis must be moved in special mode before the brake check, the axis can be moved under defined conditions via the command "C6200 Command Enabling special mode without valid brake status" (see ["Enabling the Special Mode Without Valid Brake Status"](#)).

Acknowledgment of Safety

In the following states, the axis acknowledges safety in conjunction with the safety related braking and holding system:

Operating status	Brake status	Acknowledgment of safety
Normal operation		No
SGH		Yes
SGH-Parameterization	Successful	Only when safety door had been opened in OM
	Not successful	No
SGH-Error	Successful	Only with selection of special mode and without encoder error
	Not successful	No

Fig.6-21: Acknowledgment of safety with the safety related braking and holding system

Commissioning



WARNING

Remaining risk due to errors in the brake system during safety related operation. The acknowledgment of safety of the axes is removed!

⇒ The user must take appropriate measures (e.g. warning, leave the working area)

When the safety function "safety related braking and holding system" (P-0-3300) is activated, the following inputs/outputs are permanently assigned:

- P-0-3301, bit 0 → input: X32.9
- P-0-3301, bit 0 → input: X32.8 (axis 2 of controllers of the HMD type)



The diagnosis signal "HAT-Diagnose" (P-0-3211) must be assigned to an input (E1n to E4n) on X41. It is recommended that you use the input E4n (X41.7), because otherwise the connector wiring of X1 of the cable RKS0007 has to be changed.

Commissioning With Deactivated Safety Technology

For initial commissioning, it is necessary to move the axis without active safety technology. When this is done, an existing redundant holding brake must be controlled. This operating status is called "setting-up mode".



WARNING

Injury caused by moving the axis without active safety technology during initial commissioning!

Measures for personal protection must be taken, as long as safety technology is deactivated.

To set the axis to the setting-up mode, carry out the following steps:

- Safety technology must have been deactivated. If this is not the case, carry out the command "C7_2 Load defaults procedure command (load defaults procedure for safety technology)".
- The redundant holding brake must be configured in P-0-3300.

Afterwards, the axis is in the setting-up mode and the redundant holding brake is controlled synchronously to the motor holding brake.

Double Parameters

Apart from the "safety related braking and holding system", there is a non-safety-relevant holding brake check for Rexroth IndraDrive controllers. That is why some parameters have been implemented both as "normal" parameters (standard parameters) and as safety technology parameters.

Standard parameter	Safety technology parameter
S-0-0207, Drive off delay time	P-0-3307, Safety technology - drive off delay time
P-0-0051, Torque/force constant	P-0-3304, Safety related holding system: torque/force constant
P-0-0547, Nominal load of holding system	P-0-3303, Safety related holding system: nominal load
P-0-0550, Time interval brake check	P-0-3302, Safety related holding system: time interval brake check

Fig.6-22: Double parameters



The parameters contained in the table should be written with identical values, unless a good reason prohibits this.

Safety Technology Error Reaction

When the integrated safety technology is used with activated safety related braking and holding system, the drive is shut down in the case of error; when this happens, an escalation strategy is run. This strategy is used to make sure that the drive is shut down in an optimum way and that wear of existing holding brakes, as well as load of the mechanical system, are minimized. According to the initial situation, shutdown in the case of error takes place on several levels. Each of the levels is monitored via two channels.

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Error Reaction Normally, the escalation strategy is not run completely. This means that depending on the currently present error message and the resulting error reaction, the drive jumps to the corresponding escalation level. This can be one of the following levels:

- Escalation strategy, level 1: Velocity command value reset with ramp and filter
- Escalation strategy, level 2: Velocity command value reset at the torque limit
- Escalation strategy, level 3: Torque disable and control of the motor holding brake
- Escalation strategy, level 6: Control of the motor holding brake and of the redundant holding brake without trend monitoring

On level 6 of the escalation strategy, the axis is shut down with the mechanisms used on this level and afterwards both holding brakes are applied.

Escalation Strategy Within the individual levels of the escalation strategy, the effectiveness of the escalation level is monitored via dual-channel, parameterizable trend monitoring. When the trend monitoring triggers and thereby has detected that the axis cannot be shut down in the desired time / the desired distance, the error reaction is taken to the next escalation level until the axis has been shut down.

The figure below shows the escalation strategy with its individual levels:

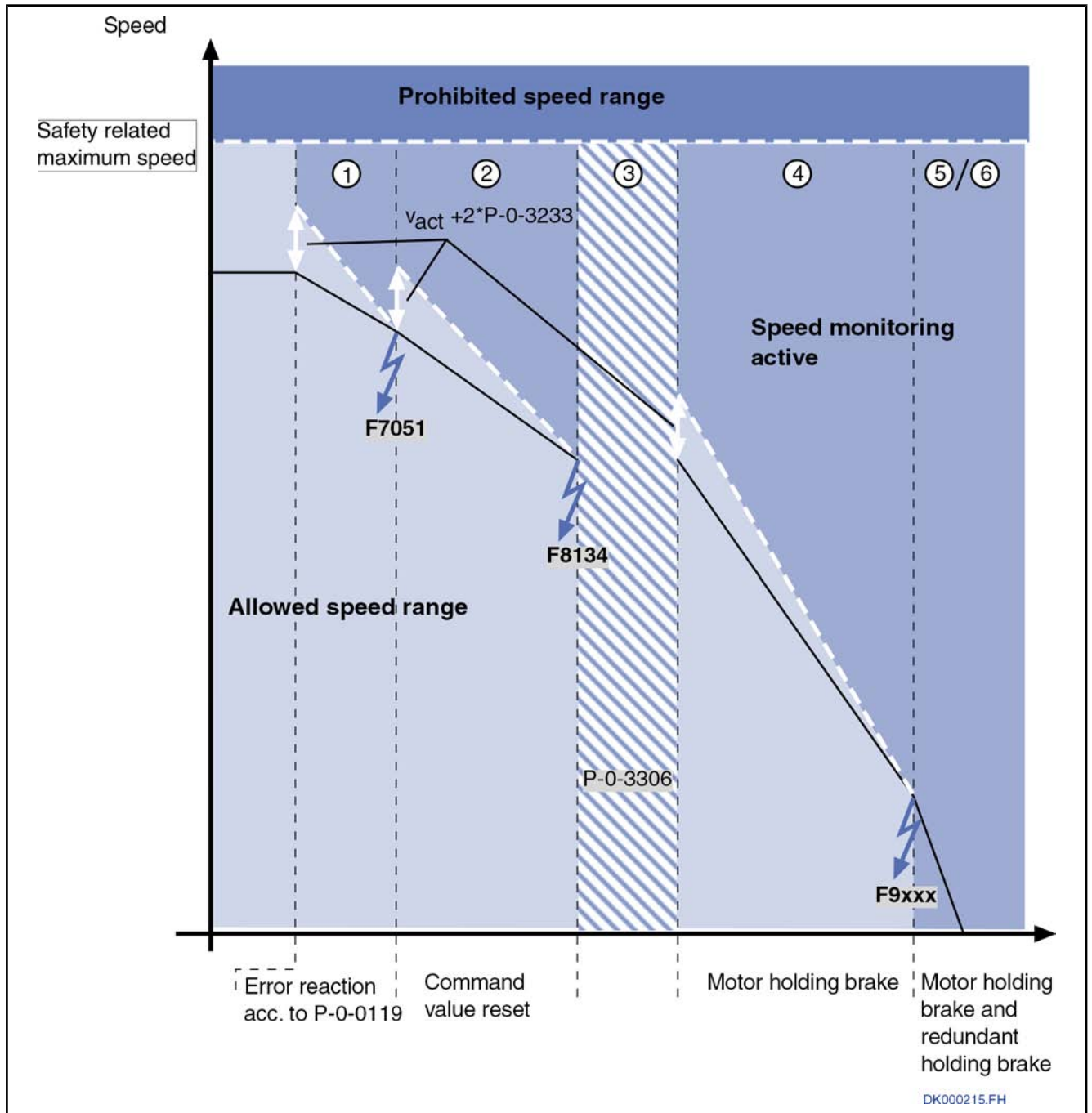


Fig.6-23: Safety technology error reaction, escalation strategy

Escalation Strategy, Level 1

(Velocity) command value reset with ramp and filter

Level 1 of the escalation strategy is activated under the following conditions:

- Parameterized best possible deceleration (P-0-0119) with velocity command value reset with ramp and filter **and**
 - "drive off" **or**
 - F2, F3 or F4 error **or**
 - drive-controlled transition to the special mode halt ("ASP", "SGH", "SH"; "SBH"; "S(G)H-Error")

The drive is shut down with the values parameterized in S-0-0372 and S-0-0349. Safety technology trend monitoring takes place with the ramp parameterized in P-0-3282. If shutdown is not successful, i.e. trend monitoring

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	triggers, the error F7051 is generated and switching to the next level of the escalation strategy takes place.
Escalation Strategy, Level 2	<p>(Velocity) command value reset at the torque limit</p> <p>Level 2 of the escalation strategy is activated under the following conditions:</p> <ul style="list-style-type: none"> • Parameterized best possible deceleration (P-0-0119) with velocity command value reset and <ul style="list-style-type: none"> – "drive off" or – F2, F3 or F4 error or – drive-controlled transition to the special mode halt ("ASP", "SGH", "SH"; "SBH"; "S(G)H-Error") or • F6 or F7 error <p>The drive is shut down taking the torque limit value into account. Safety technology trend monitoring takes place with the ramp parameterized in P-0-3282. If shutdown is not successful, i.e. trend monitoring triggers, the error F8134 is generated and switching to the next level of the escalation strategy takes place.</p>
Escalation Strategy, Level 3	<p>Torque disable and control of the motor holding brake</p> <p>Level 3 of the escalation strategy is activated under the following condition:</p> <ul style="list-style-type: none"> • Previous escalation levels were unsuccessful <p>The drive applies the motor holding brake and switching to escalation level 4 takes place after the time parameterized in P-0-3306 is over.</p>
Escalation Strategy, Level 4	<p>Holding torque of motor holding brake takes effect</p> <p>Level 4 of the escalation strategy is activated under the following condition:</p> <ul style="list-style-type: none"> • Level 3 of the escalation strategy was run <p>The drive is shut down by the applied motor holding brake. Safety technology trend monitoring takes place with the ramp parameterized in P-0-3282. If shutdown is not successful, i.e. trend monitoring triggers, switching to the next level of the escalation strategy takes place before standstill of the axis.</p>
Escalation Strategy, Level 5	<p>Control of redundant holding brake</p> <p>Level 5 of the escalation strategy is activated under the following condition:</p> <ul style="list-style-type: none"> • Level 4 of the escalation strategy was run or • trend monitoring of level 4 has triggered <p>The drive is shut down by applying the motor holding brake and the redundant holding brake.</p>
Escalation Strategy, Level 6	<p>Control of the motor holding brake and of the redundant holding brake without trend monitoring</p> <p>Level 6 of the escalation strategy is activated under the following condition:</p> <ul style="list-style-type: none"> • F9xx error <p>The drive torque is disabled and the drive is shut down by applying the motor holding brake and the redundant holding brake.</p>

6.4 Safety Functions in Special Mode "Safety Related Motion ("SBB")"

6.4.1 Safety Related Reduced Speed

Brief Description

In the case of the safety function "safety related reduced speed", dual-channel monitoring prevents the drive from exceeding the preset velocity limit value

(P-0-3244, P-0-3254, P-0-3264, P-0-3274); the effective threshold can be selected via two additional safety switches (S1, S2).



Using the function "safety related reduced speed" requires the optional safety technology module ("S1") which can be selected as configuration for the control sections **CSH01.1** or **CSH01.2** (ADVANCED) and **CDB01.1** (BASIC).



WARNING

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

Please observe the warnings in the chapter "Commissioning the Safety Technology".

Features

The safety function "safety related reduced speed" has the following features:

- The safety function "safety related reduced speed" has been realized for personal protection in accordance with EN 954-1 category 3.
- Dual-channel monitoring for exceeding the velocity limit values (P-0-3244, P-0-3254, P-0-3264, P-0-3274); when a velocity limit value is exceeded, the drive switches off with the error message "F7013 Velocity threshold exceeded".
- The safety function is always active when special mode "safety related motion" is selected.
- The safety function "safety related reduced speed" can be combined with the other safety functions of the special mode "safety related motion".
- The special mode "safety related motion" with the safety function "safety related reduced speed" is selected by actuating an enabling control and the mode selector.
- The activation time of the enabling control which can be set is monitored.

Pertinent Parameters

The following parameters are used in conjunction with the safety function "safety related reduced speed":

- "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration"
- P-0-3220, Tolerance time transition from normal operation
- P-0-3225, Tolerance time transition from safety rel. oper.
- P-0-3222, Max. activation time of enabling control
- "P-0-3240, Control word for safety related motion 1" or "P-0-3240, Configuration of safety related motion 1"
- P-0-3244, Safety related reduced speed 1
- "P-0-3250, Control word for safety related motion 2" or "P-0-3250, Configuration of safety related motion 2"
- P-0-3254, Safety related reduced speed 2
- "P-0-3260, Control word for safety related motion 3" or "P-0-3260, Configuration of safety related motion 3"
- P-0-3264, Safety related reduced speed 3
- "P-0-3270, Control word for safety related motion 4" or "P-0-3270, Configuration of safety related motion 4"
- P-0-3274, Safety related reduced speed 4

Additionally as of MPx04:

- P-0-3239, Configuration of global safety technology functions

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Additionally as of MPx05:

- P-0-3246, Max. activation time of enabling control 1
- P-0-3256, Max. activation time of enabling control 2
- P-0-3266, Max. activation time of enabling control 3
- P-0-3276, Max. activation time of enabling control 4

Pertinent Diagnostic Messages

The following diagnostic messages can be generated in conjunction with the safety function "safety related reduced speed":

- F3142 Activation time of enabling control exceeded
- F7013 Velocity threshold exceeded
- F7040 Validation error parameterized - effective threshold
- With motion monitoring activated, "SBB" is shown on the display of the IndraDrive control panel.

Safety Function

Selecting the Function

The safety function "safety related reduced speed" becomes active by selecting the special mode "safety related motion".

Safety related motion can be selected via

- digital inputs/outputs for both safety channels
- digital inputs/outputs of the optional safety technology module ("S1") for safety channel 2 and master communication (SERCOS, PROFIBUS) for safety channel 2 or
- PROFIBUS (or PROFI-safe).

For transition from normal operation / special mode to the safety related status, there is one programmable time available for each kind of transition:

- P-0-3220, Tolerance time transition from normal operation
- P-0-3225, Tolerance time transition from safety rel. oper.

After the respective tolerance time is over, velocity monitoring is activated.

Monitoring Functions

In the case of the safety function "safety related reduced speed", dual-channel monitoring prevents the drive from exceeding the preset velocity limit value (P-0-3244, P-0-3254, P-0-3264, P-0-3274).

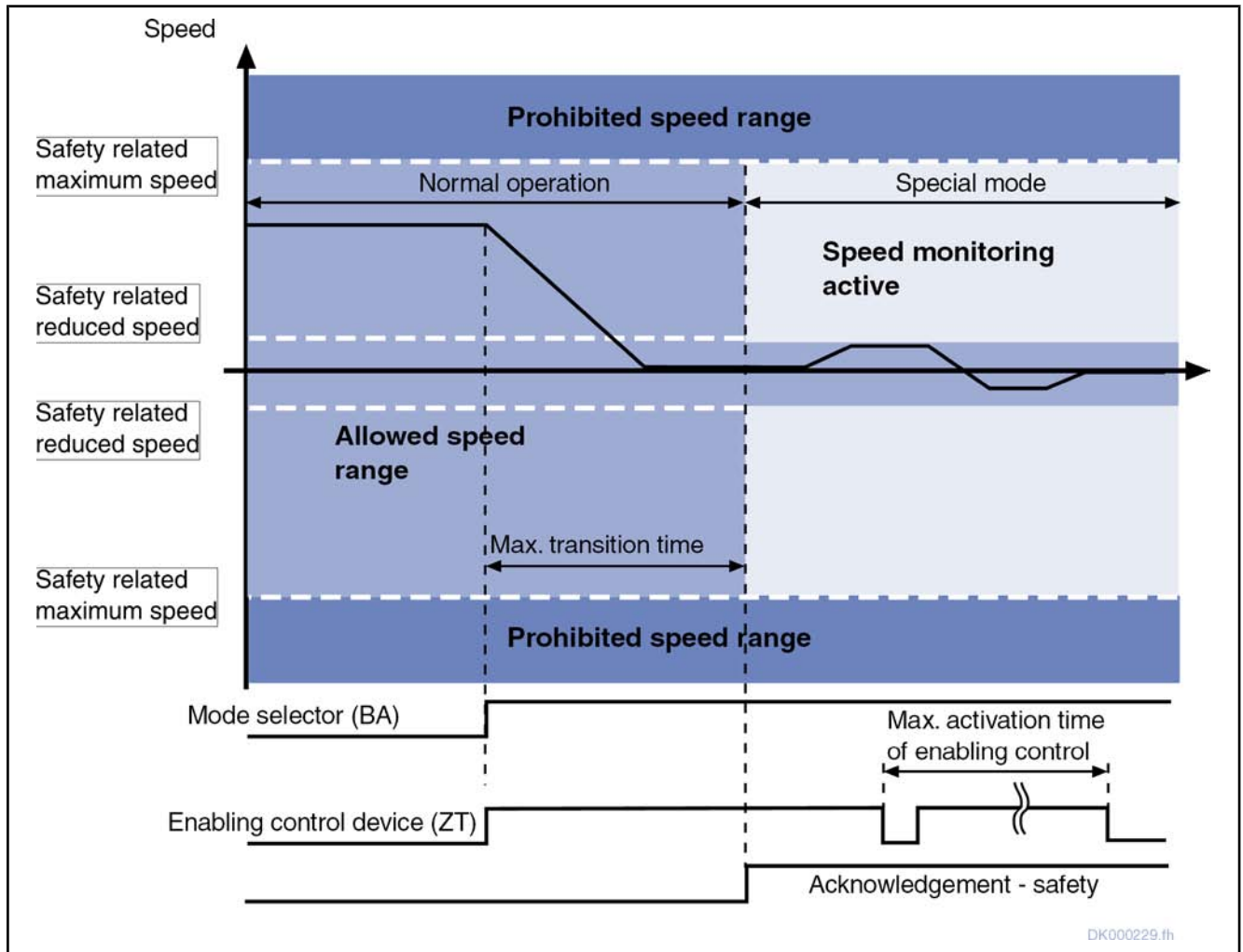


Fig. 6-24: $|V_{act}| < \text{safety related reduced speed}$ (NC-controlled transition to safety related motion from normal operation)

When the actual velocity is outside of the respective velocity limit value (P-0-3244, P-0-3254, P-0-3264, P-0-3274), the error "F7013 Velocity threshold exceeded" is generated by the drive and the drive is shut down.



After the safety technology has been activated, the velocity limit values (P-0-3244, P-0-3254, P-0-3264, P-0-3274) are write-protected with "P-0-3206, Safety technology password" and cannot be changed by unauthorized persons.

The status of the safety technology password can be seen in "P-0-3207, Safety technology password level".

The special mode "safety related motion" with the safety function "safety related reduced speed" is selected by actuating an enabling control and the mode selector. The activation time of the enabling control is cyclically monitored; it can be set using "P-0-3222, Max. activation time of enabling control". If this time is exceeded, the error message "F3142 Activation time of enabling control exceeded" is generated.

As of MPx05, individual activation times of enabling control are possible for the special modes "safety related motion". For commissioning, you can select in "P-0-3239, Configuration of global safety technology functions" whether a common maximum activation time of enabling control (P-0-3222) is active for all special modes "safety related motion", or whether an individual activation time

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of enabling control (P-0-3246, P-0-3256, P-0-3266, P-0-3276) is active for each special mode "safety related motion 1..4".



You can do without the monitoring of the activation time, if it is not common practice to use an enabling control in your industrial sector and if constant motion does not represent any danger.

The machine manufacturer is responsible for the monitoring of the activation time and his risk analysis has to show his responsibility.

With "P-0-3222, Max. activation time of enabling control"="0", the time monitoring of the special mode "safety related motion" is deactivated. **As of MPx05:** With P-0-3246="0", P-0-3256="0", P-0-3266="0", P-0-3276="0", the monitoring for each special mode "safety related motion 1..4" is deactivated.

Selecting the Effective Limit Value

By means of two additional safety switches (S1, S2) the four different "safety related motions" (SBB) can be selected with the corresponding velocity limit values:

- S2="0", S1="0": SBB1 ("P-0-3244, Safety related reduced speed 1" is effective)
- S2="0", S1="1": SBB2 ("P-0-3254, Safety related reduced speed 2" is effective)
- S2="1", S1="0": SBB3 ("P-0-3264, Safety related reduced speed 3" is effective)
- S2="1", S1="1": SBB4 ("P-0-3274, Safety related reduced speed 4" is effective)

Notes on Utilization

When using the safety function "safety related reduced speed", you absolutely have to observe the following warnings:



DANGER

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

⇒ If external force influences are to be expected with the safety function "safety related reduced speed", 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 weight compensation.



WARNING

Injury and/or material damage caused by deviation from standstill position!

⇒ When using the safety related reduced speed for axes with external force influences, error situations (e.g. mains failure, controller defect) can occur in which the drive controller can no longer keep the axis in position. In this case, the axis must be kept in position by additional measures (e.g. mechanical brake). In the time between the occurrence of the error and the triggering of the "additional holding device", axis motion can occur. This has to be taken into account for the risk assessment of the installation.

For such axes, Bosch Rexroth recommends that you use the safety related braking and holding system.

Values for "Safety Related Reduced Speed"

In accordance with the Machinery Directive (98/37/EG), the machine manufacturer has to carry out a risk analysis and afterwards a risk assessment. With these data, the values for reduced speeds have to be determined.

The following list contains guide values for different types of machines (excerpt from standards and working papers on safety measures for special mode). The abbreviation "SG" means "safety related reduced speed" ("Sicher reduzierte Geschwindigkeit"), the abbreviation "SM" means "safety related limited increment" ("Sicher begrenztes Schritmaß").

Machining centers

- Axes: SG=2 m/min + hold-to-run control
- Spindle: SG=nn rpm + hold-to-run control + enabling control (choose nn in such a way that standstill is reached after 2 revolutions)

Automatic lathes

- Axes: SG=2 m/min + hold-to-run control, SM=6 mm + hold-to-run control
- Spindle: SG=50 rpm (1 rps) + hold-to-run control + enabling control

Drilling and milling machines

- Axes: SG=2 m/min + hold-to-run control
- Spindle: SG=nn rpm + hold-to-run control + enabling control (choose nn in such a way that standstill is reached after 2 revolutions)

Robots

- SG=15 m/min + hold-to-run control

Automated manufacturing systems

- SG=2 m/min (15 m/min) + hold-to-run control + emergency halt

Printing and paper converting machines

- General: SM=25 mm+ hold-to-run control – or - SG=5 m/min (max. 10 m/min) + hold-to-run control
- "In particular": SM=75 mm+ hold-to-run control – or - SG=5 m/min (max. 10 m/min) + hold-to-run control

6.4.2 Safety Related Direction of Motion

Brief Description

The safety function "safety related direction of motion" guarantees that motion is only possible in one direction.

By means of two additional safety switches (S1, S2), up to four parameter sets for the special mode "safety related motion" can be selected.



Using the function "safety related direction of motion" requires the optional safety technology module ("S1") which can be selected as configuration for the control sections **CSH01.1** or **CSH01.2** (ADVANCED) and CDB01.1 (BASIC).



In addition to the function "safety related direction of motion", the safety function "safety related reduced speed" is active (see also "[Safety Related Reduced Speed](#)").

Features

The safety function "safety related direction of motion" has the following features:

- The safety function "safety related direction of motion" has been realized for personal protection in accordance with EN 954-1 category 3.
- The direction of motion is monitored (P-0-3240, P-0-3250, P-0-3260, P-0-3270 and P-0-3232).
- The safety function "safety related direction of motion" is active when the special mode "safety related motion" is selected, if it has been parameterized for this mode.
- The safety function "safety related direction of motion" can be used together with the other safety functions of the special mode "safety related motion".

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- The special mode "safety related motion" with the safety function "safety related direction of motion" is selected by actuating an enabling control and the mode selector.
- For transition from normal operation / special mode to the safety related status there is one programmable time available for each kind of transition.
- When the monitor for the direction of motion is triggered, this causes an error reaction which shuts down the drive system. The corresponding error message is "F7031 Incorrect direction of motion".

Pertinent Parameters

The following parameters are used in conjunction with the safety function "safety related direction of motion":

- "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word"
- P-0-3220, Tolerance time transition from normal operation
- P-0-3225, Tolerance time transition from safety rel. oper.
- P-0-3222, Max. activation time of enabling control
- "P-0-3232, Monitoring window for safety related direction of motion" or "P-0-3232, Standstill window for safety related direction of motion"
- "P-0-3240, Control word for safety related motion 1" or "P-0-3240, Configuration of safety related motion 1"
- P-0-3244, Safety related reduced speed 1
- "P-0-3250, Control word for safety related motion 2" or "P-0-3250, Configuration of safety related motion 2"
- P-0-3254, Safety related reduced speed 2
- "P-0-3260, Control word for safety related motion 3" or "P-0-3260, Configuration of safety related motion 3"
- P-0-3264, Safety related reduced speed 3
- "P-0-3270, Control word for safety related motion 4" or "P-0-3270, Configuration of safety related motion 4"
- P-0-3274, Safety related reduced speed 4

Additionally as of MPx04:

- P-0-3239, Configuration of global safety technology functions

Additionally as of MPx05:

- P-0-3246, Max. activation time of enabling control 1
- P-0-3256, Max. activation time of enabling control 2
- P-0-3266, Max. activation time of enabling control 3
- P-0-3276, Max. activation time of enabling control 4

Pertinent Diagnostic Messages

The following diagnostic messages can be generated in conjunction with the safety function "safety related direction of motion":

- F7031 Incorrect direction of motion
- F3142 Activation time of enabling control exceeded
- F7013 Velocity threshold exceeded
- With motion monitoring activated, "SBB" is shown on the display of the IndraDrive control panel.

Safety Function

Selecting the Function

The safety function "safety related direction of motion" becomes active by selecting the special mode "safety related motion".

Safety related motion can be selected via

Integrated Safety Functions

- digital inputs/outputs for both safety channels
- digital inputs/outputs of the optional safety technology module ("S1") for safety channel 2 and master communication (SERCOS, PROFIBUS) for safety channel 2 or
- PROFIBUS (or PROFIsafe).

For transition from normal operation / special mode to the safety related status, there is one programmable time available for each kind of transition:

- P-0-3220, Tolerance time transition from normal operation
- P-0-3225, Tolerance time transition from safety rel. oper.

After the respective tolerance time is over, the velocity monitoring and the monitoring of the direction of motion are activated (dual-channel monitoring).

Monitoring Functions

In the case of the safety function "safety related direction of motion", dual-channel monitoring makes sure that the drive...

- ...does not exceed the preset velocity limit values (P-0-3244, P-0-3254, P-0-3264, P-0-3274) in the enabled direction of motion, otherwise the drive generates the error "F7013 Velocity threshold exceeded".
- ...only moves in the enabled direction of motion (cf. P-0-3240, P-0-3250, P-0-3260, P-0-3270) or, when moving in the non-enabled direction of motion, that it does not exceed "P-0-3232, Monitoring window for safety related direction of motion" or "P-0-3232, Standstill window for safety related direction of motion"; otherwise, the drive generates the error "F7031 Incorrect direction of motion".



The direction of motion has to be determined in the corresponding control word:

- "P-0-3240, Control word for safety related motion 1" or "P-0-3240, Configuration of safety related motion 1"
- "P-0-3250, Control word for safety related motion 2" or "P-0-3250, Configuration of safety related motion 2"
- "P-0-3260, Control word for safety related motion 3" or "P-0-3260, Configuration of safety related motion 3"
- "P-0-3270, Control word for safety related motion 4" or "P-0-3270, Configuration of safety related motion 4"



The velocity limit values P-0-3244, P-0-3254, P-0-3264 and P-0-3274, as well as the control words/configuration parameters P-0-3240, P-0-3250, P-0-3260 and P-0-3270 and "P-0-3232, Monitoring window for safety related direction of motion" or "P-0-3232, Standstill window for safety related direction of motion", are write-protected with "P-0-3206, Safety technology password" after the safety technology has been activated and cannot be changed by unauthorized persons.

The status of the safety technology password can be seen in "P-0-3207, Safety technology password level".

The special mode "safety related motion" with the safety function "safety related direction of motion" is selected by actuating an enabling control and the mode selector. The activation time of the enabling control ("P-0-3222, Max. activation time of enabling control") can be parameterized and is cyclically monitored. If this time is exceeded, the error message "F3142 Activation time of enabling control exceeded" is generated.

Integrated Safety Functions



You can do without the monitoring of the activation time, if it is not common practice to use an enabling control in your industrial sector and if constant motion does not represent any danger.

The machine manufacturer is responsible for the monitoring of the activation time and his risk analysis has to show his responsibility.

With "P-0-3222, Max. activation time of enabling control"="0", the time monitoring of the special mode "safety related motion" is deactivated. **As of MPx05:** With P-0-3246="0", P-0-3256="0", P-0-3266="0", P-0-3276="0", the monitoring for each special mode "safety related motion 1..4" is deactivated.

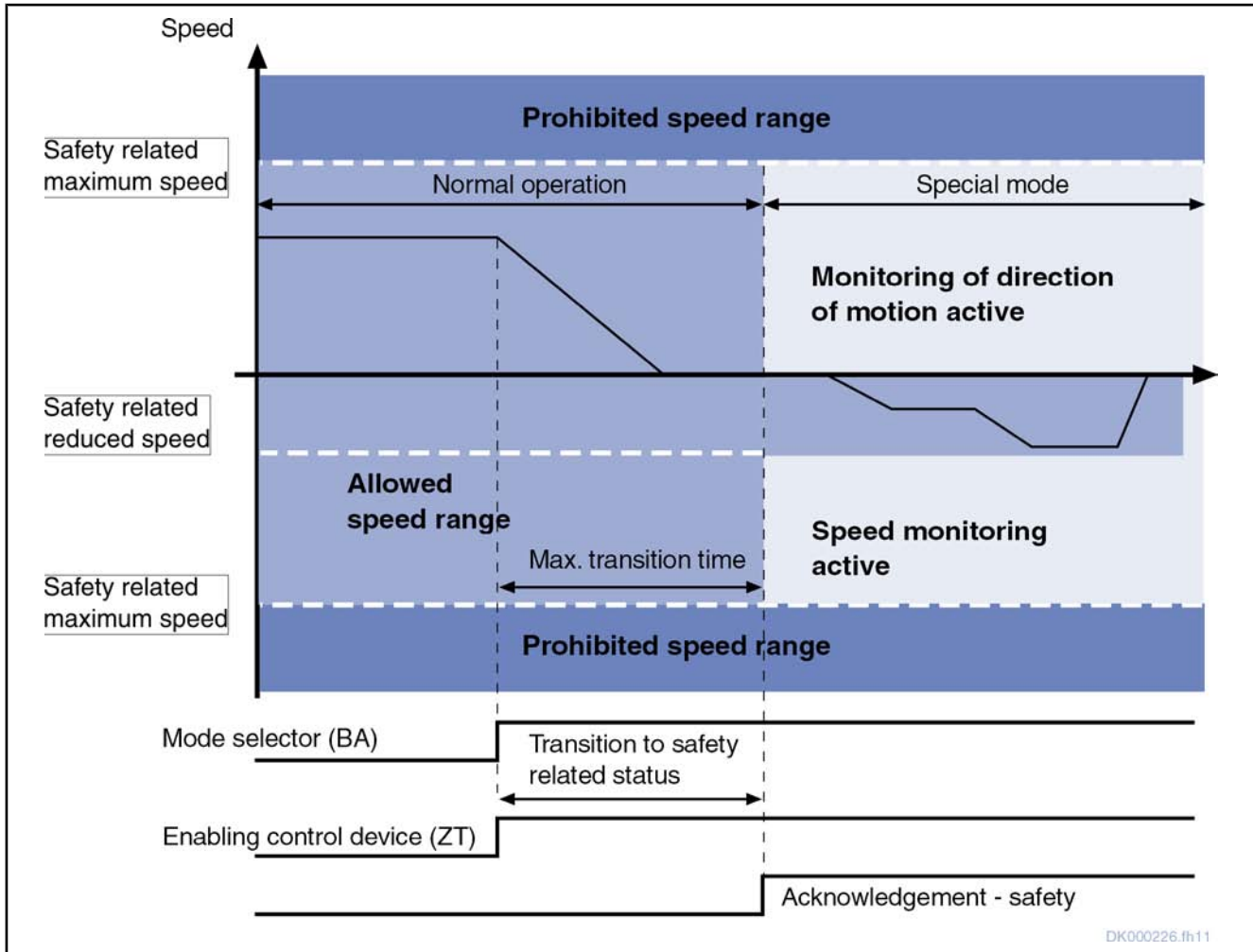


Fig.6-25: Safety related direction of motion (NC-controlled transition to safety related motion from normal operation)

Selecting the Effective Limit Value

By means of two additional safety switches (S1, S2), the four different "safety related motions" (SBB) can be selected with the corresponding velocity limit values and directions of motion:

- S2="0", S1="0": SBB1 ("P-0-3240, Control word for safety related motion 1" or "P-0-3240, Configuration of safety related motion 1" and "P-0-3244, Safety related reduced speed 1" are effective)
- S2="0", S1="1": SBB2 ("P-0-3250, Control word for safety related motion 2" or "P-0-3250, Configuration of safety related motion 2" and "P-0-3254, Safety related reduced speed 2" are effective)

Integrated Safety Functions

- S2="1", S1="0": SBB3 ("P-0-3260, Control word for safety related motion 3" or "P-0-3260, Configuration of safety related motion 3" and "P-0-3264, Safety related reduced speed 3" are effective)
- S2="1", S1="1": SBB4 ("P-0-3270, Control word for safety related motion 4" or "P-0-3270, Configuration of safety related motion 4" and "P-0-3274, Safety related reduced speed 4" are effective)

Notes on Commissioning

In preparation

6.4.3 Safety Related Limited Increment

Brief Description

In the case of the safety function "safety related limited increment", the dual-channel monitoring prevents the drive from moving by more than one maximum increment. In addition, there always is a safety related reduced speed active (see also "[Safety Related Reduced Speed](#)"). By means of two additional safety switches (S1, S2), up to four parameter sets for the special mode "safety related motion" can be selected.



Using the function "safety related limited increment" requires the optional safety technology module ("S1") which can be selected as configuration for the control sections CSH01.1 or CSH01.2 (ADVANCED) and CDB01.1 (BASIC).

Within the position window (maximum increment) it is possible to move in both directions.

To define a new position window it is necessary

- to either leave the special mode "safety related motion" and select it again or
- to change to another parameter set of safety related motion and then go back again.



In the case of transition to different operation (special mode or normal operation), the mode selected before and the corresponding monitoring functions are active until the end of the transition process.

Features

The safety function "safety related limited increment" has the following features:

- The safety function "safety related limited increment" has been realized for personal protection in accordance with EN 954-1 category 3.
- The maximum increment (P-0-3243, P-0-3253, P-0-3263, P-0-3273) is monitored.
- The safety function is active when safety related motion is selected, if it has been parameterized for this mode.
- The safety function "safety related limited increment" can be combined with the other safety functions of the special mode "safety related motion".
- The special mode "safety related motion" with the safety function "safety related limited increment" is selected by actuating an enabling control and the mode selector.
- When a monitor is triggered, this causes an error reaction which shuts down the drive system. The corresponding error message is "F7010 Safety related limited increment exceeded".

Integrated Safety Functions

- Pertinent Parameters** The following parameters are used in conjunction with the safety function "safety related limited increment":
- "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration"
 - P-0-3220, Tolerance time transition from normal operation
 - P-0-3225, Tolerance time transition from safety rel. oper.
 - P-0-3222, Max. activation time of enabling control
 - "P-0-3240, Control word for safety related motion 1" or "P-0-3240, Configuration of safety related motion 1"
 - P-0-3243, Safety related limited increment 1
 - P-0-3244, Safety related reduced speed 1
 - "P-0-3250, Control word for safety related motion 2" or "P-0-3250, Configuration of safety related motion 2"
 - P-0-3253, Safety related limited increment 2
 - P-0-3254, Safety related reduced speed 2
 - "P-0-3260, Control word for safety related motion 3" or "P-0-3260, Configuration of safety related motion 3"
 - P-0-3263, Safety related limited increment 3
 - P-0-3264, Safety related reduced speed 3
 - "P-0-3270, Control word for safety related motion 4" or "P-0-3270, Configuration of safety related motion 4"
 - P-0-3273, Safety related limited increment 4
 - P-0-3274, Safety related reduced speed 4
- Additionally as of MPx04:**
- P-0-3239, Configuration of global safety technology functions
- Additionally as of MPx05:**
- P-0-3246, Max. activation time of enabling control 1
 - P-0-3256, Max. activation time of enabling control 2
 - P-0-3266, Max. activation time of enabling control 3
 - P-0-3276, Max. activation time of enabling control 4

- Pertinent Diagnostic Messages** The following diagnostic messages can be generated in conjunction with the safety function "safety related limited increment":
- F7010 Safety related limited increment exceeded
 - F3142 Activation time of enabling control exceeded
 - F7013 Velocity threshold exceeded
 - With motion monitoring activated, "SBB" is shown on the display of the IndraDrive control panel.

Safety Function

- Selecting the Function** The safety function "safety related limited increment" becomes active by selecting the special mode "safety related motion".
- Safety related motion can be selected via
- digital inputs/outputs for both safety channels
 - digital inputs/outputs of the optional safety technology module ("S1") for safety channel 2 and master communication (SERCOS, PROFIBUS) for safety channel 2 or

Integrated Safety Functions

- PROFIBUS (or PROFIsafe).

For transition from normal operation / special mode to the safety related status, there is one programmable time available for each kind of transition:

- P-0-3220, Tolerance time transition from normal operation
- P-0-3225, Tolerance time transition from safety rel. oper.

After the respective tolerance time is over, the velocity monitoring and the monitoring of the increment are activated (dual-channel monitoring).

Monitoring Function

In the case of the safety function "safety related limited increment", dual-channel monitoring makes sure that the drive...

- ...does not exceed the preset velocity limit values (P-0-3244, P-0-3254, P-0-3264, P-0-3274) within the maximum increment, otherwise the drive generates the error "F7013 Velocity threshold exceeded".
- ...only moves within the maximum increment (cf. P-0-3243, P-0-3253, P-0-3263, P-0-3273), otherwise the drive generates the error "F7010 Safety related limited increment exceeded".



The velocity limit values P-0-3244, P-0-3254, P-0-3264 and P-0-3274, as well as the maximum allowed increments (P-0-3243, P-0-3253, P-0-3263 and P-0-3273), are write-protected with "P-0-3206, Safety technology password" after the safety technology has been activated and cannot be changed by unauthorized persons.

The status of the safety technology password can be seen in "P-0-3207, Safety technology password level".

The special mode "safety related motion" with the safety function "safety related limited increment" is selected by actuating an enabling control and the mode selector. The activation time of the enabling control ("P-0-3222, Max. activation time of enabling control") can be parameterized and is cyclically monitored. If this time is exceeded, the error message "F3142 Activation time of enabling control exceeded" is generated.

As of MPx05, individual activation times of enabling control are possible for the special modes "safety related motion". For commissioning, you can select in "P-0-3239, Configuration of global safety technology functions" whether a common maximum activation time of enabling control (P-0-3222) is active for all special modes "safety related motion", or whether an individual activation time of enabling control (P-0-3246, P-0-3256, P-0-3266, P-0-3276) is active for each special mode "safety related motion 1..4".



You can do without the monitoring of the activation time, if it is not common practice to use an enabling control in your industrial sector and if constant motion does not represent any danger.

The machine manufacturer is responsible for the monitoring of the activation time and his risk analysis has to show his responsibility.

With "P-0-3222, Max. activation time of enabling control"="0", the time monitoring of the special mode "safety related motion" is deactivated. **As of MPx05:** With P-0-3246="0", P-0-3256="0", P-0-3266="0", P-0-3276="0", the monitoring for each special mode "safety related motion 1..4" is deactivated.

Integrated Safety Functions

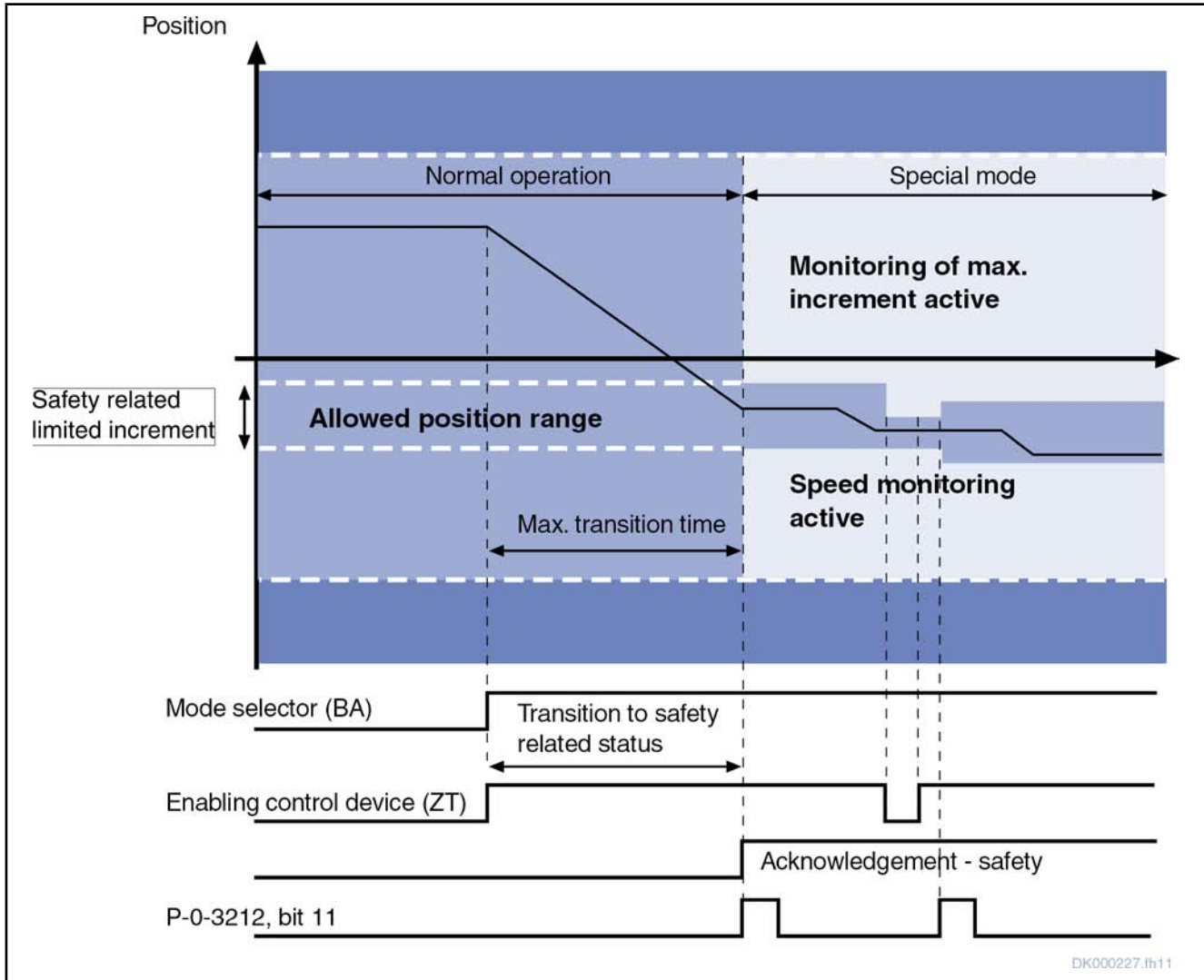


Fig.6-26: Safety related limited increment (NC-controlled transition to safety related motion from normal operation)

Selecting the Effective Limit Value

By means of two additional safety switches (S1, S2), the four different "safety related motions" (SBB) can be selected with the corresponding velocity limit values and increments:

- S2="0", S1="0": SBB1 ("P-0-3243, Safety related limited increment 1" and "P-0-3244, Safety related reduced speed 1" are effective)
- S2="0", S1="1": SBB2 ("P-0-3253, Safety related limited increment 2" and "P-0-3254, Safety related reduced speed 2" are effective)
- S2="1", S1="0": SBB3 ("P-0-3263, Safety related limited increment 3" and "P-0-3264, Safety related reduced speed 3" are effective)
- S2="1", S1="1": SBB4 ("P-0-3273, Safety related limited increment 4" and "P-0-3274, Safety related reduced speed 4" are effective)

6.4.4 Safety Related Limited Absolute Position

Brief Description

In the case of the safety function "safety related limited absolute position", the dual-channel monitoring prevents the drive from moving beyond preset absolute position limit values (+/-). In addition, monitoring with regard to safety related reduced speed is always active.



Using the function "safety related limited absolute position" requires the optional safety technology module ("S1") which can be selected as configuration for the control sections CSH01.1 or CSH01.2 (ADVANCED) and CDB01.1 (BASIC).

By means of an additional safety switch (S1), two parameter sets for the special mode "safety related motion" can be selected.



Before the safety function "safety related limited absolute position" is selected, the "safety related homing procedure" (C4000) has to be carried out.

Features

The safety function "safety related limited absolute position" has the following features:

- The safety function "safety related limited absolute position" has been realized for personal protection in accordance with EN 954-1 category 3.
- The absolute position limit values (P-0-3241, P-0-3242, P-0-3251, P-0-3252) are monitored.
- The safety function "safety related limited absolute position" is active when the special mode "safety related motion" is selected, if it has been parameterized for this mode.
- For the safety function "safety related limited absolute position" the drive must have been safely homed.
- The safety function "safety related limited absolute position" can be combined with the other safety functions of the special mode "safety related motion".
- The special mode "safety related motion" with the safety function "safety related limited absolute position" is selected by actuating an enabling control and the mode selector.

Pertinent Parameters

The following parameters are used in conjunction with the safety function "safety related limited absolute position":

- "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration"
- P-0-3220, Tolerance time transition from normal operation
- P-0-3222, Max. activation time of enabling control
- P-0-3225, Tolerance time transition from safety rel. oper.
- "P-0-3240, Control word for safety related motion 1" or "P-0-3240, Configuration of safety related motion 1"
- P-0-3241, Safety related limited absolute position 1, positive
- P-0-3242, Safety related limited absolute position 1, negative
- P-0-3244, Safety related reduced speed 1
- "P-0-3250, Control word for safety related motion 2" or "P-0-3250, Configuration of safety related motion 2"
- P-0-3251, Safety related limited absolute position 2, positive
- P-0-3252, Safety related limited absolute position 2, negative
- P-0-3254, Safety related reduced speed 2

Additionally as of MPx04:

- P-0-3239, Configuration of global safety technology functions

Additionally as of MPx05:

- P-0-3246, Max. activation time of enabling control 1

Integrated Safety Functions

Pertinent Diagnostic Messages

- P-0-3256, Max. activation time of enabling control 2
- The following diagnostic messages can be generated in conjunction with the safety function "safety related limited absolute position":
- E3102 Actual position values validation error
 - F3112 Reference missing when selecting safety related pos.
 - F7011 Safety rel. position limit val., exc. in pos. dir.
 - F7012 Safety rel. position limit val., exc. in neg. dir.
 - F3142 Activation time of enabling control exceeded
 - F7013 Velocity threshold exceeded
 - With absolute position limit value monitoring activated, "SBB" is shown on the display of the IndraDrive control panel.

Safety Function

Selecting the Function

The safety function "safety related limited absolute position" becomes active by selecting the special mode "safety related motion".

Safety related motion can be selected via

- digital inputs/outputs for both safety channels
- digital inputs/outputs of the optional safety technology module ("S1") for safety channel 2 and master communication (SERCOS, PROFIBUS) for safety channel 2 or
- PROFIBUS (or PROFI-safe).

For transition from normal operation / special mode to the safety related status, there is one programmable time available for each kind of transition:

- P-0-3220, Tolerance time transition from normal operation
- P-0-3225, Tolerance time transition from safety rel. oper.

After the respective tolerance time is over, velocity monitoring is activated.

Within the selected absolute position (=travel range which is defined by an upper and lower position limit value), it is possible to move the drive in both directions with a speed below the allowed reduced speed (cf. "P-0-3244, Safety related reduced speed 1"; "P-0-3254, Safety related reduced speed 2").



Before the safety function "safety related limited absolute position" is selected, the "safety related homing procedure" (C4000) has to be carried out.

Monitoring Functions

In the case of the safety function "safety related limited absolute position", dual-channel monitoring makes sure that the drive...

- ...does not exceed the preset velocity limit values (P-0-3244, P-0-3254) within the allowed absolute position, otherwise the drive generates the error "F7013 Velocity threshold exceeded".
- ...only moves within the allowed absolute position (cf. P-0-3241, P-0-3242, P-0-3251, P-0-3252), otherwise the drive generates the error "F7011 Safety rel. position limit val., exc. in pos. dir." or "F7012 Safety rel. position limit val., exc. in neg. dir.".



After the safety technology has been activated, the velocity limit values P-0-3244 and P-0-3254, as well as the allowed absolute positions (P-0-3241, P-0-3251, P-0-3242, P-0-3252), are write-protected with "P-0-3206, Safety technology password" and cannot be changed by unauthorized persons.

The status of the safety technology password can be seen in "P-0-3207, Safety technology password level".

The special mode "safety related motion" with the safety function "safety related limited absolute position" is selected by actuating an enabling control and the mode selector. The activation time of the enabling control ("P-0-3222, Max. activation time of enabling control") can be parameterized and is cyclically monitored. If this time is exceeded, the error message "F3142 Activation time of enabling control exceeded" is generated.

As of MPx05, individual activation times of enabling control are possible for the special modes "safety related motion". For commissioning, you can select in "P-0-3239, Configuration of global safety technology functions" whether a common maximum activation time of enabling control (P-0-3222) is active for all special modes "safety related motion", or whether an individual activation time of enabling control (P-0-3246, P-0-3256, P-0-3266, P-0-3276) is active for each special mode "safety related motion 1..4".



You can do without the monitoring of the activation time, if it is not common practice to use an enabling control in your industrial sector and if constant motion does not represent any danger.

The machine manufacturer is responsible for the monitoring of the activation time and his risk analysis has to show his responsibility.

With "P-0-3222, Max. activation time of enabling control"="0", the time monitoring of the special mode "safety related motion" is deactivated. **As of MPx05:** With P-0-3246="0", P-0-3256="0", P-0-3266="0", P-0-3276="0", the monitoring for each special mode "safety related motion 1..4" is deactivated.

Selecting the Effective Limit Values

By means of an additional safety switch (S1), the two different "safety related motions" (SBB) can be selected with the corresponding velocity limit values and absolute positions (=position ranges):

- S2="0", S1="0": SBB1 ("P-0-3241, Safety related limited absolute position 1, positive", "P-0-3242, Safety related limited absolute position 1, negative" and "P-0-3244, Safety related reduced speed 1" are effective)
- S2="0", S1="1": SBB2 ("P-0-3251, Safety related limited absolute position 2, positive", "P-0-3252, Safety related limited absolute position 2, negative" and "P-0-3254, Safety related reduced speed 2" are effective)

Integrated Safety Functions

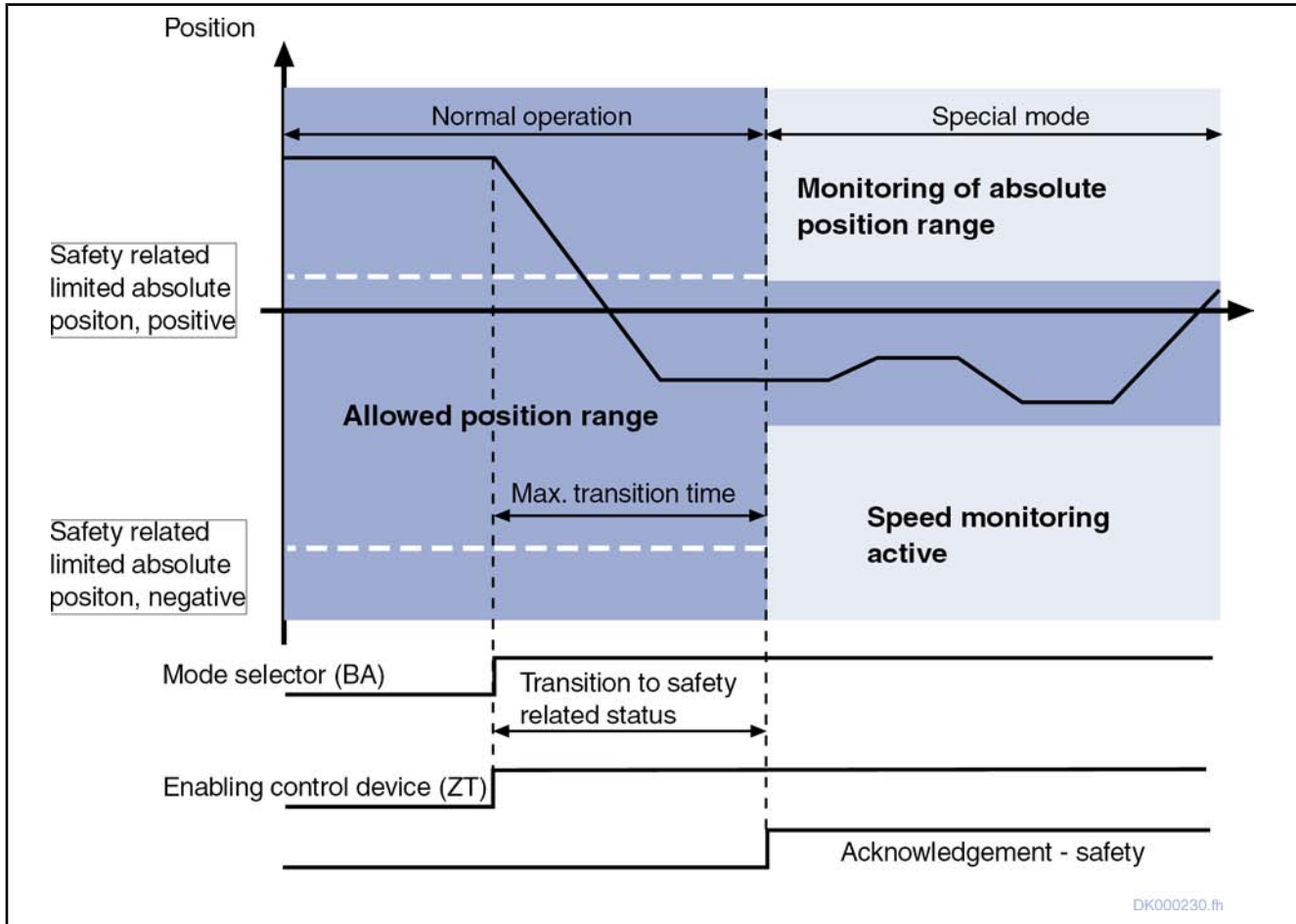


Fig.6-27: Safety related limited absolute position (NC-controlled transition to safety related motion from normal operation)

6.5 Additional or Auxiliary Functions

6.5.1 Safety Related Monitored Stopping Process

Brief Description



Using the function "safety related monitored stopping process" requires the optional safety technology module ("S1") which can be selected as configuration for the control sections CSH01.1 or CSH01.2 (ADVANCED) and CDB01.1 (BASIC).

The integrated safety technology makes available the following variants of the monitoring/safety function "safety related monitored stopping process":

- "Safety related monitored stopping process with safety related monitored deceleration time and braking ramp"
 - Monitoring Function 1: ""Safety Related Monitored Stopping Process With Safety Related Monitored Deceleration Time and Braking Ramp" (to Standstill)" (as of Firmware Version MPx03)
 - Monitoring Function 2: ""Safety Related Monitored Stopping Process With Safety Related Monitored Deceleration Time and Braking Ramp" (to Special Mode "Safety Related Motion ("SBB"))" (as of Firmware Version MPx04)

- [Monitoring Function 3: "Safety Related Monitored Stopping Process on Basis of Actual Velocity"](#) (as of firmware version MPx05)
- [Monitoring Function 5: "Safety Related Monitored Stopping Process With Safety Related Monitored Deceleration Time"](#) (as of firmware version MPx02)

Features The monitoring/safety function "safety related monitored stopping process" has the following features:

- Has been realized for personal protection in accordance with EN 954-1 category 3.
- In the case of error, the drive independently activates the monitoring functions according to the settings in the parameters "P-0-0119, Best possible deceleration" and "P-0-0117, Activation of NC reaction on error".
- The deceleration time (P-0-3220, P-0-3225) is monitored.
- As of MPx03: optional monitoring of the deceleration ramp (P-0-3282).
- As of MPx04: optional monitoring of the deceleration ramp (P-0-3282) to the special mode motion.
- As of MPx05: optional monitoring of the deceleration ramp (P-0-3282) after the delay is over (P-0-3226).

Pertinent Parameters The following parameters are used in conjunction with the safety function "safety related monitored stopping process":

- P-0-0117, Activation of NC reaction on error
- P-0-0119, Best possible deceleration
- "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration"
- P-0-3220, Tolerance time transition from normal operation
- P-0-3225, Tolerance time transition from safety rel. oper.
- "P-0-3226, NC delay trend monitoring" or "P-0-3226, Delay trend monitoring"
- P-0-3233, Velocity threshold for safety related halt
- P-0-3282, Safety related monitored deceleration
- P-0-3283, Safety related monitored deceleration, veloc. envelope curve (as of MPx05)

Pertinent Diagnostic Messages The following diagnostic messages can be generated in conjunction with the safety function "safety related monitored stopping process":

- E3108 Safety related deceleration exceeded (as of MPx05)
- F7050 Time for stopping process exceeded
- F7051 Safety related deceleration exceeded
- F8135 Velocity exceeded with trend monitoring

Safety Function

Selecting the Function

The safety function "safety related monitored stopping process" is active during every transition to a special mode. Depending on the firmware version used, you can select the kind/variant of monitoring of the stopping process with the parameters P-0-3210 and P-0-3226.

Integrated Safety Functions



As of **firmware MPx05**, delay monitoring is **always** active during the stopping process [except for drive-controlled operating mode transitions with return motion (P-0-0119)]; it is therefore definitely necessary to parameterize an effective braking ramp in P-0-3282.

Overview

The active monitoring functions depend on the parameterization of the axis, as well as on the selected special mode. The tables below show when the different kinds of monitoring are active and which error is generated when the monitoring function triggers.

Transitions	Parameterization	Reaction	
		Monitoring	Error message when monitoring function is violated
	NC delay trend monitoring or delay trend monitoring (P-0-3226)		
NO, SBBx → ASP, SH, SBH	0	1	F7051
	>0	3	F7051
NO, SBBx → SBBx	x	2	F7051

Monitoring 1 "Safety related monitored stopping process with safety related monitored deceleration time and braking ramp" (to standstill)

Monitoring 2 "Safety related monitored stopping process with safety related monitored deceleration time and braking ramp" (to special mode "safety related motion ("SBB")")

Monitoring 3 "Safety related monitored stopping process on basis of actual velocity"

Fig. 6-28: Monitoring functions during NC-controlled safety technology operating mode transitions

Transitions	Parameterization		Reaction		
	F7 deceleration (P-0-0119)	F3 deceleration (P-0-0119)	Current deceleration	Monitoring	Error message when monitoring function is violated
NO, SBBx → ASP, SH	X	0	Emergency halt	3	F8135
	1	1*	Torque disable	Output stage switch-off	F8135
	X	2	Drive Halt at S-0-0372	3	F7051
	X	3*	Return motion	5	F7050 (P-0-3220/ P-0-3225)
	0	4	Emergency halt at acceleration limit S-0-0138	3	F7051
	4	4	Emergency halt at acceleration limit S-0-0138	3	F8135

Integrated Safety Functions

Transitions	Parameterization		Reaction		
	F7 deceleration (P-0-0119)	F3 deceleration (P-0-0119)	Current deceleration	Monitoring	Error message when monitoring function is violated
NO, SBBx → SBH	X	X	Drive Halt at S-0-0372	3	F7051
SBBx → SBBx	X	X	-	5	F7013

* Cannot be parameterized in conjunction with the safety related braking and holding system
 Monitoring 3 "Safety related monitored stopping process on basis of actual velocity"
 Monitoring 5 "Safety related monitored stopping process with safety related monitored deceleration time"
Fig. 6-29: Monitoring functions during drive-controlled operating mode transitions

Parameterization			Reaction		
NC error reaction (P-0-0117)	F7 deceleration (P-0-0119)	F3 deceleration (P-0-0119)	Current deceleration	Monitoring	Error message when monitoring function is violated
0	X	0	Emergency halt	3	F8135
1*	X	0	NC-controlled	5	F7050 (P-0-3220/P-0-3225)
X	1	1*	Torque disable	Output stage switch-off	F8135
0	X	2	Drive Halt at S-0-0372	3	F7051
1*	X	2	NC-controlled	5	F7050 (P-0-3220/P-0-3225)
0	X	3*	Return motion	5	F7050 (P-0-3220/P-0-3225)
1*	X	3*	NC-controlled	5	F7050 (P-0-3220/P-0-3225)
0	0	4	Emergency halt at acceleration limit S-0-0138	3	F7051
0	4	4	Emergency halt at acceleration limit S-0-0138	3	F8135
1*	X	4	NC-controlled	5	F7050 (P-0-3220/P-0-3225)

* Cannot be parameterized in conjunction with the safety related braking and holding system
 Monitoring 3 "Safety related monitored stopping process on basis of actual velocity"
 Monitoring 5 "Safety related monitored stopping process with safety related monitored deceleration time"
Fig. 6-30: Monitoring functions in the case of F3xxx errors (non-fatal safety technology errors)

Parameterization		Reaction		
F7 safety technology reaction (P-0-3210)	F7 deceleration (P-0-0119)	Current deceleration	Monitoring	Error message when monitoring function is violated
0	0	Emergency halt	3	F8135

Integrated Safety Functions

Parameterization		Reaction		
1*	1*	Torque disable	Output stage switch-off	F8135
0	4	Emergency halt at acceleration limit S-0-0138	3	F8135

* Cannot be parameterized in conjunction with the safety related braking and holding system

Monitoring 3 "Safety related monitored stopping process on basis of actual velocity"
 Fig. 6-31: *Monitoring functions in the case of F7xxx errors*

Function

Monitoring Function 1: "Safety Related Monitored Stopping Process With Safety Related Monitored Deceleration Time and Braking Ramp" (to Standstill)" (as of Firmware Version MPx03)

The monitoring function 1 "safety related monitored stopping process with safety related monitored deceleration time and braking ramp" (to standstill)" is active during NC-controlled transition from motion (normal operation or special mode "safety related motion") to the special mode "safety related halt" and the drive interlock.



As of firmware version MPx05, the safety function "safety related monitored stopping process with safety related monitored deceleration time and braking ramp" is only active during NC-controlled transition from motion (normal operation or special mode "safety related motion") to the special mode "safety related halt" and the drive interlock, when the delay (P-0-3226) contains the value "0". If a delay unequal "0" has been parameterized, the safety function "safety related monitored stopping process on basis of actual velocity after delay is over" is carried out.

Monitoring via two channels takes place to find out whether the actual velocity is within the velocity envelope curve (P-0-3283). By means of the braking ramp ("P-0-3282, Safety related monitored deceleration"), the drive calculates the velocity envelope curve in such a way that it is at any time able to reach safety related halt (P-0-3233) - within the scope of the possible deceleration - before the transition/tolerance time (P-0-3220 or P-0-3225) is over. If this is no longer possible, the error "F7051 Safety related deceleration exceeded" is generated and the drive is shut down accordingly. Energy supply is safely (i.e. via two channels) interrupted.

Up to firmware version MPx04, the drive is shut down in the quickest possible way via velocity command value reset. **As of firmware version MPx05**, the drive is shut down according to the setting in "P-0-0119, Best possible deceleration".

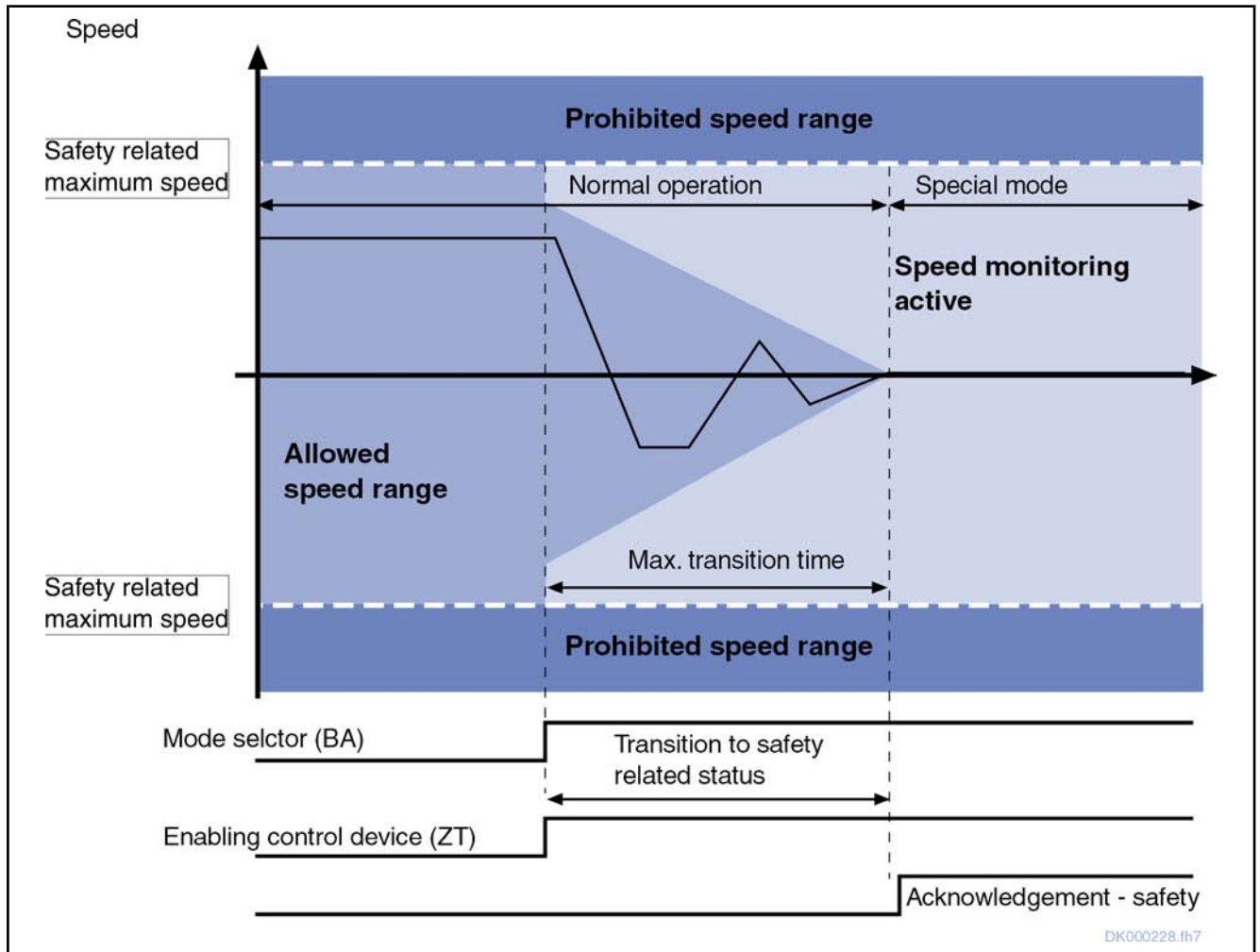


Fig.6-32: Safety related monitored stopping process with monitored deceleration time and braking ramp from normal operation (to standstill) (NC-controlled transition)

Monitoring Function 2: "Safety Related Monitored Stopping Process With Safety Related Monitored Deceleration Time and Braking Ramp" (to Special Mode "Safety Related Motion ("SBB"))" (as of Firmware Version MPx04)

The monitoring function 2 "safety related monitored stopping process with safety related monitored deceleration time and braking ramp" (to special mode "safety related motion ("SBB")") is active during NC-controlled transition from motion (normal operation or special mode "safety related motion") to the special mode "safety related motion ("SBB")".

Monitoring via two channels takes place to make sure that the actual velocity is within the velocity envelope curve (P-0-3283). By means of the braking ramp ("P-0-3282, Safety related monitored deceleration"), the drive calculates the velocity envelope curve in such a way that the parameterized velocity window of the selected special mode "safety related motion" ("P-0-3244, Safety related reduced speed 1", "P-0-3254, Safety related reduced speed 2", "P-0-3264, Safety related reduced speed 3" or "P-0-3274, Safety related reduced speed 4") is reached until the end of the transition/tolerance time (P-0-3220 or P-0-3225). When the values leave the velocity envelope curve, the drive generates the error message "F7051 Safety related deceleration exceeded".

Up to firmware version MPx04, the drive is shut down in the quickest possible way via velocity command value reset. **As of firmware version MPx05**, the drive is shut down according to the setting in "P-0-0119, Best possible deceleration".

Integrated Safety Functions

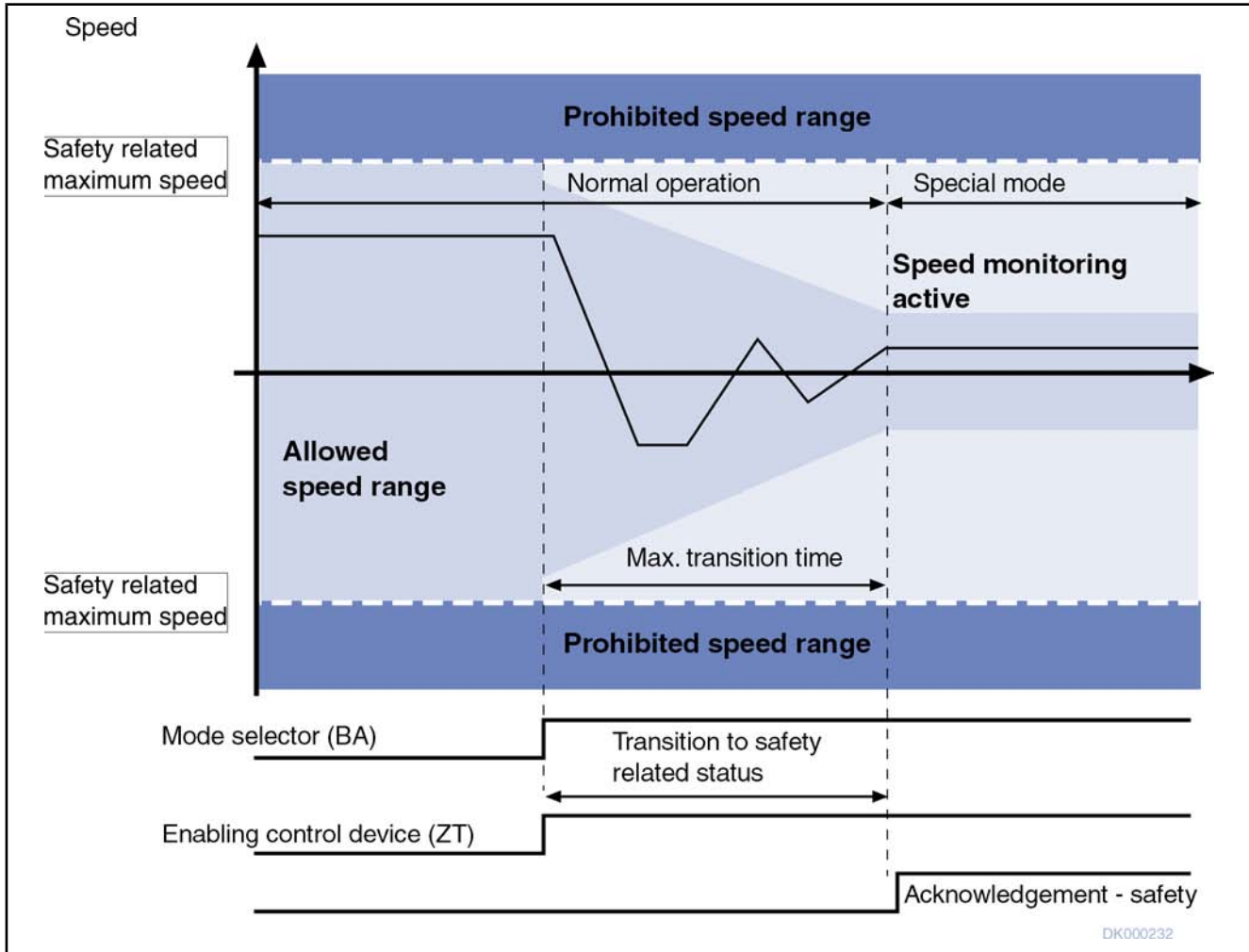


Fig.6-33: Safety related monitored stopping process with safety related monitored deceleration time and braking ramp" (to special mode "safety related motion" ("SBB"))

Monitoring Function 3: "Safety Related Monitored Stopping Process on Basis of Actual Velocity"

The monitoring function "safety related monitored stopping process on basis of actual velocity" is active

- in conjunction with the safety related braking and holding system in the case of "Drive Halt" and "drive off",
- in the case of reactions to safety technology errors and
- in the case of the following transitions:
 - Drive-controlled transitions from motion (normal operation or special mode "safety related motion") to the special mode "safety related halt" and the drive interlock
 - NC-controlled operating mode transitions (see P-0-3210) with a **delay (P-0-3226) unequal "0"**.

⇒ In the case of NC-controlled operating mode transitions and **P-0-3226="0"**, the **safety function "safety related monitored stopping process with safety related monitored deceleration time and braking ramp"** is carried out instead of the safety function "safety related monitored stopping process on basis of actual velocity"!

Monitoring via two channels takes place to make sure that the actual velocity is within the velocity envelope curve (P-0-3283). When the threshold is exceeded, the differences of the actual values and threshold values are added, this corresponds to an incorrect distance and a warning is generated. If the incorrect

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distance is greater than the position standstill window (P-0-3230), an error message is generated.

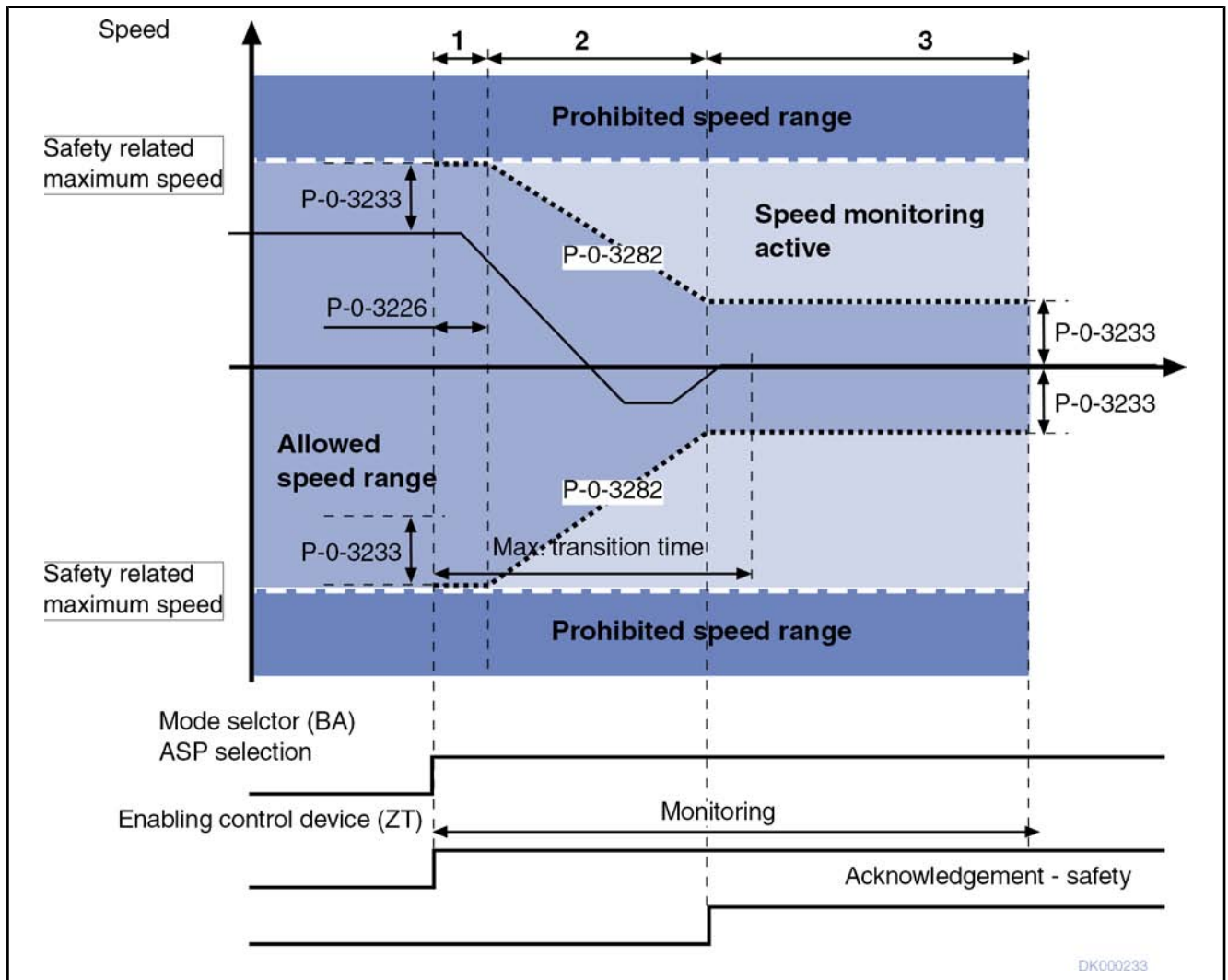


Fig.6-34: Safety related monitored stopping process on basis of actual velocity

The monitoring curve consists of three sections and is generated as follows:

1. **Actual velocity plus tolerance (P-0-3233)** for the duration of P-0-3226
2. **Deceleration ramp (P-0-3282)** until standstill window has been reached (P-0-3233)
3. **Standstill window (P-0-3233)** until the end of monitoring

By means of the pertinent parameters, it is possible to adjust the monitoring function to many applications. This can mainly be achieved by P-0-3226 and P-0-3282.

If the incorrect distance is greater than the position standstill window P-0-3230, the error "F7051 Safety related deceleration exceeded" is always generated in the case of NC-controlled transitions (see P-0-3210). In the case of drive-controlled transitions and depending on the setting in P-0-0119, the errors

- "F7051 Safety related deceleration exceeded" or
- "F8135 Velocity exceeded with trend monitoring"

are generated. The drive is shut down accordingly and the energy supply is safely interrupted via two channels.

Integrated Safety Functions

Monitoring Function 5: "Safety Related Monitored Stopping Process With Safety Related Monitored Deceleration Time"

While the incorrect distance is determined (integration of the velocity differences), the warning E3108 is generated to show that the tolerance has come to its limit.

The monitoring function "safety related monitored stopping process with safety related monitored deceleration time" is active during all transitions between safety technology operating states (P-0-3213, bit0 to bit6) due to changes in selection or in the case of reactions to safety technology errors.

Monitoring via two channels takes place to find out whether the drive has come to a standstill after the transition time (P-0-3220 or P-0-3225) is over.

Time monitoring is started when the selection is changed or when a safety technology error occurs. Time monitoring ends when the new safety technology operating status has been reached, but at the latest after the deceleration/tolerance time is over (the **deceleration/tolerance time** for transition from **normal operation to the special mode "safety related halt"** must be set in "P-0-3220, Tolerance time transition from normal operation"; the **deceleration/tolerance time** for transition from the **special mode "safety related motion" to the special mode "safety related halt"** must be set in "P-0-3225, Tolerance time transition from safety rel. oper.").

If the actual velocity is greater than P-0-3233 after the corresponding tolerance time is over (end of operating mode transition), the error "F7050 Time for stopping process exceeded" is generated. In the case of transition from **normal operation to the special mode "safety related halt"**, the drive is shut down accordingly and energy supply is safely (i.e. via two channels) interrupted. **Special case:** In the case of transitions to the **special mode "safety related motion ("SBB")"**, the transition time is monitored, too, but in this case switching to the selected special mode "safety related motion ("SBB")" takes place after the corresponding tolerance time is over. The motion monitoring functions configured in the special mode then are immediately active and trigger, if necessary.



As of firmware version MPx05 and before the corresponding tolerance time is over, the error messages

- "F7051 Safety related deceleration exceeded" or
- "F8135 Velocity exceeded with trend monitoring"

can have been generated by other monitoring functions of the safety technology function "safety related monitored stopping process" which were carried out in parallel!

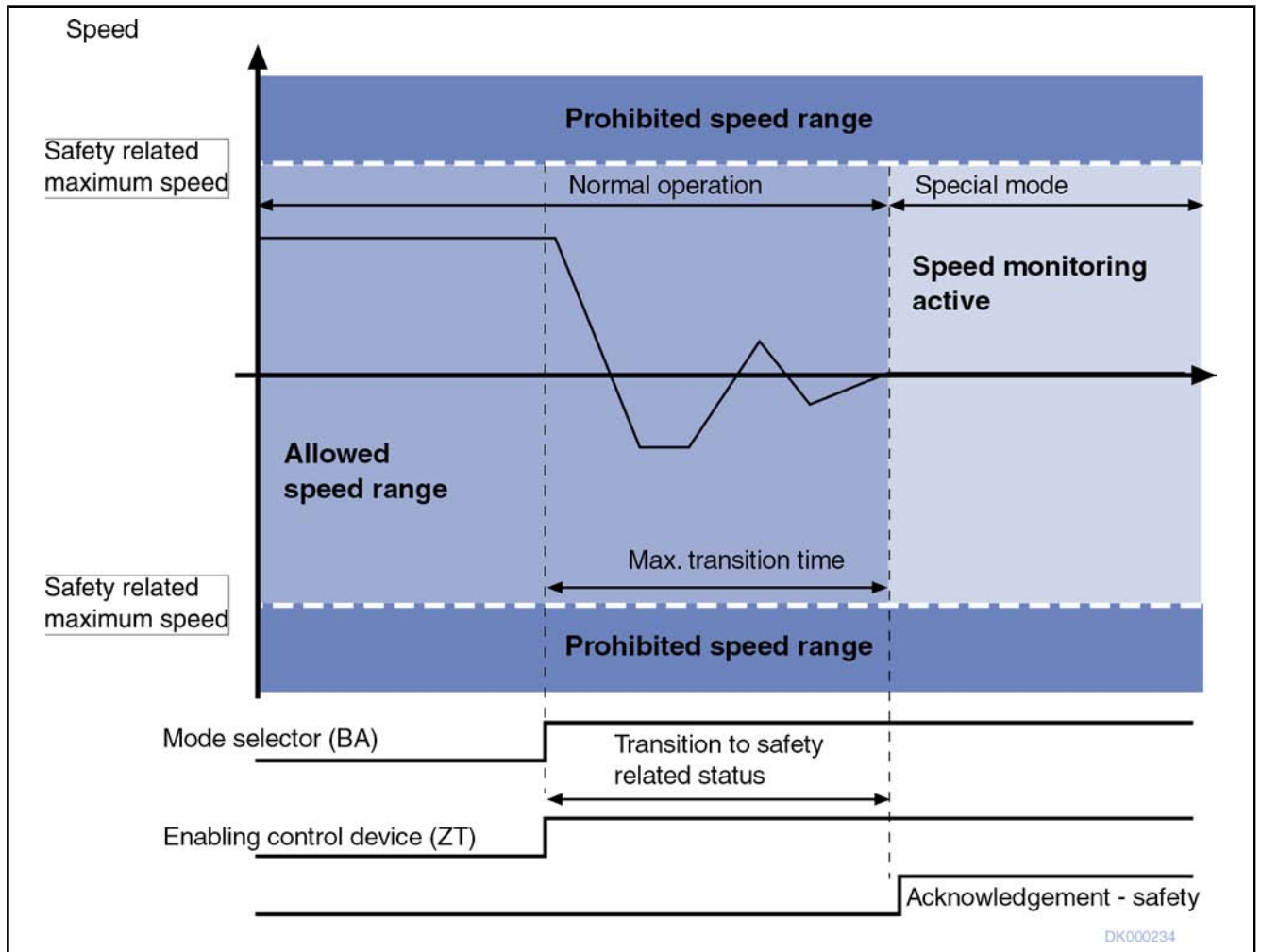


Fig.6-35: Safety related monitored stopping process with safety related monitored deceleration time

6.5.2 Safety Related Homing Procedure

Brief Description



The safety related homing procedure by itself is not an independent safety function, but the basis of all safety functions with safety related monitored position!

The auxiliary safety technology function "safety related homing procedure" has to be carried out before selecting the safety function "safety related limited absolute position". The safety related homing procedure is a homing procedure during normal operation with additional home switch for safety related determination of the reference position.



Using the function "safety related homing procedure" requires the optional safety technology module ("S1") which can be selected as configuration for the control sections CSH01.1 or CSH01.2 (ADVANCED) and CDB01.1 (BASIC).



For absolute measuring systems the safety related homing procedure has to be carried out, too, but only the homing of channel 2 is required in this case.

Integrated Safety Functions

- Features** The auxiliary safety technology function "safety related homing procedure" has the following features:
- The auxiliary safety technology function "safety related homing procedure" has been realized for personal protection in accordance with EN 954-1 category 3.
 - Individual additional homing command for channel 2 (P-0-3228); there are two possibilities for starting the homing procedure of channel 2.
 - According to application requirements, the position data reference for channel 2 can be realized by a static or dynamic reference signal.
 - Only single-channel design of the home switch required (wiring at channel 2/X41).
 - No dynamization of home switch.
 - The position difference between channel 1 and channel 2 (P-0-3229) is monitored.
 - The safety related reference gets lost when leaving phase 4.
 - The auxiliary safety technology function "safety related homing procedure" is the prerequisite for the safety function "safety related limited absolute position".

- Pertinent Parameters** The following parameters are used in conjunction with the auxiliary safety technology function "safety related homing procedure":
- "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration"
 - "P-0-3211, Safety technology I/O configuration list, channel 2" or "P-0-3211, Safety technology I/O control word, channel 2"
 - "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status"
 - P-0-3228, C4000 Homing procedure command channel 2
 - P-0-3229, Tolerance window for safety related homing procedure
 - "P-0-3231, Safety related reference position channel 2" or "P-0-3231, Reference position for safety related reference"
 - P-0-3280, Actual position value, channel 2
 - "P-0-3240, Control word for safety related motion 1" or "P-0-3240, Configuration of safety related motion 1"
 - "P-0-3250, Control word for safety related motion 2" or "P-0-3250, Configuration of safety related motion 2"
 - S-0-0147, Homing parameter
 - S-0-0148, C0600 Drive-controlled homing procedure command
 - S-0-0052, Reference distance 1
 - S-0-0051, Position feedback 1 value
 - S-0-0053, Position feedback 2 value
 - S-0-0054, Reference distance 2
 - S-0-0150, Reference offset 1
 - S-0-0151, Reference offset 2

- Pertinent Diagnostic Messages** The following diagnostic messages can be generated in conjunction with the auxiliary safety technology function "safety related homing procedure":
- C4001 Error during safety related homing procedure
 - C4002 Incorrect distance of dedicated point channel 1-2

- E3102 Actual position values validation error
- F3112 Reference missing when selecting safety related pos.
- F3117 Actual position values validation error

Functional Description - Safety Related Homing Procedure

Basic Function In order to realize diversitary position monitoring, i.e. separate dual-channel position monitoring, the individual channels have to home their actual position value systems in diversitary form, too. This requires another homing command which is available in addition to the "drive-controlled homing procedure command".

In order to get the safety related reference, it is first necessary to home channel 1 by means of the known mechanisms (see Functional Description of firmware "Establishing the Position Data Reference"). Then you have to additionally home channel 2.

The drive only remains homed in a safety related way as long as it is in phase 4. After restart or phase switch, the safety related homing procedure has to be carried out again.

Selecting the Reference Signal for Channel 2

According to application requirements, the position data reference for channel 2 can be realized by a static or dynamic reference signal. The setting is made in "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration".

- "Static evaluation" means that in standstill a high level is expected at the input of the home switch in "P-0-3231, Safety related reference position channel 2" or "P-0-3231, Reference position for safety related reference" in order to establish the position data reference. Evaluation of a static reference signal should be used, when
 - the start position of channel 1 for moving to the reference position is not unequivocally before or behind the reference distance position of channel 2 and it is therefore only possible to position the drive unequivocally at this position, or
 - the safety related reference is to be manually confirmed.
- "Dynamic evaluation" means that during a motion a defined edge is expected at the input of the home switch in "P-0-3231, Safety related reference position channel 2" or "P-0-3231, Reference position for safety related reference" in order to establish the position data reference. The evaluation of a dynamic reference signal should be used when it is possible to ensure, by moving to the reference mark in channel 1, that the reference position of channel 2 is passed with defined edge.



As these methods have a velocity and switch tolerance, the position data reference is adjusted to the actual position value of channel 1. During the adjustment a check is run to find out whether the difference of the actual position values of channel 1 and channel 2 is within the value parameterized in "P-0-3229, Tolerance window for safety related homing procedure".

Establishing the Position Data Reference for Channel 2

There are two possibilities for establishing the position data reference for channel 2:

- Via digital input or parameter, start independent command "P-0-3228, C4000 Homing procedure command channel 2" and observe points listed below:
 - Channel 1 already must have been homed (e.g. absolute encoder).
 - NC-controlled motion has to be carried out so that selected reference point is "passed" (detected), as drive does not carry out any inde-

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pendent motion during execution of command "P-0-3228, C4000 Homing procedure command channel 2".

- Start "S-0-0148, C0600 Drive-controlled homing procedure command" and observe points listed below:
 - Command "S-0-0148, C0600 Drive-controlled homing procedure command" at beginning internally also starts command "P-0-3228, C4000 Homing procedure command channel 2" automatically, if safety function "safety related limited absolute position" has been parameterized.
 - Home switch of channel 2 has to be mechanically mounted in such a way that it is actuated with the travel motion to be expected or during the concluding positioning; if this is not the case, home switch has to be actuated by NC-controlled motion.



By means of "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status", you can check whether the drive has been safely homed.

Notes on Commissioning

The paragraphs below describe typical commissioning sequences for different measuring systems. According to the mounting position of the home switches and the control unit used, there are up to three different commissioning sequences for each encoder type:

- **Variant 1: "drive-controlled"**
 - The home switches are mounted in such a way that by carrying out drive-controlled homing for channel 1 it can be ensured that the home switch for channel 2 is passed from the correct side (dynamic evaluation) or the drive is positioned at it (static evaluation).
 - The control unit knows the command "S-0-0148, C0600 Drive-controlled homing procedure command".
- **Variant 2: "drive-/NC-controlled"**
 - The home switches are mounted in such a way that by carrying out drive-controlled homing for channel 1 it **cannot** be ensured that the home switch for channel 2 is passed from the correct side (dynamic evaluation) or the drive is positioned at it (static evaluation).
 - The homing command of the control unit is extended by NC-controlled actuation of the home switch for channel 2.
- **Variant 3: "NC-controlled"**
 - The homing of channel 1 is completely carried out by the control unit (the travel motions, too); the homed system is transmitted to the drive.
 - The homing command of the control unit is extended by NC-controlled actuation of the home switch for channel 2.

The example of commissioning applying to the application is selected by means of the diagram below:

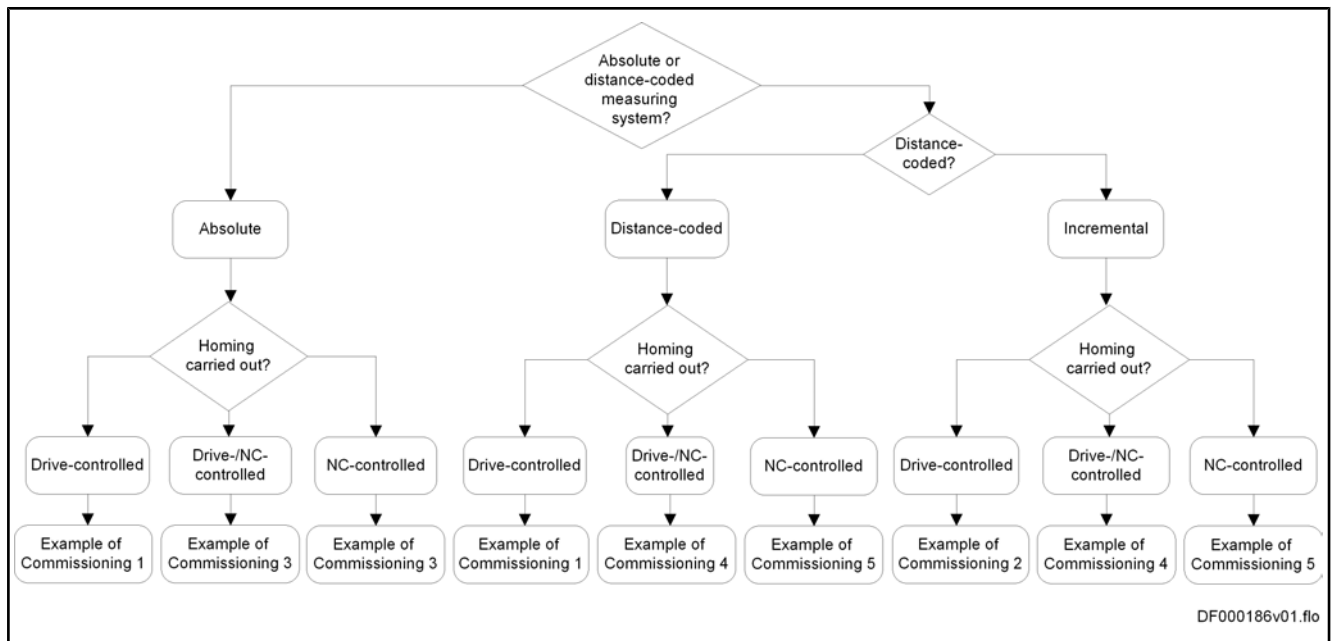


Fig. 6-36: Selection diagram for examples of commissioning of safety related homing procedure



In the descriptions below channel 1 always refers to the motor encoder. If an external encoder has been plugged in instead of the motor encoder at optional slot 1, it is only necessary to replace the following parameters, the function remains as described:

- S-0-0051 replaced by S-0-0053
- S-0-0052 replaced by S-0-0054
- S-0-0150 replaced by S-0-0151

Example of Commissioning 1

Requirements

The following requirements must have been fulfilled so that safety related reference can be established via the command "S-0-0148, C0600 Drive-controlled homing procedure command":

- Use absolute or distance-coded measuring system.
- Establish position data reference for channel 1 by means of drive-controlled homing (S-0-0148).
- Static evaluation or manual actuation of home switch for channel 2.

Presetting

The following parameter setting has to be made in the drive:

- "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration": "evaluate home switch as static switch"
- "P-0-3229, Tolerance window for safety related homing procedure": "accuracy of positioning at home switch +10%"
- "S-0-0052, Reference distance 1" (or "S-0-0054, Reference distance 2") = P-0-3231
- "S-0-0147, Homing parameter", position drive at reference point at the end of homing (S-0-0052 or S-0-0054)

How to Carry Out Safety Related Homing (Chronological Sequence)

Carry out the safety related homing procedure in the following order:

1. Start command "C0600 Drive-controlled homing procedure command"; drive establishes reference for channel 1 and positions at reference distance "S-0-0052, Reference distance 1" (or S-0-0054) = P-0-3231.

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2. In reference position for channel 2, reference signal either has to be triggered automatically by means of mounted switch or by manual actuation.
3. Complete command "C0600 Drive-controlled homing procedure command".

When the safety related homing procedure was successful, this is signaled in "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status" and the safety function "safety related limited absolute position" can be used.

Example of Commissioning 2

Requirements

The following requirements must have been fulfilled so that safety related reference can be established via the command "S-0-0148, C0600 Drive-controlled homing procedure command":

- Use an incremental measuring system.
- Establish position data reference for channel 1 by means of drive-controlled homing (S-0-0148).
- Dynamic evaluation of home switch for channel 2 without reference mark.
- Home switch for channel 2 has to be situated on the way to reference point for channel 1.
- Distance between reference point for channel 1 and channel 2 has to be greater than tolerance window ("P-0-3229, Tolerance window for safety related homing procedure" + 10%).

$$|\text{Reference point channel 2} - \text{Reference point channel 1}| < \text{P-0-3229} + 10\%$$

Fig. 6-37: Calculating minimum distance between reference points for safety related homing procedure

Presetting

The following parameter setting has to be made in the drive:

- "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration": evaluate home switch as dynamic reference signal and select corresponding edge evaluation
- adjust "P-0-3229, Tolerance window for safety related homing procedure" (value depends on delay of signals, as well as on homing velocity)

$$\text{P-0-3229}_{\text{min}} = 2 * v_{\text{ref}} * 1 \text{ms}$$

v_ref Homing velocity
 P-0-3229_min Minimum tolerance window

Fig. 6-38: Calculating minimum value for "P-0-3229, Tolerance window for safety related homing procedure"

- "P-0-3231, Safety related reference position channel 2" or "P-0-3231, Reference position for safety related reference": enter position of home switch edge channel 2

$$\begin{aligned} \text{Reference distance} &= \text{Reference point channel 2} - \text{Reference point channel 1} \\ P-0-3231 &= (S-0-0052) - (S-0-0150) - \text{Reference distance} \quad \text{or} \\ P-0-3231 &= (S-0-0054) - (S-0-0151) - \text{Reference distance} \end{aligned}$$

P-0-3231 "Safety related reference position channel 2" or "Reference position for safety related reference"

S-0-0052 Reference distance 1 (or S-0-0054)

S-0-0150 Reference offset 1 (or S-0-0151)

Fig. 6-39: Calculating "P-0-3231, Safety related reference position channel 2" or "P-0-3231, Reference position for safety related reference"

- "S-0-0147, Homing parameter": activate "evaluation home switch"

How to Carry Out Safety Related Homing (Chronological Sequence)

Carry out the safety related homing procedure in the following order:

1. Start command "C0600 Drive-controlled homing procedure command"; drive establishes reference for channel 1.
2. During homing procedure for channel 1, channel 2 detects edge of home switch for channel 2 and changes its actual position value to "P-0-3231, Safety related reference position channel 2" or "P-0-3231, Reference position for safety related reference".
3. Drive checks whether actual position value difference between channel 1 and channel 2 is smaller than "P-0-3229, Tolerance window for safety related homing procedure".
4. Complete command "C0600 Drive-controlled homing procedure command".

When the safety related homing procedure was successful, this is signaled in "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status" and the safety function "safety related limited absolute position" can be used.



Any position error in channel 1 of the size of the tolerance window (P-0-3229) won't be detected!

Example of Commissioning 3

Requirements

The following requirements must have been fulfilled so that safety related reference can be established via the command "P-0-3228, C4000 Homing procedure command channel 2":

- Use an absolute measuring system.
- For establishing reference, travel motion by control unit must be possible.
- Home switch for channel 2 can be evaluated either dynamically or statically.

Presetting

The following parameter setting has to be made in the drive:

- "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration": evaluate home switch dynamically or statically and select corresponding edge evaluation in the case of dynamic evaluation
- "P-0-3229, Tolerance window for safety related homing procedure": content depends on kind of evaluation of home switch:
 - Dynamic evaluation of the home switch: adjust "P-0-3229, Tolerance window for safety related homing procedure" (value depends on delay of signals, as well as on homing velocity)

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$$P-0-3229_{min} = 2 * v_{ref} * 1ms$$

v_ref Homing velocity
 P-0-3229_min Minimum tolerance window
Fig.6-40: Calculating minimum value for "P-0-3229, Tolerance window for safety related homing procedure"

- Static evaluation of the home switch: enter accuracy of positioning at home switch +10%
- "P-0-3231, Safety related reference position channel 2" or "P-0-3231, Reference position for safety related reference": enter position of home switch channel 2

How to Carry Out Safety Related Homing (Chronological Sequence)

Carry out the safety related homing procedure in the following order:

1. Start command "C4000 Homing procedure command channel 2".
Control unit moves drive to (static home switch evaluation) or over (dynamic home switch evaluation) safety related reference position channel 2 (P-0-3231).
2. In the case of manual actuation of home switch for channel 2, reference signal has to be triggered when drive is at reference position for channel 2.
3. Complete command "C4000 Homing procedure command channel 2".

When the safety related homing procedure was successful, this is signaled in "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status" and the safety function "safety related limited absolute position" can be used.

Example of Commissioning 4

Requirements The following requirements must have been fulfilled so that the safety related reference can be established in a drive-/NC-controlled way:

- Use incremental or distance-coded measuring system.
- Establish position data reference for channel 1 by means of drive-controlled homing (S-0-0148).
- For establishing reference, travel motion by control unit must be possible.
- Home switch for channel 2 can be evaluated either dynamically or statically.
- When incremental measuring system is used, distance between reference point for channel 1 and channel 2 has to be greater than tolerance window ("P-0-3229, Tolerance window for safety related homing procedure" + 10%).

$$|Reference\ point\ channel\ 2 - Reference\ point\ channel\ 1| < P-0-3229 + 10\%$$

Fig.6-41: Calculating minimum distance between reference points for safety related homing procedure

Presetting The following parameter setting has to be made in the drive:

- "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration": evaluate home switch dynamically or statically and select corresponding edge evaluation in the case of dynamic evaluation
- "P-0-3229, Tolerance window for safety related homing procedure": content depends on whether home switch is to be evaluated statically or dynamically:
 - **Static evaluation** of the home switch: enter accuracy of positioning at home switch +10%

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- **Dynamic evaluation** of the home switch: adjust according to formula below (value depends on delay of signals, as well as on homing velocity)

$$P-0-3229_min=2*v_ref*1ms$$

v_ref Homing velocity

P-0-3229_min Minimum tolerance window

Fig. 6-42: *Calculating minimum value for "P-0-3229, Tolerance window for safety related homing procedure"*

- "P-0-3231, Safety related reference position channel 2" or "P-0-3231, Reference position for safety related reference": enter position of home switch edge channel 2. When using an incremental encoder, calculate the position as follows:

$$\text{Reference distance} = \text{Reference point channel 2} - \text{Reference point channel 1}$$

$$P-0-3231 = (S-0-0052) - (S-0-0150) - \text{Reference distance} \quad \text{or}$$

$$P-0-3231 = (S-0-0054) - (S-0-0151) - \text{Reference distance}$$

P-0-3231 "Safety related reference position channel 2" or "Reference position for safety related reference"

S-0-0052 Reference distance 1 (or S-0-0054)

S-0-0150 Reference offset 1 (or S-0-0151)

Fig. 6-43: *Calculating "P-0-3231, Safety related reference position channel 2" or "P-0-3231, Reference position for safety related reference"*

How to Carry Out Safety Related Homing (Chronological Sequence)

Carry out the safety related homing procedure in the following order:

1. Start command "C0600 Drive-controlled homing procedure command".
Drive carries out homing on channel 1.
2. Complete command "C0600 Drive-controlled homing procedure command".
Control unit moves drive to (static home switch evaluation) or over (dynamic home switch evaluation) safety related reference position channel 2 (P-0-3231).
3. In the case of manual actuation of home switch for channel 2, reference signal has to be triggered when drive is at reference position for channel 2.
4. Drive checks whether actual position value difference between channel 1 and channel 2 is smaller than "P-0-3229, Tolerance window for safety related homing procedure".

When the safety related homing procedure was successful, this is signaled in "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status" and the safety function "safety related limited absolute position" can be used.



Any position error in channel 1 of the size of the tolerance window (P-0-3229) won't be detected!

Example of Commissioning 5

Requirements

The following requirements must have been fulfilled so that the safety related reference can be established in an NC-controlled way:

- Use incremental or distance-coded measuring system.
- Establish position data reference for channel 1 by means of NC-controlled homing.

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- For establishing reference for channel 2, additional travel motion by control unit must be possible.
- Home switch for channel 2 can be evaluated either dynamically or statically.
- When incremental measuring system is used, distance between reference point for channel 1 and channel 2 has to be greater than tolerance window ("P-0-3229, Tolerance window for safety related homing procedure" + 10%).

$$|\text{Reference point channel 2} - \text{Reference point channel 1}| < \text{P-0-3229} + 10\%$$

Fig. 6-44: Calculating minimum distance between reference points for safety related homing procedure

Presetting

The following parameter setting has to be made in the drive:

- "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration": evaluate home switch dynamically or statically and select corresponding edge evaluation in the case of dynamic evaluation
- "P-0-3229, Tolerance window for safety related homing procedure": content depends on whether home switch is to be evaluated statically or dynamically:
 - **Static evaluation** of the home switch: enter accuracy of positioning at home switch +10%
 - **Dynamic evaluation** of the home switch: adjust according to formula below (value depends on delay of signals, as well as on homing velocity)

$$\text{P-0-3229}_{\text{min}} = 2 * v_{\text{ref}} * 1\text{ms}$$

v_ref Homing velocity
 P-0-3229_min Minimum tolerance window

Fig. 6-45: Calculating minimum value for "P-0-3229, Tolerance window for safety related homing procedure"

- P-0-3231: enter position of home switch edge channel 2. When using an incremental encoder, calculate the position as follows:

$$\begin{aligned} \text{Reference distance} &= \text{Reference point channel 2} - \text{Reference point channel 1} \\ \text{P-0-3231} &= (\text{S-0-0052}) - (\text{S-0-0150}) - \text{Reference distance} \quad \text{or} \\ \text{P-0-3231} &= (\text{S-0-0054}) - (\text{S-0-0151}) - \text{Reference distance} \end{aligned}$$

P-0-3231 "Safety related reference position channel 2" or "Reference position for safety related reference"
 S-0-0052 Reference distance 1 (or S-0-0054)
 S-0-0150 Reference offset 1 (or S-0-0151)

Fig. 6-46: Calculating "P-0-3231, Safety related reference position channel 2" or "P-0-3231, Reference position for safety related reference"

How to Carry Out Safety Related Homing (Chronological Sequence)

Carry out the safety related homing procedure in the following order:

1. Establish reference for channel 1 in NC-controlled way.
2. Start command "C4000 Homing procedure command channel 2".
 Control unit moves drive to (static home switch evaluation) or over (dynamic home switch evaluation) safety related reference position channel 2 (P-0-3231).

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3. In the case of manual actuation of home switch for channel 2, reference signal has to be triggered when drive is at reference position for channel 2.
4. Drive checks whether actual position value difference between channel 1 and channel 2 is smaller than "P-0-3229, Tolerance window for safety related homing procedure".
5. Complete command "C4000 Homing procedure command channel 2".

When the safety related homing procedure was successful, this is signaled in "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status" and the safety function "safety related limited absolute position" can be used.



Any position error in channel 1 of the size of the tolerance window (P-0-3229) won't be detected!

6.5.3 Safety Related Parking Axis

Brief Description

The drive function "parking axis" can be used in conjunction with integrated safety technology, too. When this is done, it is possible to acknowledge the safety status at the diagnostic output.

For a detailed description of the drive function "parking axis" see the Functional Descriptions of the following drive firmwares:

- Rexroth IndraDrive MPx03 and
- Rexroth IndraDrive MPx04



Using the safety function "safety related parking axis" requires the optional safety technology module ("S1") which can be selected as configuration for the control sections CSH01.1 or CSH01.2 (ADVANCED) and CDB01.1 (BASIC).

The function is available as of firmware version MPx03V12.

Features

The safety function "safety related parking axis" has the following features:

- Has been realized for personal protection in accordance with EN 954-1 category 3.
- The output stage is locked via two channels for the duration of the parking axis.
- For the safety function "safety related parking axis" there isn't any encoder monitoring function active. This means that the monitoring functions for speed, acceleration and position are deactivated.
- Acknowledgment of safety with corresponding result of risk analysis.

Pertinent Parameters

The following parameters are used in conjunction with the safety function "safety related parking axis":

- "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word"
- "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status"
- "P-0-3215, Selected safety technology operating status" or "P-0-3215, Selected safety technology mode"

Pertinent Diagnostic Messages

The following diagnostic messages can be generated in conjunction with the safety function "safety related parking axis":

- F3131 Error when checking acknowledgment signal
- F3140 Safety parameters validation error

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- F7040 Validation error parameterized - effective threshold
- F7042 Validation error of safety related operating mode
- F7043 Error of output stage interlock
- F8129 Incorrect optional module firmware
- With safety related parking axis activated, "PA" is shown on the display of the IndraDrive control panel.

Safety Function

Selecting the Function

The safety function "safety related parking axis" is active after safety technology has been activated and the drive function "parking axis" has been selected. For how to proceed to activate the drive function "parking axis", see the Functional Descriptions of the following drive firmwares:

- Rexroth IndraDrive MPx03 (Windows Help, PDF format or printed edition),
- Rexroth IndraDrive MPx04 (Windows Help, PDF format or printed edition) and
- Rexroth IndraDrive MPx05 (Compiled HTML Help, PDF format or printed edition)

Monitoring Functions

With the safety function "safety related parking axis" the following monitoring functions are **deactivated**:

- Monitoring functions of the measuring systems
- Monitoring functions regarding speed, acceleration and position



The missing speed information can be replaced via the control bit "defined safety with parked axis" in "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration".

The control bit signals safety which has to result from the risk analysis of the installation. Use for axes with long coasting times (grinding wheels, spindles, rolls, ...) must be excluded.

Acknowledgment of Safety

When the control bit "defined safety with parked axis" has been set in "P-0-3210, Safety technology control word" or "P-0-3210, Safety technology configuration", the following axes will acknowledge safety with the safety function "safety related parking axis" having been activated:

- Axes with single acknowledgment at the diagnostic outputs A10 and EA10n
- Diagnostic slave axes at the diagnostic outputs A10 and EA10n, as well as via the E/A20 bus to the diagnostic master
- Diagnostic master axes with feedback to a PLC at the diagnostic outputs A10 and EA10n, when the diagnostic slaves signal safety
- Diagnostic master axes with control of a safety door at the diagnostic outputs A10 and EA10n, when the diagnostic slaves signal safety and dual-channel selection has been made via the mode selector

6.5.4 Safety Related Brake Check

Brief Description



The safety related brake check is not an independent safety function, but the basis of the "safety related braking and holding system".

To achieve safety according to EN 954-1 category 3 for the "safety related braking and holding system", it is necessary to check the function and the holding torque of the two holding brakes in regular intervals. The check is run within

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the scope of the command "C2100 Command Holding system check". Regularity is ensured by dual-channel, parameterizable time monitoring.

Features The auxiliary safety technology function "safety related brake check" has the following features:

- The auxiliary safety technology function "safety related brake check" has been realized for personal protection in accordance with EN 954-1 category 3.
- Parameterizable time interval in which the safety related brake check must be repeated.
- When control voltage is switched off, the brake status of the two brakes is set to "not successful".
- Holding torque of the two holding brakes can be checked in positive, negative or in both directions.
- Check for releasing the two holding brakes.
- Monitoring of the actual load torque of the holding system.
- The auxiliary safety technology function "safety related brake check" is the prerequisite for using the safety related braking and holding system.

Pertinent Parameters The following parameters are used in conjunction with the auxiliary safety technology function "safety related brake check":

- P-0-0525, Holding brake control word
- P-0-0539, Holding brake status word
- P-0-0540, Torque of motor holding brake
- P-0-0541, C2100 Command Holding system check
- P-0-0542, C2000 Command Release motor holding brake
- P-0-0543, C3800 Command Apply motor holding brake
- P-0-0545, Test torque for releasing motor holding brake
- P-0-0546, Starting torque for releasing motor holding brake
- P-0-0547, Nominal load of holding system
- P-0-0549, Oper. hours control section at last successful brake check
- P-0-0550, Time interval brake check
- P-0-0551, Current load torque
- P-0-3300, Redundant holding brake: configuration
- P-0-3301, Redundant holding brake: status word
- P-0-3302, Safety related holding system: time interval brake check
- P-0-3303, Safety related holding system: nominal load
- P-0-3304, Safety related holding system: torque/force constant
- P-0-3306, Delay time motor holding brake
- P-0-3307, Safety technology - drive off delay time
- P-0-3310, Safety related holding system: travel range brake check
- P-0-3311, Safety rel. hold. sys.: dur. test torque injection br. check

Pertinent Diagnostic Messages The following diagnostic messages can be generated in conjunction with the auxiliary safety technology function "safety related brake check":

- E3115 Prewarning, end of brake check time interval
- F3115 Error, brake check time interval exceeded
- E3116 Nominal load torque of holding system reached

Integrated Safety Functions

- F3116 Nominal load torque of holding system exceeded
- F3122 Safety related holding system: system error
- F3123 Safety related holding system: brake check missing
- F7051 Safety related deceleration exceeded
- F8134 Safety related holding system: fatal error
- C2100 Command Holding system check
- C2101 Holding system check only possible with drive enable
- C2103 Motor holding brake: torque too low
- C2104 Command execution impossible
- C2105 Load of holding system > test torque
- C2106 Test torque of holding system not reached
- C2107 Redundant holding brake: torque too low
- C2108 Error when releasing the holding system
- C2109 Safety related holding system: test torque invalid

Functional Description

With the brake check, the function of the two holding brakes is checked. The objective is to detect sleeping errors, soiling (fouling of the brake by oil, film rust on the friction surface of the brake) and wear.

The "safety related brake check" is started via the command "C2100 Command Holding system check" (P-0-0541).

Monitoring Functions

The following aspects are checked:

- Releasing the "safety related braking and holding system": A check is run to find out whether the two holding brakes can be released. For this purpose, the axis is moved by the distance P-0-3310; if this is impossible, the command error "C2108 Error when releasing the holding system" is generated.
- Holding torque of motor holding brake in positive and negative direction: A check is run with applied motor holding brake and released redundant holding brake to find out whether the motor holding brake holds the 1.3-fold torque of P-0-3303. When this is done, the axis may not move, within the parameterized check time (P-0-3311), by more than the distance parameterized in P-0-3310; otherwise, the command error "C2103 Motor holding brake: torque too low" is generated.
- Holding torque of redundant holding brake in positive and negative direction: A check is run with released motor holding brake and applied redundant holding brake to find out whether the redundant holding brake holds the 1.3-fold torque of P-0-3303. When this is done, the axis may not move, within the parameterized check time (P-0-3311), by more than the distance parameterized in P-0-3310; otherwise, the command error "C2107 Redundant holding brake: torque too low" is generated.



To check the holding torque of the brakes, the value parameterized in P-0-0547 is used as test torque. During the check, the safety technology monitors that the test torque reaches at least the value of P-0-3303.



If brakes are used which generate the holding torque in one direction only or if the brake check is only possible in one direction due to the mechanical axis system, the brake check can be carried out in direction-dependent form (P-0-3300).

Integrated Safety Functions

The regular, user-side performance of the "safety related brake check" is monitored, too. Depending on the status of the safety related brake check and the selected operating status (normal operation/special mode), the following diagnostic messages are possible:

Status "safety related brake check" (P-0-0539, P-0-3301)	Selection normal operation/special mode	Drive enable < 10s	Drive enable
Not successful	Normal operation	No warning, no error	0-5 min after end of status "safety related brake check" → No warning / no error
			5-15 min after end of status "safety related brake check" → E3115
			> 15 min after end of status "safety related brake check" → F3115
	Special mode	→ F3123	→ F3123
Successful	Normal operation / special mode	No warning, no error	15 – 0 min before end of status "safety related brake check" → E3115
			At end of status "safety related brake check" → F3115

Fig.6-47: Drive reaction depending on status safety related brake check (P-0-0539 and P-0-3301)

After control voltage was switched on, the status of the motor holding brake in P-0-0539 and the status of the redundant holding brake in P-0-3301 is set to "not successful".

After successful safety related brake check, the status "safety related brake check" is set to "successful" for the time parameterized in P-0-3302 and reset to "not successful" after this time is over. The time interval for the brake check is monitored on the basis of the operating hours of the control section; i.e. the brake status "successful" is set to "not successful" again after the parameterized time is over, independent of whether the drive is in control or not.

Commissioning

The command "C2100 Command Holding system check" can only be started in normal operation and under drive enable.



If such states can occur at the installation in which the axis must be moved in special mode before the brake check, the axis can be moved under defined conditions via the command "C6200 Command Enabling special mode without valid brake status" (see "Enabling the Special Mode Without Valid Brake Status").



Property damage caused by collisions with other axes when carrying out the brake check!

⇒ On user-side and control-unit-side, make sure that collisions with other axes are avoided when the brake check is carried out.

Integrated Safety Functions

After control voltage was switched on, the status of the motor holding brake in P-0-0539 and the status of the redundant holding brake in P-0-3301 is always set to "not successful". A brake check must therefore be carried out in order to be able to use the safety related braking and holding system.

To allow carrying out the command C2100 in a position defined by the user or the control unit, there isn't any warning or error displayed at first. Activating drive enable starts the "rest time" of 5 minutes, before the warning E3115 appears for another 10 minutes. After 15 minutes under drive enable, the error message F3115 is generated if the command C2100 has not been carried out successfully.

The error F3115 can be cleared. Then the procedure described in the preceding paragraph is started again.

With command C2100 carried out successfully, the status "safety related brake check" is set to "successful". The time monitoring P-0-3302 is started again. 15 minutes before the end of the time interval, the warning E3115 is displayed again.



When guards are used, a brake check should be carried out before the safety door is opened; this gives the user the maximum time (and safety) with safety related feedback.

6.5.5 Enabling the Special Mode Without Valid Brake Status

Brief Description

With the command "C6200 Command Enabling special mode without valid brake status", it is possible to cause the enabling of the special mode under defined conditions, as a one-time event for the duration of a maximum of 15 minutes, although the brake status (status of holding brake check P-0-0539/ P-0-3301) is invalid. This allows manually moving the axis (after an error or E-Stop, for example) in the special mode to an appropriate position for the brake check. The brake check itself can only be carried out after the command C62 has been terminated and only in normal operation.



WARNING

Possible personal injury and property damage, as the holding torques of motor brake and/or redundant holding brake are not sufficient!

If the point of time of the last brake check "C2100 Command Holding system check" has passed for a long operating time or downtime, the holding torques of motor brake and/or redundant holding brake might no longer be sufficient; an error in the safety related braking and holding system cannot be excluded any longer! Only the brake check can give information about the holding torques.

The command C62 must have been enabled during commissioning. You should only enable and use the command after a risk assessment.

Features

The command C62 has the following features:

- The command C62 must have been enabled during commissioning.
- The command C62 can only be executed, if
 - it had not yet been executed (only allowed once per control voltage ON),
 - the safety function "safety related braking and holding system" is active,
 - the brake status of motor brake and/or redundant holding brake is invalid ("status of holding brake check"="carried out without success"),

Integrated Safety Functions

- the operating mode is active and
- the command C21 is not active at the same time.
- The special mode is only enabled for a maximum of 15 minutes, by
 - setting the status of holding brake check of the motor brake and the status of the redundant holding brake to "successful" and
 - setting the remaining time of the brake check interval to 15 minutes.
- The command C62 must be reset before the command C21 is executed.

Pertinent Parameters

The following parameters are used in conjunction with the command C62:

- P-0-3315, C6200 Comm. Enabling special mode without valid brake status
- P-0-3300, Redundant holding brake: configuration
- P-0-3301, Redundant holding brake: status word
- P-0-3302, Safety related holding system: time interval brake check
- P-0-0539, Holding brake status word
- P-0-0541, C2100 Command Holding system check

Pertinent Diagnostic Messages

The following diagnostic messages can be generated in conjunction with the command C62:

- C6200 Command Enabling special mode without valid brake status
- C6201 Command execution impossible
- F3123 Safety related holding system: brake check missing
- F3115 Error, brake check time interval exceeded
- C2100 Command Holding system check

Functional Description

With the command "C6200 Command Enabling special mode without valid brake status", the machine operator can - under defined conditions - move an axis with safety related braking and holding system in the special mode without valid brake status (P-0-0539 and P-0-3301).

**WARNING****Possible personal injury and property damage, as the holding torques of motor brake and/or redundant holding brake are not sufficient!**

The command "C6200 Command Enabling special mode without valid brake status" may only be used, when the use of the command was taken into account in the risk analysis of the installation ("danger to persons in the safety area due to brake defect").

If the point of time of the last brake check "C2100 Command Holding system check" has passed for a long operating time or downtime, the holding torques of motor brake and/or redundant holding brake might no longer be sufficient! Only the brake check can give information about the holding torques.

Moving the axis in special mode without the brakes having been checked causes additional dangers for the operator! This requires the following measures:

- The machine manual must contain explicit information on the additional danger caused when the axis is moved in special mode without the brakes having been checked.
- The operator must be informed (e.g. within the scope of a training course) on the additional danger caused when the axis is moved in special mode without the brakes having been checked.
- It may only be possible to start the command C62 at the machine in the specific safety technology context (key switch, warning on the display, ...).

Integrated Safety Functions

The command is active for a maximum of 15 minutes and can only be started once per control voltage ON.

The command is destined for special cases in which it is impossible to comply with the standard procedure; such cases are, for example:

- Restart of an axis with automatic, position-dependent selection of the special mode
- Manual release of the axis after E-Stop or error

Starting Command C62

Requirements for starting the command C62:

- The intention to use the command was defined at commissioning and the use of the command was taken into account in the risk analysis of the machine.
- The safety function "safety related braking and holding system" is active (P-0-3300).
- The brake states of motor brake and/or redundant holding brake are invalid ("status of holding brake check"="carried out without success").
- The command C62 had not yet been executed (only allowed once per control voltage ON).
- The operating mode is active.
- The command C21 is not active.

When the requirements have been fulfilled, the following **actions** are carried out by starting the **command C62**:

- The brake states of motor brake and redundant holding brake are set to valid ("status of holding brake check"="successful").
- The time remaining up to the next brake check (P-0-3302) is set to 15 minutes.
- The warning "E3115 Prewarning, end of brake check time interval" is suppressed in favor of the diagnostic command message "C62".

While the command is active (max. 15 minutes), safety is acknowledged in the special mode. The possibly present error message F3123 can be cleared. The machine operator can now move the axis in the special mode to reach a position in which the brake check is possible. In this position, the brake check can be carried out after the special mode has been deselected and the command C6200 has been terminated.

The enabling of the special mode is removed by errors in the control circuit of the redundant holding brake. After 15 minutes, the enabling of the special mode is deactivated and the error F3115 is signaled.

When the command "C6200 Command Enabling special mode without valid brake status" is terminated, the states of holding brake check of motor brake (P-0-0539) and redundant holding brake (P-0-3301) are set to "carried out without success" again.

6.6 Safety Functions "Safety Related Feedback"

6.6.1 Safety Related Diagnostic Outputs

Via safety related diagnostic outputs, "safety related detected states" are transmitted from the drive to other system components (e.g. control of safety relays, safety PLC) in order to initiate, from these system components, a reaction to the process.



When PROFIsafe is used, the safety related diagnostic message is not output via the safety related diagnostic outputs, but the signal is handled as a PLC signal and constantly stored in the F-data to the control unit in the PROFIsafe protocol (see also "PROFIsafe").

6.6.2 Safety Related Control of a Door Locking Device

In a drive controller, it is possible to activate a diagnostic master for several axes within a protective zone which recognizes the safety related status of these axes and controls the locking device of the safety door.

In the case of the safety function "safety related control of a door locking device", the locking device of an interlocking guard is controlled via two channels when all axes of this zone are in the safety related status. The position monitor of the locking device is monitored, too.



Position monitoring of the interlocking guard is still required.



When PROFIsafe is used, safety related control of the door locking device is not possible.

6.6.3 Safety Related I/Os

Brief Description

When you use the safety related master communication PROFIsafe via PRO-FIBUS, the drive-internal safety functions are controlled via PROFIsafe. The safety related 2-channel inputs (a maximum of 4 per axis) and the 2-channel safety related output (one per axis) available in the drive can be made available to a higher-level safety PLC.

Sensors such as switches, E-Stop pushbuttons and light barriers can be connected to the safety related inputs. Actuators such as contactors, valves and brake can be connected to the safety related output.



Using the function "safety related I/Os" requires the optional safety technology module ("S1") and the master communication PROFIBUS ("PB") which can be selected as configuration for the control sections CSH01.1 or CSH01.2 (ADVANCED) and CDB01.1 (BASIS).

The function is available as of firmware version MPx04.

Features

The safety function "safety related I/Os" has the following features:

- Has been realized for personal protection in accordance with EN 954-1 category 3.
- Safety related I/Os can only be used in conjunction with PROFIsafe.
- 3 or 4 safety related inputs per axis in N/C-N/O combination. When you use the safety related reference, only 3 safety related inputs are available.
- 1 safety related output per axis, optionally as Plus-Plus-switching output or Plus-Minus-switching output.
- The freely configurable digital inputs/outputs (24 V) for channel 1 can be realized in the following ways:
 - Using digital I/Os at the control section of the single-axis device (e.g. CSH01.1) at terminal connector X31 / 32

Integrated Safety Functions

- Using digital I/Os at the control section of the double-axis device (CDB01.1) at terminal connector X31 / X32 / X33 / X34
 - Using digital I/Os at an I/O extension (MD1) at terminal connector X10
 - The digital inputs/outputs (24 V) for channel 2 are situated on the optional safety technology module ("S1") at terminal connector X41.
- Pertinent Parameters** The following parameters are used in conjunction with the safety function "safety related I/Os":
- P-0-0300, Digital I/Os, assignment list
 - P-0-0301, Digital I/Os, bit numbers
 - P-0-0302, Digital I/Os, direction
 - P-0-0303, Digital I/Os, status display
 - P-0-0304, Digital I/Os, outputs
 - "P-0-3211, Safety technology I/O configuration list, channel 2" or "P-0-3211, Safety technology I/O control word, channel 2"
 - "P-0-3212, Safety technology control word, channel 1" or "P-0-3212, Safety technology signal control word, channel 1"
 - "P-0-3214, Safety technology status word, channel 1" or "P-0-3214, Safety technology signal status word, channel 1"
 - P-0-3216, Active safety technology signals
 - P-0-3221, Max. tolerance time for different channel states
 - P-0-3295, Safety technology field bus configuration
 - P-0-3296, Safety technology field bus control word
 - P-0-3297, Safety technology field bus status word

Configuring the Safety Related I/Os

The digital I/Os of the drive controller which are used have to be accordingly configured during safety technology commissioning:

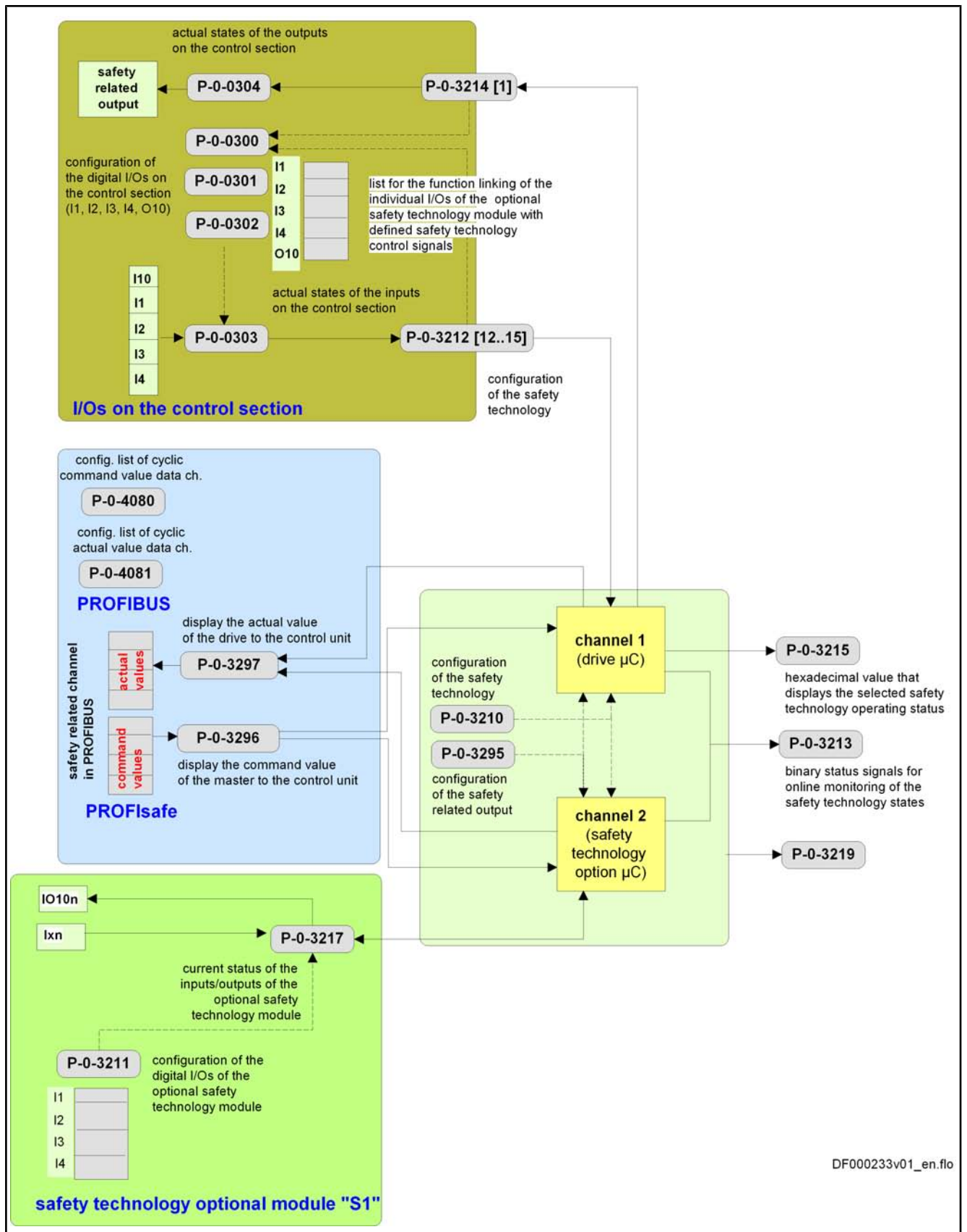
- Digital I/Os on the control section or an I/O extension (channel 1) have to be configured (like all other digital I/Os in the drive) via the following parameters:
 - P-0-0300, Digital I/Os, assignment list
 - P-0-0301, Digital I/Os, bit numbers
 - P-0-0302, Digital I/Os, direction

See also Functional Description of firmware "Digital Inputs/Outputs"

- The digital I/Os situated on the optional safety technology module have to be configured by means of "P-0-3211, Safety technology I/O configuration list, channel 2" or "P-0-3211, Safety technology I/O control word, channel 2".



To simplify commissioning, the commissioning software IndraWorks D provides a commissioning wizard.



DF000233v01_en.flo

Fig. 6-48: Communication PROFIsafe and safety related I/Os

Integrated Safety Functions

Functional Principle

Safety Related Inputs

It is only possible to connect sensors of the design N/C-N/O combination to the safety related inputs. As illustrated in the figure below, the connected sensors are dynamized by a dynamization master to detect "sleeping errors" (see "Dynamization").

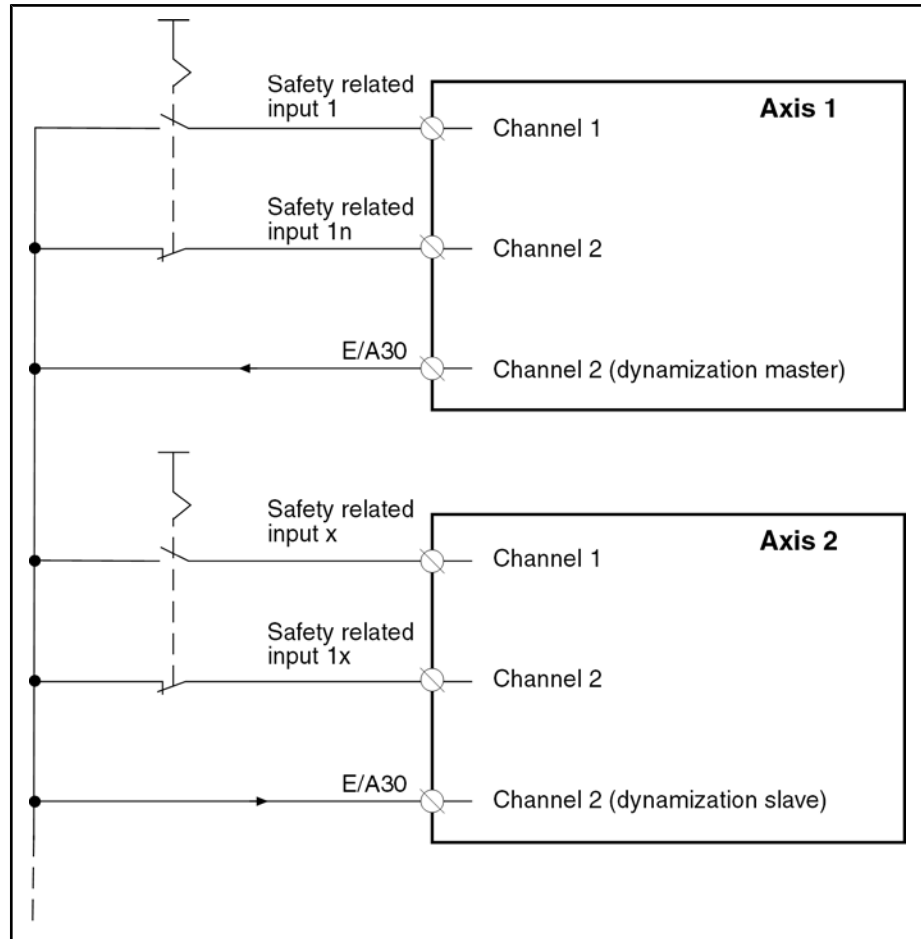


Fig.6-49: Safety related inputs with dynamization by the drive

The results of the signal evaluation of the safety related inputs are not directly transmitted to the corresponding data container of the safety bus, as these results are synchronized due to the possibly different signal run times between channel 1 and channel 2. In parameter "P-0-3221, Max. tolerance time for different channel states", you can set the time within which the safety related inputs of channel 1 and channel 2 may have different signal states.

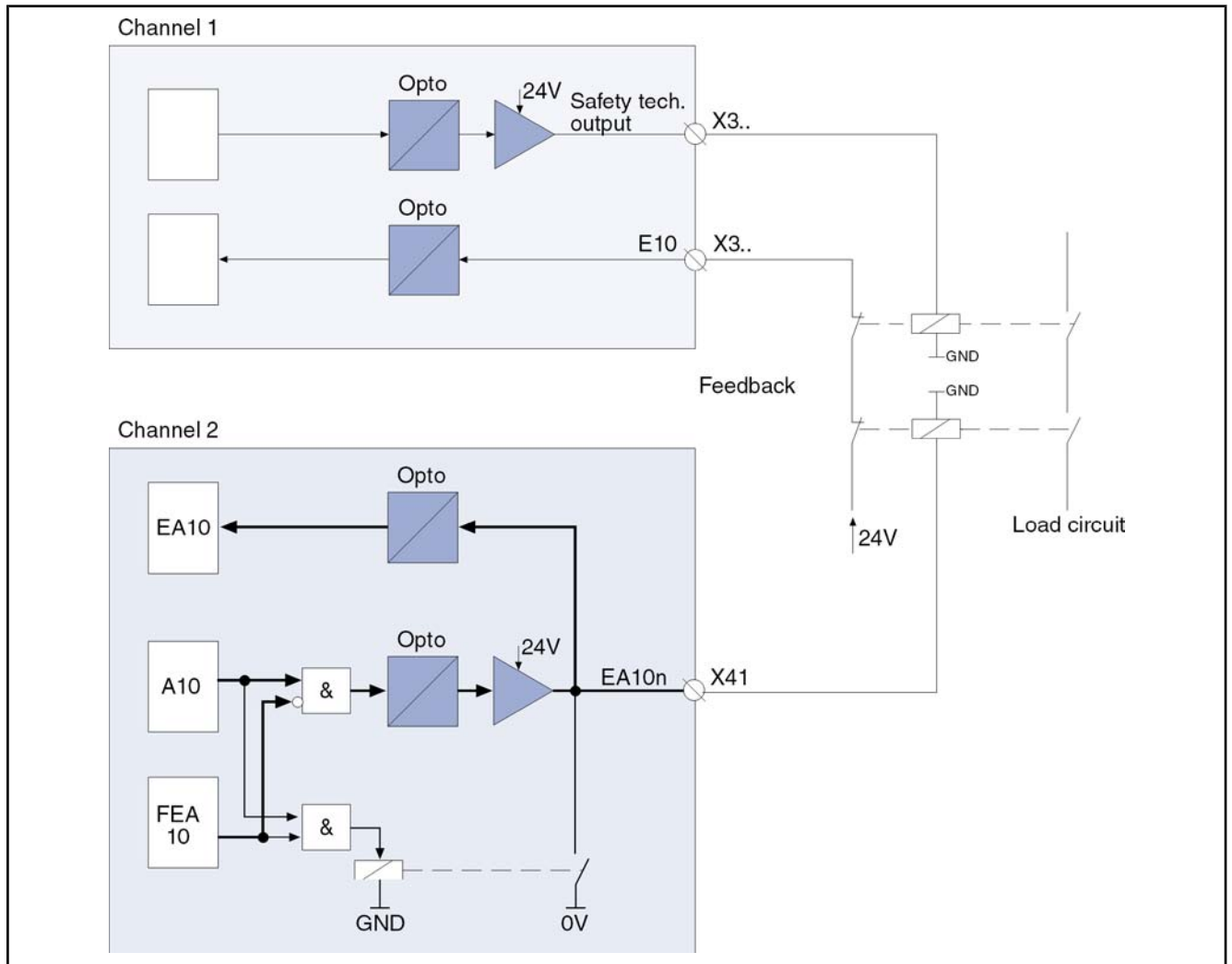
Safety Related Output

The safety related output can be designed in two variants as Plus-Plus-switching output or Plus-Minus-switching output. The safety related output is activated and parameterized in parameter "P-0-3295, Safety technology field bus configuration".

Plus-Plus-switching output

In the Plus-Plus-switching design, the two outputs (channel 1 X3x and channel 2 X41) only switch one load circuit. In their active status, both channels output 24 V. Feedback on the current status of the load circuit takes place via two N/C contacts connected in series which are supplied with 24 V.

With non-activated safety related output, the two channels are not controlled (open); the load circuit in this case is in the safety related status (corresponds to "Safety Default" status).



Note The active part in channel 2 has been marked bold.

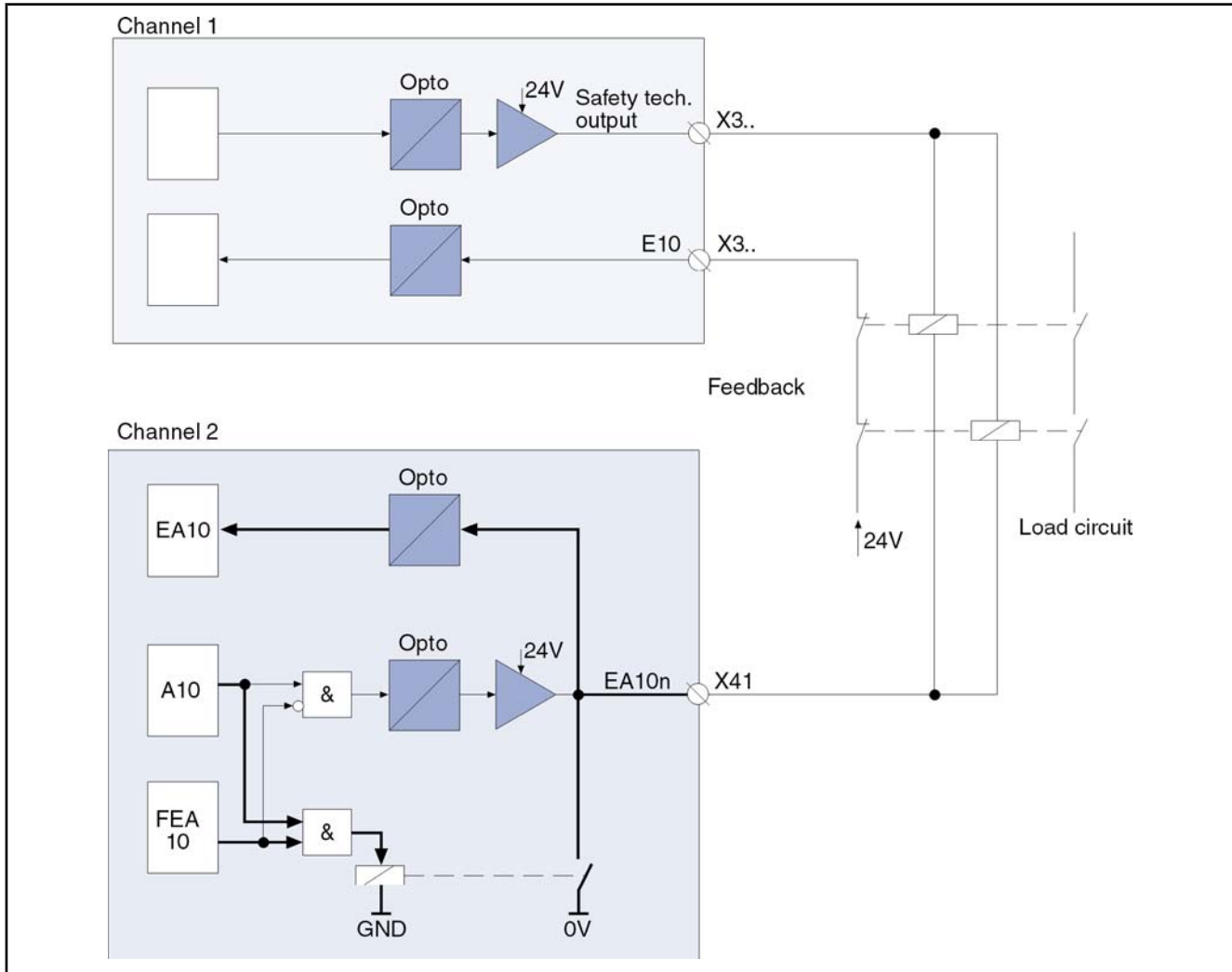
Fig.6-50: Plus-Plus-switching output

Plus-Minus-switching output

In the Plus-Minus-switching design, channel 1 (X3x) is Plus-switching, i.e. output of 24 V when output active, and channel 2 (X41) is Minus-switching, i.e. output of 0 V when output active. This variant can be used for safety related control of a coil (e.g. brake, contactor, ...). With activated safety related output, both channels are controlled (channel 1 active => 24 V and channel 2 active => 0 V). Feedback on the current status of the load circuit takes place via an N/C contact which is supplied with 24 V.

With non-activated safety related output, the two channels are not controlled (open); the load circuit in this case is in the safety related status (corresponds to "Safety Default" status).

Integrated Safety Functions



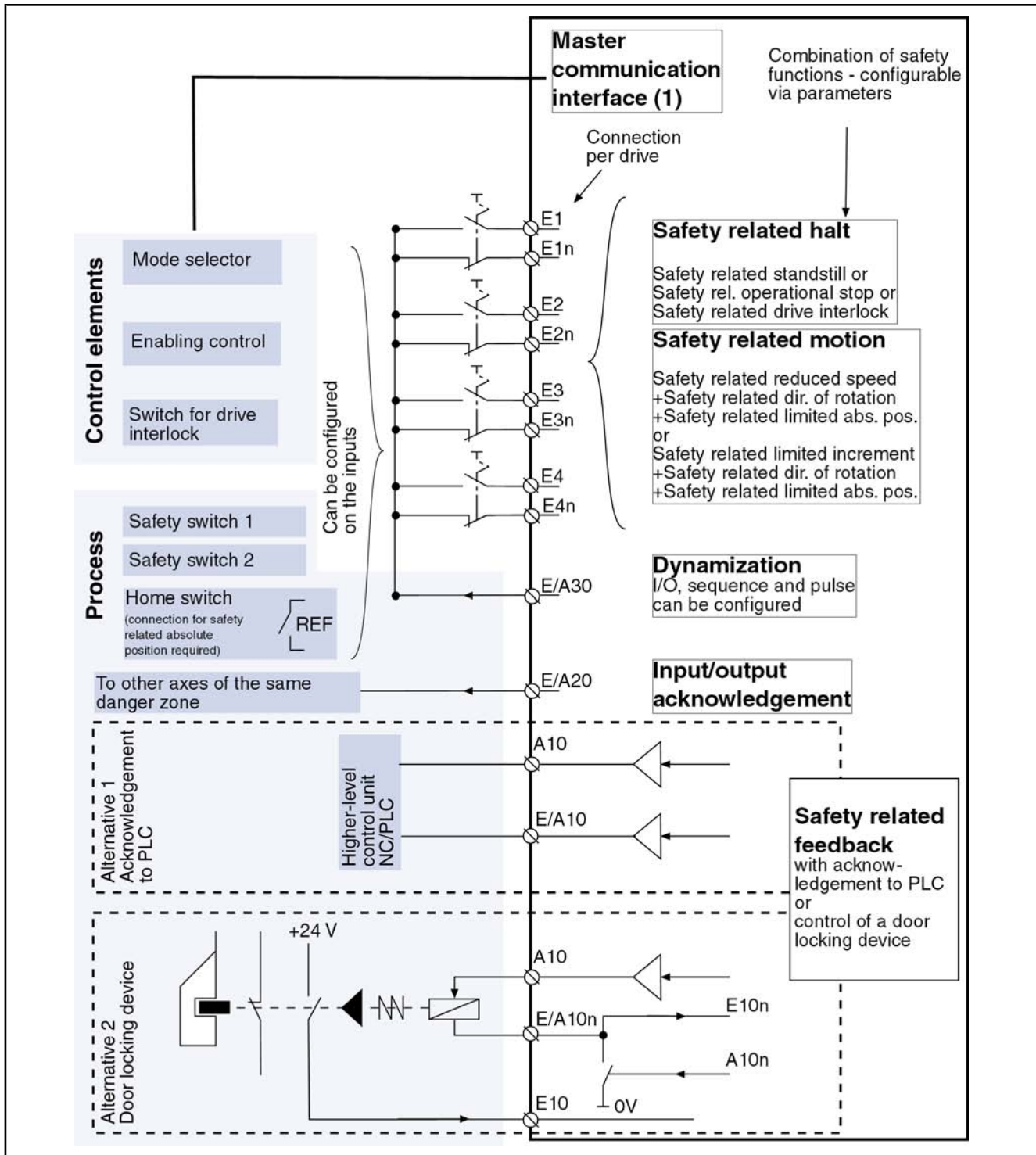
Note
 Fig.6-51: The active part in channel 2 has been marked bold.
 Plus-Minus-switching output

7 Examples of Application

7.1 Overview

Functionality and connections for integrated safety technology at the IndraDrive controller.

Examples of Application



1 Alternatively, channel 1 can be selected via the master communication.
 E1, ... , E4 Channel 1 for selection and reference input
 E1n, ... , E4n Channel 2 for selection inverted and reference input
 Fig. 7-1: Overview



A maximum of 4 safety functions can be selected at the inputs: E1 to E4 for channel 1 and E1n to E4n for channel 2. Configuration takes place via parameters.

7.2 Selecting Normal Operation/Special Mode With Position Monitoring of Safety Door With Door Locking Device

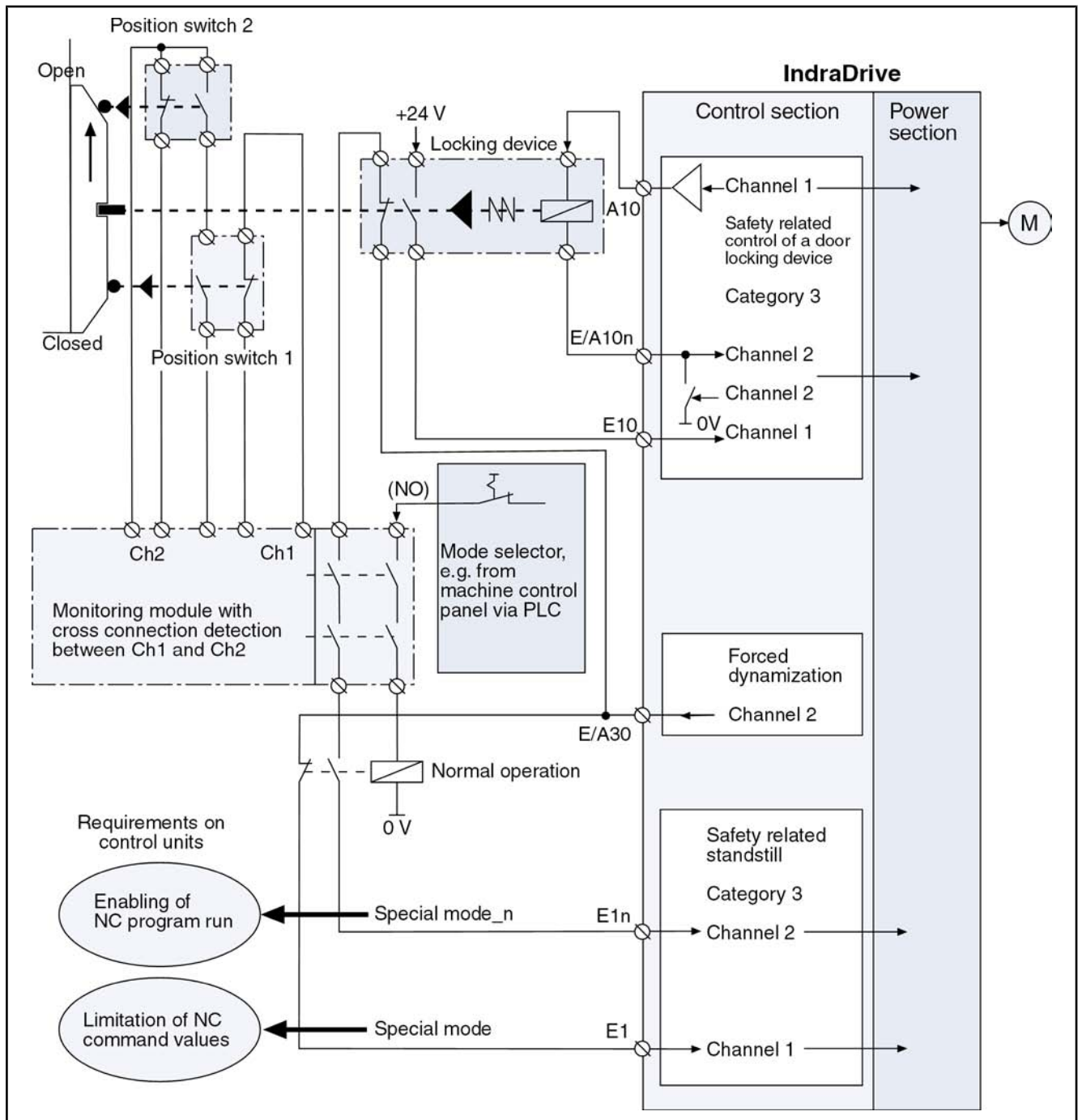


Fig.7-2: Single-channel mode selector combined with position monitoring of a safety door with door locking device

Examples of Application

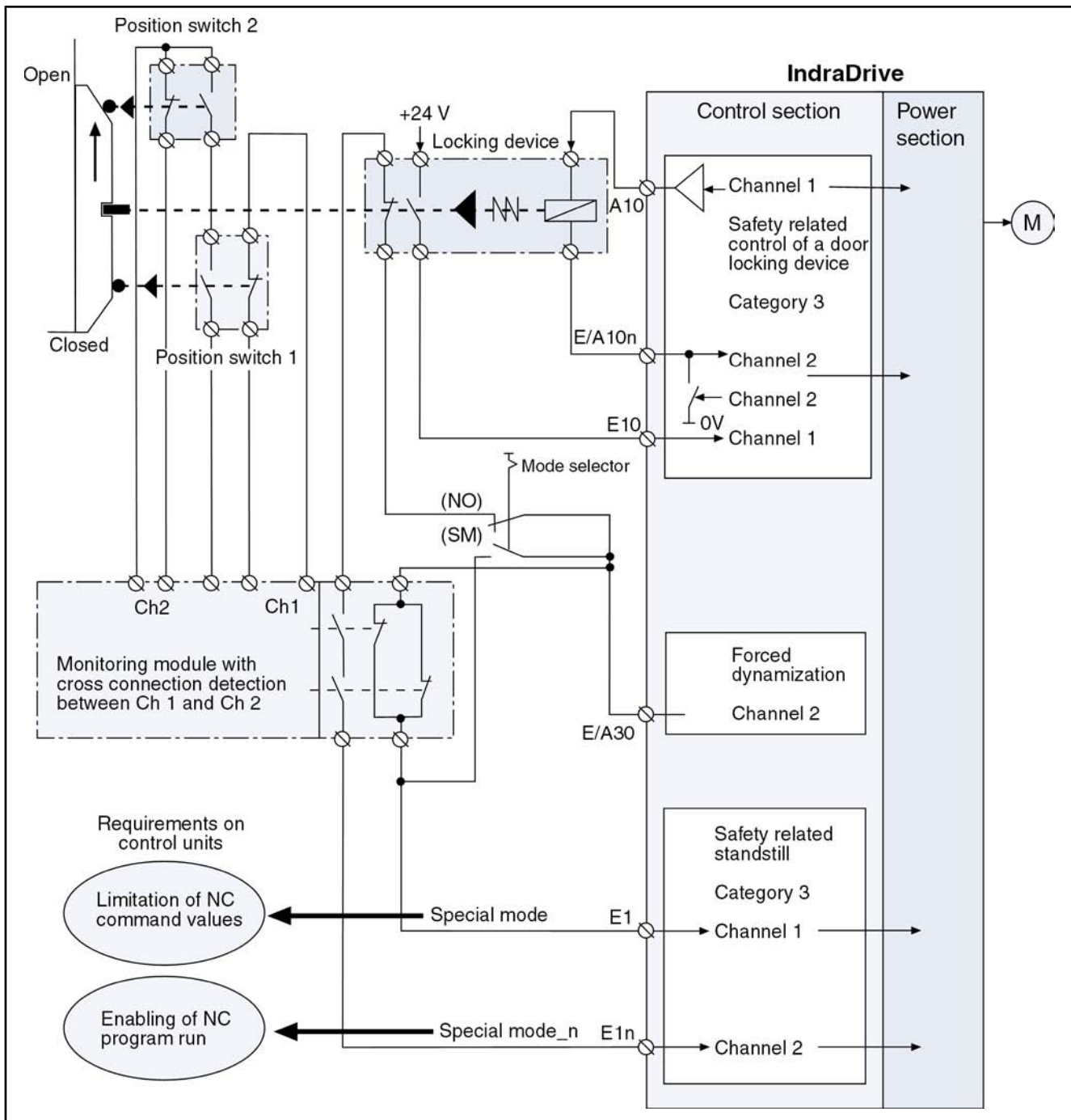


Fig.7-3: Dual-channel mode selector combined with position monitoring of a safety door with door locking device

7.3 Enabling Control With Three Positions

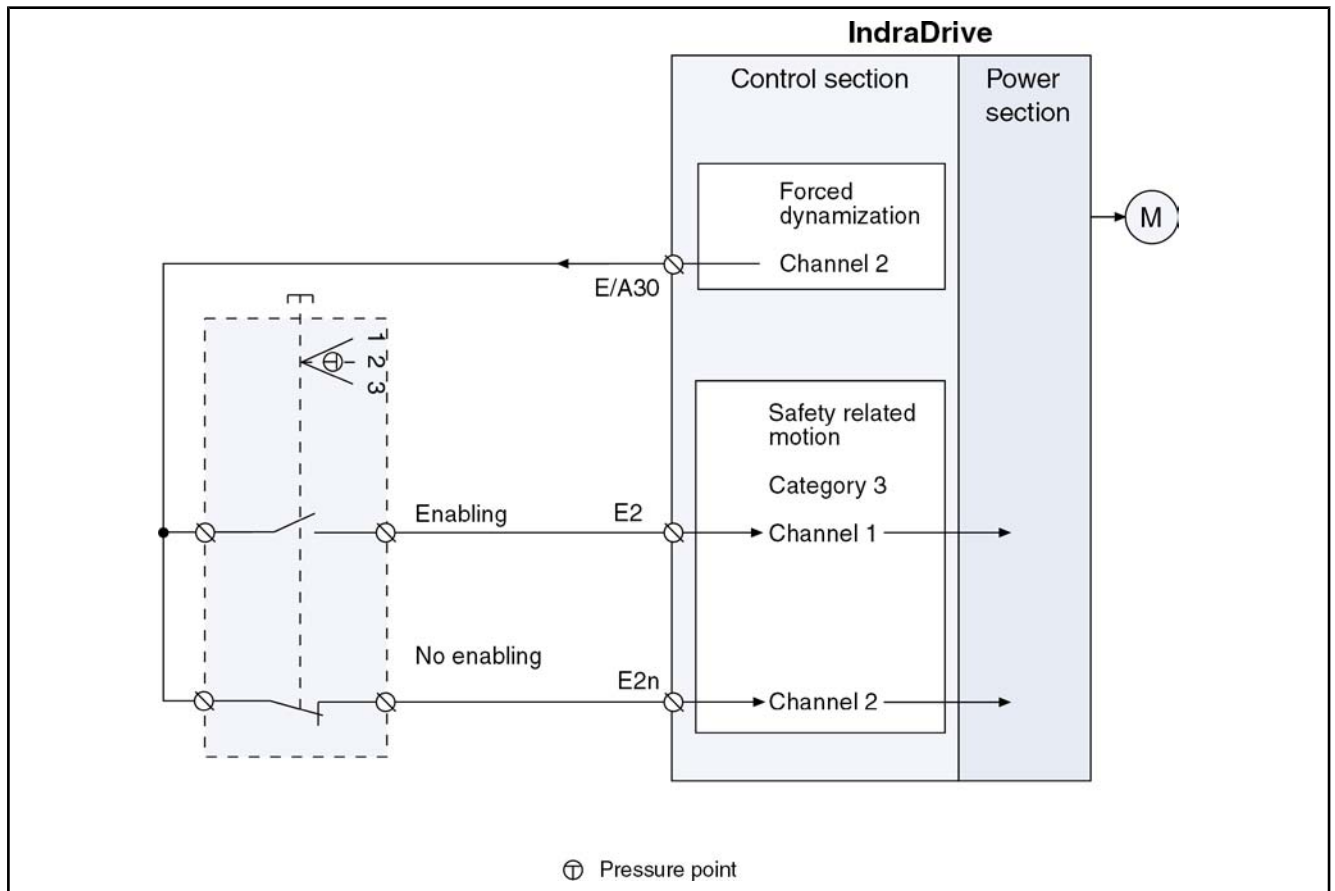


Fig.7-4: Enabling control with three positions

7.4 Hold-to-Run Control Device (Safety Related Hold-to-Run Pushbutton)

Control devices must correspond to category 3 according to EN 954-1. If this category cannot be reached, this function has to be combined with an enabling control.



Possible control devices for initiating a safety related monitored motion according to table 2, para. 14.1.1 of EN 12417 "Machine tools – Safety – Machining centres":

- Single-channel hold-to-run pushbuttons (+/- direction) combined with a dual-channel enabling control. Enabling control is controlled according to category 3 of EN 954-1.
- Single-channel preselection switches (+/- direction) combined with a dual-channel enabling control. Enabling control is at the same time hold-to-run pushbutton. Enabling control is controlled according to category 3 of EN 954-1.
- Dual-channel hold-to-run pushbuttons (+/- direction). Hold-to-run control is controlled according to category 3 of EN 954-1.

Examples of Application

7.5 Temporary Inspections or Visual Checks in the Danger Zone

If "safety related operational stop" is selected in special mode, a workpiece check can be carried out in the processing area / danger zone, for example.

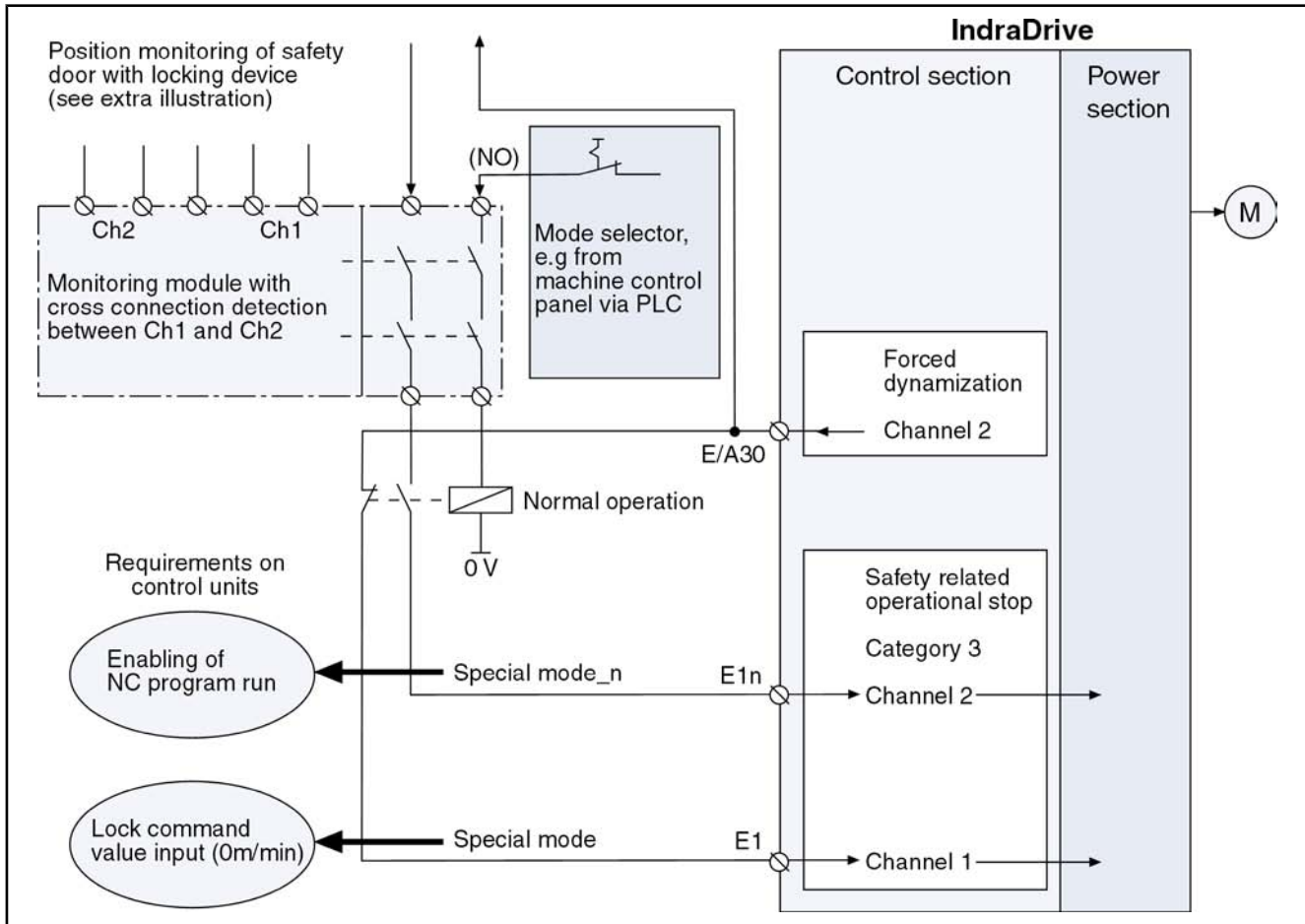


Fig.7-5: Safety related operational stop; the drive is monitored for standstill

In special mode, movement for a visual check in the processing area / danger zone can be executed by actuating the enabling control (selecting safety related reduced speed) and by means of the travel command.

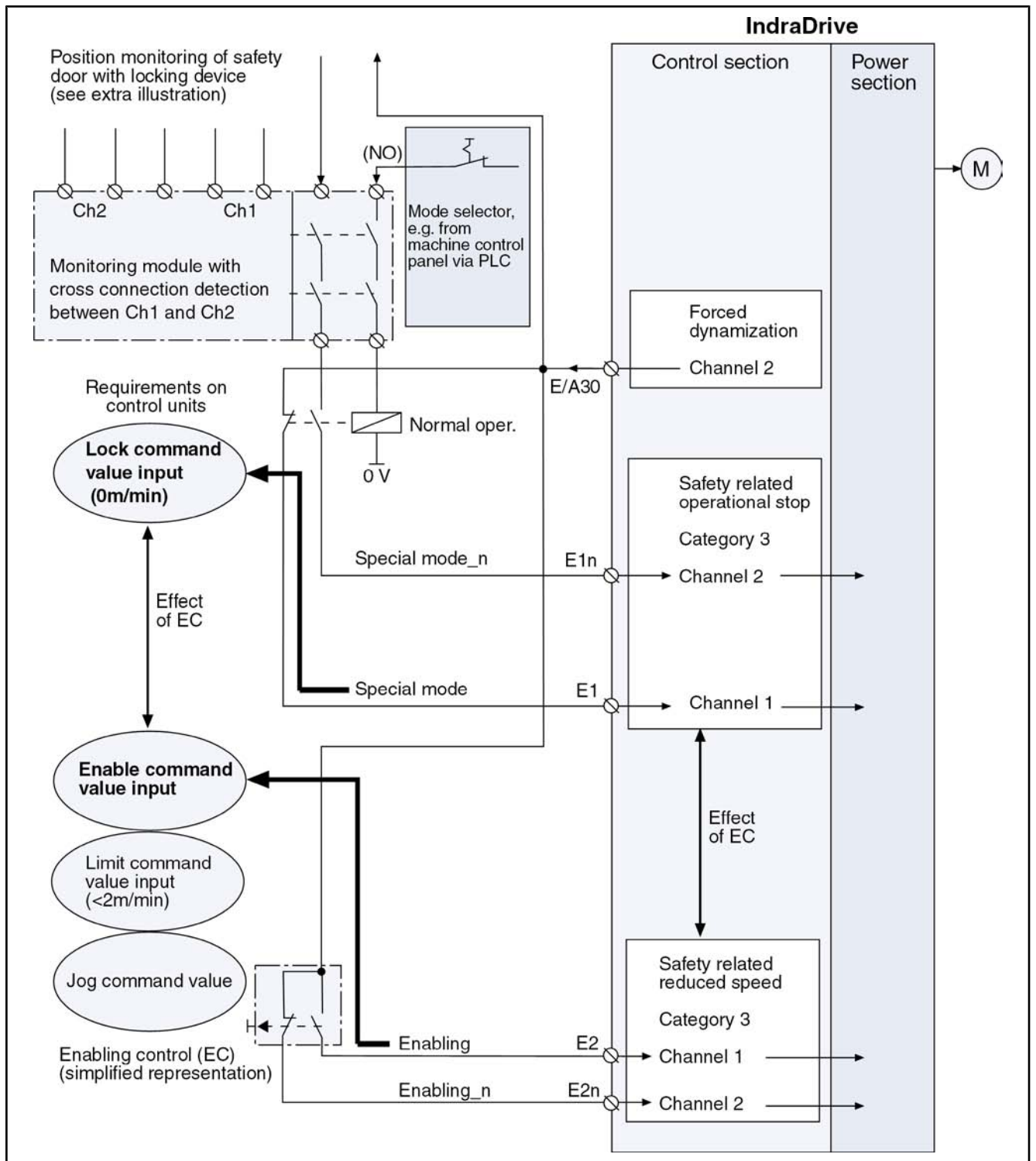


Fig. 7-6: Safety related operational stop / safety related reduced speed; the drive is monitored for standstill / movement

7.6 Working When Drive is Without Torque/Force

If, for example, tools are to be changed manually, the function "drive interlock" must be activated (separate switch in addition to the mode selector and the enabling control); in this way, it is possible to manually move the shaft using the tool spindle.

Examples of Application

The power supply to the motor is interrupted in a safety related way. No standstill monitor is active. The drive interlock cannot be disabled by actuating the enabling control.

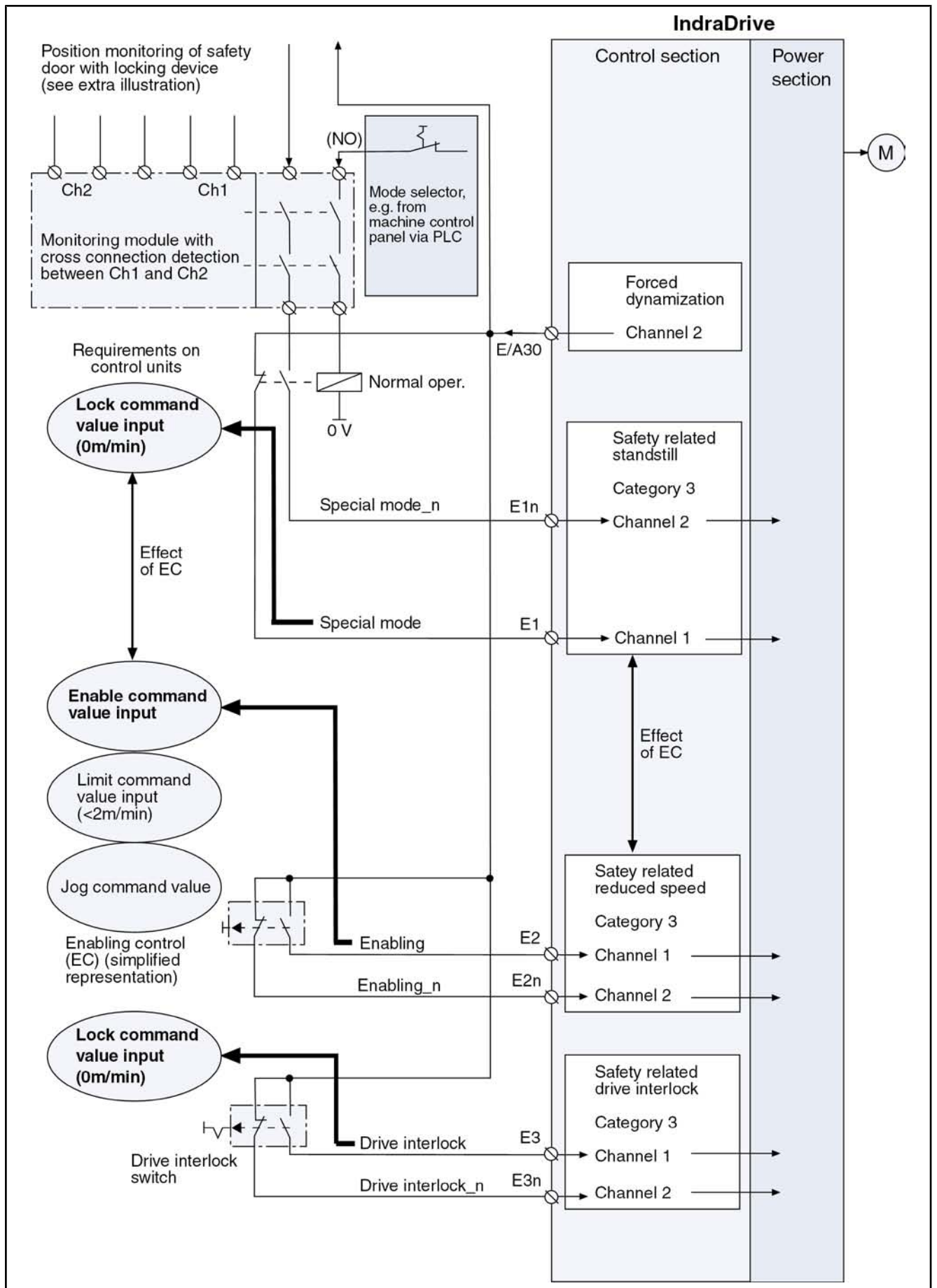


Fig.7-7: Safety related drive interlock; the power supply to the drive is interrupted

Examples of Application

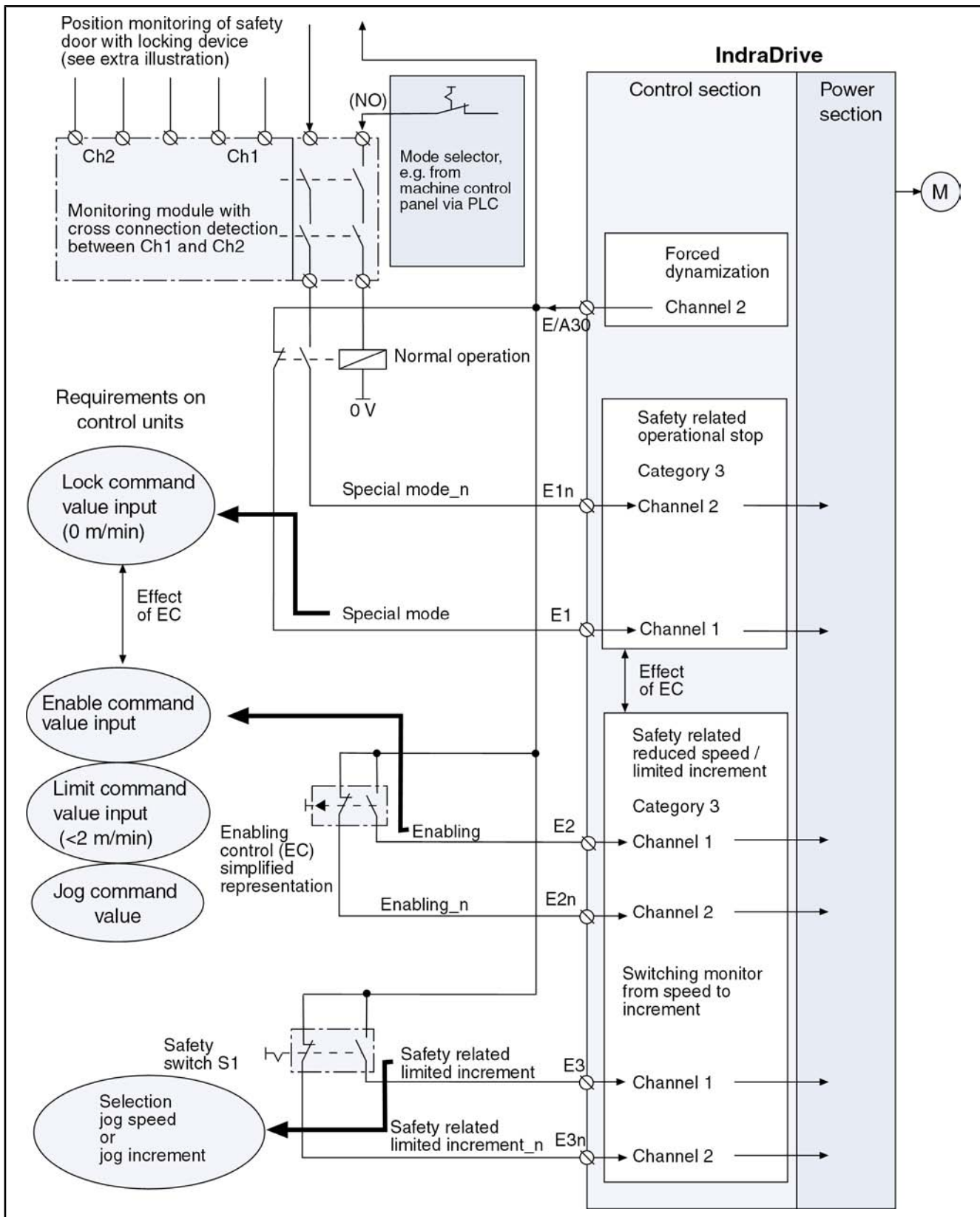


Fig. 7-8: "Safety related reduced speed" or "Safety related limited increment"; the drive is monitored for speed/standstill or increment/standstill

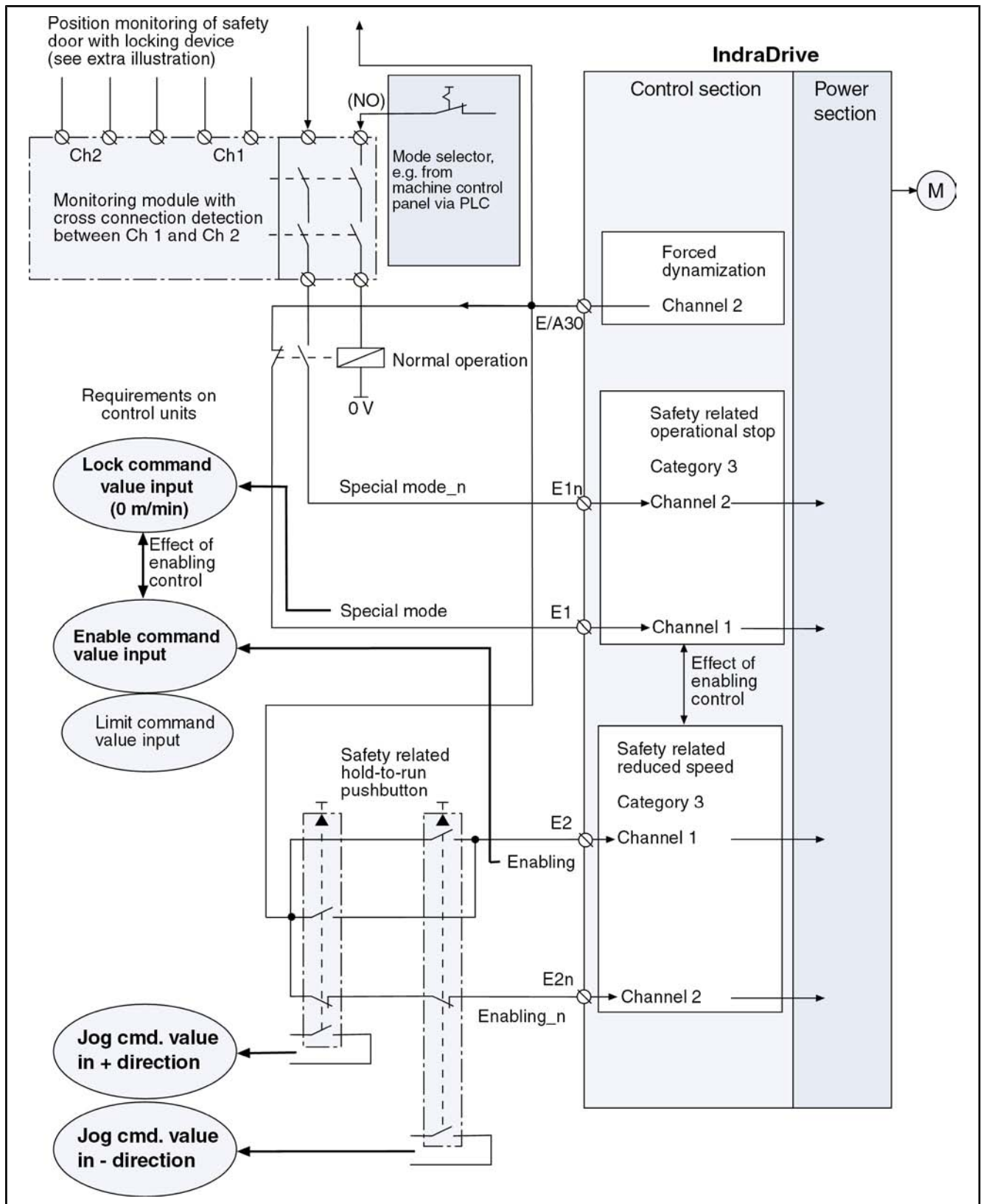


Fig.7-9: Hold-to-run control device (safety related hold-to-run pushbutton)

Examples of Application



For information on the safety related hold-to-run pushbuttons, please see "[Hold-to-Run Control Device \(Safety Related Hold-to-Run Pushbutton\)](#)".

7.7 Drive Groups for Different Danger Zones

The figure below shows two machining areas of one machine. Each of these machining areas forms a separate danger zone.

The illustrated operating status is as follows:

- Danger zone A is in normal operation with drives A1, A2 and A3. The access door is closed.
- Danger zone B is in special mode with an open safety door and with drives B1, B2 and B3. One person is doing setup work or insertion work in the danger zone.

The door locking device is enabled or locked by the diagnosis master of a drive that belongs to the corresponding danger zone. Via the bidirectional connection E/A20, all drives in the corresponding danger zone are queried when switching from normal operation to special mode.

By means of the enabling control (not shown in the figure), the person can now move the drives in danger zone B.

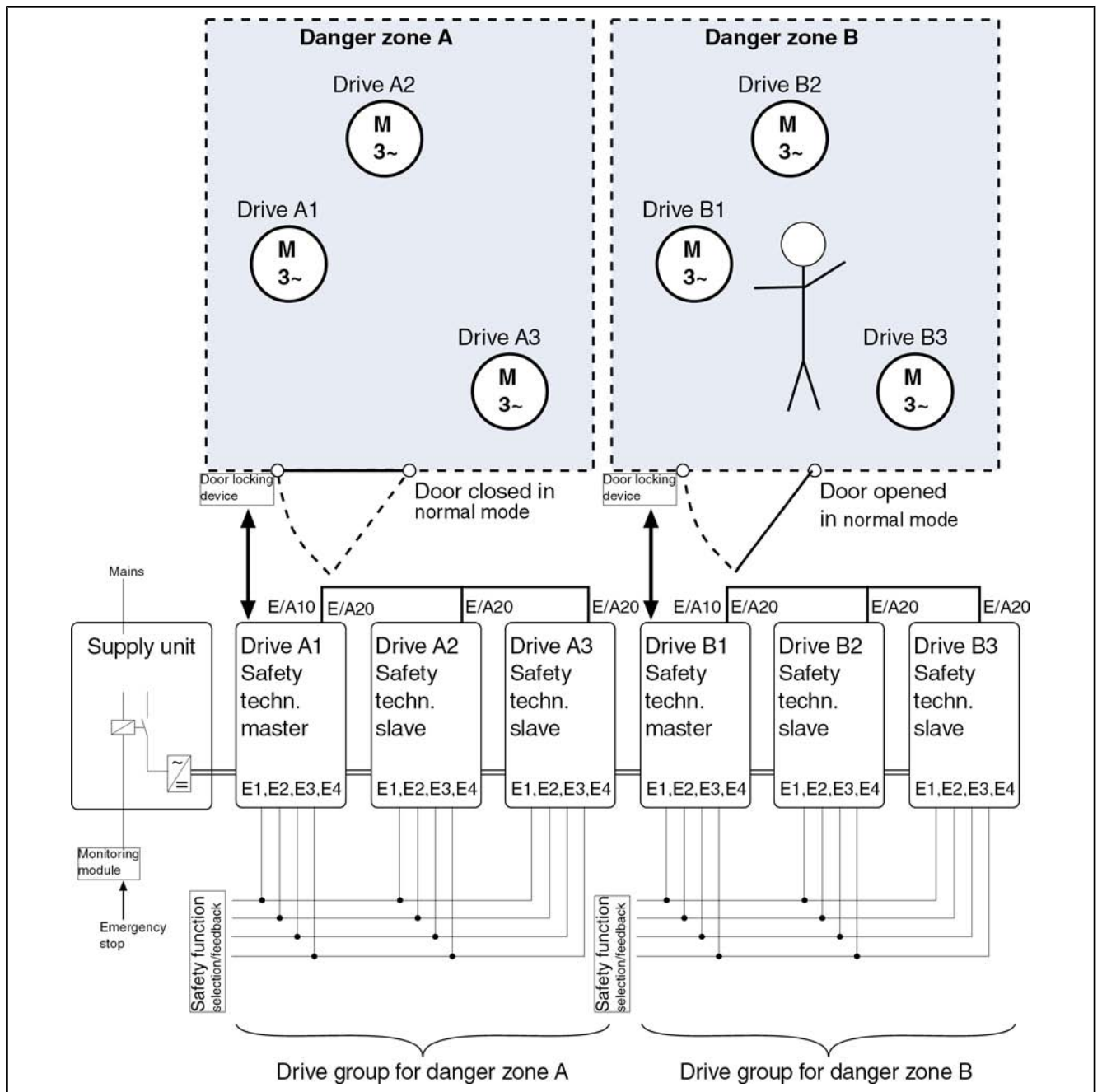


Fig. 7-10: Drive groups for different danger zones

Examples of Application

7.8 Safety Related Control of the Door Locking Devices of Several Safety Doors

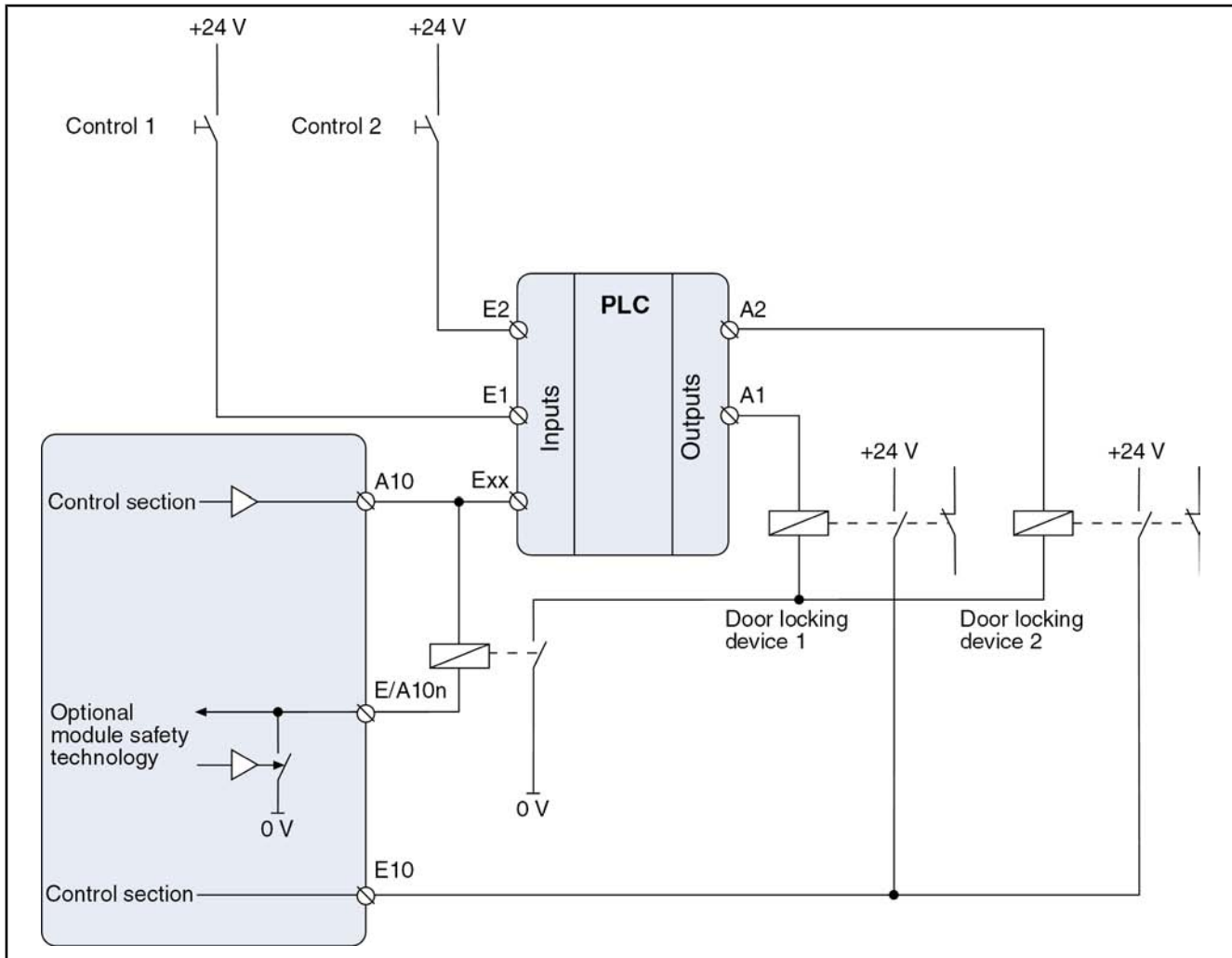


Fig.7-11: Safety related control of the door locking devices of two safety doors, with selection via standard PLC

8 Commissioning the Safety Technology

8.1 Introduction

The integrated safety technology is a dual-channel system in which a second processor redundantly carries out the monitoring functions. The processor uses the known system data of encoder, mechanical system and scaling of the main system and stores them in the system/parameter memory. Changing these data is no longer allowed after safety technology has been commissioned. Changes are detected and acknowledged with error / warning. After the system was changed, it is necessary to commission the safety technology again.

All direct safety technology parameters are characterized by double input which is realized in such a way that individual parameters have to be written by a list of two equal values. Tables are of double size, the same table being attached as a copy. This allows carrying out a validation test of the data, also in the case of an input via SERCOS monitor.

All safety technology parameters must be write-protected by a password to be assigned by the user. The safety technology is activated at the same time that the password is assigned.



For commissioning the safety technology, you should always use the current release of the corresponding firmware version.

Otherwise, take the corresponding manufacturer information on detected and solved problems into account and verify their relevance for the machine application.

For the manufacturer information, see drive information portal under www.boschrexroth.com.

8.2 Prerequisites for Using Integrated Safety Technology

8.2.1 General Information

The IndraDrive system (axis / spindle / roll) consists of the components control section, power section and motor.

By the interaction of hardware and software components, IndraDrive provides the "integrated safety technology".

8.2.2 Required Drive Firmware

The drive-integrated safety technology is a functionality only scalable by means of the hardware and does **not require any additional enabling of functional firmware packages**.

The integrated safety functions via I/Os (optional module "S1") and the function "safety related starting lockout" (optional module "L1") can be used as of firmware version MPx02VRS.

PROFIsafe can be used as of firmware version MPx03VRS.

See also Functional Description of firmware "Firmware Types"

8.2.3 Required Control Section 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.

Commissioning the Safety Technology

Safety Related Starting Lockout

Using the function "safety related starting lockout" requires the optional safety technology module "starting lockout" ("L1"). The optional module "starting lockout" can be configured for the following control sections:

- Single-axis BASIC UNIVERSAL (CSB01.1C)
- Single-axis BASIC SERCOS (CSB01.1N-SE)
- Single-axis BASIC PROFIBUS (CSB01.1N-PB)
- Single-axis BASIC Analog (CSB01.1N-AN)
- Single-axis ADVANCED (CSH01.1C and CSH01.2C)
- Double-axis BASIC UNIVERSAL (CDB01.1C)



For pin assignments and technical data of the optional safety technology module "L1", please see the Project Planning Manual for the control section or the Appendix: [X41, Connection Point Starting Lockout L1](#).

Safety Technology I/O

The following control sections can use the integrated safety functions via I/Os, if they have been configured with the optional safety technology module ("S1"):

- Single-axis ADVANCED (CSH01.1C and CSH01.2C)
- Double-axis BASIC UNIVERSAL (CDB01.1C)



Using the integrated safety technology requires one optional module "safety technology I/O" ("S1") **per axis** in conjunction with the firmware component.

For pin assignments and technical data of the optional safety technology module "S1", please see the Project Planning Manual for the control section or the Appendix: [X41, Connection Point Safety Technology S1](#).

PROFIsafe

The following control sections can use the integrated safety functions via PROFIBUS (PROFIsafe), if they have been realized with the optional safety technology module ("S1") and the master communication PROFIBUS ("PB"):

- Single-axis ADVANCED (CSH01.1C-PB and CSH01.2C-PB)
- Double-axis BASIC UNIVERSAL (CDB01.1C-PB)

See also "Project Planning Manual for control sections"



Using the integrated safety technology requires one optional module "safety technology I/O" ("S1") **per axis** in conjunction with the firmware component and a master communication module PROFIBUS ("PB").

For pin assignments and technical data, please see the "Project Planning Manual for the control section" or the Appendix: ["X41, Connection Point Safety Technology S1"](#).



PROFIsafe can be used as of firmware version MPx03VRS.

8.2.4 Required Power Sections

All power section of the IndraDrive system have been designed for using the integrated safety technology.

8.2.5 Required Motors and Measuring Systems

All Rexroth **motors** have been basically designed for using the integrated safety technology; the **decisive** factor is the **motor encoder type** which is used.

Allowed and inadmissible encoder types:

Allowed Encoder Types

When using the optional safety technology module "S1", the following encoder types can be used:

- Encoders with 1 Vpp signals (e. g. EnDat, HIPERFACE,...) can be used for integrated safety technology.
- Resolvers supported by the encoder interface can be used for integrated safety technology.



Please observe that the encoder can also be evaluated by the corresponding encoder option (EN1, EN2, ENS) (see "Project Planning Manual for the control section").

When using the optional safety technology module "S1", it is **always** the encoder at the optional slot **X4** (X4.1 and X4.2 for double-axis devices) which is evaluated for the safety functions.

The following encoder types are supported (depending on the firmware version used):

		Encoder type (P-0-0074, P-0-0075)									
		1	2	3	4	6	8	10	14	15	16
MPx02	As of V06	x	x	x	-	-	x	-	x	-	-
	As of V11	x	x	x	x	-	x	x	x	-	-
	As of V14	x	x	x	x	x	x	x	x	-	-
MPx03	As of V04	x	x	x	x	x	x	x	x	-	-
	As of V28	x	x	x	x	x	x	x	x	-	x
MPx04	As of V02	x	x	x	x	x	x	x	x	x	-
	As of V22	x	x	x	x	x	x	x	x	x	x
MPx05	As of V02	x	x	x	x	x	x	x	x	x	-
	As of V08	x	x	x	x	x	x	x	x	x	x

Fig. 8-1: Allowed encoder types depending on the firmware version used

Inadmissible Encoder Systems

When using the optional safety technology module "S1", the following encoder types **cannot** be used:

- Encoders with TTL interface cannot be used for integrated safety technology.
- Encoders which only have a serial interface cannot be used for integrated safety technology.

Allowed Motor Holding Brake

When the safety function "safety related braking and holding system" is to be used with an integrated motor holding brake, it is only allowed to use an electrically releasing friction surface brake.

8.2.6 Required Commissioning Tools

One of the following tools is required for commissioning the safety technology:

- Any commissioning tool for visualizing and modifying parameters
- Commissioning software IndraWorks with safety technology wizard

Commissioning the Safety Technology

8.3 Commissioning the Function "Safety Related Starting Lockout" (Optional Safety Technology Module "L1")

8.3.1 Overview

The function "safety related starting lockout" can preferably be commissioned by means of the dialog "Starting Lockout" in the commissioning software IndraWorks or manually.



The following commissioning steps describe the commissioning by means of the dialog "Starting Lockout". 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 "safety related starting lockout", e.g. due to the weight of the load in the case of a vertical axis, this motion has to be safely prevented by additional measures, e.g. by a mechanical brake or weight compensation.
 - ⇒ In this case, all cases of operation occurring in the application must be taken into account, including mains failure and tripped fuses.
 - ⇒ In the case of danger to persons, Bosch Rexroth recommends the Rexroth safety related braking and holding system.
-

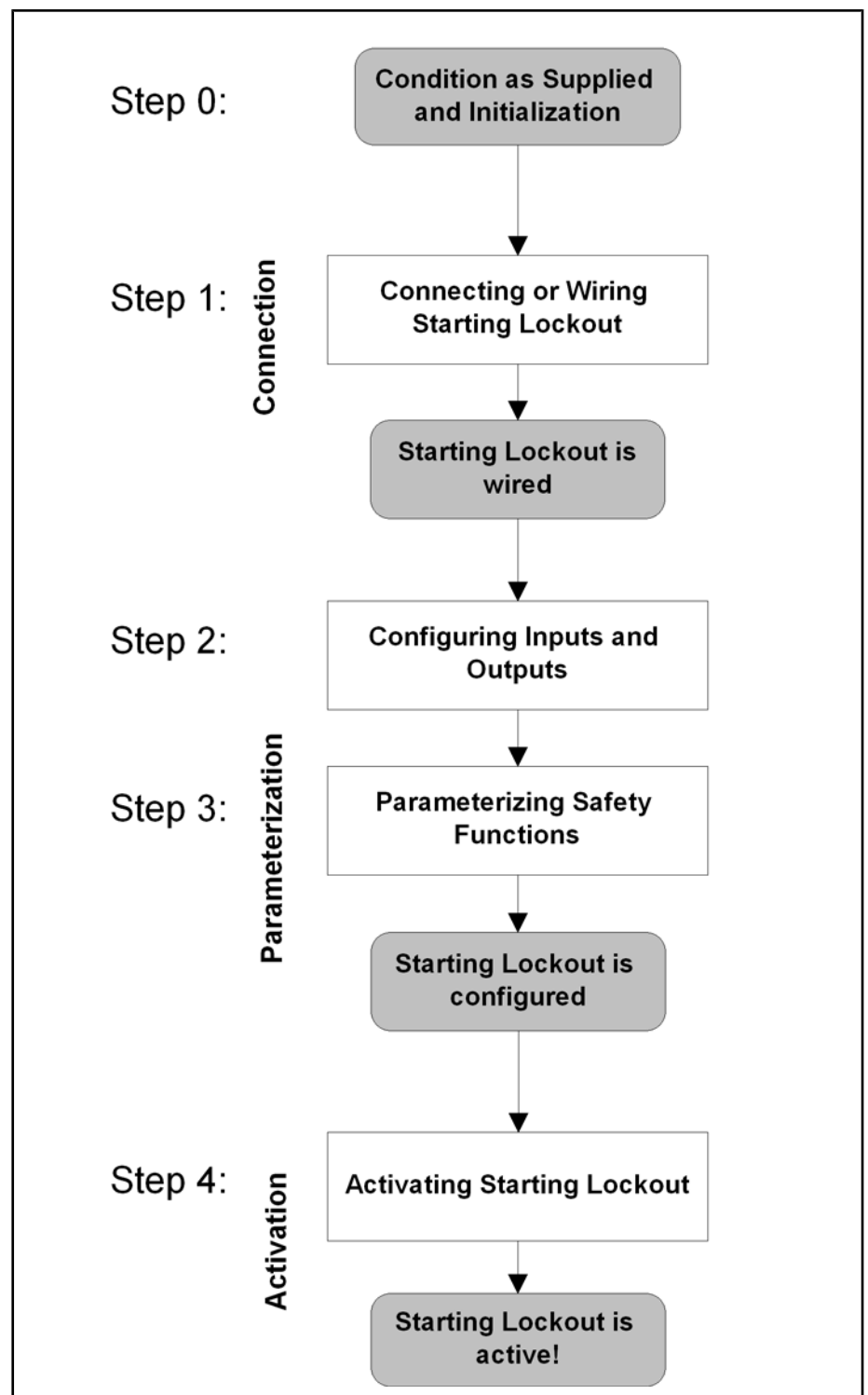


Fig. 8-2: Overview - commissioning steps of starting lockout

8.3.2 Commissioning Steps

Step 0: Condition as Supplied and Initialization

The starting lockout is always active and cannot be deactivated. **In the condition as supplied**, the following default parameter setting is active:

- Selection configuration: N/C - N/O combination
- Time interval of forced dynamization: 8 hours

Commissioning the Safety Technology

After the booting process, the drive system is in the operating status "starting lockout"; i.e. the output stage has been switched off via two channels. Depending on the selection, safety is acknowledged or not.

When the drive is switched from **operating mode to parameter mode**, the functionality of starting lockout is maintained, i.e. according to the selection, starting lockout becomes active or not.

Step 1: Connecting or Wiring Starting Lockout

The connection or wiring of the starting lockout depends on the possibility used to make the selection and carry out the acknowledgment at the drive:

- Selection via N/C - N/O combination:
 - Connection N/C: ASn (X41/2)
 - Connection N/O: AS-B (X41/3)
 - Connect unassigned input AS-A (X41/1) to 0 V
- Selection with two N/C contacts:
 - Connection N/C: ASn (X41/2)
 - Connection N/C: AS-A (X41/1)
 - Connect unassigned input AS-B (X41/3) to 0 V
- Acknowledgment: See "Safety Related Starting Lockout ("AS")" and "Project Planning Manual for the control section"

Step 2: Configuring Inputs and Outputs

Only the inputs of starting lockout can be configured. The inputs can be parameterized in the window "Safety Technology/Starting Lockout" in IndraWorks.

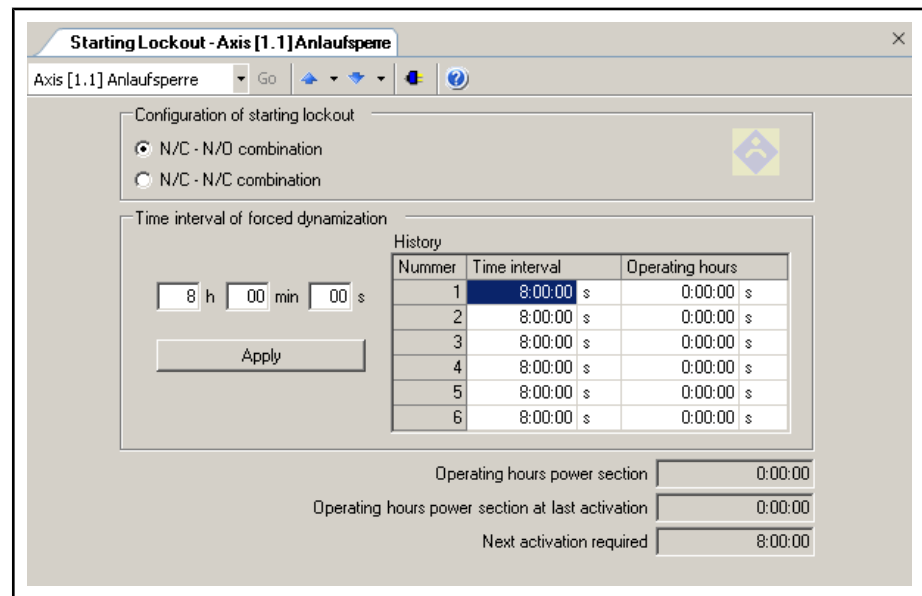


Figure name DB000086

Fig. 8-3: IndraWorks dialog "Starting Lockout"

Switch drive to parameter mode (phase 2) before starting the parameter setting. In the dialog section "Configuration of starting lockout" of the IndraWorks dialog "Starting Lockout", you can parameterize the selection; only the combinations N/C-N/O or N/C-N/C are allowed ("P-0-0101, Configuration for starting lockout selector").

Step 3: Parameterizing Safety Functions

In the dialog section "Time interval of forced dynamization" of the IndraWorks D dialog "Starting lockout", you can enter the time interval within which the starting lockout has to be activated with the drive controller being active ("P-0-0103, Time interval of forced dynamization"). The time that has been set is activated with the "Apply" button.

Step 4: Activating / Deactivating Starting Lockout



Before selecting starting lockout, shut down the drive system by means of the command value input and reset drive enable. There is no drive-controlled stopping process!

The starting lockout is automatically activated when you switch to the operating mode (phase 4). It cannot be deactivated. Changes in the parameter setting will take immediate effect.

8.4 Commissioning the Safety Technology I/O (Optional Safety Technology Module "S1")

8.4.1 Overview

The safety technology can preferably be commissioned by means of the safety technology wizard in the commissioning software IndraWorks, or manually.



The following commissioning steps describe the commissioning by means of the safety technology wizard on the basis of IndraWorks MLD 05V04. For commissioning with a different commissioning tool, the corresponding parameters which have to be set are listed.



For commissioning the safety technology, you should always use the current release of the corresponding firmware version.

Otherwise, take the corresponding manufacturer information on detected and solved problems into account and verify their relevance for the machine application.

For the manufacturer information, see drive information portal under www.boschrexroth.com.

When using the safety functions, you absolutely have to observe the following warnings:



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 when you use the safety functions, e.g. due to the weight of the load in the case of a vertical axis, this motion has to be safely prevented by additional measures, e.g. by a mechanical brake or weight compensation.

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

⇒ In the case of danger to persons, Bosch Rexroth recommends the Rexroth safety related braking and holding system.

Commissioning the Safety Technology



WARNING

Injury and/or material damage caused by deviation from standstill position!

⇒ When using the safety related operational stop or the safety related reduced speed for axes with external force influences, the drive controller might possibly no longer be able to keep the axis in position in the case of error situations (e.g. mains failure, controller defect). When the error case occurs, the axis must be kept in position by additional measures (e.g. mechanical brake).

⇒ In the time between the occurrence of the error and the triggering of a holding device, axis motion can occur. This has to be taken into account for the risk assessment of the installation.

⇒ In the case of danger to persons, Bosch Rexroth recommends that you use the Rexroth safety related braking and holding system.

Commissioning the Safety Technology

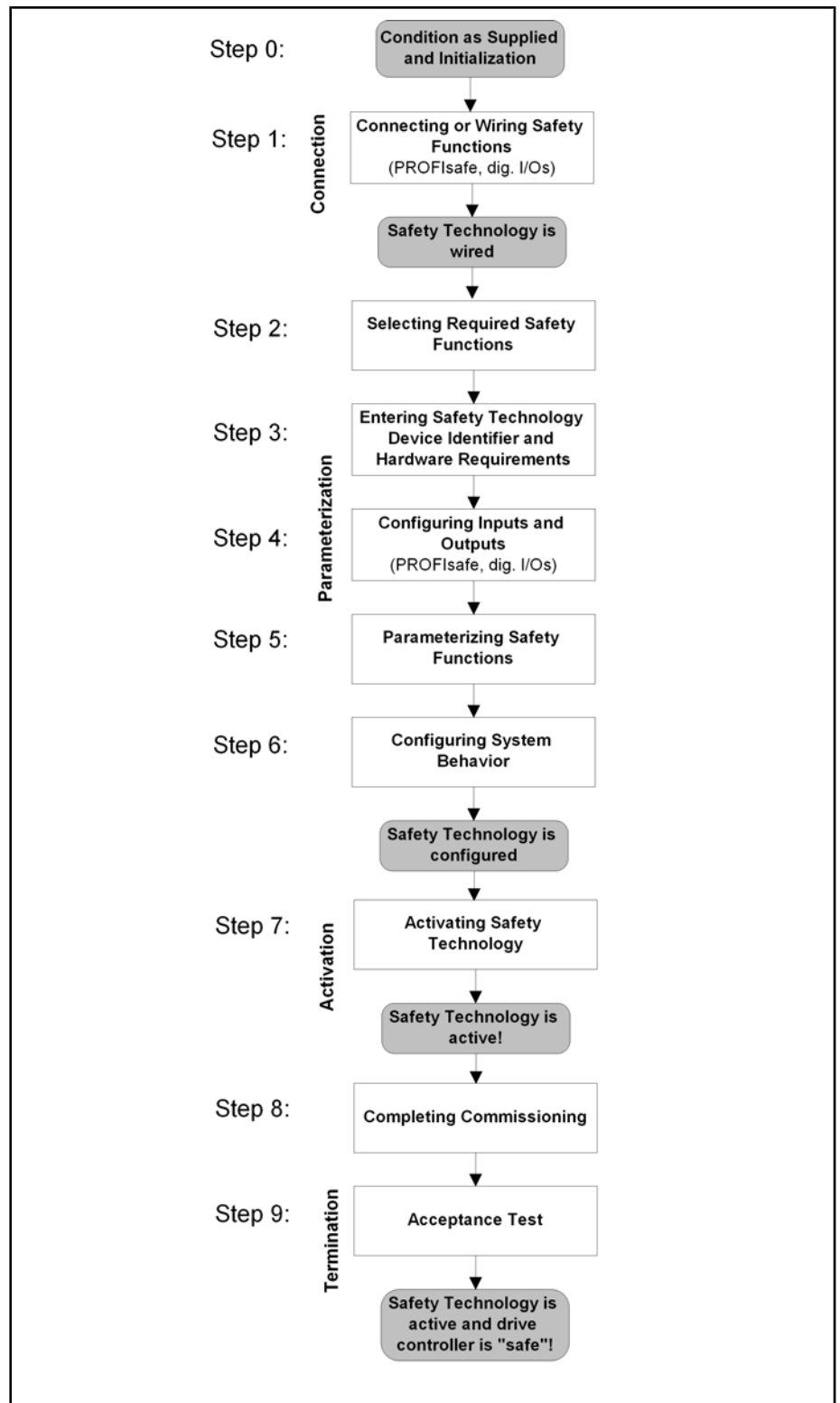


Figure name DF000179

Fig. 8-4: Overview - commissioning steps of integrated safety technology

8.4.2 Commissioning Steps

Step 0: Condition as Supplied and Initialization

In the **condition as supplied**, safety technology is not active; the status of "P-0-3207, Safety technology password level" is zero. The "normal" commissioning of the drive can take place.

Commissioning the Safety Technology



When using the safety function "safety related braking and holding system", set the redundant holding brake to the setting-up mode ("P-0-3300, Redundant holding brake: configuration") for "normal" commissioning of the drive.

If safety technology is not active, the system parameters are invalid and there isn't any validation test and comparison of data carried out. The safety parameters are set to default values and the write protection is disabled. "INDRA-SAVE" has been entered as the default password in "P-0-3206, Safety technology password". Under these circumstances it is possible to preload the safety parameters from a parameter file (when drive configurations are copied).

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

When the drive is switched from **operating mode to parameter mode**, the system, too, automatically goes to safety related standstill.



System initializations and repeated setting of encoder evaluation take place when the drive is switched (again) to the operating mode. Only in the operating mode does the evaluation of the safety technology selection inputs take place and the drive, if necessary, is switched to another operating status!

Step 1: Connecting or Wiring Safety Functions

The connection or wiring of the safety functions depends on the possibility used to make the selection and carry out the acknowledgment, and on the configuration of the device. This is why the I/Os in the examples of application are symbolically named "E1" to "E4", "E1n" to "E4n", "A10", "E10", "E/A10n", "E/A20" and "E/A30" and do not comply with the terminal designations at the device.

There are the following options of wiring:

- **Channel 1 and channel 2 via digital I/Os of the drive** (see "[Safety Technology I/O](#)")
- **Channel 1 via standard master communication and channel 2 via digital I/Os of the drive** (see "[Safety Technology I/O in Conjunction With a Master Communication](#)")
- **Channel 1 and channel 2 via PROFIsafe** (see "[PROFIsafe](#)")



Using safety technology functions which need the "safety related homing procedure" (e.g. "safety related limited absolute position") requires an additional hardware input via which the additional home switch can be read in. The home switch must be connected to one of the inputs ("E1n" to "E4n") on connector X41.



When using the safety function "safety related braking and holding system", you have to wire the control and diagnosis signals of HAT ("HAT-Steuer", "HAT-Diagnose") in addition to the signals for selection and acknowledgment.

Step 2: Selecting Required Safety Functions

See "[Overview of Safety Functions](#)"

Step 3: Entering Safety Technology Device Identifier and Hardware Requirements

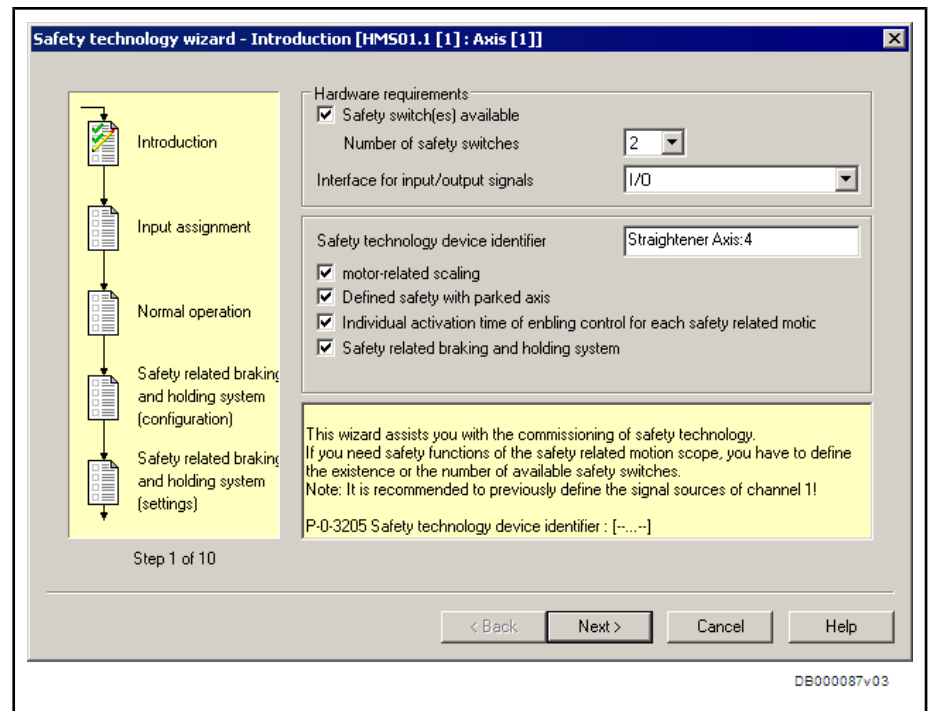


Figure name DB000087

Fig. 8-5: Safety technology wizard in IndraWorks (Note: The contents of the dialog depend on the firmware used / the IndraWorks version used)

- Switch drive to parameter mode
- Start safety technology wizard in IndraWorks
- In dialog section "Hardware requirements" enter number of safety switches used (this is required for following sequence of safety technology wizard).
- In dialog section "Interface" select via which interface safety technology inputs and outputs are read.
 - I/O: When using I/Os or I/Os and master communication
 - PROFIsafe: When using PROFIsafe (as of firmware MPx03)
- In text field "Safety technology device identifier" enter an identifier of device on which safety technology was commissioned (e.g. machine type, unit, drive for .. axis/spindle).

This device identifier is required for identifying backup of safety technology data. Corresponding parameter is "P-0-3205, Safety technology device identifier".

- **As of firmware MPx03:** Tick check box "Motor-related scaling", if scaling mustn't be changed any more after safety technology commissioning. For example, when using parameter set switching (load gear switching) or gear switching in parameter mode.

Corresponding parameter is "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word".



When you use the function "safety related homing procedure", the "motor-related scaling" mustn't be activated!

- **As of firmware MPx03:** Tick check box "Defined safety with parked axis", if drive is to acknowledge safety when drive function "parking axis" is selected.

Commissioning the Safety Technology

Corresponding parameter is "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word".



The control bit signals safety which has to result from the risk analysis of the installation. Use for axes with long coasting times (grinding wheels, spindles, rolls, ...) must be excluded.

- **As of firmware MPx05:** Tick check box "Individual activation time of enabling control for each safety related motion (SBB)", if individual monitoring of the activation time of enabling control is to be parameterized for each special mode motion (SBB1..4). If you do not select check box, common monitoring of activation time of enabling control is active for all special modes motion (SBB1..4).

Corresponding parameter is "P-0-3239, Configuration of global safety technology functions".

- **As of firmware MPx05:** Via the check box "Safety related braking and holding system", you can activate this safety function. (If the safety function "safety related braking and holding system" is selected, the following dialogs are automatically adjusted accordingly.)
- **As of firmware MPx05:** Tick check box "Gear independence with load-side safety technology encoder", when encoder relevant to safety technology has been mounted on load side and an existing switchable gear is to be used. If you do not select check box, gear ratio between motor and load mustn't be changed any more after safety technology commissioning.

Corresponding parameter is "P-0-3210, Safety technology configuration".

- Apply inputs with "Next".

Step 4: Configuring Inputs and Outputs

There are two variants of configuration for the inputs and outputs, depending on the interface set in the previous step ("I/O" or "PROFIsafe").

Interface "I/O":

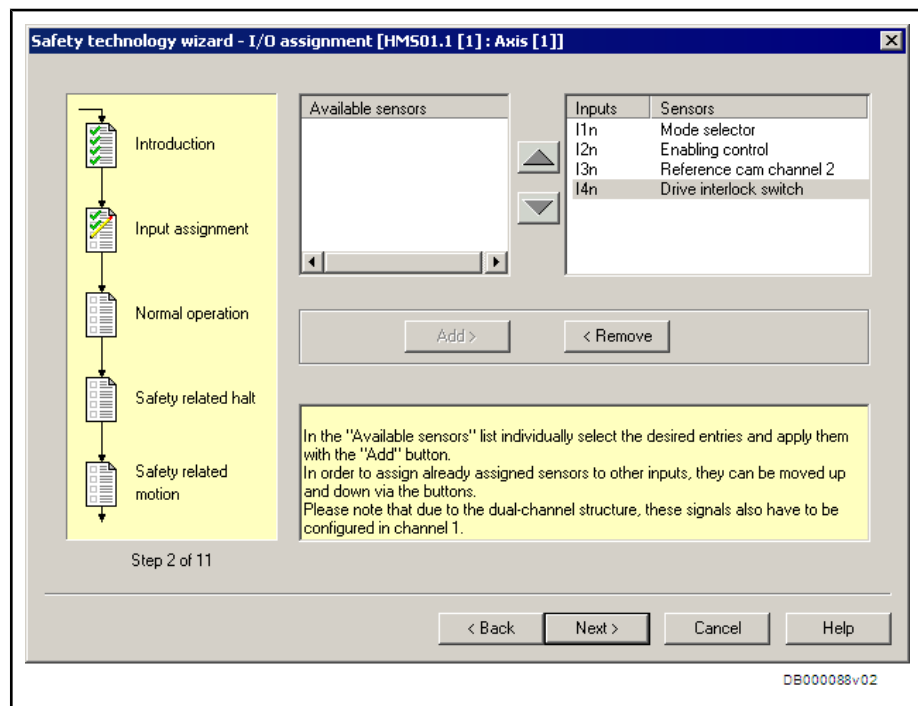


Figure name DB000088

Fig. 8-6: Dialog "I/O Assignment" when "Interface"="I/O"

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- From list "Available sensors" highlight safety technology sensors used and assign them to an input of channel 2 via "Add". If required, change assignment to inputs by means of two arrow keys.

Corresponding parameter is "P-0-3211, Safety technology I/O configuration list, channel 2" or "P-0-3211, Safety technology I/O control word, channel 2".



The physical inputs for channel 1 have to be separately determined by means of appropriate parameter setting (see "Step 1: Connecting or Wiring Safety Functions" on page 174).

- Apply inputs with "Next".

Interface "PROFIsafe":

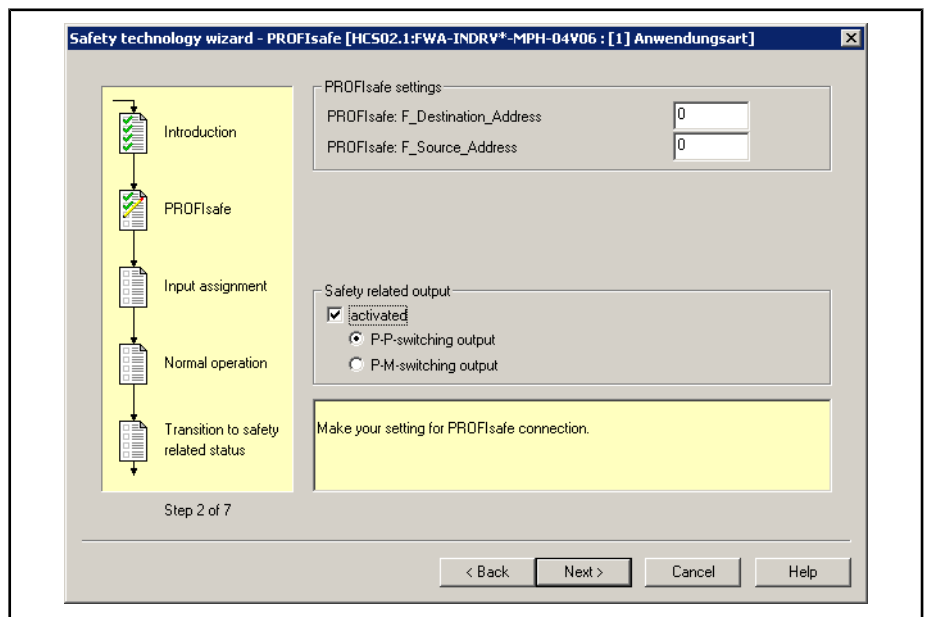


Figure name DB000089

Fig. 8-7: Dialog "PROFIsafe" when "Interface"="PROFIsafe" (Note: The contents of the dialog depend on the firmware used / the IndraWorks version used)

- In text field "PROFIsafe: F_Destination_Address" enter target address (F_Destination_Address) of safety related communication connection.
For further information, please see description of "P-0-3290, PROFIsafe: F_Destination_Address".
- In text field "PROFIsafe: F_Source_Address" enter source address (F_Source_Address) of safety related communication connection.
For further information, please see description of "P-0-3291, PROFIsafe: F_Source_Address".
- As of firmware MPx04:** In the dialog section named "Safety related output" you can activate the safety related output. You can select either Plus-Plus-switching output or Plus-Minus-switching output.
Corresponding parameter is "P-0-3295, Safety technology field bus configuration".
- Apply inputs with "Next".
- Confirm changed safety technology parameters by repeated input.
Every input applied to safety technology parameters has to be verified by a second input. In safety technology wizard, inputs are cleared in corre-

Commissioning the Safety Technology

spending edit fields and then highlighted with green color. To assist with repeated input, initial input value is displayed below in notice field.

- Apply inputs with "Next".

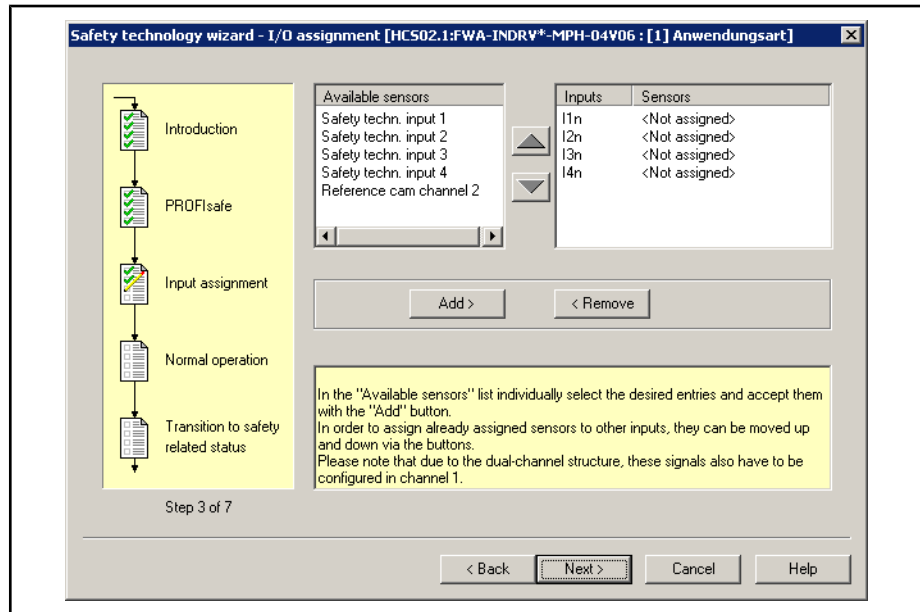


Figure name DB000091

Fig.8-8: Dialog "I/O Assignment" when "Interface"="PROFI-safe"

- From list "Available sensors" highlight safety technology sensors used and assign them to an input of channel 2 via "Add". If required, change assignment to inputs by means of two arrow keys.

Corresponding parameter is "P-0-3211, Safety technology I/O configuration list, channel 2" or "P-0-3211, Safety technology I/O control word, channel 2".

- Apply inputs with "Next".

Step 5: Parameterizing Safety Functions

Parameterizing normal operation

Commissioning the Safety Technology

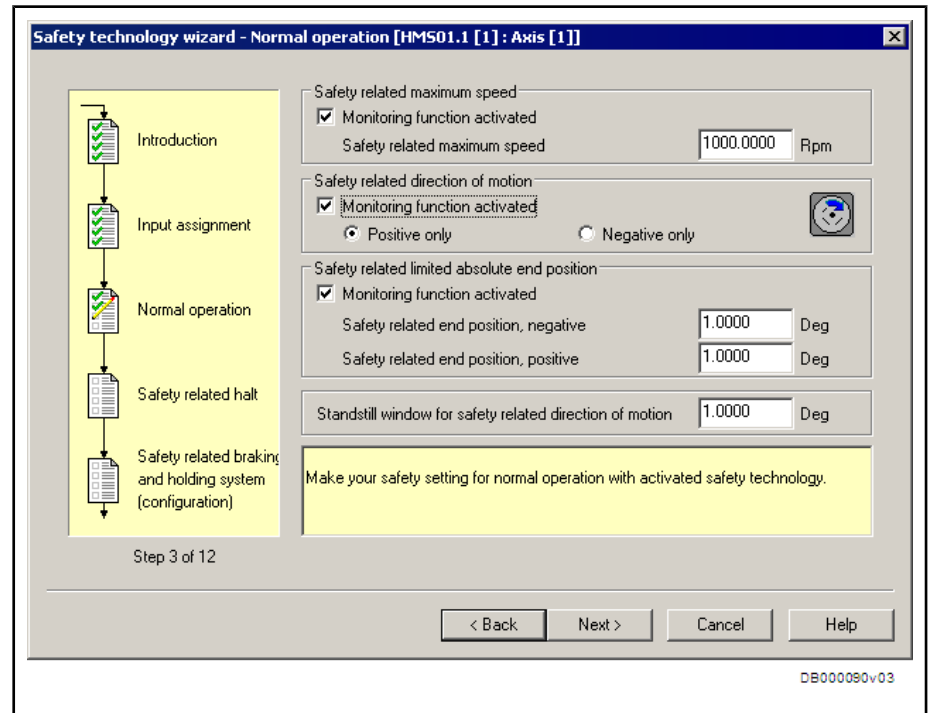


Figure name DB000090

Fig. 8-9: Dialog for settings of normal operation

- **As of firmware MPx04:** In dialog section "Safety related maximum speed" you can activate monitoring function for safety related maximum speed ("P-0-3239, Configuration of global safety technology functions"). When monitoring function has been activated, enter maximum effective speed limit which is to be monitored both in normal operation and in special mode (e.g. "SBB" [= safety related motion]) ("P-0-3234, Safety related maximum speed").



In the firmware versions MPx02 and MPx03, the monitoring of safety related maximum speed cannot be deactivated but, in applications in which it is not required, has to be made ineffective by setting an accordingly high value in "P-0-3234, Safety related maximum speed".

- **As of firmware MPx05:** In dialog section "Safety related direction of motion" you can parameterize global monitoring of direction of motion. By activating the function, individual monitoring functions of direction of motion of special modes motion are deactivated. For monitoring of direction of motion, you have to parameterize the standstill window ("P-0-3232, Standstill window for safety related direction of motion").
- **As of firmware MPx04:** In dialog section "Safety related limited absolute end position" you can activate corresponding safety function. To do this, enter both end positions and standstill window for safety related direction of motion. Corresponding parameters are:
 - P-0-3232, Standstill window for safety related direction of motion
 - P-0-3235, Safety related end position, positive
 - P-0-3236, Safety related end position, negative
 - P-0-3239, Configuration of global safety technology functions
- Apply inputs with "Next".
- Confirm changed safety technology parameters by repeated input.

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Every input applied to safety technology parameters has to be verified by a second input. In safety technology wizard, inputs are cleared in corresponding edit fields and then highlighted with green color. To assist with repeated input, initial input value is displayed below in notice field.

- Apply inputs with "Next".

Parameterizing the functions for "safety related halt"

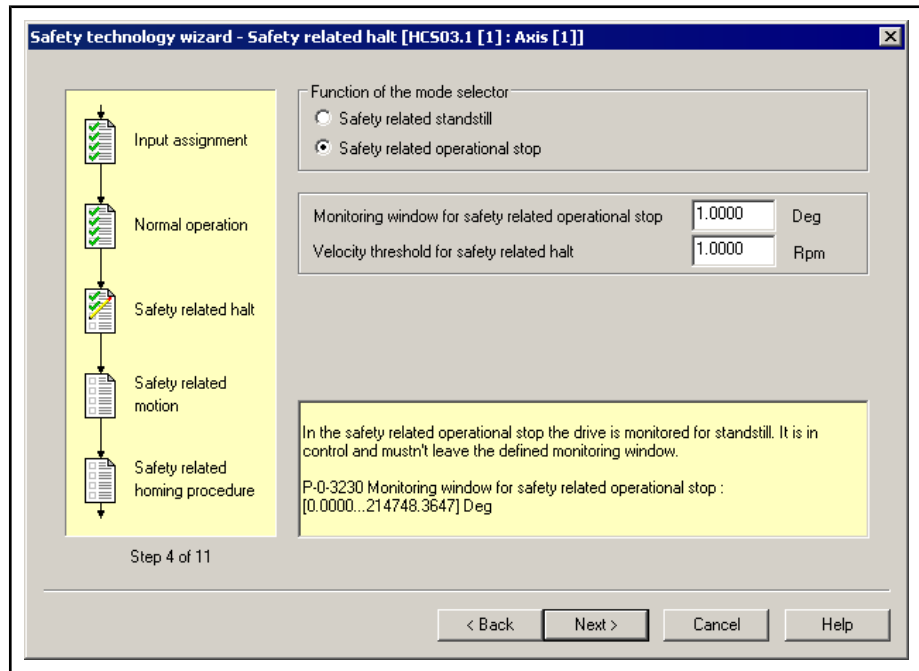


Figure name DB000092

Fig.8-10: Dialog for settings of safety related halt

- In dialog section "Function of the mode selector" select whether transition to "safety related standstill" or "safety related operational stop" is to take place when mode selector is selected.

Corresponding parameter is "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word".

- Field "Monitoring window for safety related operational stop" is only visible, when "Safety related operational stop" has been selected. Enter maximum allowed travel distance in this field. Maximum allowed travel distance refers to actual position available at point of time when safety related operational stop is activated.

Corresponding parameter is "P-0-3230, Monitoring window for safety related operational stop".

- In field "Velocity threshold for safety related halt" enter velocity threshold for special mode "halt" or for drive interlock.

Corresponding parameter is "P-0-3233, Velocity threshold for safety related halt".

- Apply inputs with "Next".
- Confirm changed safety technology parameters by repeated input.

Every input applied to safety technology parameters has to be verified by a second input. In safety technology wizard, inputs are cleared in corresponding edit fields and then highlighted with green color. To assist with repeated input, initial input value is displayed below in notice field.

- Apply inputs with "Next".



For further information on commissioning, see "[Safety Functions in Special Mode "Safety Related Halt"](#)".

Parameterizing the safety related braking and holding system



The following dialogs are only displayed, when the safety related braking and holding system (available as of MPx05) has been parameterized in the start dialog of the safety technology wizard.

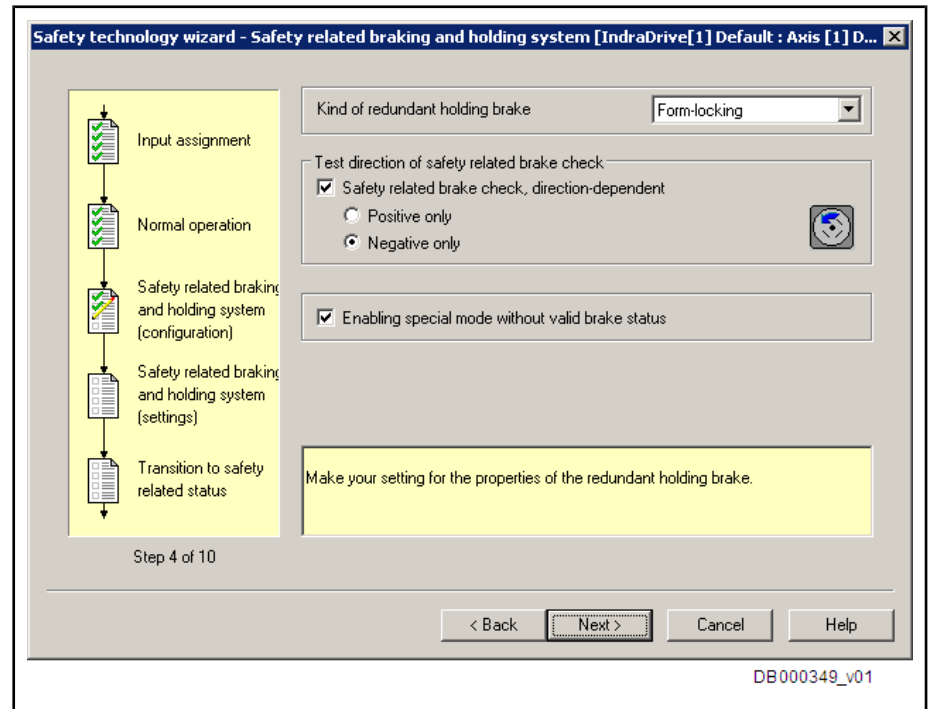


Fig. 8-11: Dialog "Safety related braking and holding system (configuration)"

- In field "Kind of redundant holding brake" select design of redundant holding brake. You can choose between form-locking and friction-fitting brake. Corresponding parameter is "P-0-3300, Redundant holding brake: configuration".
- Via dialog section "Test direction of safety related brake check" it is possible to have brake check carried out in one direction only. This is necessary, for example, when such brakes are used which generate holding torque in one direction only. Corresponding parameter is "P-0-3300, Redundant holding brake: configuration".
- Tick check box "Enabling special mode without valid brake status", if command "C6200 Command Enabling special mode without valid brake status" is to be enabled. Before using the command, observe explanations in chapter "[Enabling the Special Mode Without Valid Brake Status](#)". Corresponding parameter is "P-0-3300, Redundant holding brake: configuration".
- Apply inputs with "Next".

Commissioning the Safety Technology

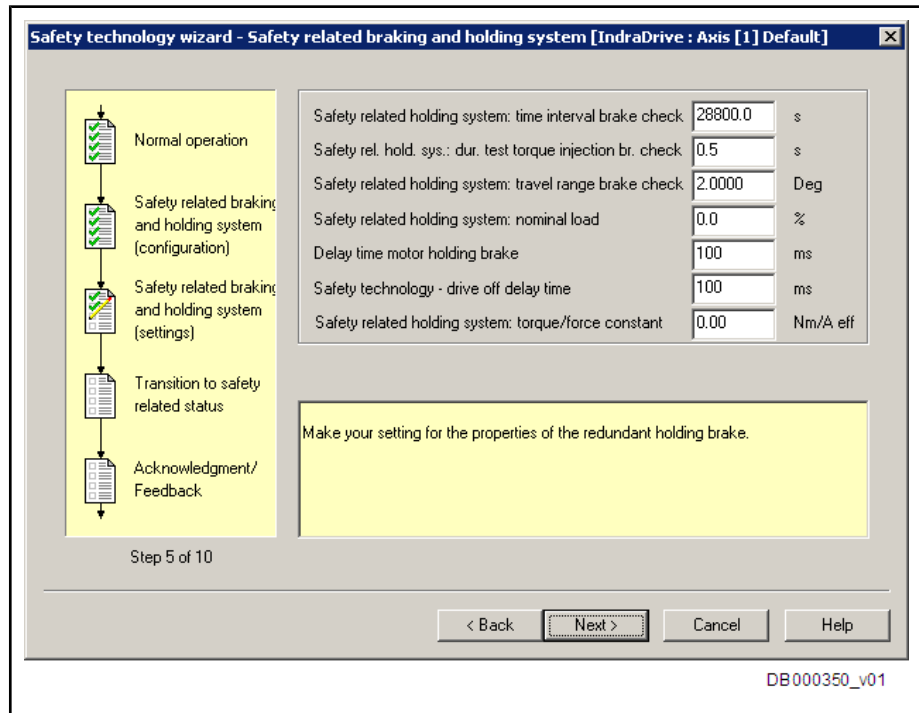


Fig. 8-12: Dialog "Safety related braking and holding system (settings)"

- In field "Safety related holding system: time interval brake check" parameterize maximum allowed time within which brake check must be repeated. This time and "P-0-0550, Time interval brake check" should be parameterized identically.

Corresponding parameter is "P-0-3302, Safety related holding system: time interval brake check".
- Via field "Safety rel. hold. sys.: dur. test torque injection br. check" you can parameterize how long torque is applied to axis in individual test steps of brake check. Suggested value should only be increased, if total test torque cannot be applied to brake during parameterized time due to mechanical properties (e.g. backlash).

Corresponding parameter is "P-0-3311, Safety rel. hold. sys.: dur. test torque injection br. check".
- In field "Safety related holding system: travel range brake check" you can parameterize allowed travel distance during brake check. Suggested value should only be increased, if due to backlash between brake and motor, greater travel distance is required to successfully check brake.

Corresponding parameter is "P-0-3310, Safety related holding system: travel range brake check".
- In field "Safety related holding system: nominal load" enter greatest load occurring in operation. Unit is "%" and refers to nominal torque of motor (M_N corresponds to 100%). Value entered in this field should be used in "P-0-0547, Nominal load of holding system", too. If value to be parameterized is unknown, it can be determined by means of "P-0-0551, Current load torque".

Corresponding parameter is "P-0-3303, Safety related holding system: nominal load".
- Via field "Delay time motor holding brake" you can parameterize trigger behavior of motor holding brake and of redundant holding brake. Value corresponds to minimum delay between control of both brakes. If redun-

Commissioning the Safety Technology

nant holding brake is to be controlled together with motor holding brake, set value to "0".

Corresponding parameter is "P-0-3306, Delay time motor holding brake".

- In field "Safety technology - drive off delay time" enter clamping delay of motor holding brake used. When drive enable is switched off, drive remains under torque for this time to bridge clamping delay of motor holding brake and prevent axis from moving down. Value entered in this field should be used in "S-0-0207, Drive off delay time", too.

Corresponding parameter is "P-0-3307, Safety technology - drive off delay time".

- In field "Safety related holding system: torque/force constant" enter torque/force constant of motor. Take value from type plate of motor or "P-0-0051, Torque/force constant".
- Apply inputs with "Next".
- Confirm changed safety technology parameters by repeated input. Every input applied to safety technology parameters has to be verified by a second input. In safety technology wizard, inputs are cleared in corresponding edit fields and then highlighted with green color. To assist with repeated input, initial input value is displayed below in notice field.
- Apply inputs with "Next".



For further information on commissioning, see "[Safety Related Braking and Holding System](#)".

Parameterizing the functions for "safety related motion"

In the following dialogs make all settings for safety related motion. The number of following dialogs depends on settings previously made. The parameter setting for safety related motion is explained by means of the example of safety related motion 1. The parameter setting for other safety related motions is made in the same way.



For "safety related motion" it is possible to create up to four different parameter sets:

- "P-0-3240, Configuration of safety related motion 1" or "P-0-3240, Control word for safety related motion 1"
 - "P-0-3250, Configuration of safety related motion 2" or "P-0-3250, Control word for safety related motion 2"
 - "P-0-3260, Configuration of safety related motion 3" or "P-0-3260, Control word for safety related motion 3"
 - "P-0-3270, Configuration of safety related motion 4" or "P-0-3270, Control word for safety related motion 4"
-

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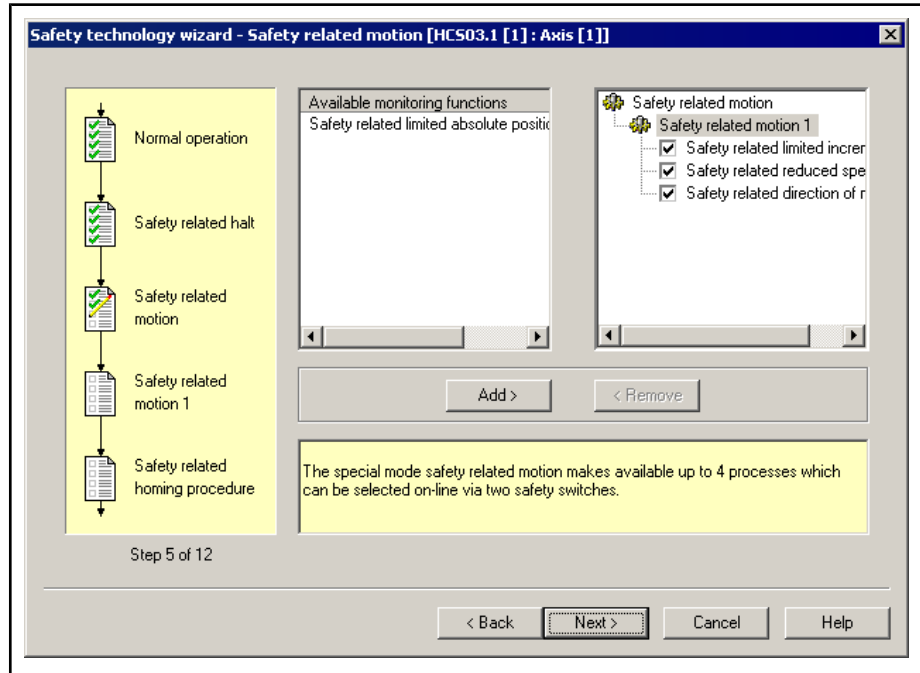


Figure name DB000093

Fig.8-13: Start dialog for settings of safety related motion

- Select monitoring functions to be applied to safety related motion 1: From list of available monitoring functions, highlight monitoring functions which are used and assign them to safety related motion via "Add". Via "Remove" you can undo incorrect selection. "Safety related reduced speed" is always part of safety related motion and cannot be deselected. Corresponding parameter is "P-0-3240, Configuration of safety related motion 1" or "P-0-3240, Control word for safety related motion 1".
- Apply inputs with "Next".



For further information on commissioning, see "Safety Functions in Special Mode "Safety Related Motion ("SBB")".

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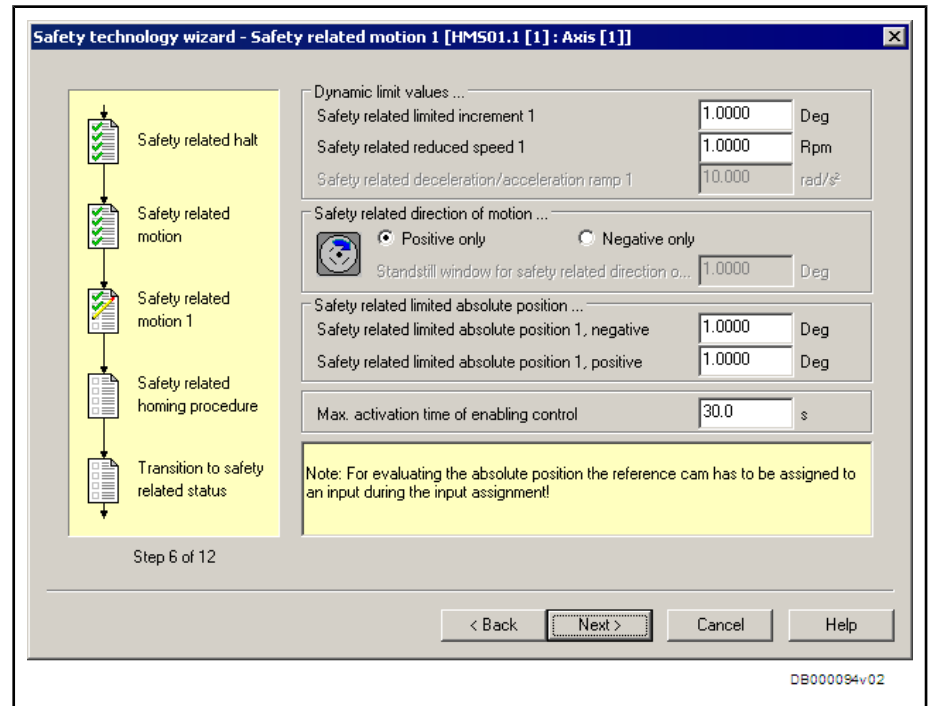


Figure name DB000094

Fig. 8-14: Dialog for settings of safety related motion

- Field "Safety related limited increment 1" only takes effect in special mode "safety related motion 1" ("SBB").

In this field, by entering numeric value, define relative position window for SBB 1 which is opened with beginning of SBB 1. For duration of SBB 1, drive can be freely moved within this position window.



The increment for the respective parameter set can be defined via the following parameters:

- P-0-3243, Safety related limited increment 1
- P-0-3253, Safety related limited increment 2
- P-0-3263, Safety related limited increment 3
- P-0-3273, Safety related limited increment 4

- In field "Safety related reduced speed 1" define speed threshold (bipolar) for safety function "safety related reduced speed".

Safety function "safety related reduced speed" is always active in special mode "safety related motion 1".



Via the following parameters you can define the speed threshold for the respective parameter set which is monitored:

- P-0-3244, Safety related reduced speed 1
- P-0-3254, Safety related reduced speed 2
- P-0-3264, Safety related reduced speed 3
- P-0-3274, Safety related reduced speed 4

- In respective special mode "safety related motion", axis may only be moved in parameterized direction when monitoring function of direction of motion has been activated. In dialog section "Safety related direction of

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motion..." determine direction of safety related motion (positive or negative).



Via the following parameters you can define the safety related direction of motion for the respective parameter set which is monitored:

- "P-0-3240, Configuration of safety related motion 1" or "P-0-3240, Control word for safety related motion 1"
- "P-0-3250, Configuration of safety related motion 2" or "P-0-3250, Control word for safety related motion 2"
- "P-0-3260, Configuration of safety related motion 3" or "P-0-3260, Control word for safety related motion 3"
- "P-0-3270, Configuration of safety related motion 4" or "P-0-3270, Control word for safety related motion 4"

- Dialog section "Safety related direction of motion..." contains field called "Monitoring window for safety related direction...". Value entered in this field determines how far axis may move in direction which has not been enabled.

Corresponding parameter is "P-0-3232, Standstill window for safety related direction of motion" or "P-0-3232, Monitoring window for safety related direction of motion".



You cannot make any input in the field called "Monitoring window for safety related direction..." when the safety function "Safety related limited absolute end position" has been activated in the dialog "Normal Operation"; the monitoring window / standstill window thereby has already been parameterized.

- In dialog section "Safety related limited absolute position..." define upper and lower position limit which mustn't be passed in respective special mode "safety related motion".



Via the following parameters you can define the upper and lower position limits for the respective parameter set which are monitored:

- P-0-3241, Safety related limited absolute position 1, positive
- P-0-3242, Safety related limited absolute position 1, negative
- P-0-3251, Safety related limited absolute position 2, positive
- P-0-3252, Safety related limited absolute position 2, negative

- In text field "Max. activation time of enabling control" or "Max. activation time of enabling control 1" enter maximum allowed time for activating enabling control. At the latest when entered time is over, enabling control has to be deactivated; i.e. special mode "safety related motion" is temporary.

Corresponding parameter is "P-0-3222, Max. activation time of enabling control" or in the case of individual activation time of enabling control for each safety related motion ("SBB"):

- P-0-3246, Max. activation time of enabling control 1
- P-0-3256, Max. activation time of enabling control 2
- P-0-3266, Max. activation time of enabling control 3
- P-0-3276, Max. activation time of enabling control 4

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You can do without the monitoring of the activation time, if it is not common practice to use an enabling control in your industrial sector and if constant motion does not represent any danger.

The machine manufacturer is responsible for the monitoring of the activation time and his risk analysis has to show his responsibility.

"P-0-3222, Max. activation time of enabling control"="0" deactivates the time monitoring of the special mode "safety related motion"; as of firmware version MPx05, this also applies to the individual activation times of enabling control P-0-3246, P-0-3256, P-0-3266 and P-0-3276.

- Apply inputs with "Next".
- Confirm changed safety technology parameters by repeated input. Every input applied to safety technology parameters has to be verified by a second input. In safety technology wizard, inputs are cleared in corresponding edit fields and then highlighted with green color. To assist with repeated input, initial input value is displayed below in notice field.
- Apply inputs with "Next".

Parameterizing the additional and auxiliary functions

In the following dialog you have to make all settings for additional functions which are relevant both for "safety related halt" and for "safety related motion". Only such dialogs are displayed in which it is necessary to make settings due to the parameter settings made before.

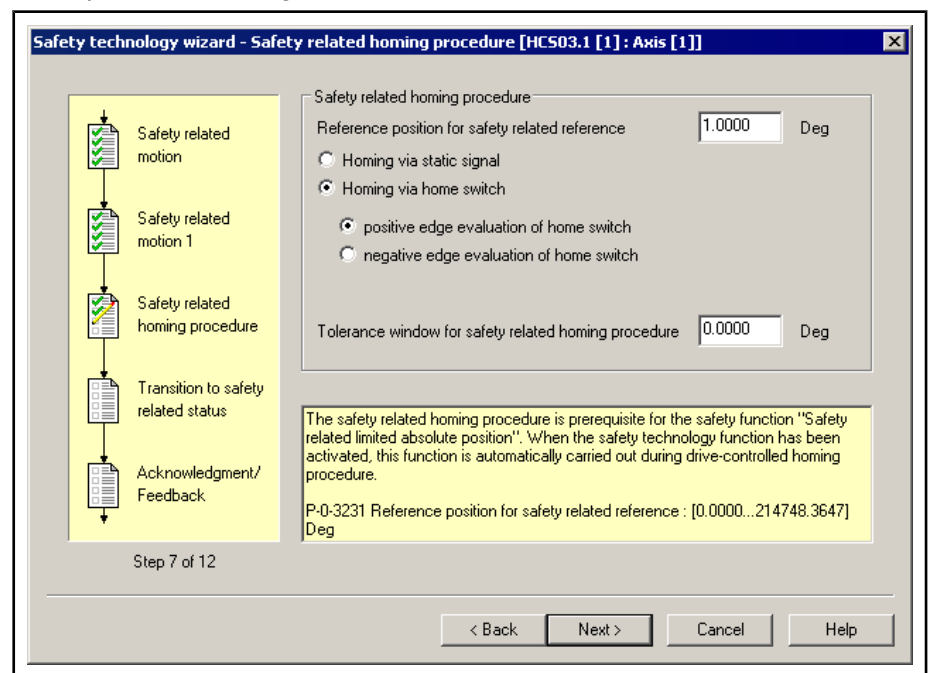


Figure name DB000095

Fig. 8-15: IndraWorks dialog for parameter setting of additional and auxiliary function "safety related homing procedure"

- In text field "Safety related reference position channel 2" determine position value for channel 2; value takes effect as actual position value after command "C4000 Homing procedure command channel 2" has been executed.

Corresponding parameter is "P-0-3231, Reference position for safety related reference" or "P-0-3231, Safety related reference position channel 2".

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- Then determine whether reference signal for channel 2 is to be evaluated statically or dynamically. In the case of dynamic evaluation (home switch), evaluation can refer to positive or negative edge.

Corresponding parameter is "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word".



Dynamization mustn't be carried out for the home switch / cam.

- In text field "Tolerance window for safety related homing procedure" set maximum allowed deviation of actual position values of channel 1 and 2 during execution of command "C4000 Homing procedure command channel 2".

Corresponding parameter is "P-0-3229, Tolerance window for safety related homing procedure".



For further information on commissioning, see "[Safety Related Homing Procedure](#)".

- Apply inputs with "Next".
- Confirm changed safety technology parameters by repeated input.

Every input applied to safety technology parameters has to be verified by a second input. In safety technology wizard, inputs are cleared in corresponding edit fields and then highlighted with green color. To assist with repeated input, initial input value is displayed below in notice field.

- Apply inputs with "Next".

Step 6: Configuring System Behavior

Configuring the transition to safety related status

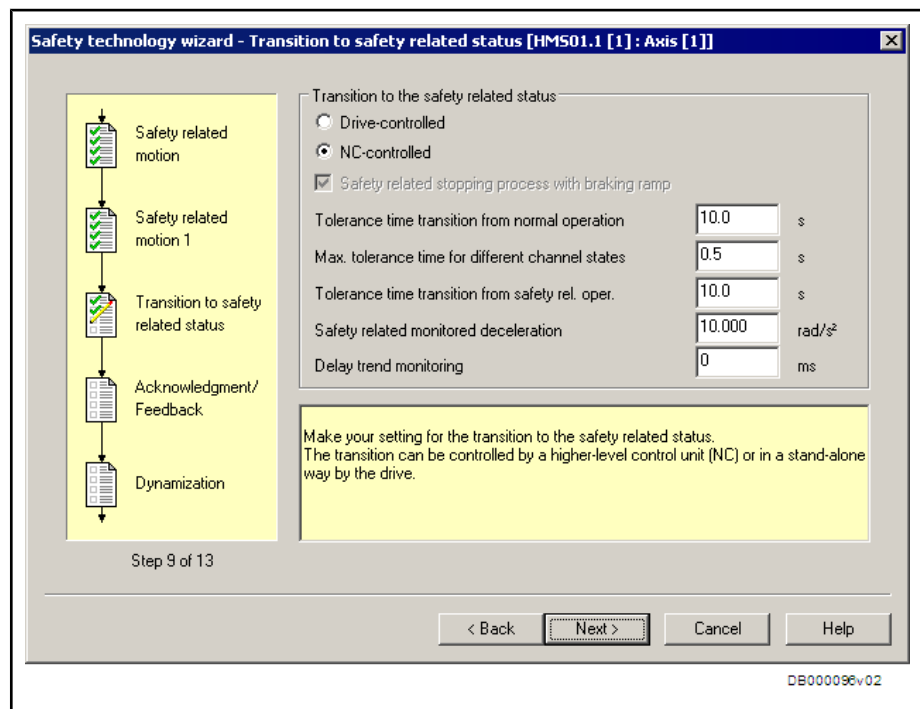


Figure name DB000096

Fig.8-16: Dialog for settings for transition to safety related status

- Select whether transition to safety related status is to take place in drive-controlled or NC-controlled form. In the case of NC-controlled transition, "Safety related stopping process with braking ramp" can be selected as of firmware MPx03.

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Corresponding parameter is "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word".



For further information on the transition to the safety related status, see "[Transition to Safety Related Status](#)".

For further information on commissioning, see "[Safety Related Monitored Stopping Process](#)".

- In text field "Tolerance time transition from normal operation" enter maximum time made available within which, in the case of transitions from normal operation to a safety function, command value system of drive has to have been adjusted to new safety function.
Corresponding parameter is "P-0-3220, Tolerance time transition from normal operation".
- In text field "Max. tolerance time for different channel states" enter maximum allowed time during which selection of monitoring channels 1 and 2 may differ without an error being generated.
Corresponding parameter is "P-0-3221, Max. tolerance time for different channel states".
- In text field "Tolerance time transition from safety rel. oper." enter maximum time made available within which, in the case of transitions from one safety function to another, command value system of drive has to have been adjusted.
Corresponding parameter is "P-0-3225, Tolerance time transition from safety rel. oper.".
- When "Safety related stopping process with braking ramp" has been selected (as of firmware MPx03), maximum deceleration has to be entered in text field "Safety related monitored deceleration" which control unit can input for drive.
Corresponding parameter is "P-0-3282, Safety related monitored deceleration".



As of firmware MPx05, "safety related stopping process with braking ramp" is always active in the case of the corresponding transitions and cannot be deactivated.

For further information on commissioning, see "[Safety Related Monitored Stopping Process](#)".

- **As of firmware MPx05:** If "NC-controlled transition" has been selected, an NC delay can be parameterized for trend monitoring. With this time, activation of parameterized monitoring function can be delayed. To deactivate NC delay, enter value "0".
Corresponding parameter is "P-0-3226, NC delay trend monitoring".
- Apply inputs with "Next".
- Confirm changed safety technology parameters by repeated input.
Every input applied to safety technology parameters has to be verified by a second input. In safety technology wizard, inputs are cleared in corresponding edit fields and then highlighted with green color. To assist with repeated input, initial input value is displayed below in notice field.
- Apply inputs with "Next".

Configuring the outputs for feedback of safety functions

In the following dialog make the settings for diagnosis and acknowledgment of safety, as well as for safety related feedback.

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If you use PROFIsafe, there aren't any settings required as feedback to the safety PLC takes place via the F-data.

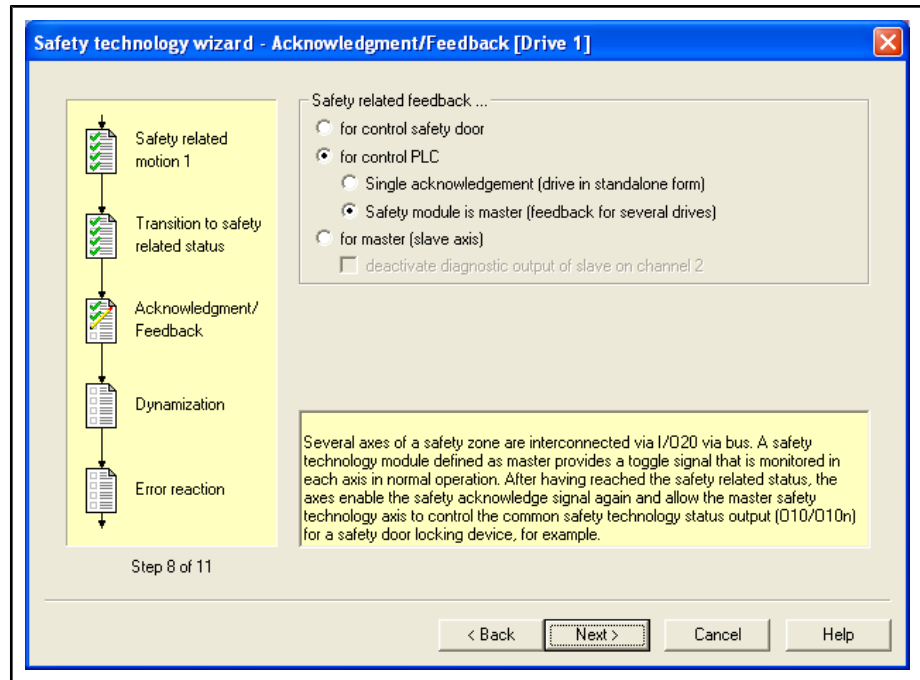


Figure name DB000097

Fig.8-17: IndraWorks dialog for diagnosis and acknowledgment of safety, as well as for safety related feedback (Note: The contents of the dialog depend on the firmware used / the IndraWorks version used)

- Axis can be parameterized in such a way that it gives safety related feedback in the form of
 - "control safety door",
 - "control PLC" or
 - as "slave axis" within a safety zone to feedback master.

When you have selected "for control PLC", you can choose whether axis works in stand-alone form: "Single-axis acknowledgment" or gives safety related feedback for a safety zone: "Option. safety techn. module is master".

- When setting up safety zones, one master for diagnosis and acknowledgment has to be parameterized for each zone. Set all other drives in this zone as slaves. When I/Os on optional safety technology module (connector X41) are wired as bus (e.g. via ribbon cable), diagnostic output has to be deactivated for all slaves ("Deactivate diagnostic output of slave on channel 2"). When a single safety technology axis, which is not to acknowledge safety, is commissioned, this axis has to be parameterized with "for control PLC" / Option. safety techn. module is master". Corresponding parameter is "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word".



It is possible to have a maximum of 25 drives in one safety zone!



For further information on commissioning, see "[Feedback of Safety Technology Operating States to the Peripherals](#)".

- Apply inputs with "Next".

Dynamization



Using PROFIsafe does not require dynamization.

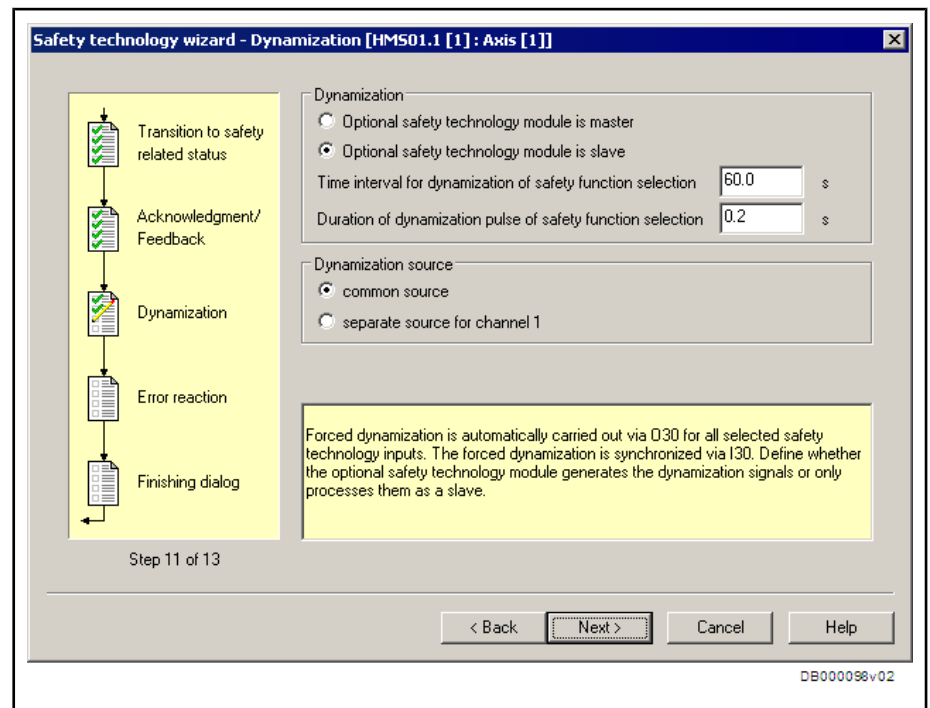


Figure name DB000098

Fig. 8-18: Dialog for settings of forced dynamization of inputs

- In dialog section named "Dynamization" you have to select whether axis is to carry out dynamization of safety zone ("Optional safety technology module is master") or different axis resp. higher-level control unit is to carry out dynamization ("Optional safety technology module is slave").
Corresponding parameter is "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word".
- In text field "Time interval for dynamization of safety function selection" define cycle time in which forced dynamization is to take place.
When axis has been parameterized as **dynamization master**, you have to set, in this field, time interval in which axis is to carry out dynamization.
When axis has been parameterized as **dynamization slave**, you have to set, in this field, time within which dynamization must have taken place.
Corresponding parameter is "P-0-3223, Time interval for dynamization of safety function selection".



"Time interval for dynamization of safety function selection" has an effect on the reaction time, because during the dynamization of safety function selection the evaluation of the selection signals inevitably has to be suspended. This is why the time shouldn't be too short.

- In text field "Duration of dynamization pulse of safety function selection" define maximum duration of dynamization pulse.
When axis has been parameterized as **dynamization master**, you have to set, in this field, duration of dynamization pulse with which axis is to carry out dynamization.

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When axis has been parameterized as **dynamization slave**, you have to enter, in this field, maximum length which dynamization pulse may have; externally generated dynamization signal can be shorter but mustn't be shorter than **minimum pulse width of 30 ms!**

Corresponding parameter is "P-0-3224, Duration of dynamization pulse of safety function selection".



The "duration of dynamization pulse of safety function selection" has an effect on the reaction time, because during the dynamization of safety function selection the evaluation of the selection signals inevitably has to be suspended. This is why the duration shouldn't be too long.

-
- In dialog section named "Dynamization source" you can set whether dynamization of channel 1 and 2 is to be carried out by a common source or two separate sources.

Corresponding parameter is "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word".



In the case of separate dynamization, the substitute for input E/A30 has to be supplied in "P-0-3212, Safety technology control word, channel 1" or "P-0-3212, Safety technology signal control word, channel 1" for channel 1, and E/A30 has to be supplied on connector X41 for channel 2.

-
- Apply inputs with "Next".
 - Confirm changed safety technology parameters by repeated input.
Every input applied to safety technology parameters has to be verified by a second input. In safety technology wizard, inputs are cleared in corresponding edit fields and then highlighted with green color. To assist with repeated input, initial input value is displayed below in notice field.
 - Apply inputs with "Next".

Error reaction

In the following dialog you can set the error reaction of the drive to safety technology errors.



The reaction to safety technology errors can be set as of firmware MPx03V20; in older firmware versions this parameter setting is not possible / this dialog is not available.

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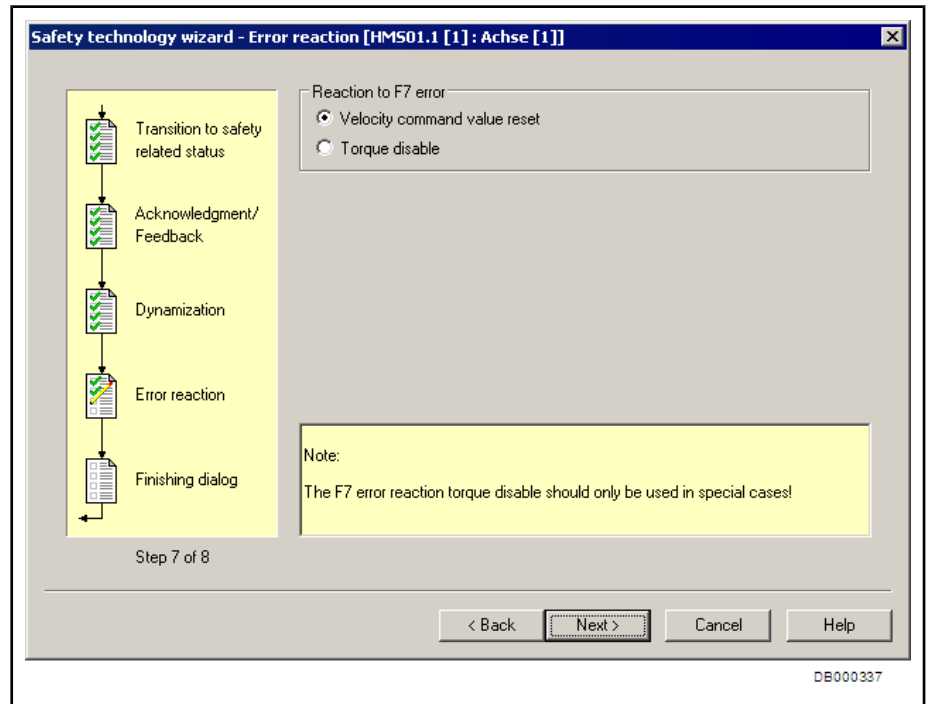


Figure name DB000337

Fig. 8-19: Dialog for setting error reaction to safety technology errors

- In dialog section "Reaction to F7 error" you can parameterize error reaction of axis to safety technology errors.

Corresponding parameter is "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word".



The F7 error reaction "torque disable" should only be used when forced deceleration by velocity command value reset generally causes problems, e.g. in the case of mechanically coupled axes.

The machine manufacturer is responsible for the F7 error reaction "torque disable" and his risk analysis has to show his responsibility.

- Apply inputs with "Next".

Finishing the parameter setting

Commissioning the Safety Technology

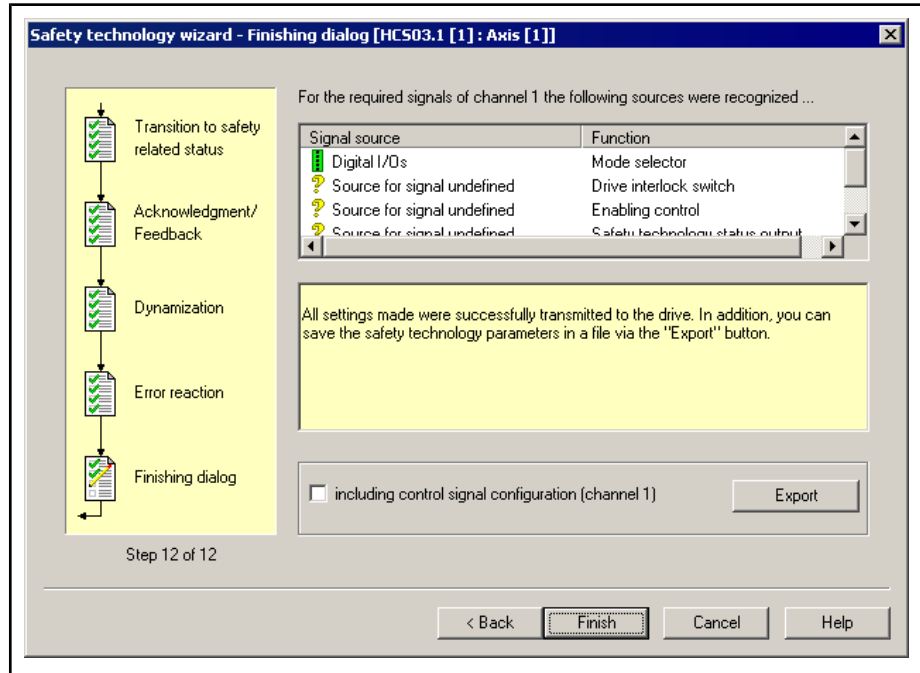


Figure name DB000099
 Fig.8-20: Finishing the parameter setting

In the finishing dialog, the first check is run to find out whether a source was found for all parameterized inputs/outputs (I/Os) of channel 1. If there is no source available for a signal, "?" appears in the column "Signal source" and the message "Source for signal undefined" is generated. Commissioning via the safety technology wizard can nevertheless continue in unmodified form. The missing signal has to be assigned afterwards.

- By means of "Export" button you can save safety technology setting that was made in a parameter file; you can include control signal configuration for channel 1 in backup.



It is impossible to replace the control section with the exported parameter file, because the parameter relevant for replacing the control section ("P-0-3208, Backup of safety techn. data channel 2") is not contained in this parameter file!

- With "Finish" button, safety technology wizard is completed, drive switched to phase 4 and command "P-0-3204, C3000 Synchronize and store safety technology IDN command" is started.

By execution of command "P-0-3204, C3000 Synchronize and store safety technology IDN command", channel 2 applies safety parameters of channel 1 and stores them in safety memory.

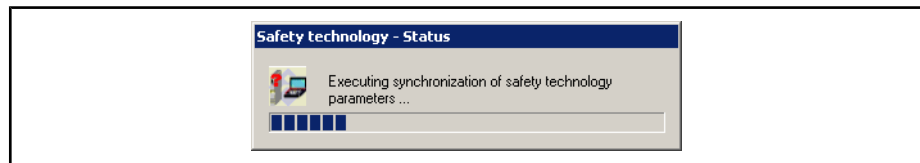


Figure name DB000100
 Fig.8-21: Synchronizing the safety technology parameters



In the case of switching errors, the command cannot be automatically started; it has to be restarted manually after the switching errors have been fixed.

**Step 7: Activating / Deactivating
Safety Technology****Activating the safety technology**

After having successfully synchronized and stored the safety technology parameters, the safety technology must be activated.

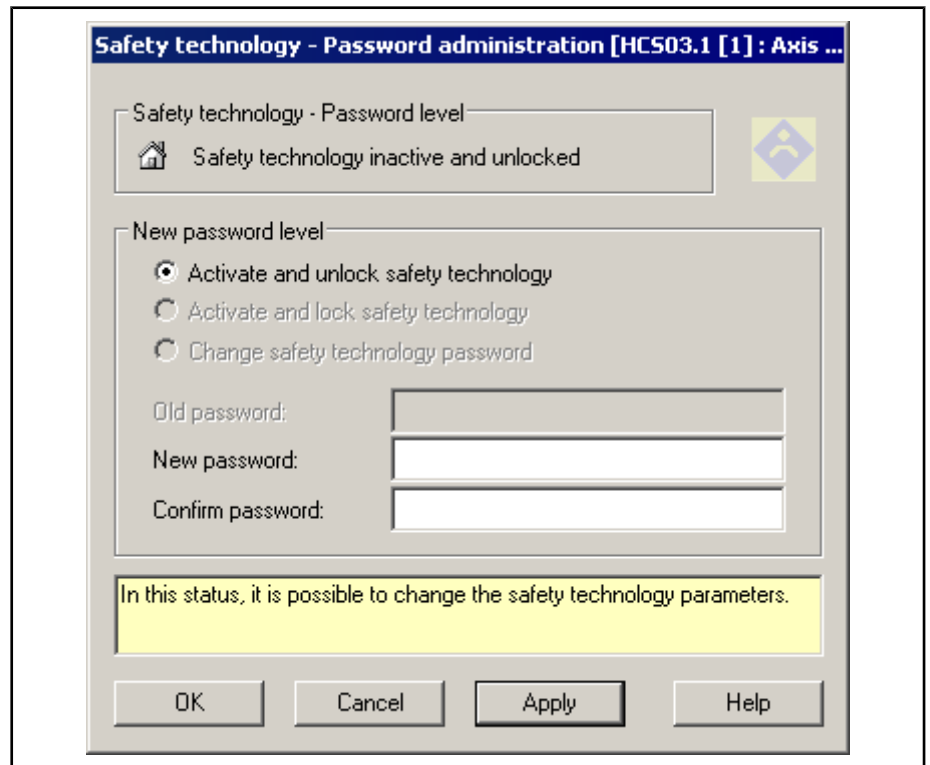


Figure name DB000101

Fig. 8-22: Safety technology – Password administration

- Safety technology is activated by input of safety technology password ("P-0-3206, Safety technology password") and confirmation by "Apply" button.

Safety technology now is active and unlocked. In this status, it is possible to change safety technology parameters without entering password. After every change, command "P-0-3204, C3000 Synchronize and store safety technology IDN command" has to be executed again in order to apply change.

Commissioning the Safety Technology



Figure name DB000102

Fig. 8-23: Safety technology – Password administration

In the safety technology password administration, you can now write-protect the safety technology parameters by means of the field "Activate and lock safety technology".



When the drive is switched off, safety technology is automatically locked.

Deactivating the safety technology

Executing the command "S-0-0262, C07_x Load defaults procedure command" (with "P-0-4090, Index for C07 Load defaults procedure" = 165) deactivates safety technology. The system parameters then are invalid and there isn't any validation test and comparison of data carried out. The safety technology parameters are set to their default values again.



The execution of the command "S-0-0262, C07_x Load defaults procedure command" cannot be undone. In the case of changes to safety-relevant parameters, it is necessary to subsequently carry out the safety technology commissioning with safety technology acceptance test again!

If there aren't any changes required, the safety technology can be activated again according to the procedure for replacing the control section.



At other drive modules that have been equipped with the optional module "safety technology I/O", deactivating a drive within a safety zone causes the error F3131. **The safety of a zone can only be guaranteed, when all drives run with active safety technology.**

Commissioning the Safety Technology

To complete the commissioning, you can test the new parameters of the safety functions. To do this, select the safety functions one after the other and trigger the monitoring functions by means of command value input.

**Loss of safety-relevant settings when replacing the control section!**

⇒ Save the safety technology parameters on an external storage medium ("S-0-0192, IDN-list of backup operation data"), in order to transfer all safety-relevant settings to the new control section in case the control section is replaced.



A binary image of the safety technology data for channel 2 is contained in parameter "P-0-3208, Backup of safety techn. data channel 2".

Acceptance test of the safety function

Change status: Every change of the safety technology memory can be assigned to an unequivocal change status which has to be documented within the scope of the safety acceptance test. The change status is stored in the following parameters:

- P-0-3201, Change counter of safety technology memory
- P-0-3202, Operating hours at last change of memory

Change history: In case you are obliged to produce supporting documents, you can reproduce the last states of the safety technology memory by means of the parameter "P-0-3203, Memory image of safety technology memory" via an external program.



After safety technology has been commissioned, it is necessary to make a safety acceptance test (test protocol) in which the count of the change counter (P-0-3201) and the required acceptance tests are documented.

Step 9: Acceptance Test**Acceptance procedure**

The scope of changes at the installation or in the parameter setting requires a more or less extensive acceptance procedure:

- When the machine is commissioned and in the case of any **software or hardware change relevant to functional safety** (e.g. version upgrade of the firmware), a **complete acceptance test** has to be carried out by authorized staff.
- In case safety-relevant data are **partially changed**, they have to be checked by means of a **partial acceptance test**.



In either case, the changes and tests carried out have to be recorded.



For commissioning the safety technology, you should always use the current release of the corresponding firmware version.

Otherwise, take the corresponding manufacturer information on detected and solved problems into account and verify their relevance for the machine application.

For the manufacturer information, see drive information portal under www.boschrexroth.com.

Complete acceptance test

The following points apply to a complete acceptance test:

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- All intended safety functions (e.g. compliance with limit values, functions of control devices, function of actuators, ...) have to be checked.
- The error reaction becomes physically effective.
- You have to check the correct functioning of the safety function. To do this, you have to deactivate, in the higher-level control unit, the command value limitations in the special mode for the duration of the acceptance test.



The required tests for the complete safety technology acceptance test can be made by means of the instructions on the safety technology acceptance test.

Partial acceptance test

For a partial acceptance test, only those safety functions affected by changes of safety-relevant data have to be checked.



The required tests for the partial safety technology acceptance test can be selected from the instructions on the safety technology acceptance test and carried out.

Instructions on the acceptance test

Completed commissioning is the prerequisite for the subsequent safety tests.

Each test has to be carried out for each individual axis/spindle/roll drive. To call the **instructions on the acceptance test** in IndraWorks D, proceed as follows:

1. Open window "Safety Technology/Diagnosis".

Right side of window displays acceptance test protocol, left side displays current status of safety technology.

2. Open context menu on left side of window by clicking right mouse button.
3. Select "Instructions on the acceptance test protocol".

Instructions are displayed on right side of window.

Figure name DB000103

Fig.8-24: Part of the instructions on the safety technology acceptance test

By means of these instructions, you can check all parameter settings of the active safety technology step by step and document them in the safety technology report.

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You can generate a print-out of the safety technology report with the currently effective safety functions and corresponding values in the window "Safety Technology/Diagnosis" (see example below).

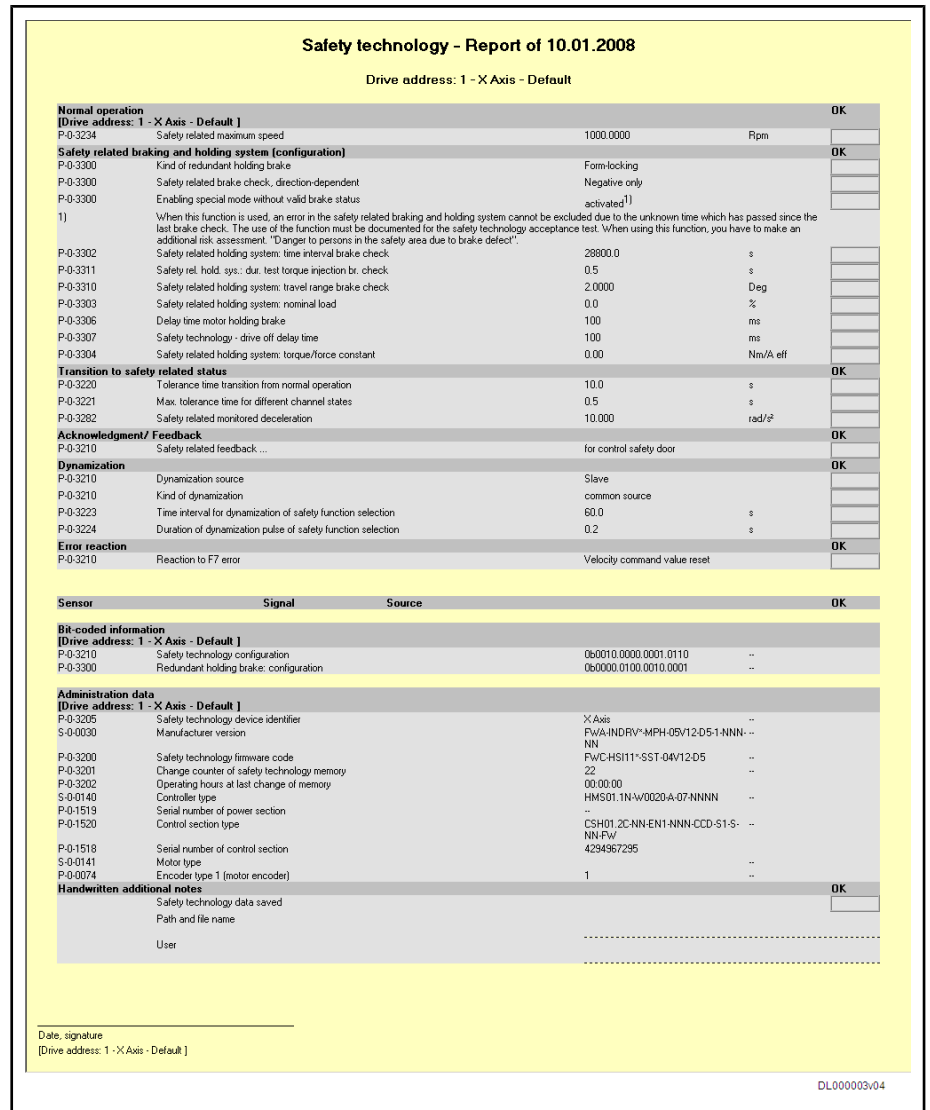


Fig. 8-25: Example of a safety technology report

8.5 Mounting and Installing the Safety Related Braking and Holding System

8.5.1 Connection Diagram

Connect the control module (HAT) according to the following description.

- The control voltage supply
 - of the power section,
 - of the assigned drive controller and
 - the control voltage supply of the control module at terminal connector X1
 should be connected to a common voltage source.
- The control voltage supply
 - of the standard I/Os, terminal connector X31

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- the optional safety technology module (S1), terminal connector X41
 - the interface supply of the control module, terminal connector X3
- comes from a common control voltage supply. This can be the control voltage supply of the power section.

The power supply of these three interfaces is isolated from the power supply mentioned under item 1.

3. The power supply of the optional safety technology module (safety technology I/O) takes place via the connection cable RKS007 at terminal connector X3 of the control module.
4. The control module is controlled via a dynamized signal output at the standard I/O (X3/3).
5. The dynamized feedback signal of the control module is applied at the input (X3/4) of the optional safety technology module (S1).
6. The redundant holding brake is connected at terminal connector X2 of the control module.

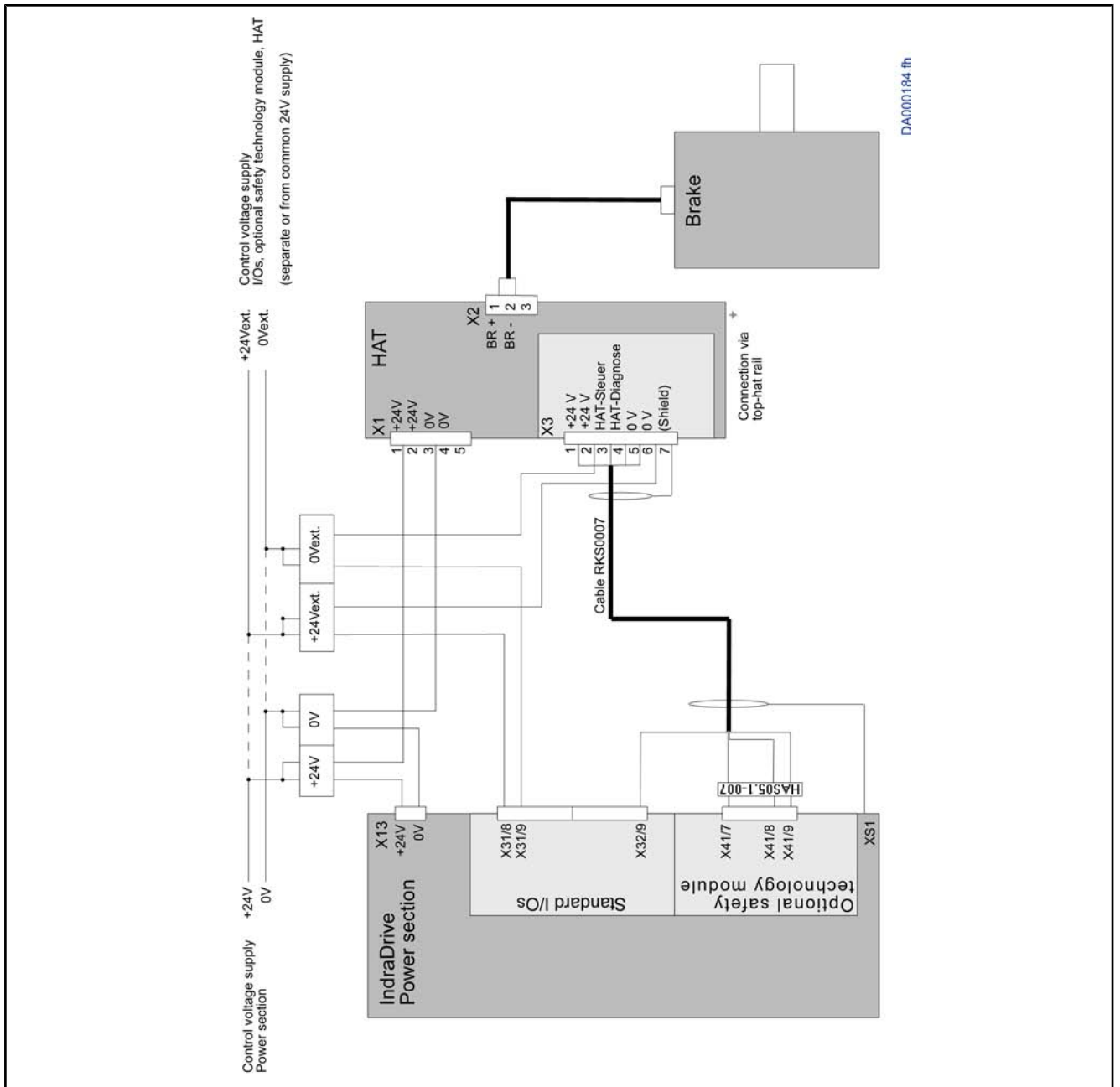


Fig. 8-26: Connection diagram of the "safety related braking and holding system" at single-axis drive controllers

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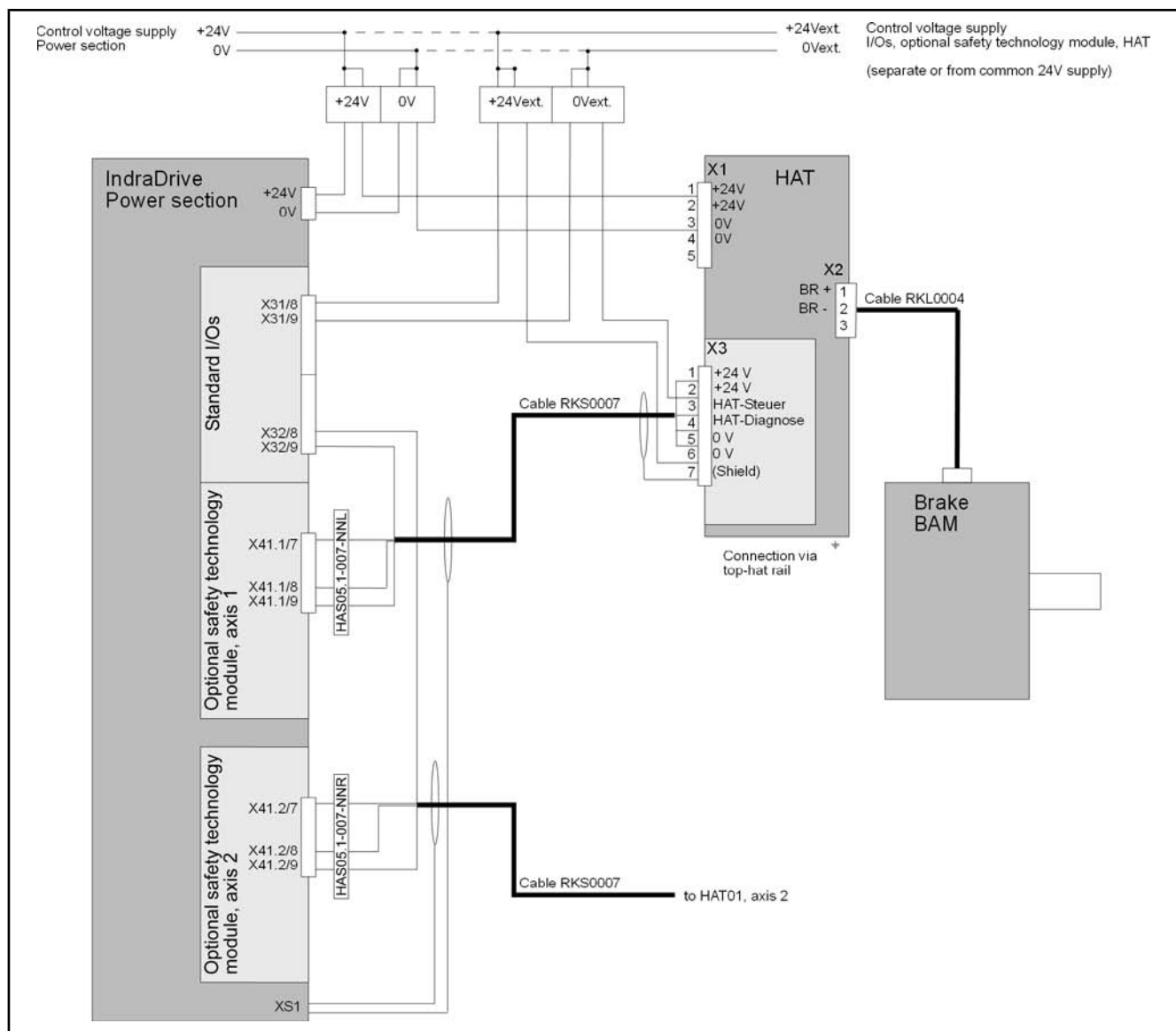


Fig.8-27: Connection diagram of the "safety related braking and holding system" at double-axis drive controllers

8.5.2 Control Module

The control module **HAT01.1-002-NNN-NN** is required for controlling the redundant holding brake. It is provided for top-hat rail mounting in the control cabinet.

8.5.3 Connection

Connecting the Control Module to the Drive Controller

Use the connection cable **RKS0007** to connect the control module **HAT01.1-002-NNN-NN** to the IndraDrive controller. You can order the cable in the required length. Do not exceed the allowed maximum length of 5 m.

Commissioning the Safety Technology

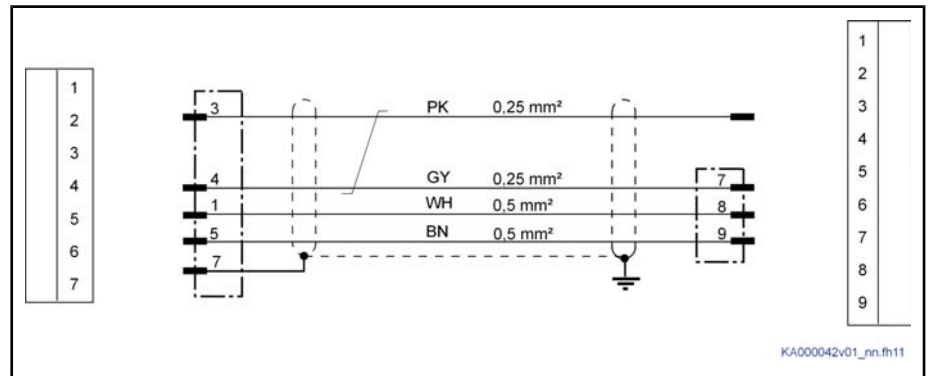


Fig. 8-28: Connection cable RKS0007

Connecting the Redundant Holding Brake to the Control Module

Connect the redundant holding brake to the control module. When doing this, observe the specifications of the brake supplier. Establish a possible existing shield connection of the connection cable near the control module, e.g. top-hat rail clamp with Wago 790-113 and 790-124.

8.5.4 Accessory

Adapter HAS05.1-007

Use the adapter HAS05.1-007 to connect HAT to the drive controller. The adapter allows applying other signal lines, for selecting the individual safety functions, at connector X41 in addition to the connection cable RKS0007.

For a detailed description of the adapter, see [Appendix](#) of this documentation.

8.6 Commissioning Series Machines

For commissioning series machines, you can use a simplified procedure. To do this, the following requirements must have been fulfilled:

- The wiring of the I/Os has not changed compared to the first series machine.
- The parameter setting is the same compared to the first series machine.

When these requirements have been fulfilled, series machines can be commissioned by means of the following simplified procedure without repeated safety technology acceptance test:

1. Check wiring of I/Os.



Before safety technology is activated, the I/O wiring must have been checked.

2. Load parameter file to drive and activate safety technology (for how to proceed see Functional Description of firmware "Replacing the Controller").
3. Check and if necessary adjust "P-0-3205, Safety technology device identifier" to new machine:
 - Unlock safety technology by password input in IndraWorks in window "Safety technology/Password" ("P-0-3206, Safety technology password")
 - Adjust "P-0-3205, Safety technology device identifier"
 - Switch drive to phase 4
 - Execute command "P-0-3204, C3000 Synchronize and store safety technology IDN command"
4. Enter new safety technology password if different from first series machine and lock drive:

Commissioning the Safety Technology

- Change safety technology password in IndraWorks in window "Safety technology/Password" ("P-0-3206, Safety technology password")
 - Lock safety technology via same dialog or by switching drive off ("P-0-3206, Safety technology password")
5. Save safety technology parameters and add them to safety-relevant documentation of machine:
- Open window "Safety technology/Diagnosis".
=> Right side of window displays acceptance test protocol, left side displays current status of safety technology.
 - Open context menu on left side of window by clicking right mouse button.
 - Select "Export safety technology parameters" and save parameters.
6. Compile new protocol with contents listed below and add it to safety-relevant documentation of machine, together with copy of safety technology report of first series machine:
- 7.
- Commissioning of series machine carried out on basis of safety technology report "safety technology device identifier (P-0-3205) of first series machine" of (date of report)
 - Safety technology device identifier (P-0-3205) is at (value)
 - Change counter of safety technology memory (P-0-3201) is at (value)
 - Operating hours at last change of memory (P-0-3202) is at (value)
 - (Date), (name), (signature)

8.7 Requirements on Control Unit

The control unit must know the operating modes (normal operation / special mode), as well as their safety functions.

It is the responsibility of the control unit that the drive is interpolated within the given time within the limits given by the safety function.

For this purpose, the control unit must be able to recognize the selection of a safety function so that it can react at any time to a switchover to safety related operation (e.g. read "P-0-3215, Selected safety technology operating status" or "P-0-3215, Selected safety technology mode" from the drive). For online monitoring of the safety technology states, the binary status signals provided by "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status" can be read by the control unit.

The transition to safety related standstill, to safety related drive interlock and to safety related operational stop can alternatively be controlled by the drive or the control unit (parameterized via "P-0-3210, Safety technology configuration" or "P-0-3210, Safety technology control word").

In the case of transition, controlled by the control unit, to the safety technology operating states "drive interlock" and special mode "safety related halt" with the safety function "safety related standstill", the control unit has to remove drive enable. In the case of transitions controlled by the drive, the drive removes drive enable.

The transition to safety related halt in the case of error takes place according to the settings in the parameters "P-0-0117, Activation of NC reaction on error" and "P-0-0119, Best possible deceleration".

Commissioning the Safety Technology



The control unit must react to the selection of a safety function with the corresponding command value input!

9 Acceptance Test

9.1 Acceptance Procedure

9.1.1 General Information

When the machine is commissioned and in the case of any software or hardware change relevant for functional safety (e.g. changes by remote data transmission), a complete acceptance test has to be carried out by authorized staff.

In case safety-relevant data are partially changed, they have to be checked by means of a partial acceptance test.

In either case the changes and tests carried out have to be recorded (see "[Check List for Acceptance Test](#)").

9.1.2 Complete Acceptance Test

For a complete acceptance test, all intended safety functions (e.g. compliance with limit values, functions of control devices, function of actuators) have to be checked. During the check, the error reaction becomes physically effective. You have to check the correct functioning of the safety function. To do this, you have to deactivate, in the higher-level control unit, the command value limitations in the special mode for the duration of the acceptance test.

The required tests have to be selected from the check list below and then carried out.

9.1.3 Partial Acceptance Test

For a partial acceptance test, only those safety functions affected by changes of safety-relevant data have to be checked.

The required tests have to be selected from the check list below and then carried out.

9.2 Check List for Acceptance Test

Completed commissioning is the prerequisite for the subsequent safety tests.

Each test has to be carried out for each individual axis/spindle/roll drive.

You can generate a print-out with the currently effective safety functions and corresponding values by means of the safety technology wizard in the IndraWorks commissioning software (see example below).

Acceptance Test

Safety technology - Report of 10.01.2008				
Drive address: 1 - X Axis - Default				
Normal operation [Drive address: 1 - X Axis - Default]				OK
P-0-3234	Safety related maximum speed	1000.0000	Rpm	
Safety related braking and holding system (configuration)				OK
P-0-3300	Kind of redundant holding brake	Form-locking		
P-0-3300	Safety related brake check, direction-dependent	Negative only		
P-0-3300	Enabling special mode without valid brake status	activated ¹⁾		
1)	When this function is used, an error in the safety related braking and holding system cannot be excluded due to the unknown time which has passed since the last brake check. The use of this function must be documented for the safety technology acceptance test. When using this function, you have to make an additional risk assessment: "Danger to persons in the safety area due to brake defect".			
P-0-3302	Safety related holding system: time interval brake check	28800.0	s	
P-0-3311	Safety rel. hold. sys.: dur. test torque injection br. check	0.5	s	
P-0-3310	Safety related holding system: travel range brake check	2.0000	Deg	
P-0-3303	Safety related holding system: nominal load	0.0	%	
P-0-3306	Delay time motor holding brake	100	ms	
P-0-3307	Safety technology - drive off delay time	100	ms	
P-0-3304	Safety related holding system: torque/force constant	0.00	Nm/A eff	
Transition to safety related status				OK
P-0-3220	Tolerance time transition from normal operation	10.0	s	
P-0-3221	Max. tolerance time for different channel states	0.5	s	
P-0-3282	Safety related monitored deceleration	10.000	rad/s ²	
Acknowledgment/ Feedback				OK
P-0-3210	Safety related feedback: ...	for control safety door		
Dynamization				OK
P-0-3210	Dynamization source	Slave		
P-0-3210	Kind of dynamization	common source		
P-0-3223	Time interval for dynamization of safety function selection	60.0	s	
P-0-3224	Duration of dynamization pulse of safety function selection	0.2	s	
Error reaction				OK
P-0-3210	Reaction to F7 error	Velocity command value reset		
Sensor				
	Signal	Source		OK
Bit-coded information [Drive address: 1 - X Axis - Default]				
P-0-3210	Safety technology configuration	0b0010.0000.0001.0110	--	
P-0-3300	Redundant holding brake: configuration	0b0000.0100.0010.0001	--	
Administration data [Drive address: 1 - X Axis - Default]				
P-0-3205	Safety technology device identifier	X Axis		--
S-0-0030	Manufacturer version	FwA-INDRV*-MPH-05/12-D5-1-NNN-NN		--
P-0-3200	Safety technology firmware code	FwC-HS111*-SST-0M/12-D5		--
P-0-3201	Change counter of safety technology memory	22		--
P-0-3202	Operating hours at last change of memory	00:00:00		--
S-0-0140	Controller type	HMS01.1N-W0020-A-07-NNNN		--
P-0-1519	Serial number of power section	--		--
P-0-1520	Control section type	CSH01.2C-NN-EN1-NNN-CCD-S1-S-NN-Fw		--
P-0-1518	Serial number of control section	4294967295		--
S-0-0141	Motor type	--		--
P-0-0074	Encoder type 1 (motor encoder)	1		--
Handwritten additional notes				OK
	Safety technology data saved			
	Path and file name			
	User			
Date, signature [Drive address: 1 - X Axis - Default]				

DL000003v04

Fig.9-1: Example of a safety technology report/acceptance test

10 Error Messages and Error Elimination

10.1 Firmware Code

The parameter "P-0-3200, Safety technology firmware code" contains the designation of the safety technology firmware version.

10.2 Errors

The error handling of safety technology is covered by the error handling of the standard drive.

In the case of error, the drive is decelerated in the best possible or quickest possible way and then goes to safety related standstill.



In the case of a feedback error (encoder error), the safety technology can no longer guarantee dual-channel safety. It is then impossible, for example, to detect a coasting spindle. In this case, the safety door may only be unlocked manually after an additional visual check by the operators. The door has to be unlocked at the drive that signals the encoder error. This drive then acknowledges safety and the master can open the safety door.

The parameter "P-0-3218, C3700 Manually unlocking the safety door" allows manually unlocking the safety door in the case of a feedback error.



For causes of errors and troubleshooting, please see the documentation "Troubleshooting Guide".

10.3 Errors in Operating Mode "Normal Operation"



Detection of errors in **inactive safety functions** causes a warning in normal operation. In **active safety functions**, detection of an error causes an error of category F31xx or F7xxx.

For causes of errors and troubleshooting, please see the documentation "Troubleshooting Guide".

10.4 Status Messages

The parameter "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status" makes available 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.

The parameter "P-0-3215, Selected safety technology operating status" or "P-0-3215, Selected safety technology mode" makes available the selected safety technology mode of the individual monitoring channels in coded form.

The parameter "P-0-3216, Active safety technology signals" shows the current states of the safety technology signals of the individual channels.

The parameter "P-0-3217, I/O status channel 2 (optional safety technology module)" shows the current states of the inputs/outputs of the optional safety technology module.

10.5 Change Status of Safety Technology Memory

Every change of the safety technology memory can be assigned to an unequivocal change status which has to be documented together with the password within the scope of the safety acceptance test.

The parameter "P-0-3201, Change counter of safety technology memory" is incremented each time the safety technology memory is changed; this also applies to the command "S-0-0262, C07_x Load defaults procedure command".

The parameter "P-0-3202, Operating hours at last change of memory" indicates the point of time the safety technology memory was changed the last time. It is part of the safety technology memory.

10.6 Tracing Back the Change History

In case you are obliged to produce supporting documents, you can reproduce the last states of the safety technology memory by calling the content of the parameter "P-0-3203, Memory image of safety technology memory". The content of the parameter is a hexadecimal list.

By means of an external program, it is possible to trace back the old states.

11 Notes on Troubleshooting

11.1 Introduction

For the purpose of diagnosis (messages of error, warning, operating status) and service (firmware and hardware replacement), it is necessary that you make yourself familiar, by means of the Functional Description of the firmware, with some functions/elements:

- MultiMediaCard,
- Control panel (standard and comfort version) and
- Parameter handling

The paragraphs below above all explain the points 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 which can be read from the display of the control panel ("Diagnostic Messages of Integrated Safety Technology")
- Diagnostic possibilities specifically extended for integrated safety technology ("Extended Diagnostic Possibilities")

11.2 Diagnostic System

11.2.1 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 Functional Description of firmware "Diagnostic System").

In this chapter we only list the parameters which 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
- P-0-0478, Logbook event
- P-0-0479, Logbook time stamp
- P-0-3219, Diagnostic safety technology message



For integrated safety technology, an extended diagnostic function is provided in the form of a safety technology error code (cf. "P-0-3219, Diagnostic safety technology message") which should be read in the case of error. The error code supports quick and easy error diagnosis (see also "Extended Diagnostic Possibilities").

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 diagnosis and service are stored in the following parameters:

- S-0-0140, Controller type

Notes on Troubleshooting

- 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
- P-0-3200, Safety technology firmware code



"P-0-3200, Safety technology firmware code" contains the designation of the safety technology firmware version which is required for operating the optional safety technology module ("S1")!

11.2.2 Diagnostic Messages of Integrated Safety Technology

Overview

We distinguish the following operating states of integrated safety technology:

- In **normal operation**, the triggering of a monitoring function in **inactive safety functions** causes a warning of category E31xx. In **active safety functions**, detection of an error causes an error of category F31xx or F7xxx.
- In **special mode**, the triggering of a monitoring function causes an error of category F3xxx or F7xxx.

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

Safety Technology Errors (F7xxx, F3xxx)

Errors in the integrated safety technology (F3xxx, F7xxx) are basically handled like "normal" drive errors (F2xxx, F4xxx,...).

But as regards the error reaction and above all the required measures for eliminating an error, specific measures are required for integrated safety technology.



For causes of errors and troubleshooting, please see the documentation "Troubleshooting Guide".

Error Reaction in the Case of F7xxx

In case safety technology errors of category F7xxx occur, the drive, independent of the setting in "P-0-0119, Best possible deceleration" and "P-0-0117, Activation of NC reaction on error", is shut down as fast as possible; the drive is stopped by velocity command value reset (see also Functional Description of firmware "Error Reaction").



NC-controlled shutdown is no longer possible in the case of safety technology errors (F7xxx).

At the end of the error reaction, the drive goes torque-free and the output stage is locked via two channels after the time entered in "P-0-3220, Tolerance time transition from normal operation" or "P-0-3225, Tolerance time transition from safety rel. oper." is over.

As of firmware MP*-03V20, the error reaction can be parameterized via the configuration bit "reaction to F7 error" in "P-0-3210, Safety technology configuration"; the error reaction "velocity command value reset" has been activated as a standard, but can be deactivated so that the drive immediately goes torque-free when an F7 error occurs.



The F7 error reaction "torque disable" should only be used when forced deceleration by velocity command value reset generally causes problems, e.g. in the case of mechanically coupled axes.

The machine manufacturer is responsible for the F7 error reaction "torque disable" and his risk analysis has to show his responsibility.

Commissioning in the Case of F7xxx

The drive can only be put into operation again when:

1. The error message was cleared by the error clearing command (cf. "S-0-0099, C0500 Reset class 1 diagnostics").
2. The actual cause of the error was recognized and removed (e.g. incorrect parameterization of velocity thresholds or time windows).
3. The drive is in the operating mode again and power was switched on again ("Ab").
4. Drive enable was switched on again (0-1 edge).



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

Special Case: Encoder Error

In the case of an encoder error, the integrated safety technology can no longer guarantee dual-channel safety; a coasting spindle, for example, cannot be recognized. In this case the safety door may only be unlocked manually after an additional visual check by the operators. The door has to be unlocked at the drive that signals the encoder error. This drive then acknowledges safety and the master can open the safety door.



The parameter "P-0-3218, C3700 Manually unlocking the safety door" allows manually unlocking the safety door in the case of an encoder error.

Safety Technology Warnings in Operating Mode "Normal Operation"

Warnings in the integrated safety technology (E3xxx) are basically handled like "normal" drive warnings (E2xxx, E4xxx). However, you have to observe the following points:

- With activated safety technology, warnings of category E3xxx only occur in normal operation.
- When a safety related operation is selected, the cause of the warning results in an error being triggered.



For causes of warnings and troubleshooting, please see the documentation "Troubleshooting Guide".

Status Information of Integrated Safety Technology

For the purpose of diagnosis, the following status information is made available for integrated safety technology:

- The parameter "P-0-3213, Safety technology operating status" or "P-0-3213, Safety technology status" makes available 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.

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- The parameter "P-0-3215, Selected safety technology operating status" or "P-0-3215, Selected safety technology mode" makes available the selected safety technology mode in coded form.
- The parameter "P-0-3216, Active safety technology signals" shows the current states of the safety technology signals of the individual channels.
- The parameter "P-0-3217, I/O status channel 2 (optional safety technology module)" shows the current states of the inputs/outputs of the optional safety technology module.

11.3 Extended Diagnostic Possibilities

11.3.1 General Information

Apart from the diagnostic standard functions, the drive system Rexroth IndraDrive with integrated safety technology provides extended diagnostic possibilities specifically implemented for integrated safety technology:

- Change status of the safety technology memory
- Tracing back the change history
- Extended safety technology diagnosis

11.3.2 Change Status of the Safety Technology Memory

Each change of the safety technology memory can be assigned to an unequivocal change status.

Within the scope of the safety technology acceptance test, the change status has to be documented together with the password.

- The parameter "P-0-3201, Change counter of safety technology memory" is incremented each time the safety technology memory is changed; this also applies to the command "S-0-0262, C07_x Load defaults procedure command".
- The parameter "P-0-3202, Operating hours at last change of memory" indicates the point of time the safety technology memory was changed the last time. It is part of the safety technology memory.

11.3.3 Tracing Back the Change History

In case you are obliged to produce supporting documents, you can reproduce the last states of the safety technology memory by calling the content of the parameter "P-0-3203, Memory image of safety technology memory". The content of the parameter is a hexadecimal list. By means of an external program it is possible to trace back the old states.

11.3.4 Extended Safety Technology Diagnosis

In conjunction with integrated safety technology, the parameter "P-0-3219, Diagnostic safety technology message" was introduced to provide an extended possibility of diagnosis in case safety technology errors (F3xxx, F7xxx) or safety technology warnings (E3xxx) occur.

Extended Safety Technology Diagnosis in P-0-3219

An error or a warning which is generated by one of the two safety technology channels is processed by the error handling of the standard drive. In addition, an error code for the corresponding channel, which provides detailed error description, is entered in "P-0-3219, Diagnostic safety technology message".

The procedure is as follows:

1. Read diagnostic message number in the case of error.

2. Read error code entered in "P-0-3219, Diagnostic safety technology message".
3. Select corresponding list by means of diagnostic message number.
4. By means of error code, see cause and remedy of error.



For a list with the error codes of "P-0-3219, Diagnostic safety technology message", see the documentation "Troubleshooting Guide".

11.4 Replacing Drive Components

11.4.1 General Information



When replacing drive components, observe the safety instructions in the chapter "Safety Instructions for Electric Drives and Controls"!

11.4.2 Replacing the Motor

- If necessary, write down last absolute value
- Open main switch
- Make sure main switch cannot be switched on again
- 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 soiling may occur (allowed degree of soiling according to EN50178: 2).

- Replace motor



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

- Connect plug-in connectors



WARNING

Risk of accident caused by unwanted axis motion!

Servo axes with indirect distance measuring system via the motor encoder will lose the position data reference when the motor is replaced!

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

- For servo axes with absolute motor encoder, reestablish the position data reference

11.4.3 Replacing the Supply Unit



Replacing the supply unit might require a lifting device due to its size and weight.



WARNING

Lethal electric shock caused 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.

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

Before working on live parts: De-energize the installation and secure the power switch against unintentional or unauthorized re-energization.

Wait at least **30 minutes** after switching off the supply voltages to allow discharging. To shorten the waiting time until voltage has fallen below 50 V, you can use a discharging device (see chapter "Appendix").

Check whether voltages have fallen below 50 V before touching live parts!



Prior to the replacement of the supply unit, check by means of the type plates whether these devices are of the same types. Only replace devices of the same types.

To replace the supply unit, proceed as follows:

1. De-energize installation and secure it against being switched on again by unauthorized staff or in an accidental way.
2. Using an appropriate measuring device, check whether installation has been de-energized. If necessary, wait for devices to discharge.
3. Make sure that motors have come to a safe standstill.
4. Secure vertical axes against motion.
5. Remove all electrical connections at defective device.
6. Release fixing screws and remove device from control cabinet (use lifting device, if necessary).
7. Mount replacement device in control cabinet (use lifting device, if necessary).
8. Connect replacement device according to connection diagram of machine manufacturer.
9. If you secured vertical axes mechanically before replacing the device, remove these securing devices at this point.
10. By reading error memories of connected drive controllers make sure that device defect has not been caused by drive controllers.

The replacement has been completed. You can put the installation into operation again.

11.4.4 Replacing the Controller

Overview

A controller of the IndraDrive range consists of the components power section and control section (incl. firmware). The control section can be configured with additional components (encoder interface, optional safety technology module,...). In the case of a defect, it is basically possible to replace one of the two components (control section or power section). As control section and power section are firmly connected and one of the two components may only be replaced by Rexroth service engineers or especially trained users, the paragraphs below describe how to replace the complete controller as regards safety technology. The mounting and dismounting of the entire drive controller is described in the Project Planning Manual for the power section.



Only applies to Rexroth service engineers or especially trained users. The replacement of a defective power section does not require any specific handling due to integrated safety technology; i.e. it is not necessary to repeat safety technology commissioning and acceptance test.

When a controller is replaced for which the control section has been configured with the option starting lockout ("L1"), this does not require any specific measure, i.e. the additional measures only apply to the use of option "S1"!



When you replace the controller, you should not carry out the firmware version upgrade, as otherwise it is necessary to repeat the safety technology acceptance test!

When replacing a controller with activated safety technology, observe that **safety technology is not active for controllers in their condition as supplied**:

- The status of "P-0-3207, Safety technology password level" is zero and
- "INDRASAVE" has been entered in "P-0-3206, Safety technology password".



A controller supplied for replacement which already was in operation has to be put in its condition as supplied before it is used (see "Deactivating the safety technology").

The figure below illustrates the basically required individual steps.

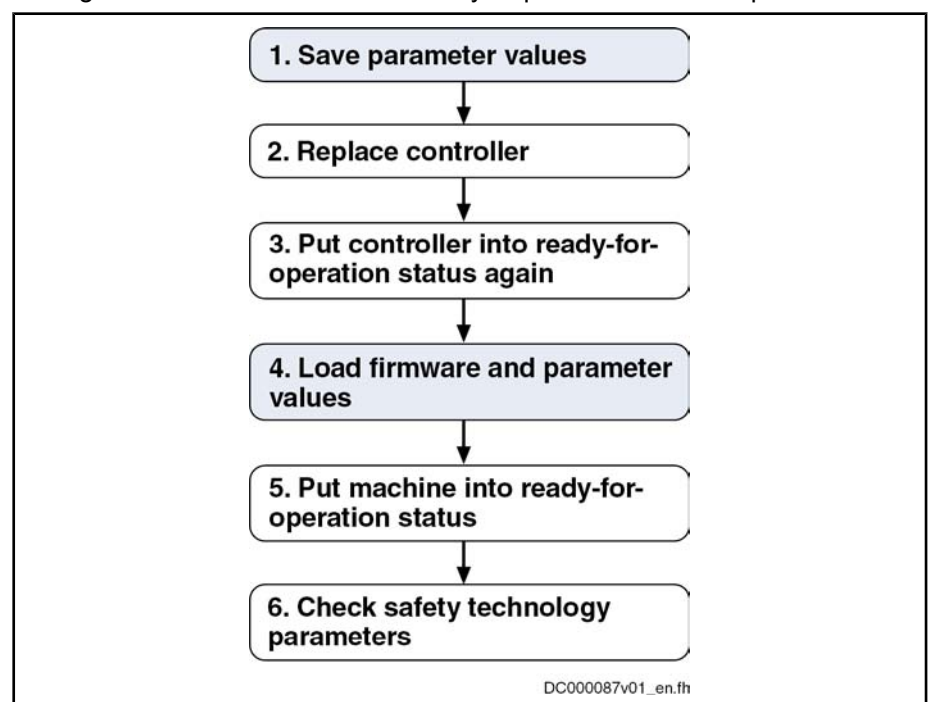


Fig. 11-1: General Sequence of Controller Replacement

Replacing Controller Without Stationarily Plugged MMC

1. Save Parameter Values

Before dismounting defective device, save drive parameter values, if possible.

Notes on Troubleshooting

When the controller is to be replaced by means of the MMC, make sure before starting the replacement that the MMC folder "Firmware" contains the firmware required for the drive (e.g. FWA-INDRV*-MPH-04V08-D5.ibf).



If saving the parameter values before replacing the device should be impossible due to a total breakdown of the device, only the parameter values backed up after initial commissioning can be loaded when the parameter values are loaded later on (see [marginal note "Load Parameter Values in Case of Total Breakdown of Device"](#))!

1. Switch drive off and on again.
2. Switch to parameter mode (PM or P2).

Parameter values of defective device are saved via control panel with MMC temporarily plugged ("hot plug").



If the MMC does not remain stationary (permanently) plugged in the device, it may be temporarily plugged **in the switched-on device after the booting phase** and removed again ("hot plug" or "hot unplug").

The steps below depend on the utilized firmware version:

3a. ! Only for MPx02/03 !

1. Go to command menu.
⇒ By simultaneously pressing "Esc" and "Enter" keys for at least 8 seconds, you can call up extended displays. Subsequently pressing "Up" key (once) activates the command menu.
2. Select command "2.6 C26" (command "C2600 Copy IDN from internal memory to optional memory") by means of arrow keys and activate it with "Enter" key.
⇒ Active parameter values [according to "S-0-0192, IDN-list of backup operation data" and "P-0-0195, IDN list of retain data (replacement of devices)"] are copied from the controller-internal memory to an MMC temporarily plugged in the controller.



MPx02/03: When the optional module "MD01" is used, the PLC retain data cannot be stored to the MMC. Therefore, the replacement device can only be commissioned without the PLC retain data.

3b. ! Only for MPx04/05 !

1. Go to service menu.
⇒ By simultaneously pressing "Esc" and "Enter" keys for at least 8 seconds, you can call up extended displays; subsequently pressing "Up" key (twice) activates service menu.
2. Select submenu "device replace" by means of arrow keys and activate it with "Enter" key.
3. Activate command "save Data?".
⇒ Active parameter values [according to "S-0-0192, IDN-list of backup operation data" and "P-0-0195, IDN list of retain data (replacement of devices)"] and the PLC retain data are copied from the

controller-internal memory to an MMC temporarily plugged in the controller.

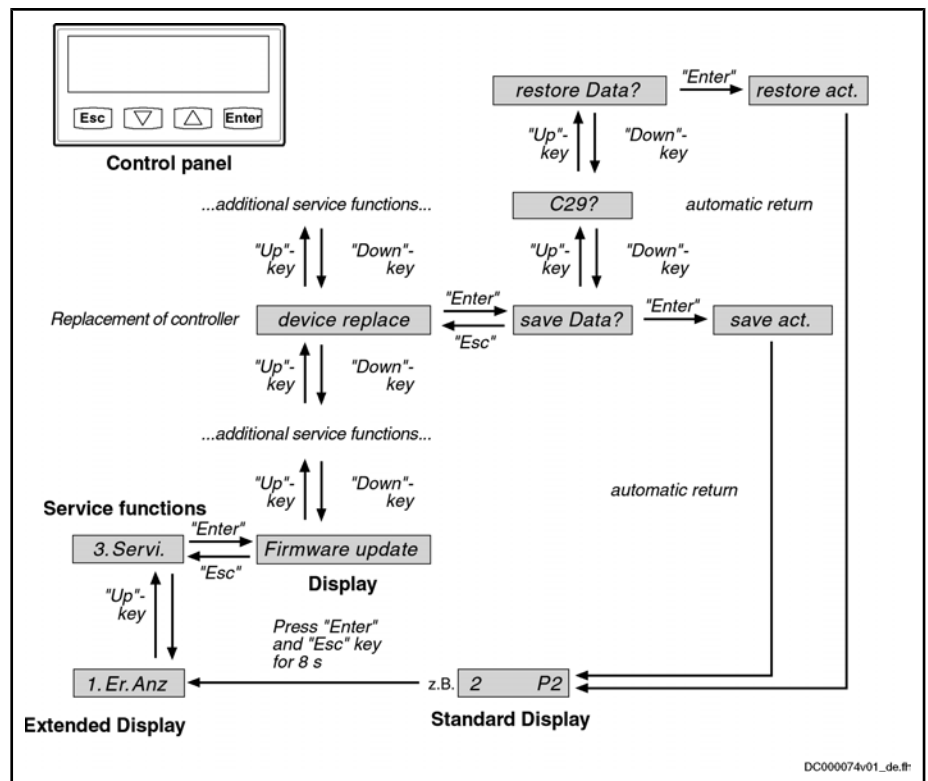


Fig. 11-2: Activating Commands "save Data?" and "restore Data?" When Replacing Controller via Control Panel (Exemplary Illustration of the Menu Structure for MPx04/05)

2. Replace Controller

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



WARNING

Lethal electric shock caused by live parts with more than 50 V!

Before working on live parts: De-energize the installation and secure the power switch against unintentional or unauthorized re-energization.

Wait at least **30 minutes** after switching off the supply voltages to allow dis-charging. To shorten the waiting time until voltage has fallen below 50 V, you can use a discharging device (see chapter "Appendix").

Check whether voltages have fallen below 50 V before touching live parts!

4. Remove touch guard and separate connecting lines from drive controller
 5. Unscrew screws on top and bottom of housing
 6. Take drive controller out of drive system
 7. Mount new drive controller
 8. Connect new drive controller as specified in machine circuit diagram
 9. Mount touch guard
3. Put Controller Into Ready-For-Operation Status Again

Notes on Troubleshooting

Put machine into ready-for-operation status again according to machine manufacturer's instructions.

4. Load Firmware and Parameter Values via MMC

When firmware and drive parameters are to be transmitted via MMC to replacement controller, you have to make sure that MMC folder "Firmware" contains firmware required for drive and the MMC folder "Parameters" contains parameters saved before having replaced device.

1. Disconnect replacement controller from control voltage
2. Put MMC into replacement controller
3. Supply device with control voltage again
4. Depending on the previous configuration of the replacement device, the message "Firmware-Update?" can appear during the booting phase. Acknowledge this message by pressing "Enter" key of control panel. By doing this, firmware is loaded from plugged MMC to controller.



If the message "Firmware Update?" is not displayed, the firmware update must be started via the display.

- MPx02/03: "2. Command" → "2.11 C29"
- MPx04/05: "3. Service" → "Firmware update" → "FWA update"

5. Then one of the messages below might be displayed:

- "Load new param.?"
- "Load Par from MMC?"

⇒ Acknowledge the respective message by pressing "Enter" key of control panel. Drive parameters are now loaded from MMC to volatile memory of device; message "Load new safety?" then possibly appears.

⇒ Acknowledge this message by pressing "Enter" key of control panel, too. Safety technology parameters are now loaded from MMC to memory of optional safety technology module.

6. Switch to parameter mode (PM or P2)

The step below depends on the utilized firmware version:

7a. ! Only for MPx02/03 !

1. Go to command menu.
 - ⇒ By simultaneously pressing "Esc" and "Enter" keys for at least 8 seconds, you can call up extended displays. Subsequently pressing "Up" key (once) activates the command menu.
2. ⇒ Store parameters from MMC to internal, non-volatile memory of controller via control panel by activating command "C25" (command "C2500 Copy IDN from optional memory to internal memory") (storing according to parameters "S-0-0192, IDN-list of backup operation data" and "P-0-0195, IDN list of retain data (replacement of devices)"). After parameter loading processes have been completed, drive waits for further actions of control master.

7b. ! Only for MPx04/05 !

1. Go to service menu.
 - ⇒ By simultaneously pressing "Esc" and "Enter" keys for at least 8 seconds, you can call up extended displays; subsequently pressing "Up" key (twice) activates service menu.

2. Select submenu "device replace" by means of arrow keys and activate it with "Enter" key.
3. ⇒ Store PLC retain data and parameters from MMC to internal, non-volatile memory of controller via control panel by activating command "restore Data?" (storing according to parameters "S-0-0192, IDN-list of backup operation data" and "P-0-0195, IDN list of retain data (replacement of devices)"). After parameter loading processes have been completed, drive waits for further actions of control master.



If safety technology is to be activated in the replacement device (in accordance with replaced device), the drive after loading the safety technology parameters has to be switched to operating mode (OM) or communication phase (P4) before it is switched off!

8. Switch controller off
 9. Remove MMC from device
 10. Switch controller on again
 11. The message "Load new param.?" can then be displayed. Acknowledge this message by pressing "Enter" key of control panel. Drive parameters are now loaded from the non-volatile memory ("flash") to volatile memory ("RAM") of device. From now on, device behaves like device without MMC plugged.
5. **Put Machine Into Ready-For-Operation Status**
 1. Put machine into ready-for-operation status again according to machine manufacturer's instructions.
 2. Check functions of drive.
 6. **Check Safety Technology Parameters**

Completing the process, it must be checked with activated safety technology whether the correct safety technology parameters have been loaded for the drive; for this, check data in "P-0-3205, Safety technology device identifier" (machine type, unit, drive for .. axis/spindle) and compile protocol with contents listed below and add it to safety-relevant documentation of machine:

 - Drive controller replaced on (date)
 - Change counter of safety technology memory (P-0-3201) is at (value)
 - Operating hours at last change of memory (P-0-3202) is at (value)
 - (Date), (name), (signature)

Replacing Controller With Stationarily Plugged MMC

1. Save Parameter Values

When the firmware characteristic IndraMotion MLD (firmware type code: FWA-INDRV*-MPH-04VRS-D5-1-***-ML) is activated and the controller to be replaced is configured in one of the following optional modules, the retain data of the drive PLC must be stored on the MMC before disassembling the defective device.

- Module digital I/O (control section type code: CSH01.**_**_***_***-MD1-**-S-NN-FW)
- Module digital I/O and SSI encoder interface (control section type code: CSH01.**_**_***_***-MD2-**-S-NN-FW)

Notes on Troubleshooting



With the firmware versions MPx02 and MPx03, storing the PLC retain data on the MMC is not possible for control sections with above stated hardware options. Therefore, the replacement device can only be commissioned without the PLC retain data.



If saving the PLC retain data before replacing the device should be impossible due to a total breakdown of the device, the parameter values and retain data backed up after initial commissioning must be loaded when the parameter values are loaded later on (see "Load Parameter Values in Case of Total Breakdown of Device")!

The steps below are only relevant to firmware versions MPx04 and MPx05:

1. Switch drive off and on again
2. Switch to parameter mode (PM or P2)
3. Change drive to service menu via display; by simultaneously pressing "Esc" and "Enter" keys for at least 8 seconds, you can call up extended displays; subsequently pressing "Up" key (twice) activates service menu.
4. Select submenu "device replace" by means of arrow keys and activate it with "Enter" key.
5. Activate command "save Data?"; the active PLC retain data are copied from the controller-internal memory to the MMC plugged in the controller.

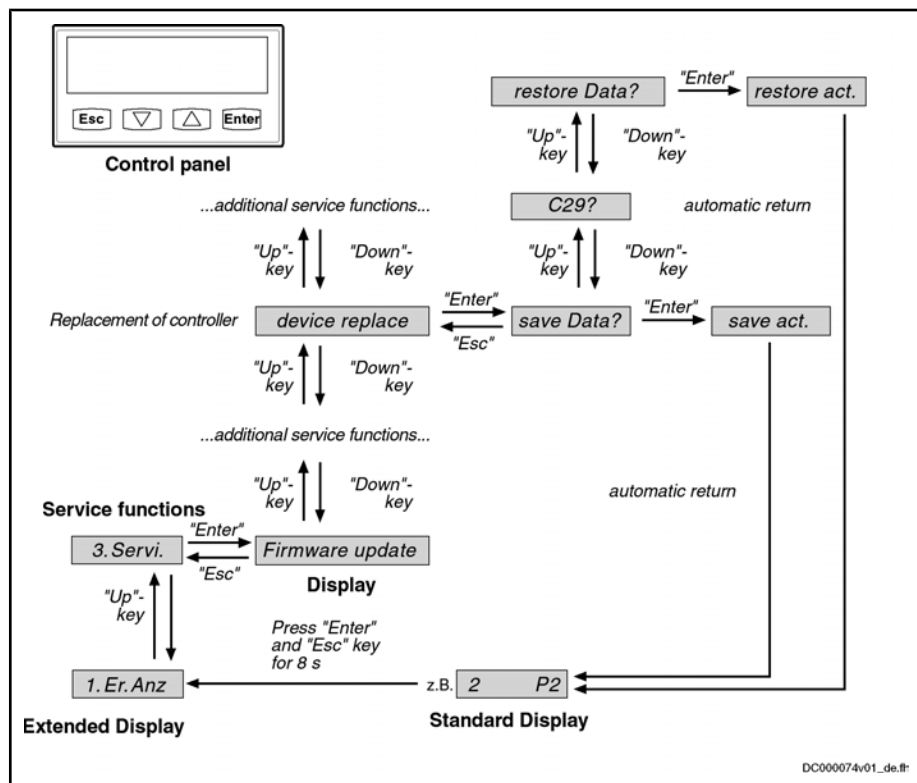


Fig. 11-3: Activating Commands "save Data?" and "restore Data?" When Replacing Controller via Control Panel (Exemplary Illustration of the Menu Structure for MPx04/05)

6. Disconnect controller from control voltage (this automatically saves parameter values).

7. Remove MMC from controller
2. **Replace Controller**
 1. Open main switch
 2. Make sure main switch cannot be switched on again
 3. Make sure drive controller is completely de-energized

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

Before working on live parts: De-energize the installation and secure the power switch against unintentional or unauthorized re-energization.

Wait at least **30 minutes** after switching off the supply voltages to allow dis-charging. To shorten the waiting time until voltage has fallen below 50 V, you can use a discharging device (see chapter "Appendix").

Check whether voltages have fallen below 50 V before touching live parts!

4. Remove touch guard and separate connecting lines from drive controller
5. Unscrew screws on top and bottom of housing
6. Take drive controller out of drive system
7. Mount new drive controller
8. Connect new drive controller as specified in machine circuit diagram
9. Mount touch guard

3. **Put Controller Into Ready-For-Operation Status Again**

Put machine into ready-for-operation status again according to machine manufacturer's instructions.

4. **Load Firmware and Parameter Values via MMC**

When firmware and drive parameters are to be transmitted via MMC to replacement controller, you have to make sure that MMC folder "Firmware" contains firmware required for drive and the MMC folder "Parameters" contains parameters saved before having replaced device.

1. Disconnect replacement controller from control voltage
 2. Put MMC into replacement controller
 3. Supply device with control voltage again
 4. Depending on the previous configuration of the replacement device, the message "Firmware-Update?" can appear during the booting phase. Acknowledge this message by pressing "Enter" key of control panel. By doing this, firmware is loaded from plugged MMC to controller.
-



If the message "Firmware Update?" is not displayed, the firmware update must be started via the display.

- **MPx02/03:** "2. Command" → "2.11 C29"
 - **MPx04/05:** "3. Service" → "Firmware update" → "FWA update"
-

5. Then one of the messages below might be displayed:

- "Load new param.?"
- "Activate new MMC?"

Notes on Troubleshooting

⇒ Acknowledge the respective message by pressing "Enter" key of control panel. Drive parameters are now loaded from MMC to volatile memory of device; message "Load new safety?" then possibly appears.

⇒ Acknowledge this message by pressing "Enter" key of control panel, too. Safety technology parameters are now loaded from MMC to memory of optional safety technology module.

After parameter loading process has been completed, drive waits for further actions of control master.



If safety technology is to be activated in the replacement device (in accordance with replaced device), the drive after loading the safety technology parameters has to be switched to operating mode (OM) or communication phase (P4) before it is switched off!

5. Put Machine Into Ready-For-Operation Status

1. Put machine into ready-for-operation status again according to machine manufacturer's instructions.
2. Check functions of drive.

6. Check Safety Technology Parameters

Completing the process, it must be checked with activated safety technology whether the correct safety technology parameters have been loaded for the drive; for this, check data in "P-0-3205, Safety technology device identifier" (machine type, unit, drive for .. axis/spindle) and compile protocol with contents listed below and add it to safety-relevant documentation of machine:

- Drive controller replaced on (date)
- Change counter of safety technology memory (P-0-3201) is at (value)
- Operating hours at last change of memory (P-0-3202) is at (value)
- (Date), (name), (signature)

Replacing Controller Without MMC



The execution of a **controller replacement without MMC** only makes sense if the controller is equipped with a **BASIC single-axis control section**.

If the controller is equipped with another control section, it cannot be ensured that after the replacement of the device all parameterized device functions are available again when carrying out the process described below. Therefore, for such controllers, **replacement is only recommended with MMC**.

1. Save Parameter Values

Before dismounting defective device, save drive parameter values, if possible.



If saving the parameter values before replacing the device should be impossible due to a total breakdown of the device, only the parameter values backed up after initial commissioning can be loaded when the parameter values are loaded later on (see "Load Parameter Values in Case of Total Breakdown of Device")!

1. Switch drive off and on again
2. Switch to parameter mode (PM or P2)
3. Saving the parameter values of the defective device can take place via the commissioning tool "IndraWorks D" or the control master:
 - Commissioning tool "IndraWorks D"
By selecting the respective menu item, the parameter values according to the list parameters S-0-0192 and P-0-0195 are stored on an external data carrier (hard disk, floppy disk or the like) [serial communication with the controller or via SYSDA/SERCOS interface].
 - Control master
The parameter values according to the list parameters S-0-0192 and P-0-0195 are stored on a master-side data carrier by the control master.
2. **Replace Controller**
 1. Open main switch
 2. Make sure main switch cannot be switched on again
 3. Make sure drive controller is completely de-energized



Lethal electric shock caused by live parts with more than 50 V!

Before working on live parts: De-energize the installation and secure the power switch against unintentional or unauthorized re-energization.

Wait at least **30 minutes** after switching off the supply voltages to allow dis-charging. To shorten the waiting time until voltage has fallen below 50 V, you can use a discharging device (see chapter "Appendix").

Check whether voltages have fallen below 50 V before touching live parts!

4. Remove touch guard and separate connecting lines from drive controller
5. Unscrew screws on top and bottom of housing
6. Take drive controller out of drive system
7. Mount new drive controller
8. Connect new drive controller as specified in machine circuit diagram
9. Mount touch guard
3. **Put Controller Into Ready-For-Operation Status Again**
Put machine into ready-for-operation status again according to machine manufacturer's instructions.
4. **Load Firmware and Parameter Values**
When firmware and drive parameters are to be transmitted to the replaced controller, the required firmware and a parameter backup of the respective axis must be available.
 1. Supply controller with control voltage
 2. Depending on the previous configuration of the replacement device, one of the following messages can appear during the booting phase:
 - "F2120 MMC: Defective or missing, replace"
⇒ Acknowledge this message by pressing "Esc" key of control panel.
 - "Load new param.?"

Notes on Troubleshooting

⇒ Acknowledge this message by pressing "Enter" key of control panel.

3. By selecting the respective menu item in IndraWorks, the firmware stored on an external data carrier (hard disk, floppy disk or the like) is loaded to the controller (serial communication with the controller).

4. Loading the parameter values can take place via the commissioning tool "IndraWorks D" or the control master:

- Commissioning tool "IndraWorks D"

By selecting the respective menu item, the parameter values stored on an external data carrier (hard disk, floppy disk or the like), immediately before the device was replaced, according to list parameters S-0-0192 and P-0-0195 are loaded to the controller (serial communication with the controller or via SYSDA/SERCOS interface). With safety technology available, further actions are required (see "Replacing the Controller Without Stationarily Plugged MMC").

- Control master

The axis-specific parameter values saved before having replaced the device can also be loaded via the control master. The parameter values saved immediately before the replacement of the device on a master-side data carrier (according to list parameters S-0-0192 and P-0-0195) are loaded to the controller by the control master. With safety technology available, further actions are required (see "Replacing the Controller Without Stationarily Plugged MMC").

5. Put Machine Into Ready-For-Operation Status

1. Put machine into ready-for-operation status again according to machine manufacturer's instructions.
2. Check functions of drive.

Possible Problems During Controller Replacement

The paragraphs below give a brief description of critical problems and their recommended handling.

Load Parameter Values in Case of Total Breakdown of Device

If it should have been impossible to save the parameter values according to the list parameters S-0-0192 and P-0-0195 immediately before replacing the device (total breakdown of device), the parameter values saved after initial commissioning have to be loaded.



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 parameter "S-0-0403, Position feedback value status"!



WARNING

The parameter values saved after initial commissioning are not generally suited for reestablishing the operability of the drive after replacement of devices!

⇒ Before setting drive enable, check actual position values and active target position and, if necessary, PLC retain data!

11.4.5 Replacing the Cables



WARNING

Lethal electric shock caused by live parts with more than 50 V!

Power connectors of the cables may only be separated or connected if the installation has been de-energized.



When replacing cables, observe the instructions of the machine manufacturer.

If you do not use ready-made Rexroth cables, check to ensure that the cables match the terminal diagram of the machine manufacturer!

- Open main switch
- Make sure main switch cannot be switched on again
- Disconnect connections



When replacing cables, cover the open ends of power lines with protective caps if sprinkling with cooling liquid/lubricant or soiling may occur (allowed degree of soiling according to EN50178: 2).

- Replace cables



CAUTION

Property damage caused by bad power connectors!

Only separate or connect clean and dry power connectors.

- Re-establish connections

11.4.6 Replacing the Components of Safety Technology

Replacing the Control Module

When the control module is replaced, it is not necessary to repeat safety technology commissioning and acceptance test.



The same type of control module has to be used after replacement.

Replacing the Redundant Holding Brake

When the redundant holding brake is replaced, it is not necessary to repeat safety technology commissioning and acceptance test.



DANGER

While the redundant holding brake is replaced, secure the axis by a blocking device or by moving the axis to a safety related end position.



The same type of brake has to be used after replacement.

11.4.7 Firmware Replacement

General Notes on How to Replace the Firmware

Basic Principles

Explanation of Terms

For firmware replacement we distinguish the following cases:

- **Release update**

An older firmware release (e.g. MPH05 **V06**) in the device is replaced by a newer firmware release (e.g. MPH05 **V08**).

- **Version upgrade**

The older firmware version (e.g. MPH **04** V20) in the device is replaced by a later firmware version (e.g. MPH **05** V08).



The paragraphs below describe the recommended options of firmware replacement by higher releases ("update") or versions ("upgrade"). The same conditions and sequences of actions apply to firmware replacement by older releases or older firmware versions.

Firmware for IndraDrive is replaced using the following hardware and software:

- **MultiMediaCard (MMC)**
- **PC with software "IndraWorks D"**



The commissioning software "IndraWorks D" can be ordered from one of our sales and service facilities under the designation SWA-IWORKS-D**-04VRS-D0-CD650-COPY (part no. R911319744). The scope of supply of "IndraWorks D" contains a documentation which describes the operation of the program.

Preparations and Conditions for Firmware Replacement

Preparing the Firmware Replacement

You have to make the following preparations for firmware replacement:

1. Drive controller must be on (24 V supply).
2. Be absolutely sure to save parameter values before any firmware version upgrade (for release update this is recommended), otherwise a complete (re-) commissioning is required.
See section "Loading, Storing and Saving Parameters"
3. Drive controller **mustn't** be in operating mode (communication phase 4) (cf. P-0-0115).

General Notes on How to Carry Out Firmware Replacement

You have to observe the following points when carrying out the firmware replacement:

- Do not switch off the 24 V control voltage while replacing the firmware.
- Firmware replacement always must be carried out completely, i.e. firmware on optional safety technology module must be replaced, too.
- For firmware replacement we distinguish between **release update** and **version upgrade**.



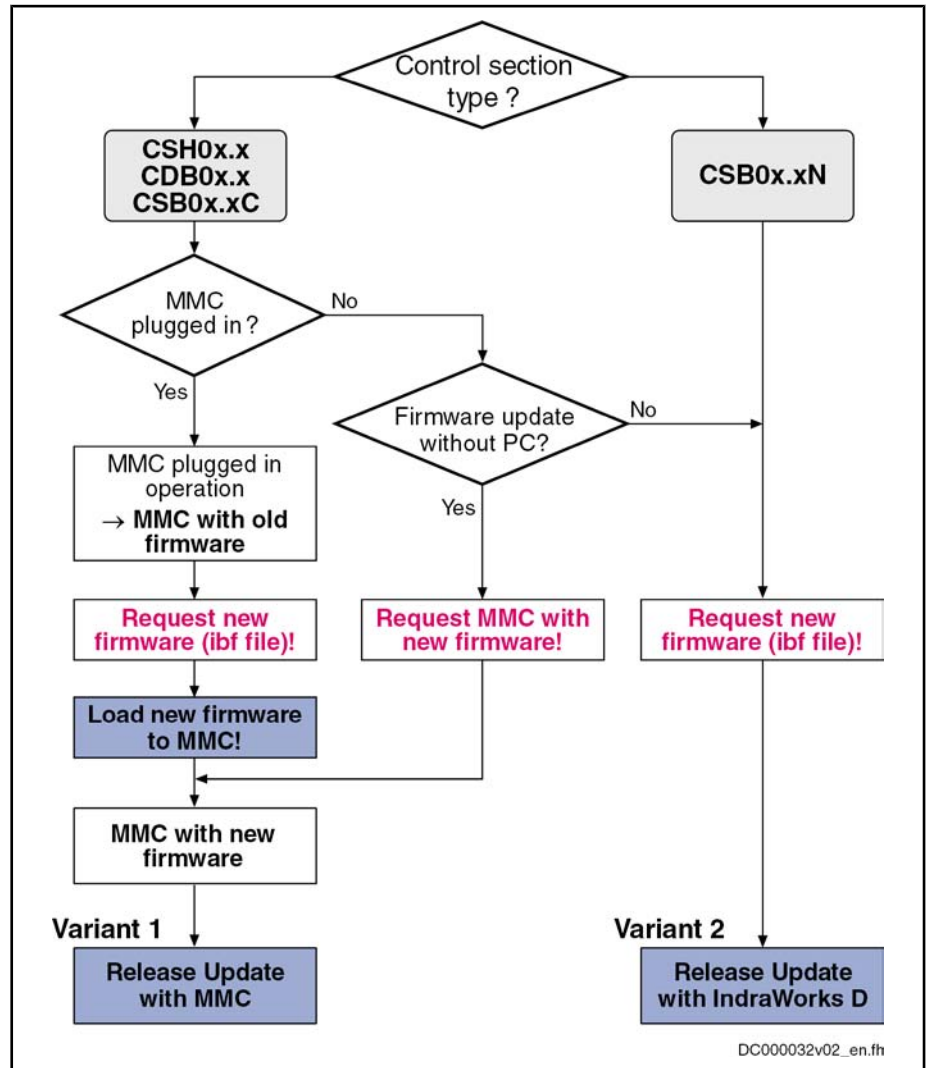
When firmware is replaced in conjunction with the option "starting lockout" (L1), this does not require any specific measure, i.e. the additional measures described below only apply to the use of option "S1"!

Firmware Release Update

General Information

When firmware in a drive controller is replaced by firmware of a **new release**, this is called firmware release update (e.g. FWA-INDRV*-MPH-05V06-D5 replaced by FWA-INDRV*-MPH-05V08-D5).

The described sequences of the firmware release update depend on the configuration of the control section and the hardware (MMC or PC) used for update. The basically recommended sequence of the firmware release update is illustrated in the scheme below:



- CSH0x.x ADVANCED single-axis control section
- CDB0x.x BASIC double-axis control section
- CSB0x.xC BASIC single-axis control section (configurable)
- CSB0x.xN BASIC single-axis control section (not configurable)
- Active memo-ry "programming module" operation of MMC (see P-0-4065)

Fig. 11-4: Schematic sequence of firmware release update



The actions to be taken which are marked with dark background in this figure are described in the paragraphs below.

Notes on Troubleshooting

Loading New Firmware to MMC

Requirements

The following requirements must have been fulfilled for loading firmware to the MMC of the drive:

- New firmware available (ibf file)
- PC with MMC reader
- MMC with old firmware in drive

Loading Firmware to MMC

The following steps are required for loading the firmware to the MMC:

1. Switch drive off and remove MMC.
2. Plug MMC into MMC reader and open folder "Firmware" on MMC.
3. Delete old firmware (e.g. FWA-INDRV*-MPH-05V06-D5.ibf)!
4. Copy new firmware (e.g. FWA-INDRV*-MPH-05V08-D5.ibf) to folder "Firmware"!

Note: Only one firmware file may be stored in the folder "Firmware" on the MMC. With several firmware files, the message "MMC not correct" appears on the display of the drive after booting.

5. Remove MMC from MMC reader after writing process has been completed.

Variant 1: Release Update with MMC

Selection Criterion

Carrying out the firmware release update with MMC makes sense when the controller has **not** been equipped with a BASIC single-axis control section.

Firmware Update with MMC

The optional MultiMediaCard (MMC) allows transmitting drive firmware to the drive controller in a quick and uncomplicated way.



As the MMC is a storage medium that can be written in a simple way (e.g. via PC), it is recommended that you check the MMC content before downloading the firmware. You have to make sure that the MMC really contains the appropriate firmware type.

An MMC with the current release of the required firmware can be ordered from one of our sales and service facilities.

Carrying out the firmware release update with MMC requires the following steps:

1. Load firmware

- ⇒ Switch drive off!
- ⇒ Plug MMC with new firmware into corresponding slot at controller.
- ⇒ Restart drive with MMC plugged.

After drive has been booted, the following message appears:

- "Firmware update?"

⇒ Acknowledge this message by pressing "Enter" key of control panel. By doing this, firmware is loaded from plugged MMC to controller.

The messages below will be displayed, depending on the operating status of the drive:

- "Load Param from MMC" or "Load new param?"
- "Activate new MMC?"
- "F2120 MMC: Defective or missing, replace"

⇒ Switch off drive, remove MMC (if drive was operated without MMC plugged) and restart drive!

2. Put machine into ready-for-operation status

⇒ Put machine into ready-for-operation status again according to machine manufacturer's instructions.

⇒ Check functions of drive.

3. Check safety technology parameters (only when safety technology has been activated in the drive)

In the case of a release update, safety technology parameters are retained. With safety technology activated, the following steps are additionally required:

⇒ Check whether correct safety technology parameter settings for drive are still available.

To do this, check the following points:

- Data in parameter "P-0-3205, Safety technology device identifier"
- Status of safety technology via parameter "P-0-3207, Safety technology password level" (in the case of active and locked safety technology, level is 2)
- Change counter of safety technology memory (parameter "P-0-3201, Change counter of safety technology memory")
- Operating hours at last change of memory (parameter "P-0-3202, Operating hours at last change of memory")

**CAUTION**

If the integrated safety technology is used and a firmware release update is carried out for firmware versions older than MPx02V20, it is necessary to re-approve the safety technology.

After firmware release update, a re-approval of the safety technology must be carried out!

Variant 2: Release Update with IndraWorks D**Selection Criterion**

The following requirements should have been fulfilled in order that carrying out the firmware release update with IndraWorks D makes sense:

- Controller is operated without MMC.

- or -

- Controller has been equipped with BASIC single-axis control section of type CSB0x.xN.

Firmware Update With IndraWorks D

Carrying out the firmware release update with IndraWorks D requires the following steps:

1. Load firmware

⇒ Call IndraWorks D.

⇒ Load project for corresponding axis or create new project; to do this, address axis via a serial connection.

⇒ Switch project "online".

⇒ Select/highlight controller and call "Firmware Management" in context menu.

A new window opens and firmware currently available in drive is displayed on its right side. On left side of window, firmware available in current firmware directory is displayed.

⇒ Highlight new firmware (*.ibf file) on left side and start firmware download via "Download" button.

Notes on Troubleshooting

Firmware download runs automatically and all required firmware components are loaded to drive.

⇒ After firmware download has been completed, close "Firmware Management" window.

2. **Put machine into ready-for-operation status**

⇒ Put machine into ready-for-operation status again according to machine manufacturer's instructions.

⇒ Check functions of drive.

3. **Check safety technology parameters** (only when safety technology has been activated in the drive)

In the case of a firmware release update, safety technology parameters are retained. With safety technology activated, the following steps are additionally required:

⇒ Check whether correct safety technology parameter settings for drive are still available.

To do this, check the following points:

- Data in parameter "P-0-3205, Safety technology device identifier"
- Status of safety technology via parameter "P-0-3207, Safety technology password level" (in the case of active and locked safety technology, level is 2)
- Change counter of safety technology memory (parameter "P-0-3201, Change counter of safety technology memory")
- Operating hours at last change of memory (parameter "P-0-3202, Operating hours at last change of memory")

Firmware Version Upgrade

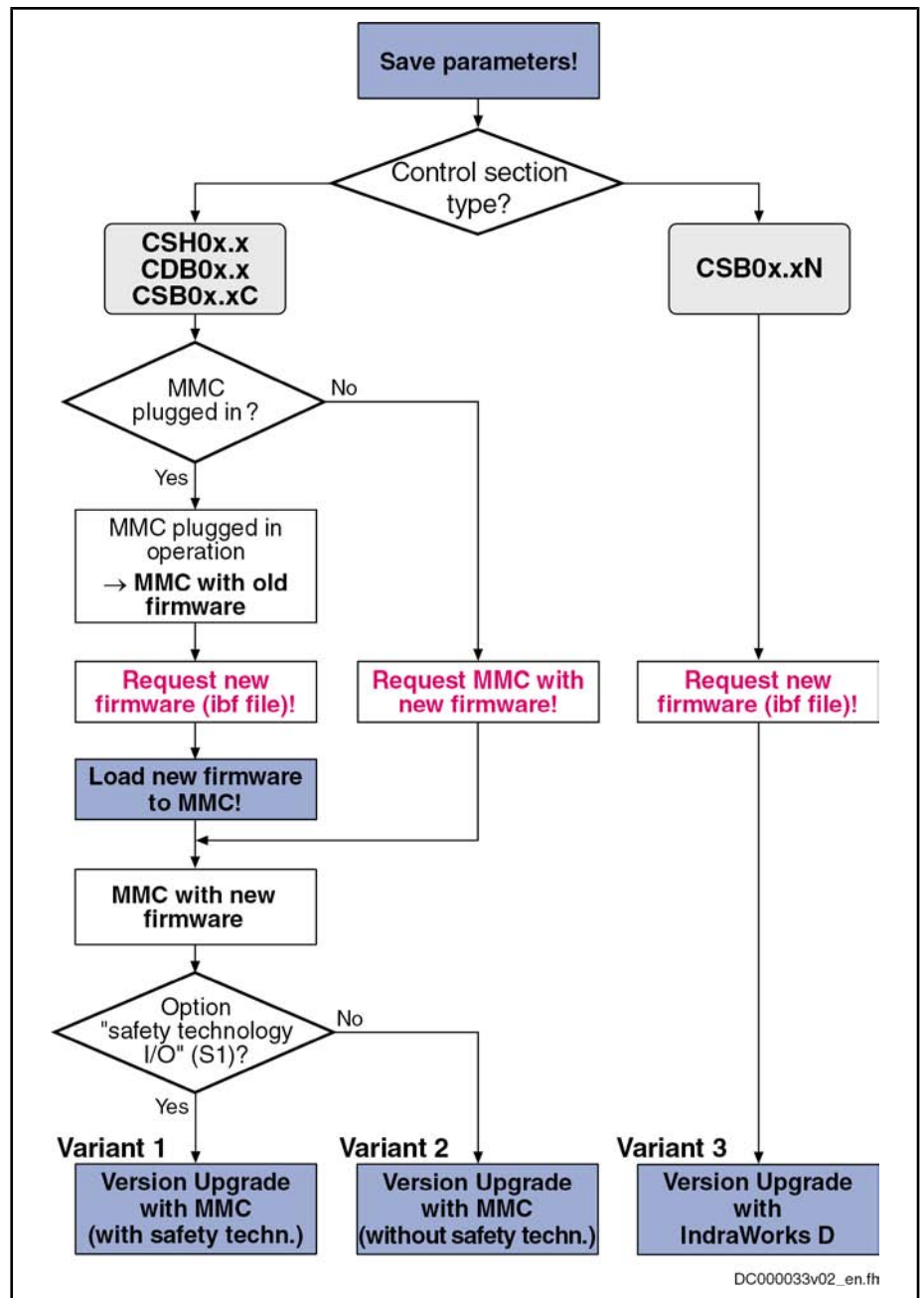
General Information

When firmware in a drive controller is replaced by firmware of a **later version**, this is called firmware version upgrade (e.g. FWA-INDRV*-MPH-**04**V20-D5 replaced by FWA-INDRV*-MPH-**05**V08-D5).



Before carrying out the firmware version upgrade, you must save all parameters (e.g. with IndraWorks D). **After** firmware replacement the parameters must be restored because the command "C07_1 Load defaults procedure command" is carried out automatically. After the desired parameter file was loaded, the drive controller is ready for operation again.

The described sequences of the firmware version upgrade depend on the configuration of the control section and the firmware used. The basically recommended sequence of the firmware version upgrade is illustrated in the scheme below:



CSH0x.x ADVANCED single-axis control section
 CDB0x.x BASIC double-axis control section
 CSB0x.xC BASIC single-axis control section (configurable)
 CSB0x.xN BASIC single-axis control section (not configurable)
 Active memo- "programming module" operation of MMC (see P-0-4065)
 ry

Fig. 11-5: Schematic sequence of firmware version upgrade

The actions to be taken which are marked with dark background in this figure are described in the paragraphs below.

Save Parameter Values

Before firmware upgrade all application-specific parameter values must be saved on a data carrier. Parameter backup can be carried out by means of:

Notes on Troubleshooting

- **Commissioning software "IndraWorks D"**
→ saving parameter values on external data carrier
- or -
- **Control master**
→ saving parameter values on master-side data carrier



Saving the parameters on the MMC available in the drive is without effect, as this backup will be deleted during the firmware upgrade.

Loading New Firmware to MMC

Requirements

The following requirements must have been fulfilled for loading firmware to the MMC of the drive:

- New firmware available (ibf file)
- PC with MMC reader
- MMC with old firmware in drive

Loading Firmware to MMC

The following steps are required for loading the firmware to the MMC:

1. Switch drive off and remove MMC.
2. Plug MMC into MMC reader and open folder "Firmware" on MMC.
3. Delete old firmware (e.g. FWA-INDRV*-MPH-03V20-D5.ibf).
4. Copy new firmware (e.g. FWA-INDRV*-MPH-04V08-D5.ibf) to folder "Firmware".

Note: Only one firmware file may be stored in the folder "Firmware" on the MMC. With several firmware files, the message "MMC not correct" appears on the display of the drive after booting.

5. Remove MMC from MMC reader after writing process has been completed.

Variant 1: Version Upgrade with MMC (with Safety Technology)

Selection Criterion

The following requirements should have been fulfilled in order that carrying out the firmware version upgrade with MMC makes sense (with safety technology):

- Controller has **not** been equipped with BASIC single-axis control section.
- Optional slot for safety technology has been equipped with the optional module "safety technology I/O" (S1).
- Current parameter setting of axis was saved.

Firmware Upgrade with MMC (with Safety Technology)

Carrying out the firmware version upgrade with MMC requires the following steps (with safety technology):

1. Load firmware

- ⇒ Switch drive off!
- ⇒ Plug MMC with new firmware into corresponding slot at controller.
- ⇒ Restart drive with MMC plugged.

After drive has been booted, the following message appears:

- "Firmware update?"

⇒ Acknowledge this message by pressing "Enter" key of control panel. By doing this, firmware is loaded from plugged MMC to controller.

The messages below will be displayed, depending on the operating status of the drive:

- "Load Param from MMC" or "Load new param?"

- "Activate new MMC?"
 - "F2120 MMC: defective or missing, replace"
- ⇒ Switch off drive, remove MMC (if drive was operated without MMC plugged) and restart drive!
2. **Put drive into ready-for-operation status**
- ⇒ After re-starting the drive the error message "F8201" is generated.
- ⇒ Clear all present error messages and start execution of "C07_2 Load defaults procedure command (load defaults procedure for safety technology)"!
- ⇒ As the number of parameters to be buffered has changed, subsequently "C07_1 Load defaults parameter command (loading basic parameters)" must be activated. By this all buffered parameters are set to their default values.
3. **Load parameter values**
- ⇒ Load parameter file which was saved.
- ⇒ Switch off drive and start again, in order for the parameter to become active.
4. **Complete commissioning of integrated safety technology**
- ⇒ Switch drive to operating mode (communication phase 4).
- The error message "F3152 Incorrect backup of safety technology data" appears as safety technology parameter set between firmware versions 02, 03, 04 and 05 has changed.
- ⇒ Clear error message.
- ⇒ Activate command "synchronize and store safety technology IDN" (C3000).
- ⇒ Activate safety technology by inputting safety technology password (P-0-3206).
- ⇒ Carry out new acceptance test.



See sections "Activating the Safety Technology" and "Acceptance Test" in the separate documentation "Rexroth IndraDrive: Integrated Safety Technology" (DOK-INDRV*-SI*-**VRS**-FK**-EN-P; part no. R911297838)



DANGER

Dangerous movements possible! Danger to life, risk of injury, severe bodily harm or material damage!

In order to ensure correct functioning and to prevent personal damage, subsequent to a firmware version upgrade for drive control devices with the optional module for safety technology (S1), a complete approval test must be carried out.

- ⇒ Make safety technology parameter backup, compile acceptance test protocol and add it to safety-relevant documentation of machine.
5. **Put machine into ready-for-operation status**
- ⇒ Put machine into ready-for-operation status again according to machine manufacturer's instructions.
- ⇒ Check functions of drive.

Notes on Troubleshooting

Variant 2: Version Upgrade with MMC (without Safety Technology)**Selection Criterion**

The following requirements should have been fulfilled in order that carrying out the firmware version upgrade with MMC makes sense (without safety technology):

- Controller has **not** been equipped with BASIC single-axis control section of type CSB0x.xN.
- Optional slot for safety technology has **not** been equipped with the optional module "safety technology I/O" (S1).
- Current parameter setting of axis was saved.

Firmware Upgrade with MMC (without Safety Technology)

Carrying out the firmware version upgrade with MMC requires the following steps (without safety technology):

1. Load firmware

- ⇒ Switch drive off!
- ⇒ Plug MMC with new firmware into corresponding slot at controller.
- ⇒ Restart drive with MMC plugged.

After drive has been booted, the following message appears:

- "Firmware update?"

⇒ Acknowledge this message by pressing "Enter" key of control panel. By doing this, firmware is loaded from plugged MMC to controller.

The messages below will be displayed, depending on the operating status of the drive:

- "Load Param from MMC" or "Load new param?"
- "Activate new MMC?"
- "F2120 MMC: Defective or missing, replace"

⇒ Switch off drive, remove MMC (if drive was operated without MMC plugged) and restart drive!

2. Put drive into ready-for-operation status

⇒ As number of parameters to be buffered has changed, "PL" appears on display (in case errors are present, remove them first). If you now press "Esc" key, all buffered parameters are set to their default values. During this time, message "C07 Load default parameters" appears on display. If errors are present, they first have to be removed and the command C07_1 must then be manually activated!

3. Load parameter values

- ⇒ Load parameter file which was saved.
- ⇒ Switch off drive and start again, in order for the parameter to become active.

4. Put machine into ready-for-operation status

- ⇒ Put machine into ready-for-operation status again according to machine manufacturer's instructions.
- ⇒ Check functions of drive.

Variant 3: Version Upgrade with IndraWorks D**Selection Criterion**

The following requirements should have been fulfilled in order that carrying out the firmware version upgrade with IndraWorks D makes sense:

- Controller has been equipped with BASIC single-axis control section.
- Current parameter setting of axis was saved.

Firmware Upgrade with IndraWorks D

Carrying out the firmware version upgrade with IndraWorks D requires the following steps:

1. Load firmware

⇒ Call IndraWorks D.

⇒ Load project for corresponding axis or create new project. To do this, address axis via a serial connection.

⇒ Switch project "online".

⇒ Select/highlight controller and call "Firmware Management" in context menu.

A new window opens and firmware currently available in drive is displayed on its right side. On left side of window, firmware available in current firmware directory is displayed.

⇒ Highlight new firmware (*.ibf file) on left side and start firmware download via "Download" button.

Firmware download runs automatically and all required firmware components are loaded to drive.

⇒ After firmware download has been completed, close "Firmware Management" window.

2. Put drive into ready-for-operation status

⇒ Switch project "offline" and then "online" again.

After project has been switched online, a message signals that IndraWorks D could not establish communication to drive via serial interface, as drive-internal settings for serial communication were reset.

⇒ Reconfigure communication via button "Search for devices".

⇒ As firmware in drive no longer complies with version stored in project, a corresponding message is displayed. To adjust firmware version in project, first select option "Repair" and then options "Delete existing drive from project" and "Add new drive to project".

⇒ As number of parameters to be buffered has changed, "PL" appears on display (in case errors are present, remove them first). If you now press "Esc" key, all buffered parameters are set to their default values. During this time, message "C07 Load default parameters" appears on display.

If errors are present, they first have to be removed and the command C07_1 must then be manually started!

3. Load parameter values

⇒ Load parameter file which was saved.

4. Put machine into ready-for-operation status

⇒ Put machine into ready-for-operation status again according to machine manufacturer's instructions.

⇒ Check functions of drive.

Possible Problems During Firmware Replacement**Problematic Situations**

Firmware replacement is carried out incompletely if one of the following situations occurs during the sequence of firmware replacement:

- 24V supply of control section is switched off
- Connection to drive is interrupted (e.g. defective interface cable)
- Software crashes

The drive controller then possibly is no longer operable because the firmware contained in the components is no longer compatible.

Notes on Troubleshooting

If there isn't any valid firmware available in the control section in this case, the loader is started. The drive display signals "LOADER". The loader only allows updating the firmware of the control section. Optional cards, such as "safety technology I/O" (S1) or "cross communication" (CCD) cannot be programmed in this status. This must be done, after successful firmware replacement in the control section, in a second run according to the descriptions of the firmware replacement variants.

In this situation, replacement of the control section firmware is only supported by IndraWorks D.



Upon successful firmware replacement in the control section, a re-start has to be carried out. Then all available components have to be updated, too.

Requirements for Loading the Firmware

The following requirements must have been fulfilled for loading firmware to the drive:

- Serial connection to drive available
- Drive display signals "LOADER"

Firmware Replacement in Control Section in the Case of Error

The following steps are required for loading the firmware to the control section in the case of error:

1. Call IndraWorks D.
2. In the menu, call firmware management under "Tools Drive → Firmware Management".
3. Select device and COM interface.
A new window opens and firmware available in current firmware directory is displayed on its left side.
4. Highlight new firmware (*.ibf file) on left side and start firmware download via "Download" button.
Firmware download runs automatically and all required firmware components are loaded to drive.
5. After firmware download has been completed, close "Firmware Management" window.
6. Restart drive.

If drive has not been equipped with optional modules, such as "safety technology I/O" (S1) or "cross communication" (CCD), continue following instructions for release update or version upgrade! Otherwise, carry out release update or version upgrade again to program optional modules.

12 Certificates

On demand, you can get copies of the declarations of conformity and mark certificates from our Bosch Rexroth sales representative (see "[Service and Support](#)").

13 Service and Support

13.1 Helpdesk

Our service helpdesk at our headquarters in Lohr, Germany, will assist you with all kinds of inquiries.

Contact us:

- By phone through the Service Call Entry Center
Monday to Friday: 7:00 am - 6:00 pm Central European Time
+49 (0) 9352 40 50 60
- By fax
+49 (0) 9352 40 49 41
- By e-mail: service.svc@boschrexroth.de

13.2 Service Hotline

Out of helpdesk hours please contact our German service department directly:

+49 (0) 171 333 88 26

or

+49 (0) 172 660 04 06

Hotline numbers for other countries can be found in the addresses of each region on the Internet (see below).

13.3 Addresses

For the current addresses of our sales and service offices, see

<http://www.boschrexroth.com>

On this website you will find additional notes regarding service, maintenance (e.g. delivery addresses) and training.

Outside Germany please contact our sales/service office in your area first.

13.4 Helpful Information

For quick and efficient help please have the following information ready:

- Detailed description of the fault and the circumstances
- Information on the type plate of the affected products, especially type codes and serial numbers
- Your phone and fax numbers and e-mail address, so we can contact you in case of questions

14 Appendix

14.1 Optional Safety Technology Modules

14.1.1 S1 - Safety Technology

Description Safety Technology S1

The option allows different application-related safety functions, such as safety related standstill, safety related drive interlock, safety related reduced speed, safety related direction of motion etc.



The option can only be used in conjunction with an encoder (at slot X4 or X4.1 and X4.2).

X41, Connection Point Safety Technology S1

Connection point	Type	No. of poles	Type of design	Stranded wire [mm ²]	AWG	Tightening torque [Nm]	Figure
X41	D-Sub	9	Female (device)	0,25–0,5	-	-	<p>DA000054v01_nn.FHS</p>

Fig. 14-1: Connection

Function		Signal	Connection	Nominal data	Technical data
Input/output forced dynamization	Digital input	EA30	1	24 V / 3 mA	See chapter Digital Inputs Type 1 (Standard) , page 246
	Digital output			24 V / 0.5 A	See chapter Digital Outputs , page 247
Input/output acknowledgment	Digital input	EA20	2	24 V / 3 mA	See chapter Digital Inputs Type 1 (Standard) , page 246
	Digital output			24 V / 0.5 A	See chapter Digital Outputs , page 247
Input/output / relay contact diagn. message / door locking device	Digital input	EA10n	3	24 V / 3 mA	See chapter Digital Inputs Type 1 (Standard) , page 246
	Digital output			24 V / 0.5 A	See chapter Digital Outputs , page 247
	N/O contact			DC 24 V / 1A	See chapter Relay Contact Type 3 , page 248

Appendix

Function		Signal	Connection	Nominal data	Technical data
Digital inputs	Operating mode selection	E1n	4	24 V / 3 mA	See chapter Digital Inputs Type 1 (Standard) , page 246
		E2n	5		
		E3n	6		
		E4n	7		
Power supply of isolated inputs and outputs ¹⁾		+24V	8	DC 24 V	DC 19.2 ... 30 V Min. 0.1 A Max. 1.6 A (depending on load of outputs)
		0 VE	9		

¹⁾ The maximum current consumption depends on the required current at the outputs EA10n, EA20 and EA30 ($3 \times 0.5 \text{ A} + 0.1 \text{ A} = 1.6 \text{ A}$).

Fig.14-2: Pin assignment

Accessories For the connection X41, there is the accessory **HAS05.1-007** "adapter from D-Sub to terminal connector" .



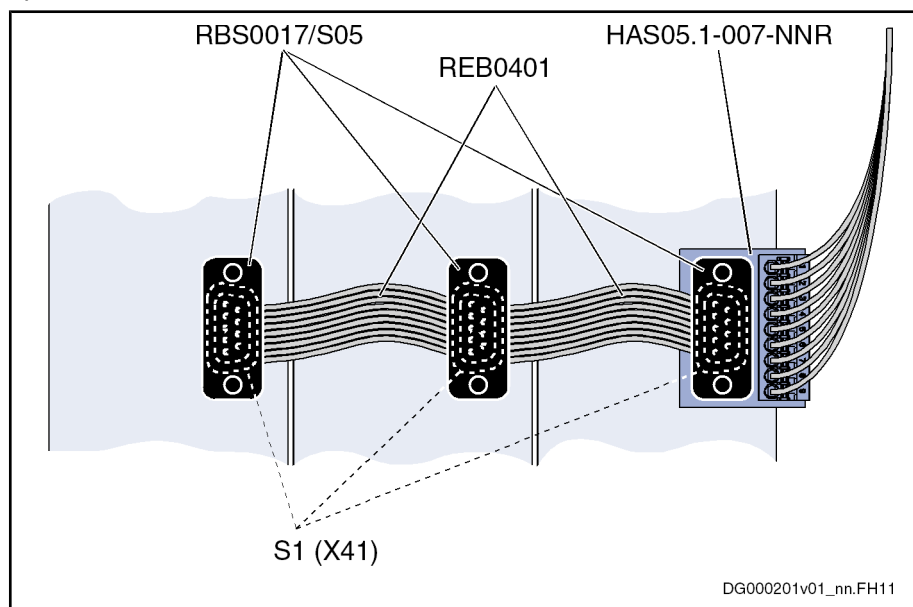
For a detailed description of this accessory, see Project Planning Manual "Rexroth IndraDrive, Drive System".

For the connections of involved X41 via ribbon cable, there are the accessories

- **RBS0017/S05**, D-Sub connector for ribbon cable
- **REB0401**, ribbon cable

Wiring Example With HAS05.1-007-NNR

HAS05.1-007-NNR is the preferred adapter for the bus connection of several optional modules S1.



RBS0017/S05 D-Sub connector with connection for ribbon cable

REB0401 ribbon cable

Fig.14-3: HAS05.1-007-NNR

At CSH01.1C control sections, the adapter HAS05.1-007-NNL can only be used at the left end of the bus connection, when option 3 has not been equipped.

Note on Commissioning If the connection X41 is wired via ribbon cable, the safety related feedback for channel 2 must be deactivated for the slave axes.

See also Parameter Description "P-0-3210, Safety technology configuration".

14.1.2 L1 - Starting Lockout

Description

The starting lockout complies with stop category 0 acc. to EN60204-1.

X41, Connection Point Starting Lockout L1

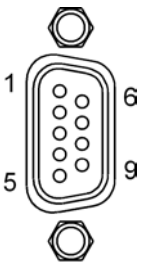
Connection point	Type	No. of poles	Stranded wire [mm ²]	AWG	Tightening torque [Nm]	Figure
X41	D-Sub, female (device)	9	0,25–0,5	-	-	 <p>DA000054v01_nn.FHG</p>

Fig. 14-4: Connection

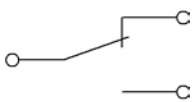
Function		Signal	Connection	Nominal data	Technical data
Inverted acknowledgment	 <p>DA000016v01_nn.FH11</p>	ASQ2	6	DC 24 V / 1 A	See chapter Relay Contact Type 3 , page 248
Supply for acknowledgment potential		ASQ	4		
Acknowledgment		ASQ1	5		
Control signal starting lockout assignment A		AS A	1	24 V / 3 mA	See chapter Digital Inputs Type 1 (Standard) , page 246
Inverted control signal starting lockout		AS n	2		
Control signal starting lockout assignment B		AS B	3		
Power supply of isolated inputs and outputs "AS A"; "AS B"; "AS n"		+24V	8	DC 24 V	DC 19.2...30 V Min. 0.1 A Max. 1.1 A (depending on load of outputs)
		0VE	9		
n.c.			7		

Fig. 14-5: Pin assignment

Function	AS	ASn	Status	ASQ1	ASQ2
	1	0	Starting lockout active	= ASQ	Open
0	1	Starting lockout not active	Open	= ASQ	

Appendix

AS	ASn	Status	ASQ1	ASQ2
0	0	Error when selecting starting lockout	Open	= ASQ
1	1			

Fig. 14-6: Function

Connection Accessory, Starting Lockout L1

The bus wiring is **not** suited for several options "starting lockout L1".

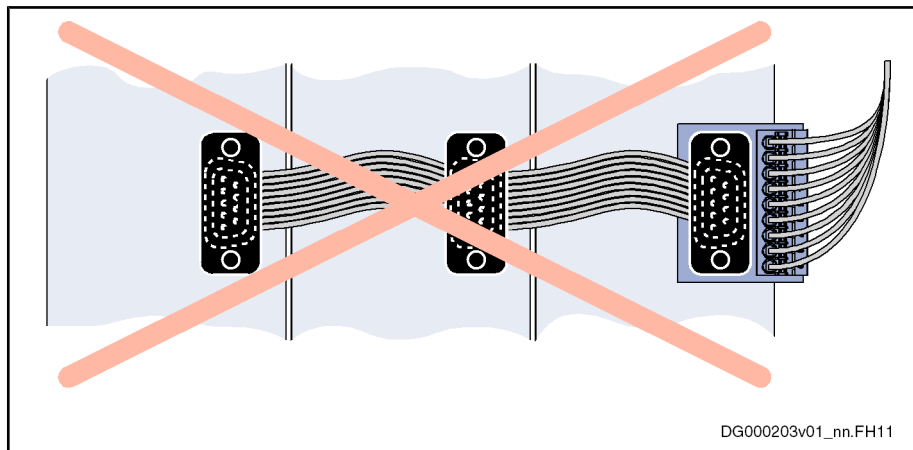


Fig. 14-7: No bus wiring for several options L1

For wiring with single cores, use the ready-made cable **RKS0001** (D-Sub connector for single wire ends) or the adapter **HAS05.1-007-NNR**.

Note on Commissioning

Via the ribbon cable, the signals of all involved connection points X41 are connected in parallel. Differentiated evaluation is impossible with N/O contacts (ASQ, ASQ2) connected in parallel.



Feedback by means of all N/C contacts (ASQ, ASQ1) connected in parallel is allowed via one channel, if the signal "supply for acknowledgment potential" (ASQ) has been realized in dynamized form.

14.1.3 Technical Data of the Digital Inputs/Outputs and Relay Contacts

14.1.4 Digital Inputs Type 1 (Standard)

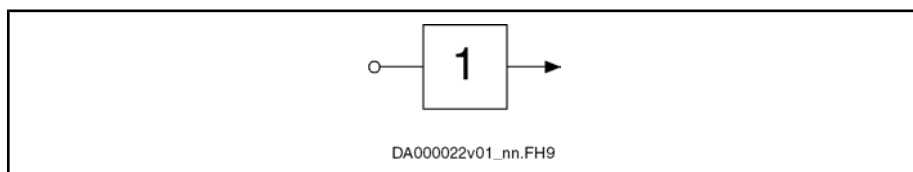


Fig. 14-8: Symbol

Data	Unit	Min.	Typ.	Max.
Allowed input voltage	V	-3		30
On	V	15		
Off	V			5
Input current	mA	2		5
Input resistance	kΩ	Non-linear; varies depending on input voltage		

Data	Unit	Min.	Typ.	Max.
Sampling frequency	kHz	Depending on firmware		
Delay	µs	20		100 + 1 cycle time of po- sition con- trol

Fig. 14-9: Digital inputs type 1

14.1.5 Digital Outputs

The digital outputs correspond to IEC 61131.

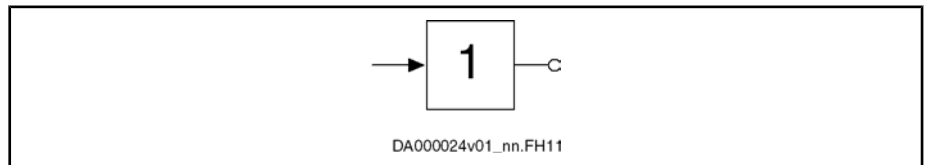


Fig. 14-10: Symbol

Data	Unit	Min.	Typ.	Max.
Output voltage ON	V	$U_{ext} - 0.5$	24	U_{ext}
Output voltage OFF	V			2,1
Output current OFF	mA			0,05
Allowed output current per out-put	mA			500
Allowed output current total or per group	mA			1000
Update interval	ns	Depending on firmware		
Short circuit protection		Present		
Overload protection		Present		
Allowed energy content of con-nected inductive loads, e.g. re-lay coils; only allowed as single pulse	mJ			400

Fig. 14-11: Digital outputs



The digital outputs have been realized with high-side switches. This means that these outputs can actively supply current, but not drain it.



The energy absorption capacity of the outputs is used to limit volt-age peaks caused when inductive loads are switched off.
Limit voltage peaks by using free-wheeling diodes directly at the relay coil.

Appendix

14.1.6 Relay Contact Type 3

Data	Unit	Min.	Typ.	Max.
Current load capacity	A			DC 1
Voltage load capacity	V			DC 30
Minimum contact load	mA	10		
Contact resistance at minimum current	mΩ			1000
Switching actions at max. time constant of load			1 × 10 ⁶	
Number of mechanical switching cycles			1 × 10 ⁷	
Time constant of load	ms	ohmic		
Pick up delay	ms			10
Drop out delay	ms			10

Fig.14-12: Relay contacts type 3

14.2 HAT01 - Control Module for Holding Brake

14.2.1 Brief Description, Usage and Design

Brief Description The control module HAT01 belongs to the Rexroth IndraDrive product range and is used for the "safety related braking and holding system".

HAT01 control modules are mounted on a top-hat rail in the control cabinet.

Usage The types are used as follows:

Type	Usage
HAT01.1-002-NNN-NN	To control an electrically releasing, redundant holding brake.

Fig.14-13: Usage

14.2.2 Type Code and Identification

Type Code



The following figure illustrates the basic structure of the type code. Our sales representative will help you with the current status of available versions.

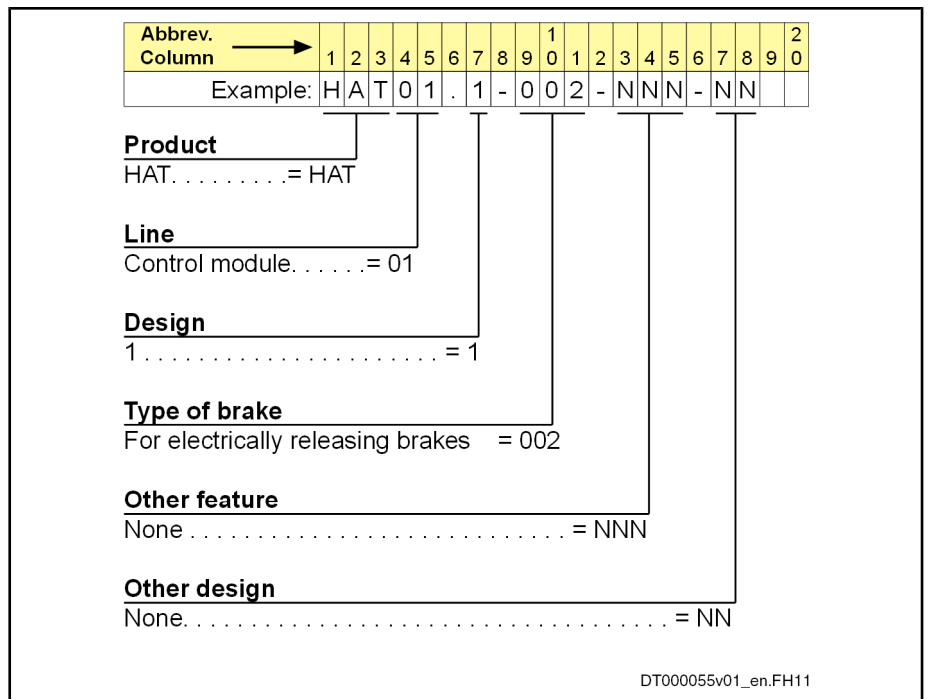
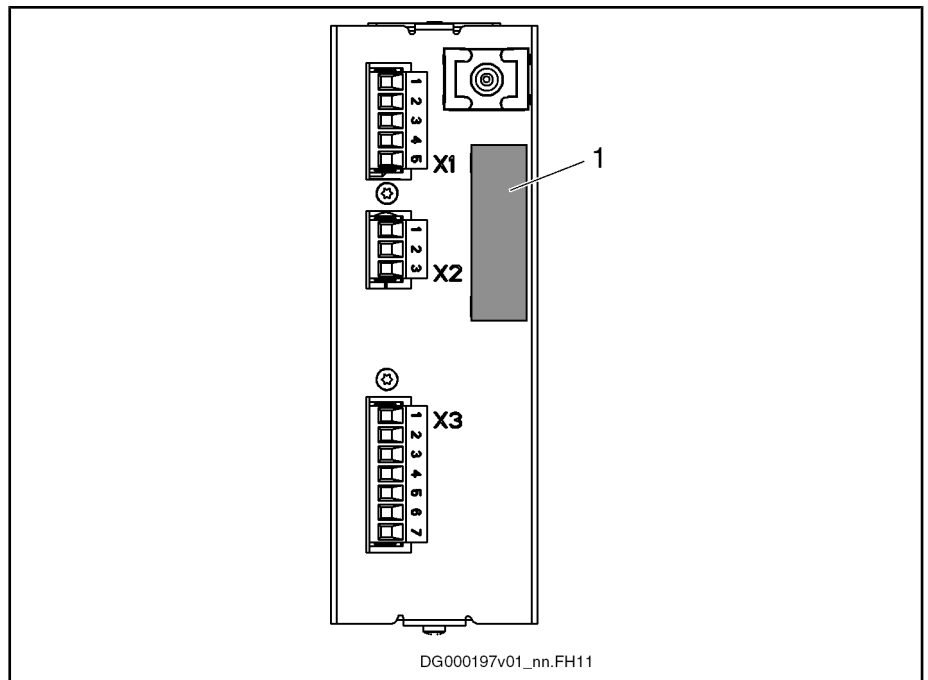


Fig. 14-14: Type code

Identification

Type Plate Arrangement

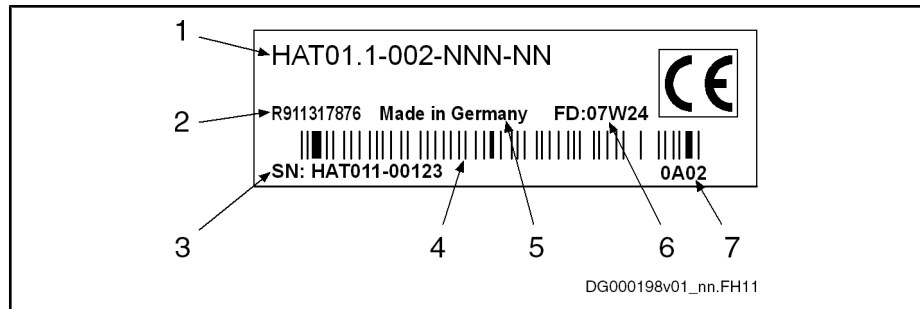


1 Type plate

Fig. 14-15: Type plate arrangement

Appendix

Type Plate



- 1 Device type
- 2 Part number
- 3 Serial number
- 4 Bar code
- 5 Country of manufacture
- 6 Production week, 07W24 meaning year 2007, week 24
- 7 Hardware index

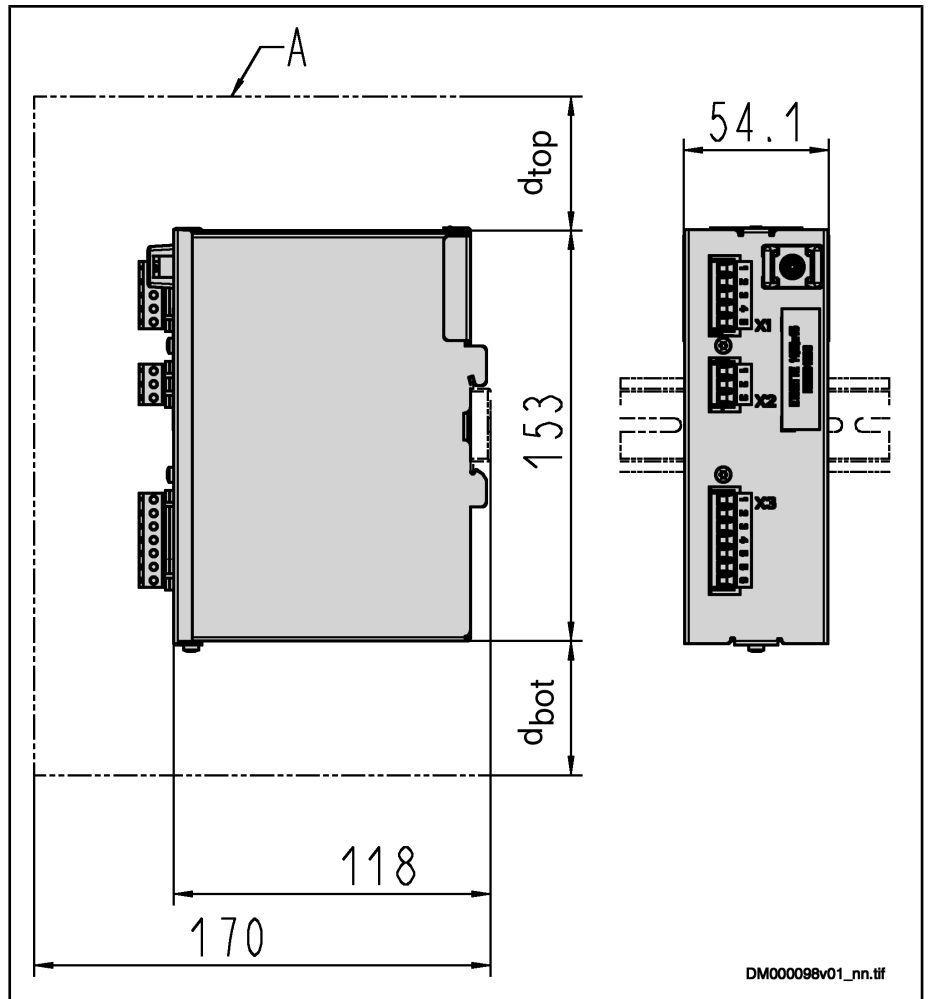
Fig. 14-16: Type plate

14.2.3 Scope of Supply

The scope of supply of the control module HAT01 contains:

- Connectors X1, X2, X3

14.2.4 Dimensions



A Minimum mounting clearance
 d_{top} , d_{bot} See table "Technical data"
 Fig.14-17: Dimensions

14.2.5 Technical Data

Technical data

Description	Symbol	Unit	HAT01.1-002-NNN-NN
Weight	m	kg	0,6
Degree of protection			IP20
Allowed mounting position			Vertical
Minimum distance from the top of the device ⁵⁾	d_{top}	mm	50
Minimum distance from the bottom of the device ⁶⁾	d_{bot}	mm	50
Minimum distance on the side of the device	d_{hor}	mm	-
Allowed ambient temperature range	T_{a_work}	°C	0 ... 55
Cooling type ³⁾			n

Appendix

Description	Symbol	Unit	HAT01.1-002-NNN-NN
Listing according to UL standard (UL)			In preparation
UL files (UL)			In preparation
Control voltage supply			
Rated control voltage input (UL) ¹⁾	U_{N3}	V	Brake cable length < 50 m: 24 ±5% Brake cable length > 50 m: 26 ±5%
Maximum allowed voltage for 1 ms ²⁾	U_{N3_max}	V	33
Rated power consumption control voltage input at U_{N3} (UL)	P_{N3}	W	1,5
Inrush current at 24V supply	I_{EIN3}	A	35
Pulse width of I_{EIN3}	$t_{EIN3Lade}$	ms	4
Input capacitance	C_{N3}	mF	3,6
Power dissipation	P_{Diss}	W	Max. 7.5 (brake controlled)
Output current	I_{Br}	A	See "X2, Output to Brake"

- 1) Observe supply voltage for motor holding brakes
 2) See following note regarding overvoltage
 3) n: Natural convection; f: Forced cooling
 5) 6) 7) See fig. "Air intake and air outlet at drive controller"
 Fig. 14-18: *HAT01 - Technical data*

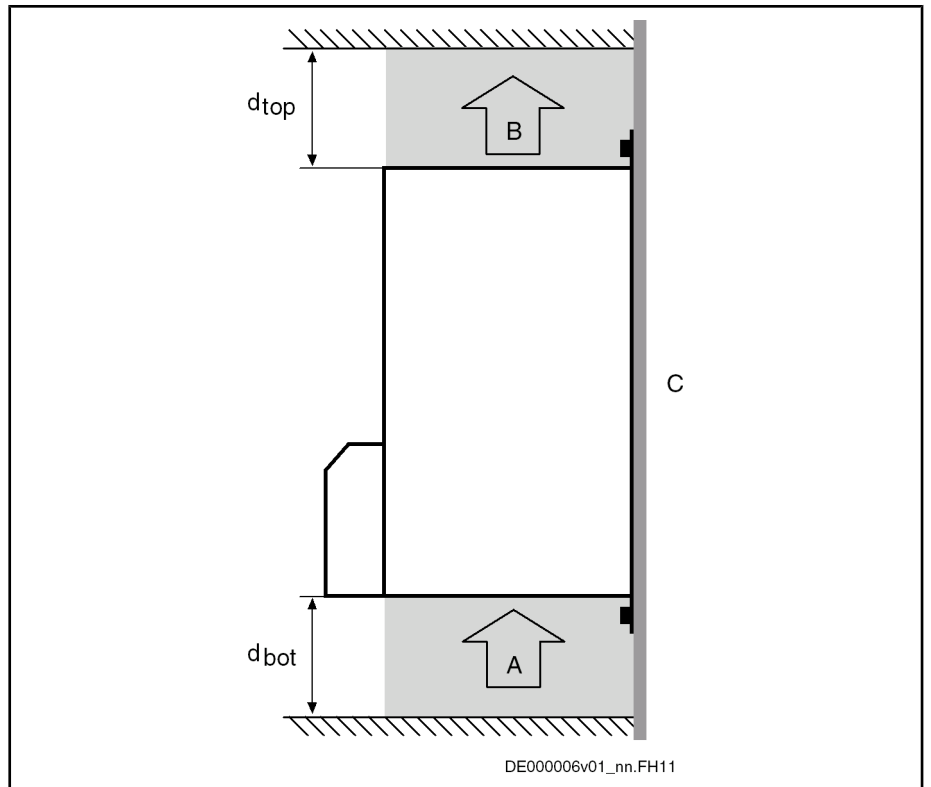


Overvoltage of more than 33V has to be discharged by means of the appropriate electrical equipment of the machine or installation.

This includes:

- 24V power supply units that reduce incoming overvoltages to the allowed value.
- Overvoltage limiters at the control cabinet input that limit existing overvoltage to the allowed value. This, too, applies to long 24V lines that have been run in parallel to power cables and mains cables and can absorb overvoltages by inductive or capacitive coupling.

Distances



- A Air intake
- B Air outlet
- C Mounting surface in control cabinet
- d_{top} Distance top
- d_{bot} Distance bottom

Fig. 14-19: Air intake and air outlet at drive controller

Appendix

14.2.6 Connection Points

Front View

Front view	Connection point	Description
<p>DG000196v01_nn.FH11</p>	X1	24 V power supply (24V, 0V)
	X2	Output to brake
	X3	Signal exchange with control section; connection with ready-made cable RKS0007
	A	Strain relief: Fix connection cable with cable tie

Fig. 14-20: Connection points

X1, 24 V Power Supply

Assignment	Conne- ction	Signal name	Function
<p>DA000230v01_nn.FH11</p>	X1.1	+24V	Power supply and "looping through"
	X1.2	+24V	
	X1.3	0V	Reference potential for power supply and "looping through"
	X1.4	0V	
	X1.5	-	Housing potential
Screw connection at connector	Unit	Min.	Max.
Tightening torque	Nm	0,5	0,6
Connection cable stranded wire	mm ²	1,0	2,5
Connection cable	AWG	18	14
Power consumption	W	See P _{N3}	
Voltage load capacity	V	See U _{N3}	

Current carrying capacity "looping through" from +24V to +24V, 0V to 0V	A		6; max. 1 other HAT01 for operation with HMD01
Polarity reversal protection	-	Within the allowed voltage range by internal protective diode	

Fig. 14-21: Function, pin assignment, properties

X2, Output to Brake

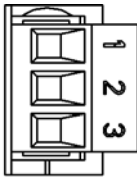
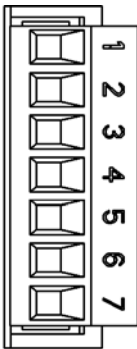
Assignment	Connection	Signal name	Function
 DA000231v01_nn.FH11	X2.1	Br+	Connection to positive pole of holding brake
	X2.2	Br-	Connection to negative pole of holding brake
	X2.3	-	Housing potential HAT01 (connection for cable shield)
Screw connection at connector			
	Unit	Min.	Max.
Tightening torque	Nm	0,5	0,6
Connection cable stranded wire	mm ²	1,0	2,5
Connection cable	AWG	18	14
Output current I_{Br_cont}	A		6
Output current $I_{Br_max}; t \leq 1 \text{ s}; I_{AV} \leq I_{Br_cont}$	A		7,5
Output voltage U_{Br}	V	$U_{N3} - 0.5 \text{ V}$	U_{N3}
Output protection	-	Short-circuit proof and overload-proof within the allowed voltage range	

Fig. 14-22: Function, pin assignment, properties

X3, Signal Exchange With Control Section

Assignment	Connection	Signal name	Function
 DA000234v01_nn.FH11	X3.1	+24V	Power supply of isolated inputs/ outputs X3.3 and X3.4 with 24 V / 0.1 A
	X3.2	+24V	
	X3.3	HAT-Steuer	Input for brake control via U_{Br} (X2)
	X3.4	HAT-Diagnose	Output HAT-Diagnose
	X3.5	0V	Reference potential for power supply at X3.1
	X3.6	0V	
	X3.7	-	Connection for cable shield
Screw connection at connector			
	Unit	Min.	Max.

Appendix

Tightening torque	Nm	0,5	0,6
Connection cable stranded wire	mm ²	1,0	2,5
Connection cable	AWG	18	14
Allowed cable length	m		3
Input X3.3 controls output Br+/Br- (X2) (dynamized input)		250 Hz ±20%, duty cycle ~50% → "H" level at output Br (X2)	
Output voltage at X3.4 shows status of controlled brake	V	Brake applied: 150 Hz ±20% Brake released: "H", (max. X3.1 - 0.5 V) Brake faulty: "L"	
Ready-made connection cable	-	RKS0007	

Fig. 14-23: Function, pin assignment, properties

RKS0007 at HAT01

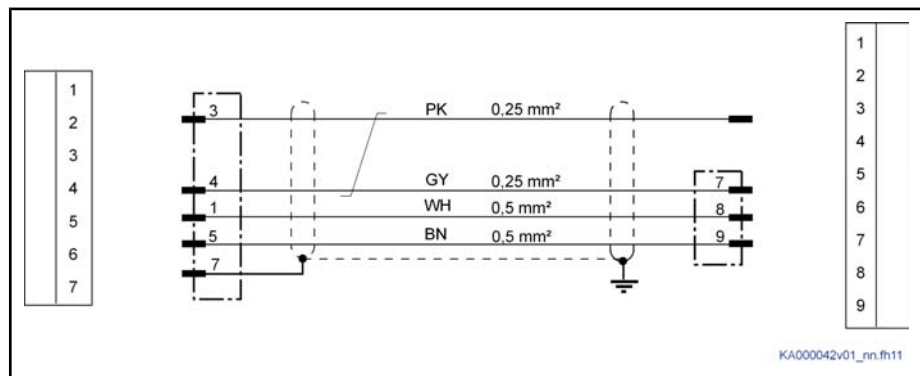


Fig. 14-24: Interconnection diagram RKS0007

14.3 HAS05.1-007, Adapter From D-Sub to Terminal Connector

14.3.1 Usage

The adapter **HAS05.1-007** exists in the following types of design:

- **NNL**: Mounting direction left (outgoing direction spring terminal left)
- **NNR**: Mounting direction right (outgoing direction spring terminal right)

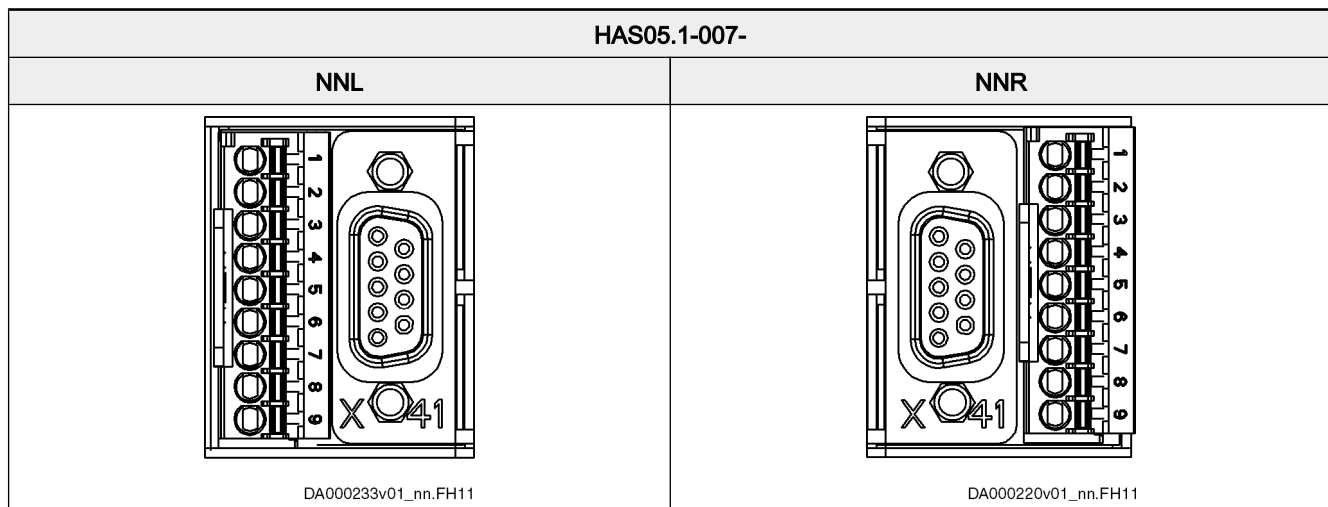


Fig. 14-25: Types of design

Assignment The accessory HAS05.1-007 can be used at the following control sections:

HAS05.1-007-NNL	HAS05.1-007-NNR
CSH01.1C at X41 (Condition: option 3 not equipped)	CSH01.1C at X41
CDB01.1C at X41.1 (option ST1)	CSH01.2C at X41
	CDB01.1C at X41.2 (option ST2)

Fig. 14-26: Assignment HAS05.1-007

At **CDB01** control sections, you can use both types of design together. However, there is the following restriction:

When using the type of design NNL at HMD01.1N-W0012 or HMD01.1N-W0020 drive controllers of a width of 50 mm, you cannot use the adapter of type of design NNR at the neighboring control section on the left-hand side.

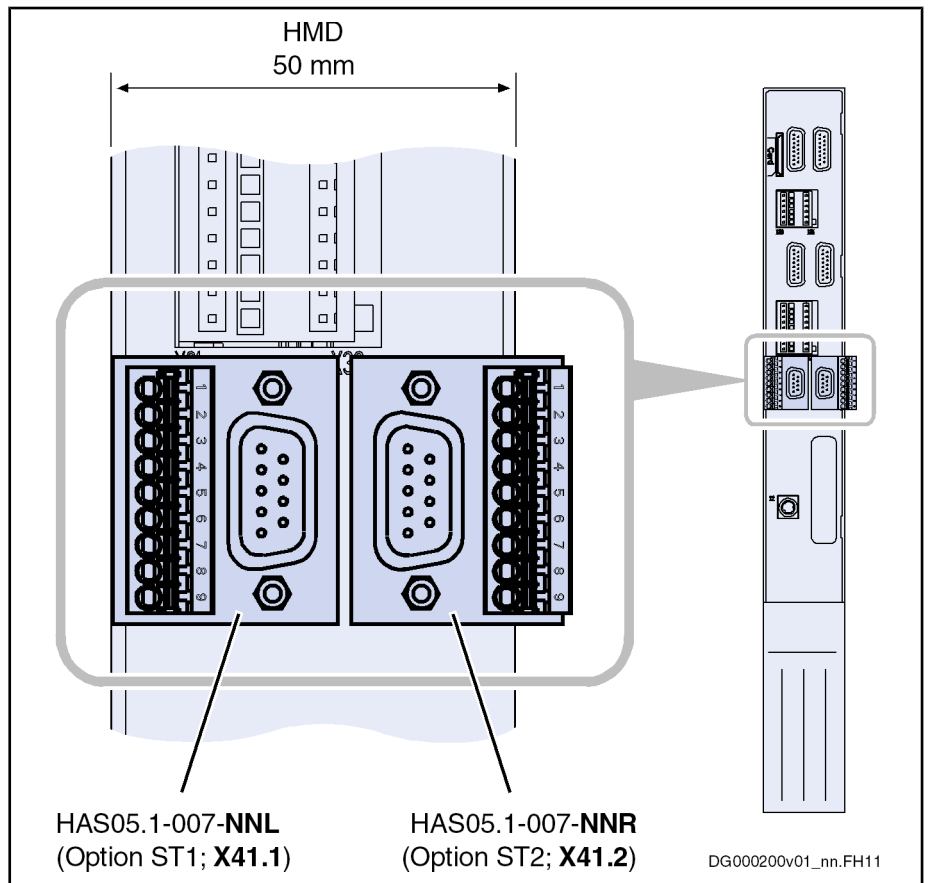


Fig. 14-27: HAS05.1-007-NNL and -NNR at HMD drive controller of a width of 50 mm

Function Universal adapter for safety technology

Usage:

1. Converter of D-Sub connection to terminal connection for an axis
2. Connection of additional component HAT01 to control section and optional module S1

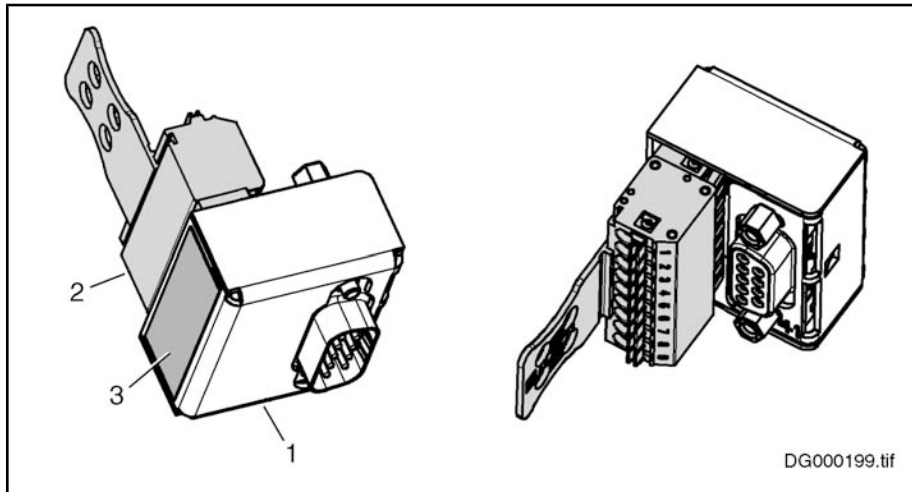
Appendix

3. Converter of D-Sub connection to terminal connection for bus connection of optional modules S1 of the axes of one zone (see figure "Wiring Example With HAS05.1-007-NNR" on page 244)

Identification, Parts

The accessory has a type plate for identification.

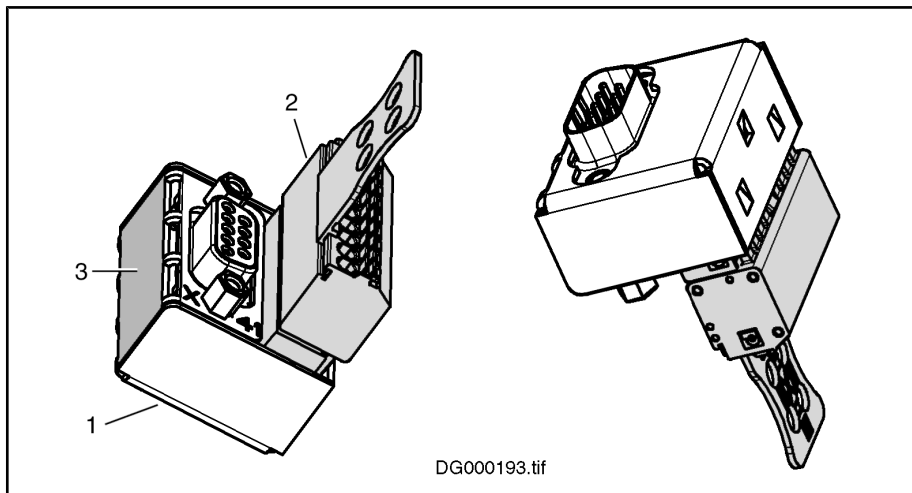
HAS05.1-007-NNL



- 1 Adapter
- 2 Connector (spring terminal)
- 3 Type plate

Fig. 14-28: HAS05.1-007-NNL

HAS05.1-007-NNR



- 1 Adapter
- 2 Connector (spring terminal)
- 3 Type plate

Fig. 14-29: HAS05.1-007-NNR

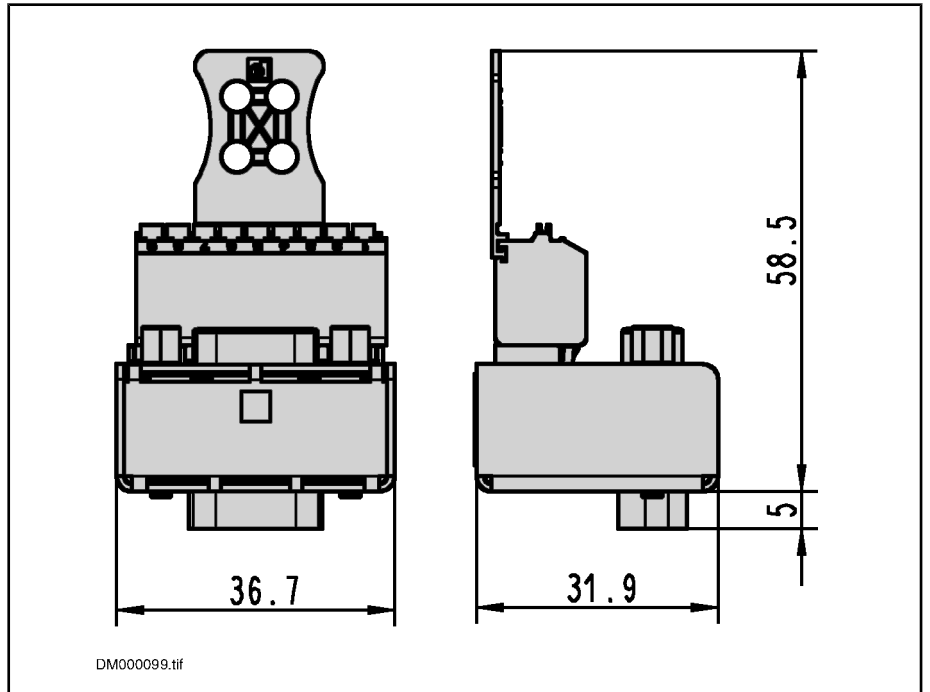
The adapter is plugged in the connection point X41 (resp. X41.1 or X41.2 for double-axis devices) of the control section and secured with screws.

14.3.2 Technical Data

Mounting Dimensions

The accessory requires the following mounting clearance at the drive controller.

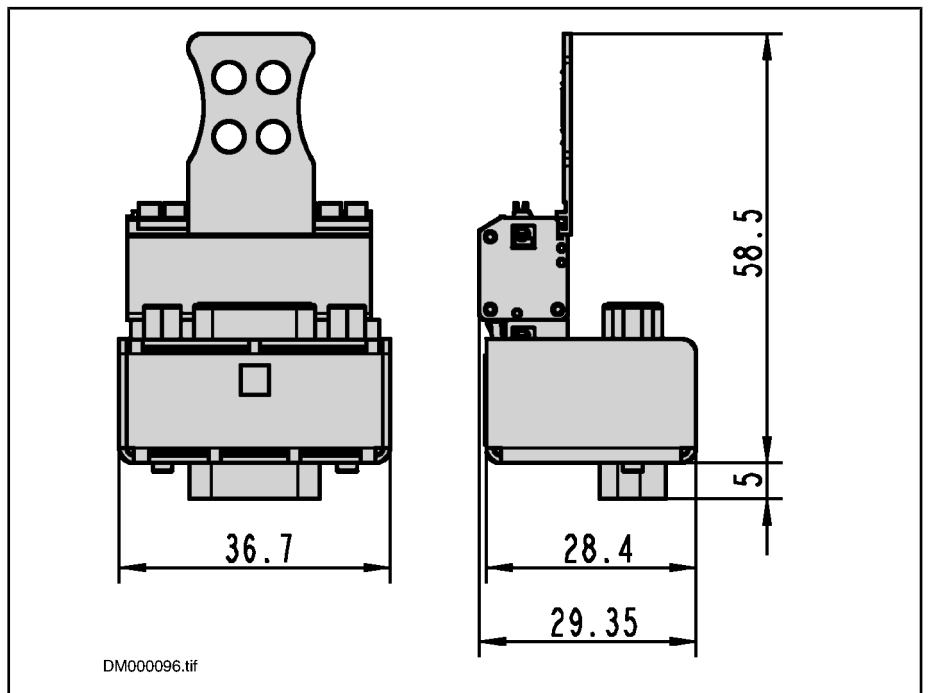
HAS05.1-007-NNL



Data in mm

Fig. 14-30: Mounting dimensions HAS05.1-007-NNL

HAS05.1-007-NNR



Data in mm

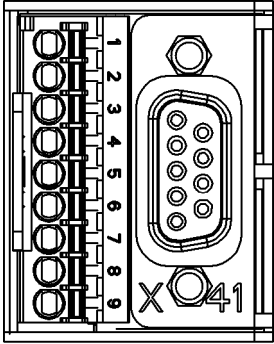

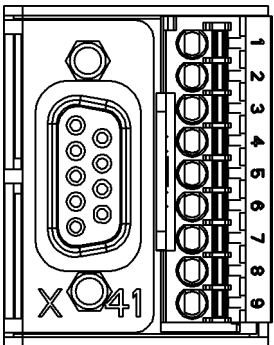
Fig. 14-31: Mounting dimensions HAS05.1-007-NNR



Observe the minimum bending radiuses of the lines used. This requires additional mounting clearance at the front of the drive controller.

Appendix

Connection Point X41

View	Conne- tion (termi- nal)	Signal name	Function
<p>HAS05.1-007-NNL Spring terminal / D-Sub female connector</p>  <p>DA000233v01_nn.FH11</p>	1	X41.1	<p>The adapter brings the connections of the optional modules L1 or S1 to the connections 1–9 of a spring terminal and a D-Sub female connector.</p>  <p>Description of connection point X41: See Project Planning Manual "Rexroth IndraDrive Control Sections", section "Optional Modules for Control Sections, Safety Technology".</p>
	2	X41.2	
	3	X41.3	
	4	X41.4	
	5	X41.5	
	6	X41.6	
	7	X41.7	
	8	X41.8	
	9	X41.9	
<p>HAS05.1-007-NNR D-Sub female connector / spring terminal</p>  <p>DA000220v01_nn.FH11</p>			
Spring terminal (connector)	Unit	Min.	Max.
Cable cross section stranded wire	mm ²	0,5	1,5
Cable cross section	AWG	20	16
Coding	At both types of design, the connection point 5 has been coded, i.e. provided with a coding section. The spring terminal was already assembled accordingly at the factory.		

<p>Electrical data</p>	<p>Description of connection point X41: See Project Planning Manual "Rexroth IndraDrive Control Sections", section "Optional Modules for Control Sections, Safety Technology".</p>
<ul style="list-style-type: none"> • Mating connector for D-Sub female connector • Ribbon cable 	<ul style="list-style-type: none"> • RBS0017/S05 → D-Sub connector, 9-pin • REB0401 → ribbon cable, 9-pin, can be ordered in steps of 0.5 m <p>For professional assembly of the ribbon cable in the D-Sub connector, use the following Tyco tools:</p> <ul style="list-style-type: none"> • Pistol-Grip tool (part number 734155-1) • Matrix for D-Sub connector (part number 734148-1)

Fig. 14-32: Function, pin assignment

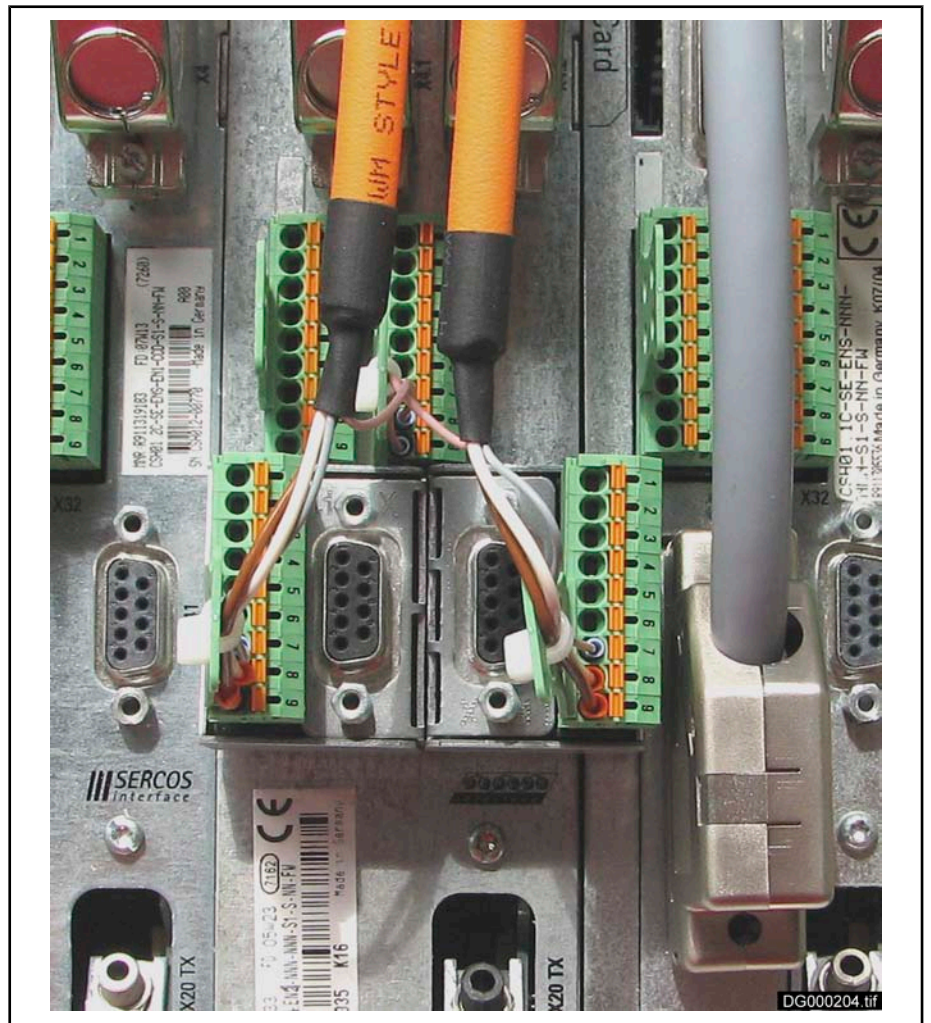
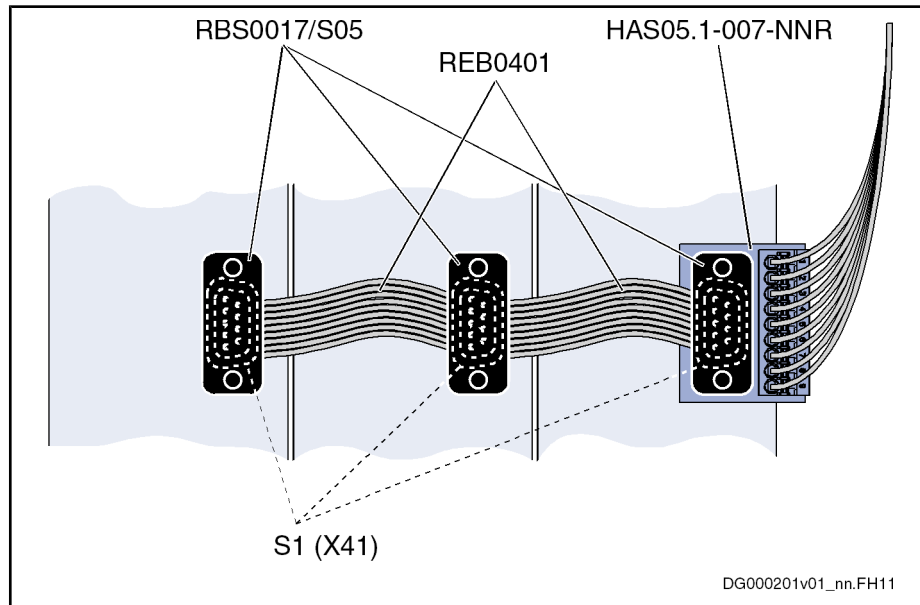


Fig. 14-33: HAS05.1-007-NNL and HAS05.1-007-NNR at CDB control section

Wiring Example With HAS05.1-007-NNR

HAS05.1-007-NNR is the preferred adapter for the bus connection of several optional modules S1.

Appendix



RBS0017/S05 D-Sub connector with connection for ribbon cable

REB0401 ribbon cable

Fig. 14-34: HAS05.1-007-NNR

At CSH01.1C control sections, the adapter HAS05.1-007-NNL can only be used at the left end of the bus connection, when option 3 has not been equipped.

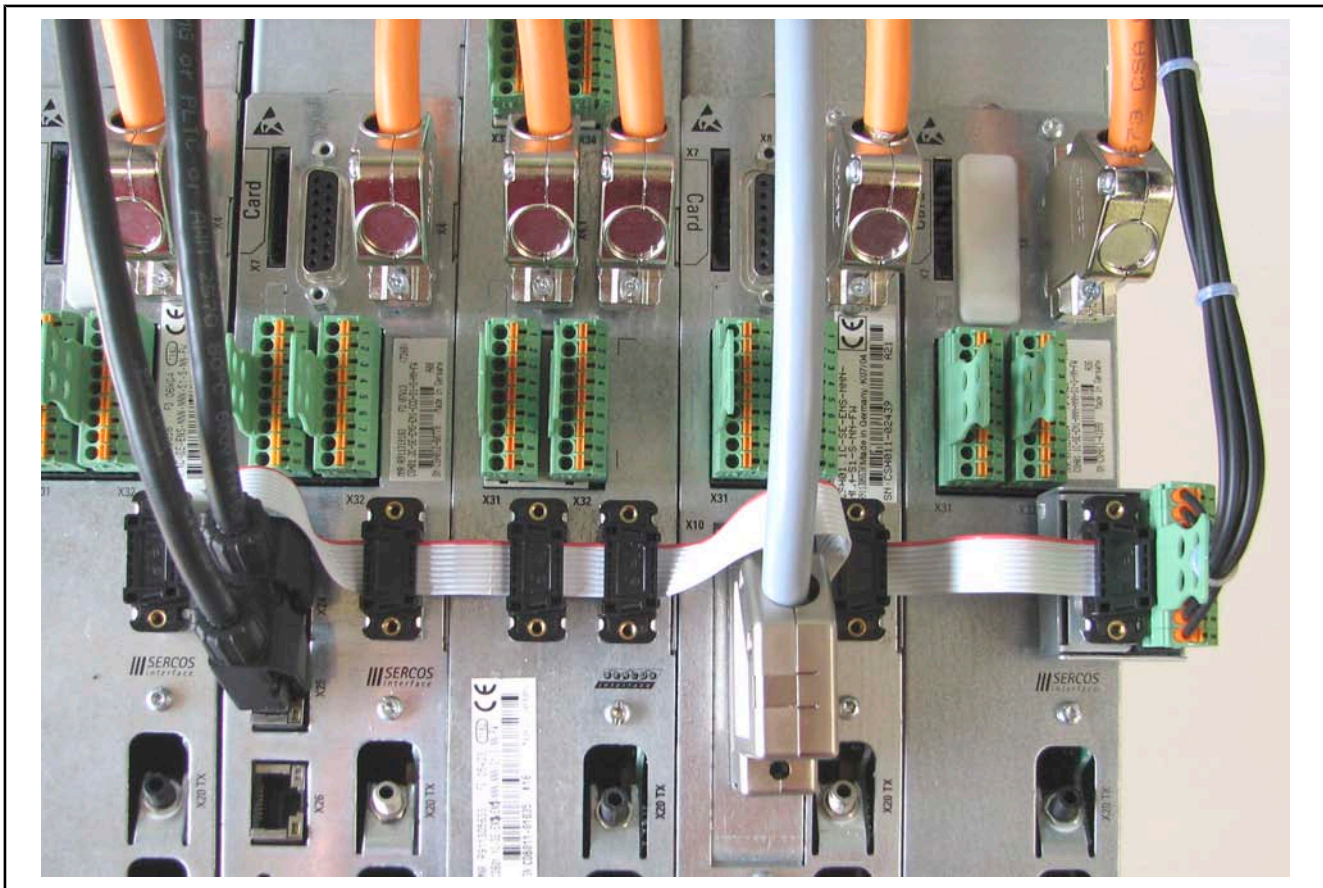


Fig. 14-35: HAS05.1-007-NNR, RBS0017/S05 and REB0401 for bus connection of optional modules S1 of the axes of one zone

Glossary

Accessories

The accessories are assigned to the corresponding device in order to support its functioning. For example, the basic accessories belong to each drive controller and supply unit to fasten them and connect them electrically.

Additional components

Additional components complement supply units, converters and inverters. Typical additional components are mains chokes, mains filters and braking resistors, for example.

Appropriate use of a machine

Use of a machine in compliance with the information made available in the user information.

Basic control section circuit board

The basic control section circuit board is the main part of the control section. It has its own interfaces and, in the case of configurable control sections, additional optional slots for optional modules.

Cable

A cable is a combination of several strands which is kept together by the cable jacket. A typical type of cable is the cable for the motor connection.

Category

Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behaviour in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability (EN ISO 13849-1).

Closed-loop (CL)

Closed-loop describes the **closed-loop-controlled** operation of motors, for example with field-oriented control. This operation is possible both in sensorless form and with encoder and is distinguished with regard to its applications.

Sensorless, i.e. without additional encoder, for **velocity** control, for example by means of observer.

With encoder, i.e. with additional encoder, for **velocity** and **position** control of synchronous motors and asynchronous motors in field-oriented operation.

Combination

Combination refers to a combination of components which is formed via a common DC bus or common mains connection; components such as mains choke, mains transformer and mains filter are used in common.

Glossary


Common DC bus

Voltage source backed up with powerful capacitors to supply drive controllers with power voltage. Common means that the DC bus connections of the involved devices are interconnected.

Configuration

Configuration describes a specific combination of optional modules to form a configured control section which is ideally suited for the intended application.

Connection point of the equipment grounding conductor

The connection point of the equipment grounding conductor is the connection point at which the equipment grounding conductor is fixed to the component; the connection point is identified with the icon .

Control panel

The control panel is the complete unit for operation; it contains input and output elements, such as a key panel and a display.

Control section

The control section is a separate component which is plugged into the power section. The control section is the brain of the drive controller.

Converter, frequency converter

Drive controller which generates three-phase alternating voltage with **variable** amplitude and frequency from the mains voltage with **fixed** amplitude and frequency in order to set the speed of three-phase a.c. motors, for example. Contains the fundamental stages mains rectifier, DC bus and inverter.

Cross data comparison

For cross data comparison, the safety-relevant parameters and processes are checked in 2 independent systems (e.g. μC). If a discrepancy is detected, the system is shut down.

Display

The display is part of the control panel for visual output of information.

Drive controller

Device with which a motor can be operated. Umbrella term for converter or inverter.

Drive system

The drive system comprises all components from mains supply to motor shaft. It consists of the components supply unit, power section with control section incl. firmware, as well as motor and required additional components and corresponding system connections.

Dynamization

Optional module "Safety technology I/O" (S1): Dynamization is to detect static error states, so-called "sleeping errors", during safety function selection and in the safety-relevant circuits. Dynamization takes place, in certain time intervals, automatically in the background without having an effect on the safety function.

Electric drive system

An electric drive system is the total of hardware and software components that have an influence on the sequence of motions of the machine. The electric drive system consists, for example, of drive controllers, plug-in control units, supply modules, motors and encoders.

Embedded software (firmware, system software)

Software which is supplied by the control unit manufacturer as part of the system and which the user of the machine cannot modify.

NOTE: Embedded software is usually written in FVL.

EMERGENCY HALT device

Manually operated control device which is used to trigger an EMERGENCY HALT function.

EMERGENCY HALT (stopping process in case of an emergency)

An emergency operation which is destined to halt a process or motion that has become dangerous.

EMERGENCY ON (switch-on in case of an emergency)

An emergency operation which is destined to switch on the supply with electric energy to a part of an installation that is required for emergency situations.

Emergency operation

An emergency operation includes individually or in combination:

- EMERGENCY HALT (stopping process in case of an emergency)
- EMERGENCY START (start in case of an emergency)
- EMERGENCY STOP (switch-off in case of an emergency)
- EMERGENCY ON (switch-on in case of an emergency)

EMERGENCY START (start in case of an emergency)

An emergency operation which is destined to start a process or motion in order to remove or prevent a dangerous situation.

EMERGENCY STOP device

Manually operated control device which causes the electric energy supply to an entire installation or part of an installation to be switched off, wherever there is a risk of electric shock or another risk of electric origin.

Glossary

EMERGENCY STOP (switch-off in case of an emergency)

An emergency operation which is destined to switch off the supply with electric energy to an entire installation or part of an installation, wherever there is a risk of electric shock or another risk of electric origin.

Enabling control

The enabling control is an additional manually actuated control device with 2 or preferably 3 positions and automatic reset. It is used in connection with a start control (hold-to-run pushbutton) that requires continuous actuation in order to enable motion.

Equipment grounding conductor

The equipment grounding conductor establishes the conductive connection from the connection point of the equipment grounding conductor of the component to the equipment grounding system.

Equipment grounding system

The equipment grounding system is the entire equipment by which the equipment grounding conductors of components are connected to the equipment grounding conductor of the mains. In the majority of cases, an earth-circuit connector belongs to the equipment grounding system.

Failure

Termination of the ability of an item to perform a required function [IEC 60050-191:1990, 04-01].

NOTE 1: After failure, the item has a fault.

NOTE 2: "Failure" is an event, as distinguished from "fault", which is a status.

NOTE 3: The concept as defined does not apply to items consisting of software only.

NOTE 4: Failures which only concern the availability of the process to be controlled are not within the field of application of this part of ISO 13849.

Fault

State of an item characterized by inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources (IEC 60050-191:1990, 05-01).

NOTE 1: A fault is often the result of a failure of the item itself, but may exist without prior failure.

NOTE 2: In this part of ISO 13849, the term "fault" means random fault.

Forced dynamization

Optional module "Starting lockout" (L1): Forced dynamization is to detect static error states, so-called "sleeping errors", during safety function selection and in the interrupting circuits. Both the control section in standard design and the optional safety technology module "L1" have their own interrupting circuits. Forced dynamization takes place by the machine operator selecting the starting lockout and must be carried out in certain time intervals.

Guard (EN ISO 12100-1)

A guard is the part of a machine that is used as a kind of physical barrier to provide protection for people. Depending on its design, the guard can be a casing, cover, shield, door, enclosing guard etc.

Hazardous situation

The hazardous situation is a circumstance in which a person is exposed to at least one hazard; the exposure can immediately or over a period of time result in harm [ISO 12100-1:2003, 3.9].

Hold-to-run control

The hold-to-run control is a control device that requires continuous actuation of the control element in order to enable motion. The hold-to-run pushbutton is a control device with automatic reset.

Hybrid cable

In the hybrid cable, both electrical signals are transmitted on copper wires and optical signals are transmitted on fiber optic cables.

Integrated safety technology

"Integrated safety technology" includes the hardware and software features that allow making available safety-relevant drive functions. A maximum of safety for persons and machines can therefore be made available. The integrated safety technology is state-of-the-art for safety-related control units of category 3 according to EN 954-1 in the field of high-dynamic drives.

Interlocking guard with guard locking (EN ISO 12100-1)

The interlocking guard with guard locking ensures that:

- The hazardous machine functions "covered" by the guard cannot operate until the guard is closed and locked and
- The guard remains closed and locked, even if a halt command was triggered, until the risk of injury due to the hazardous machine functions has disappeared and
- The hazardous machine functions, when the guard is closed and locked, can operate, but the closure and locking of the guard do not by themselves start the hazardous machine functions

Interrupting circuit

An interrupting circuit is the point of access that can be used for switching the drive or installation off. In the case of drive controllers, the interrupting circuit is used, for example, for switching off the output stage.

NOTE: Switching off in a safety-related way requires 2 interrupting circuits.

Inverter

Device which generates three-phase alternating voltage with variable amplitude and frequency from the DC bus direct voltage.

Glossary

Line

A line consists of an electric conductor and its insulation. Sheathed lines are also called cables.

Machine control

System which reacts to input signals of parts of the machine, of the user, external control devices or any combination of these, and generates output signals so that the machine acts in the intended way.

NOTE: The machine control can use any technology or combination of different technologies (e.g. electric/electronic, hydraulic, pneumatic, mechanical).

Master communication

Master communication is the specific communication between hierarchical communication levels. By means of master communication, command variables (e.g. command values) are transmitted from a higher-level control unit to receivers, and actual values, for example, are transmitted back to the control unit.

Mean time to failure

[Mean time to failure (MTTF_d)]; expected value of the mean time to failure.

NOTE: According to IEC 62061:2005, term 3.2.34.

Mode selector

The mode selector determines the operating mode relevant for safety related operation, like for example:

- Normal operation (productive operation, automatic operation etc.) and
- Special mode (manual mode, tool or workpiece change and cleaning process)

The selected kind of control has to be on a higher level than all other control functions - except for the one for the emergency control device. The mode selector can be replaced by other means of selection which allow only certain groups of operators to carry out certain machine functions (e.g. access code for certain numerical control functions etc.). Each position of the mode selector may only correspond to one control or operating mode. (For details see Machinery Directive 98/37/EG, annex I, chapter 1.2.5.)

Monitoring

Safety function which ensures that a protective measure is initiated when the ability of a component or element to fulfill its function is reduced, or the operating conditions are modified in such a way that the value of the risk reduction is reduced.

Open-loop (OL)

Open-loop describes the **open-loop-controlled** operation of asynchronous motors at frequency converters in **U/f operation** without encoder at the motor. This is the simplest operation of asynchronous motors.

Operational stop

Operational stop is the status in which the mechanical component is kept at rest and the motor is supplied with energy, i.e. it is under torque or under force.

Optional module

By means of optional modules, the configurable control sections are equipped with various functions. For example, there are optional modules for master communications, encoder evaluations, I/O extensions, safety technologies, control panels and storage media.

Optional slot

Slot into which an optional module can be plugged. Only configurable control sections have optional slots.

Performance level (PL)

Discrete level which specifies the ability of safety-related parts of a control system to carry out a safety function under predictable conditions.

Power section

The power section is a separate component which contains all the important power elements of the drive controller.

Protective measure

Measure intended to achieve risk reduction [EXAMPLE 1 Implemented by the designer: inherently safe design, safeguarding and complementary protective measures, information for use. EXAMPLE 2 Implemented by the user: by organization (safe working procedures, supervision, permit-to-work systems), provision and use of additional safeguards (use of personal protective equipment; training)].

NOTE: According to ISO 12100-1:2003, term 3.18.

Reasonably foreseeable misuse

Use of a machine in a way not intended by the designer, but which may result from readily predictable human behavior.

Required performance level

[Required performance level (PL_r)]; performance level (PL) applied to achieve the required risk minimization for each safety function.

Residual risk

Residual risk is the risk remaining after protective measures have been taken [according to ISO 12100-1:2003, 3.12].

Risk

Combination of the probability of occurrence of harm and the severity of that harm (ISO 12100-1:2003, 3.11).

Risk analysis

The risk analysis is the combination of the specification of the limits of the machine, hazard identification and risk estimation (ISO 12100-1:2003, 3.14).

Glossary

Risk assessment

Overall process comprising a risk analysis and a risk evaluation (ISO 12100-1:2003, 3.13).

Risk evaluation

Judgement, on the basis of risk analysis, of whether the risk reduction objectives have been achieved (ISO 12100-1:2003, 3.16).

Safety function

Function of a machine; the failure of the function can result in an immediate increase of the risk(s).

Safety related

In connection with drive functions (e.g. safety related standstill, safety related reduced speed etc.), "safety related" means that the behavior of the control unit parts in the case of error complies with the requirements according to EN 954-1 category 3. An error does not cause safety to be lost. Errors must be detected in time and the drive goes to a safety related status.

Safety related drive interlock

The safety function "safety related drive interlock" corresponds to "safety related standstill", but is not disabled by activating an enabling control.

Safety related limited absolute position

The limited absolute position is the absolute position at which a motion must have come to a stop.

Safety related limited increment

The limited increment is a change in position; it starts in standstill, a specified distance/angle is traveled and it ends in standstill.

Safety related maximum speed

With the function "safety related maximum speed", the speed value is monitored with regard to a maximum allowed limit value.

Safety related reduced speed

Using the measure "safety related reduced speed" implies that a person can in time escape the danger caused by hazardous movements. In general, this can be supposed if the resulting speed does not exceed 15 m/min in the case of hazardous movements without the danger of bruising and cutting, and 2 m/min in the case of hazardous movements with the danger of bruising and cutting.

In accordance with the Machinery Directive (98/37/EG), the machine manufacturer has to carry out a risk analysis and afterwards a risk assessment. With these data, the values for reduced speeds have to be determined.

Safety related starting lockout

With the safety function "safety related starting lockout", the power supply to the motor is interrupted in a safety related way. The motor cannot generate any torque/any force and therefore no dangerous movements.

SRP/CS

Parts of a machine control, which are to provide safety functions, are called safety-related parts of a control system (SRP/CS); these parts can consist of hardware and software and be a separate or integral component of the machine control. In addition to the safety functions it makes available, an SRP/CS can also provide operating functions (e.g. two-hand control device for starting a process).

Standstill

"Standstill" is the status in which the mechanical component is at rest and the motor is no longer supplied with energy, i.e. it is torque-free or force-free.

State machine

A state machine is a model of behavior composed of states, transitions between those states and actions.

Stopping process

"Stopping process" is the decrease of motion until stop is reached. The procedure starts when the signal for stopping process is triggered and ends when the motion has come to a stop.

Supply unit

Device which provides power supply to drive controllers. For disconnection from the supply mains, it often contains a mains contactor or makes available the signals required to control the mains contactor.

Third-party supply unit

Supply units which do not belong to the "Rexroth IndraDrive" product range.

U/f operation

Operation in which the drive controller generates variable voltage and frequency in order to set the speed of three-phase a.c. motors, for example.

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