Funktionale Sicherheit

Functional safety

Safety Manual

Safety module Type 5

Firmware - 5.5.0.8

Translation of the original manual

Document 20191137 EN 05

Imprint

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ma_dr_safety-typ5-20191137_en
Version 05 • Edition 03/07/2023

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1 Introduction

The described devices, accessories, hardware and/or software are products of KEB Automation KG. The enclosed documents correspond to conditions valid at printing. Misprint, mistakes and technical changes reserved.

1.1 Markings

1.1.1 Warnings

Certain operations can cause hazards during the installation, operation or thereafter. There are safety informations in the documentation in front of these operations.

Warnings contain signal words for the severity of the hazard, the type and/or source of the hazard, the consequence of non-compliance and the measures to avoid or reduce the hazard.

⚠ DANGER

Type and/or source of the hazard.

Leads to death or serious bodily injury if not observed.

a) Measures to avoid the hazard.

b) Can be supplemented by an additional danger sign or pictogram.

⚠ WARNING

Type and/or source of the hazard.

May cause death or serious injury if not observed.

a) Measures to avoid the hazard.

b) Can be supplemented by an additional danger sign or pictogram.

⚠ CAUTION

Type and/or source of the hazard.

May cause bodily injury if not observed.

a) Measures to avoid the hazard.

b) Can be supplemented by an additional danger sign or pictogram.

NOTICE

Type and/or source of the hazard.

Can cause damage to property if not observed.

a) Measures to avoid the hazard.

b) Can be supplemented by an additional danger sign or pictogram.

1.1.2 Information notes

Indicates to the user a special condition, prerequisite, scope or simplification.

This is a reference to further documentation with barcode for smartphones and link for online users.

(🌐► https://www.keb.co.uk/nc/search)

Notes on conformity for use in the North American or Canadian market.

1.1.3 Symbols and markers

✓ Condition

a) Action step

⇨ Result or intermediate result

(≡► Cross-reference to a chapter, table or picture with page reference [▸ 11])

ru21 parameter name or parameter index

(🌐► Hyperlink)

<Strg> Control code

COMBIVERT dictionary entry

1.2 Laws and guidelines

KEB Automation KG confirms with the CE mark and the EU declaration of conformity, that our device complies with the essential safety requirements.

The EU declaration of conformity can be downloaded on demand via our website.

1.3 Warranty and liability

The warranty and liability on design, material or workmanship for the acquired device is given in the general conditions of sale.

Here you will find our general sales conditions.

(🌐► https://www.keb.co.uk/terms-and-conditions)

Further agreements or specifications require a written confirmation.

1.4 Support

Through multiple applications not every imaginable case has been taken into account. If you require further information or if problems occur which are not treated detailed in the documentation, you can request the necessary information via the local KEB Automation KG agency.

The use of our units in the target products is beyond of our control and therefore exclusively the responsibility of the customer**.**

The information contained in the technical documentation, as well as any user-specific advice in spoken and written and through tests, are made to best of our knowledge and information about the intended use. However, they are considered for information only without responsibility and changes are expressly reserved, in particular due to technical changes. This also applies to any violation of industrial property rights of a third-party.

Selection of our units in view of their suitability for the intended use must be done generally by the user.

Tests can only be carried out within the scope of the intended end use of the product (Application**) by the** Customer**. They must be repeated, even if only parts of hardware, software or the unit adjustment are modified.**

1.5 Copyright

1.6 Validity of this manual

This safety manual supplements the instructions for use accompanying the unit with the implemented safety functions. The safety manual

- is only valid in conjunction with the instructions for use (control- and/or power part).
- supplements the instructions for use with the safety functions.
- contains safety-related supplements and requirements for operation in safety-related applications.
- contains only supplementary safety instructions.
- supplements existing standards. The basic and application standards must still be observed.

1.7 Target group

The safety manual is intended exclusively for qualified electrical personnel with special training or instruction in the field of safety technology. Electrical personnel for the purpose of this instruction manual must have the following qualifications:

- Further training or instruction in the field of safety engineering.
- Knowledge and understanding of the safety instructions.
- Skills for installation and assembly.
- Start-up and operation of the product.
- Understanding of the function in the used machine.
- Detection of hazards and risks of the electrical drive technology.
- Knowledge of IEC 60364.
- Knowledge of national safety regulations (e. g. DGUV Regulation).

2 General Safety Instructions

The products are developed and built according to the state of the art and recognized safety rules. Nevertheless, their use may create dangers to life and limb of the user or third parties or damage to the machine and other material property.

The following safety instructions have been created by the manufacturer for the area of electric drive technology. They can be supplemented by local, country- or application-specific safety instructions. This list is not exhaustive. Non-observance of the safety instructions by the customer, user or other third party leads to the loss of all resulting claims against the manufacturer.

NOTICE

Hazards and risks through ignorance!

a) Read the instructions for use.

b) Observe the safety and warning instructions.

c) Ask if something is unclear.

2.1 Installation

⚠ DANGER

Electrical voltage at terminals and in the device!

Danger to life due to electric shock !

✓ For any work on the device

a) Switch off the supply voltage.

b) Secure it against switching on.

c) Wait until all drives has been stopped in order that no regenerative energy can be generated.

d) Await capacitor discharge time (min. 5 minutes). Measure DC voltage at the terminals.

e) Never bridge upstream protective devices. Also not for test purposes.

⚠ DANGER

Improper installation of safety technology!

Death and serious bodily injuries.

a) Therefore the safety functions may only be installed and put into operation by qualified personnel which are trained in safety technology.

b) Check the safety functions and error responses and generate an acceptance report after installation.

⚠ CAUTION

Movement of the axis due to load

Crushing due to automatic movement with suspended loads or asymmetrical weight distribution.

a) Secure load against mechanical movement (e.g. by brake).

NOTICE

Automatic restart when STO is no longer triggered.

Unpredictable consequences for personnel and machine.

✓ In order to comply with EN 60204-1, observe the following:

a) Ensured by external measures that the drive restarts only after confirmation.

NOTICE

Malfunction due to wrong dimensioning of the current source.

a) Consider all input currents of the used safety functions.

b) If several safety modules are connected, the safety switchgear must supply the required total current.

2.2 Start-up and operation

The start-up (i.e. the starting of normal operation) is prohibited until the machinery has been proved to conform to the provisions Directive 2006/42/EG and Directive 2014/30/EU; EN 60204-1 must be observed.

⚠ DANGER

Continue mains voltage with active STO function!

Electric Shock

a) Always switch off the power supply before working on the device.

b) Await discharge time.

Without mechanical brake the drive leads to coast. Motor is free-wheeling. Additional protective devices must be installed (e.g.locking systems) if damage to persons or property can occur.

⚠ DANGER

Motor coast in the event of a fault

Danger to persons

✓ If there is a danger to persons after the motor control has been switched off by STO:

a) Block access to the hazardous area.

b) Wait until the drive stops.

The start-up can be prevented with interruption of the STO signals. STO may not be released in case of danger according to EN 60204-1. Also note the instructions to the external safety switch devices.

2.3 Maintenance

⚠ WARNING

Failure of safety functions

No protection

✓ To ensure the safety permanently:

a) The safety functions must be checked in regular intervals.

b) The intervals result from the risk analysis.

c) The useful life is limited to 20 years. After this time the unit must be replaced.

3 Product description

3.1 Validity

This manual describes the safety module type 5.

Material number:	05H6x10-00xx
Hardware:	Safety module Type 5
Firmware version:	See table
used in drive converters	xxS6P5x-xxxx xxF6P5x-xxxx

The software version of the safety module can be read out using parameter de42 (safety software version).

The software date of the safety module can be read out using parameter de43 (safety software date).

Firmware	Date code (Firmware)	Manual (Version)	Date of issue (Manual)	Comment
5.5.0.8	24.03.2020	04	10.01.2023	
5.5.0.8	21.12.2022	05	27.01.2023	

Tab. 1: Validity firmware date/manual version

Firmware	Date code	Modification notes
5.5.0.8	24.03.2020	Released firmware with full range of safety functions.
5.5.0.8	21.12.2022	Released firmware with full range of safety functions. Fixed error messages when switching on and off the modulation (≡▶ Limits of encoderless speed measurement [▷ 60]). Previous parameter lists of firmware 5.5.0.8 can still be downloaded to the safety module.

Tab. 2: Firmware modification notes

NOTICE

FS

The certification of drive controllers with safety technology is only valid under the following conditions:

a) The material number corresponds with the numerical code below.

b) The FS logo is printed on the type plate.

3.2 Function

With electronic protection devices there are safety functions integrated in the drive control in order to minimize or eliminate danger by malfunctions in machines. The integrated safety functions replace the complex installation of external safety components. The safety functions can be requested or released by an error.

3.3 Classification of the safety functions

The following general information is taken into account for the classification:

- Information IEC 61508
  - Proof-Test-Interval T = 20 years
  - PFH [1/h]
  - PFD [Failures per request]
- Information ISO 13849-1
  - DC average
  - $MTTF_D$ [years]

Function	Description	IEC 61508	ISO 13849
STO (Safe Torque Off)	**Safe torque off** The drive is switched off by the two-channel switching off of commutation of the power semiconductors. After triggering of the function the drive coasts down. The drive reaches the stop position depending on the speed and the active torque.	SIL 3	PL e
		PFH $4.5 \cdot 10^{-11}$	Category 3
		PFD $3.92 \cdot 10^{-6}$	$MTTF_D$ >1900 a
SBC (Safe Brake Control)	Safe brake control This function provides safe output signals to control up to two external brakes.	SIL 3	PL e
		PFH $5.7 \cdot 10^{-11}$	Category 3
		PFD $4.96 \cdot 10^{-6}$	$MTTF_D$ >1550 a
SS1-r (Safe Stop 1)	Safe stop 1 The drive is decelerated due to the effect of the drive control, while the brake ramp is monitored. After reaching the idle position, state STO is set.	SIL 2	PL d
		PFH $4.7 \cdot 10^{-11}$	Category 2
		PFD $4.1 \cdot 10^{-6}$	$MTTF_D$ >1800 a
SS1-t (Safe Stop 1)	Safe stop 1 The drive is decelerated due to the effect of the drive control, while the deceleration is time-monitored. After expiry of the deceleration time, state STO is set.	SIL 3	PL e
		PFH $4.5 \cdot 10^{-11}$	Category 3
		PFD $3.9 \cdot 10^{-6}$	$MTTF_D$ >1900 a
SLS (Safely-limited Speed)	Safely-limited speed Exceeding of a speed limit value is prevented by this function.	SIL 2	PL d
		PFH $3.39 \cdot 10^{-11}$	Category 2
		PFD $3.0 \cdot 10^{-6}$	$MTTF_D$ >2550 a
SMS (Safe Maximum Speed)	Safe maximum speed Exceeding of a speed limit value is prevented by this function.	SIL 2	PL d
		PFH $2.77 \cdot 10^{-11}$	Category 2
		PFD $2.4 \cdot 10_{-6}$	$MTTF_D$ >3050 a
SSM (Safe Speed Monitor)	Safe speed monitor The safety function provides a safe digital output signal below a specified speed value of a drive.	SIL 2	PL d
		PFH $4.68 \cdot 10^{-11}$	Category 2

Digital Out		PFD $4.1 \cdot 10^{-6}$	$MTTF_D$ > 1850 a
SSM (Safe Speed Monitor) Relay contact	Safe speed monitor The safety function provides a safe relay contact below a specified speed value of a drive.	SIL 2	PL d
		PFH $4.4 \cdot 10^{-9}$	Category 2
		PFD $3.86 \cdot 10_{-4}$	$MTTF_D$ >670 a
SLA (Safely-limited Acceleration)	Safe acceleration The safety function prevents exceeding or falling below the acceleration limit value.	SIL 2	PL d
		PFH $3.39 \cdot 10^{-11}$	Category 2
		PFD $2.96 \cdot 10^{-6}$	$MTTF_D$ >2550 a
SDLC (Safe Door Lock Control) Digital Out	When the drive has been decelerated to standstill, STO is set and a safe digital output signal is supplied to control a door locking device.	SIL 2	PL d
		PFH $5.96 \cdot 10^{-11}$	Category 2
		PFD $5.18 \cdot 10^{-6}$	$MTTF_D$ >1450 a
SDLC (Safe Door Lock Control) Relay contact	When the drive has been decelerated to standstill, STO is set and a safe digital output signal is supplied to control a door locking device.	SIL 2	PL d
		PFH $4.4 \cdot 10^{-9}$	Category 2
		PFD $3.86 \cdot 10^{-4}$	$MTTF_D$ >660 a

Tab. 3: Overview of safety functions with achievable SIL/PL level

For the SIL classification or the classification within a performance level in connection with the applications, the failure rates of the external switching devices must be taken into account for the final assessment.

3.4 Safe condition

In case of failure, the module changes into the safe state. The safe state is defined with the following status:

- Modulation off (STO)
- Brake not controlled (SBC)
- All digital outputs (Out1/Out2) switched off
- Relay contact is open

4 Description of the I/Os

4.1 Terminal X2B

PIN	Name	Function
1	FUNC1.1	Function1- inputs
2	FUNC1.2	
3	FUNC2.1	Function2- inputs
4	FUNC2.2	
5	FUNC3.1	Function3- inputs
6	FUNC3.2	
7	Out1	Output 1
8	Out2	Output 2

Tab. 4: Terminal X2B

The voltages of all inputs and outputs refer to the 0V of the COMBIVERT control board. The pin assignment of the control terminals is described in the respective manual of the COMBIVERT.

4.1.1 Assembly of the wires

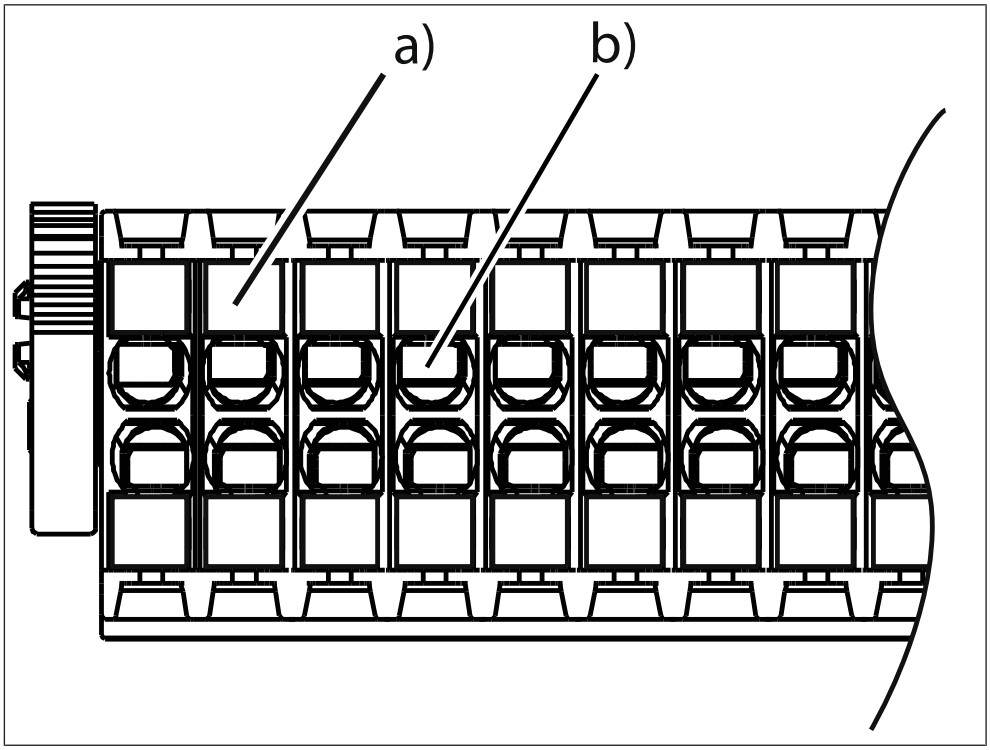


Fig. 1: Assembly of the terminal X2B

a Pusher b Connecting wire hole

- Press pusher by hand. Insert connecting wires into the respective hole, that no single wires can be seen from the outside or bend outward. A first resistance must be overcome when inserting. Release the pusher.

- Check that the connecting wire is fixed and can not be pulled-out. It is important to ensure that the connecting wire and not the insulation is clamped. The connecting wire can also be inserted without pressing the pusher in case of cross-sections upto 1.00 mm².

4.1.2 Assembly of connecting wires with wire-end ferrules according to DIN46228/4

Cross-section / AWG	Metal sleeve length	Stripping length
0.50 mm^2 / 21	10 mm	12 mm
0.75 mm^2 / 19	12 mm	14 mm
1.00 mm^2 / 18	12 mm	15 mm

4.1.3 Assembly of connecting wires without wire-end ferrules

Cross-section / AWG	Stripping length
0.14…1.5 mm^2 / 25…16	10…12 mm
Stranded wire (rigidly and flexibly)	

Note

- KEB generally recommends the use of wire-end ferrules in industrial environments.
- A safe clamping can not be guaranteed when using shorter wire-end ferrules.

4.1.4 Specification of the inputs

The inputs are specified as follows according to IEC61131-2 type 3:

Inputs	Status 0		Status 1	
	UL [V]	IL [mA]	UH [V]	IH [mA]
max.	5	15	30	15
min.	-3	not defined	11	2

The maximum short-term starting current of the input is limited to 30 mA.

4.1.5 Specification of the outputs

The short-circuit proof, digital outputs are specified in accordance with IEC 61131-2, (Type 0.1).The rated output current is 100 mA.

Only ohmic loads are permissible; there is no internal free-wheeling path.

4.2 Terminal brake

The position of the terminals and specification of the brake output is described in the respective manual of the COMBIVERT. The free-wheeling path to control the brake is integrated in the COMBIVERT.

4.3 Terminal relay output

The position of the terminals and the specification of the relay output are described in the respective COMBIVERT manual.

The control of the relay output by the safety module is only available with an appropriate equipment variant of the control unit (option 'positively driven relay'). If the required relay is not available in the present variant, a configuration of the relay output is rejected with a configuration error.

⚠ WARNING

No internal protection of the relay contact!

In order to prevent welding of the relay contacts due to an impermissible overload, the relay contact must be secured according to the electrical characteristics of the relay (see control section instructions).

a) Limit the current by the NO contact to 2A.

b) For example, use a fuse of type 2A gG to protect the relay NO contact.

4.4 Status LEDs

Arrangement of the LEDs is defined in the respective manual of the COMBIVERT.

The LED display of the safety mode indicates the following status:

LED	Status
off	No voltage supply of the safety module
green	Safety module in operation
orange	Safety module in reset or new configuration will be saved
red	Safety module in error
green orange flashing	Flashes for 30 seconds when a new user has logged in.
green orange double flashing	Flashes orange briefly twice every 1.6 seconds. Signals that the state of the bus communication is not the data state. The safety module is in a safe condition.

Tab. 5: LED displays of the safety module

5 Parameterisation and user management

The parameterisation is done with the PC program KEB COMBIVIS. A KEB safety module can be added in an existing project by right-clicking on the project and then select the entry KEB safety module under "add object".

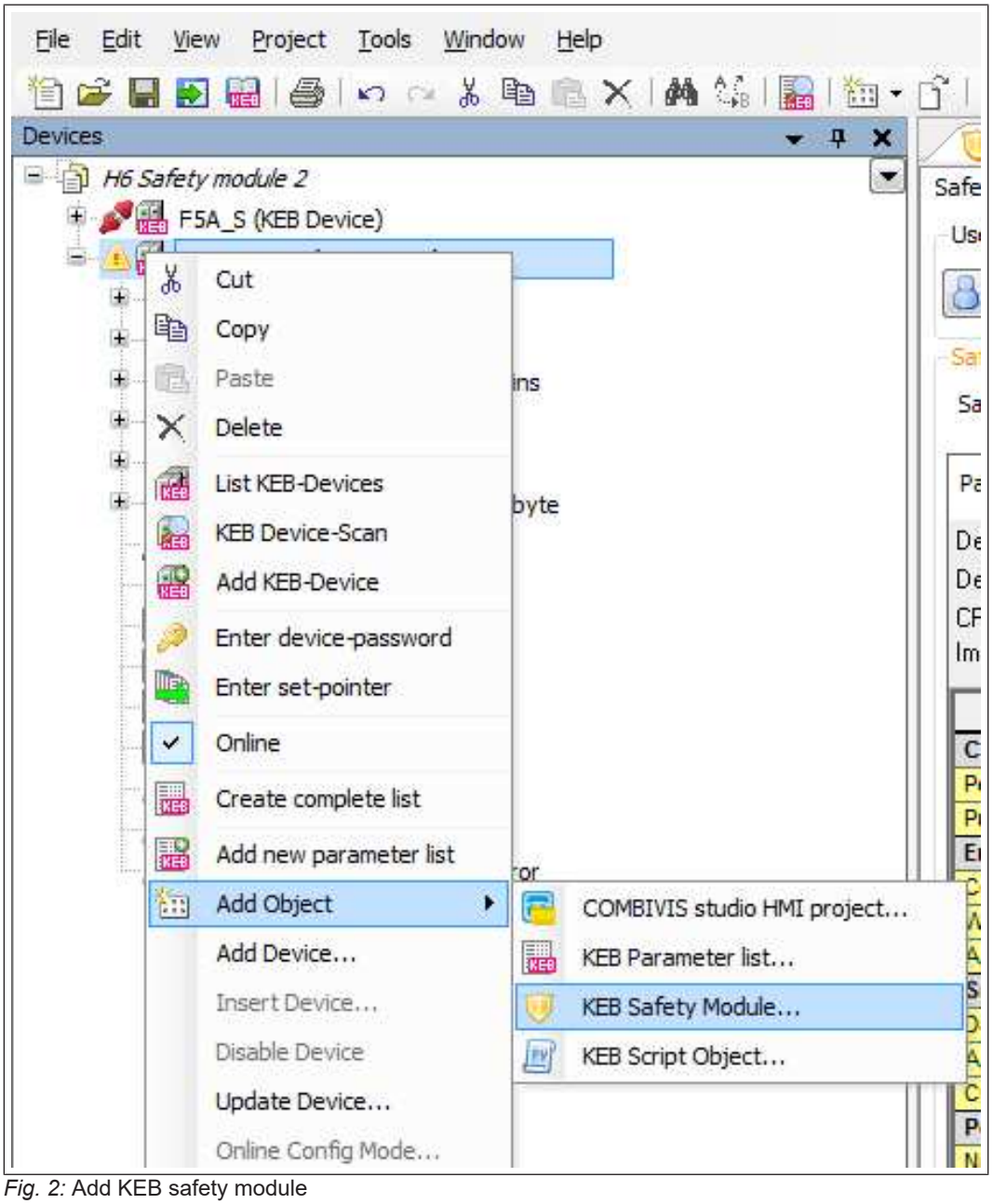


Fig. 2: Add KEB safety module

5.1 General settings

5.1.1 Settings in the safety module editor

(See also instruction manual KEB COMBIVIS)

5.1.2 User management and login

The tab "Settings" in the KEB Safety Editor contains the user administration as first button "(≡► Open user administration [▸ 22])“(≡► [▸ 21]).

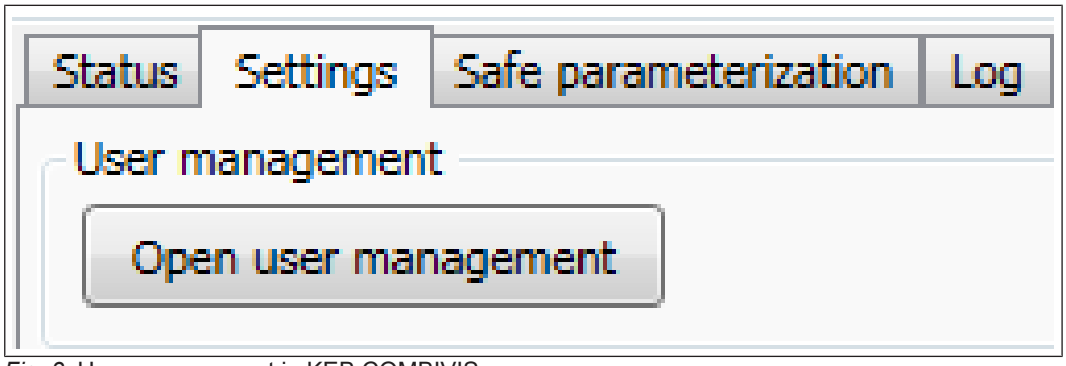


Fig. 3: User management in KEB COMBIVIS

When the "Open user administration" button is pressed, the (≡► Login window in COMBIVIS [▸ 22]) is displayed.

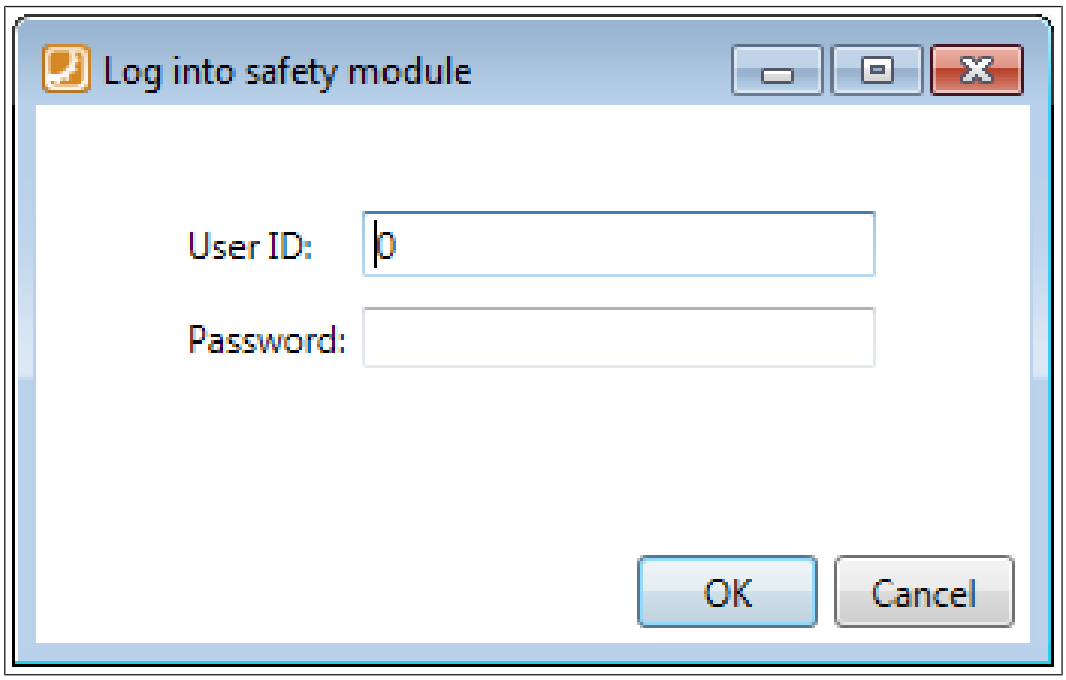


Fig. 4: Login window in COMBIVIS

For the first login there is a standard user, the login is done by input of

- User-ID = 1 and password = default
- The safety module flashes for approx. 1 minute after login. With the default user it is only possible to create new users, is not possible to download safety parameters onto the safety module or to read an existing configuration.
- Users can be created and provided with different rights. The user management is accessible via the button "User settings", see (≡► User management and login [▸ 23]). An user-ID and password can be assigned for each user. The user-ID 0 is not possible. Multiple creating of an user with the same user-ID is not possible and an error message is displayed.
- As soon as a user has been created who is allowed to manage users, logging in with user-ID 1 and password "default" is no longer possible.

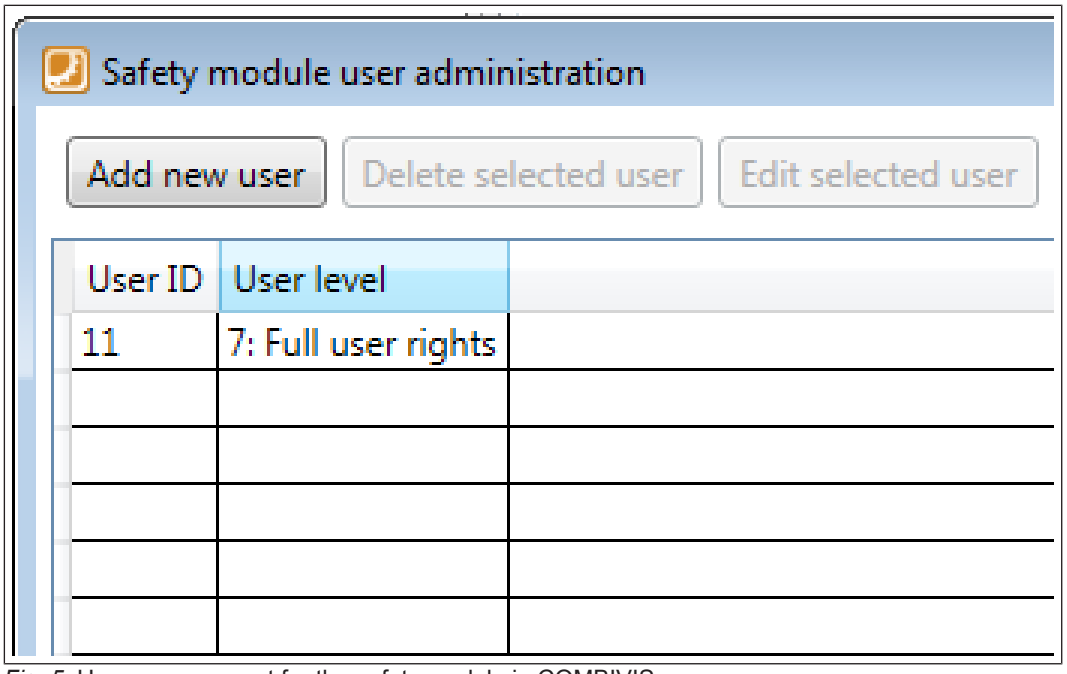


Fig. 5: User management for the safety module in COMBIVIS

5.1.2.1 Overview of user rights and user levels

There are 6 different user rights. When a new user was created the login with the default user is no longer possible.

User level	Login possible	Can change his own password	Can change existing user or add new user	Can download new configuration data	Can read an existing configuration
0: No user rights	x	x			
1: Add and change users	x	x	x		
2: Write new configuration data	x	x		x	
4: Read out configuration information	x	x			x
6: Read out and write configuration information	x	x		x	x
7: Full user rights	x	x	x	x	x

Tab. 6: Overview of the user rights to user level

5.1.3 Manual control LED (identification of the target device)

In order to facilitate identification of the device to which the Safety Module Editor is currently connected, the LED can be switched to flashing via the "Safety Module LED" buttons.

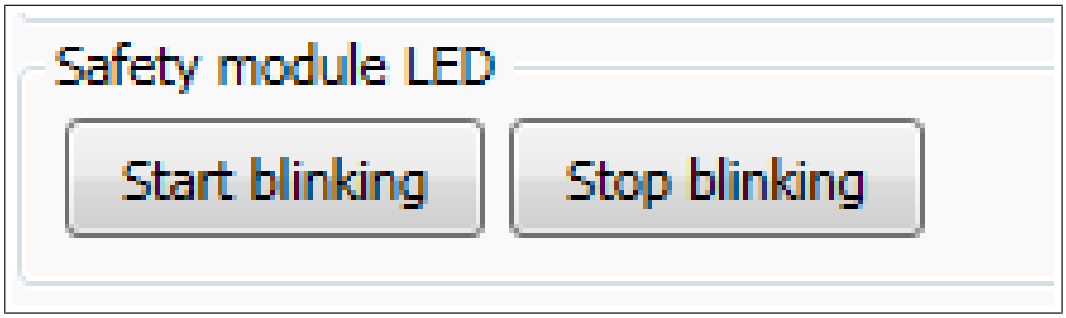


Fig. 6: Safety Module LED

Restricted function if the safety module is in error state!

If the LED is already switched to permanent red due to an error, the button "start blinking" does not change anything.

5.1.4 Real-time Clock

The safety module has a real-time clock, which is used to display the events in the log (≡► Read out of the log data [▸ 30]). The setting of the real-time clock can be changed in this area of the editor. (As a convenience function, the time of the currently used PC can be taken over by mouse click).

No login is required to set the real-time clock for the first time after a PowerOn.

The support time in which the real-time clock continues to run when the device is switched off is approx. 3 days. After this time, the clock stops and continues to run as soon as the mains voltage returns.

5.1.5 Identification (safety module address)

The safety module can be configured with an individual safety module address. To avoid confusion, the serial number of the device must be declared. The default value is address '0'.

The address specified here must always be specified in the safety-related parameterization, otherwise the configuration will be rejected. This is particularly helpful to avoid incorrect configurations if several identical drive systems are installed within a system and when they are to be equipped with different parameterizations.

5.2 Safe configuration of parameters of the safety module

The parameters of the safety module are configured in the tab "Safe parameterization" (≡► Safe configuration of parameters of the safety module [▸ 25])(≡► [▸ 24]). The parameters are classified into different groups, which can be filtered by the "parameter group" selection field. If the mouse pointer is left over a parameter for a longer time, then a tool tip is displayed, which contains further useful information about the parameter (≡► Safe configuration of parameters of the safety module [▸ 25])(≡► [▸ 24]).

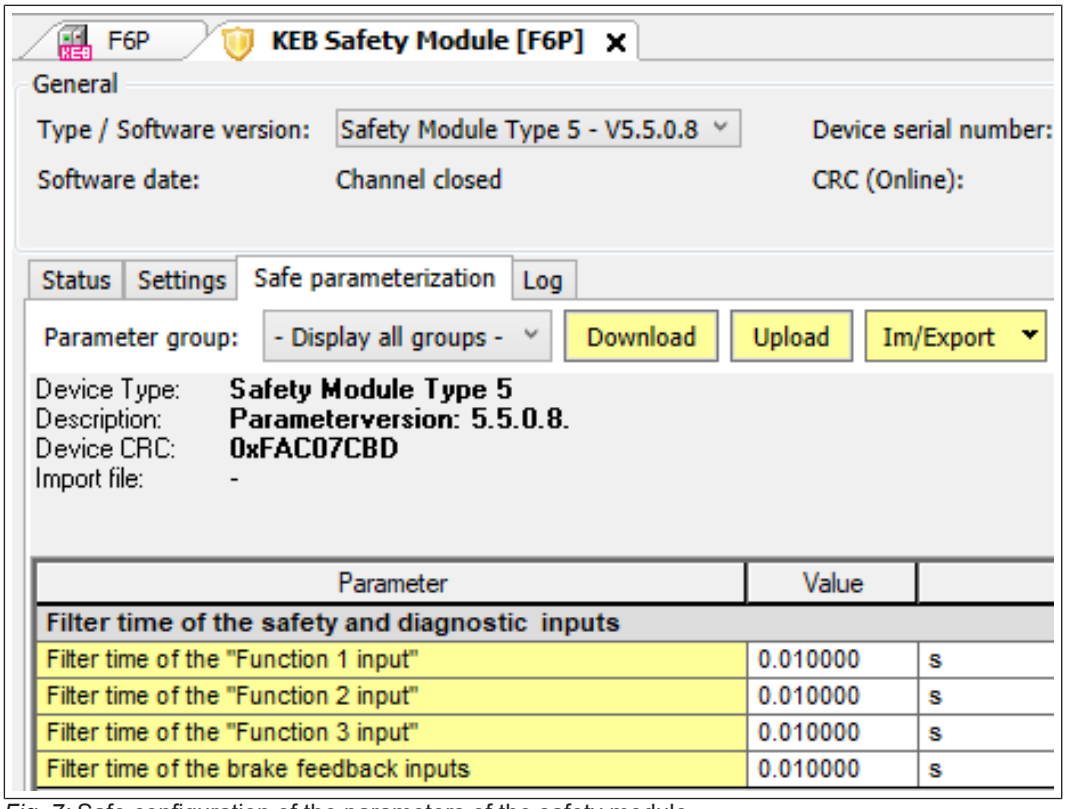


Fig. 7: Safe configuration of the parameters of the safety module

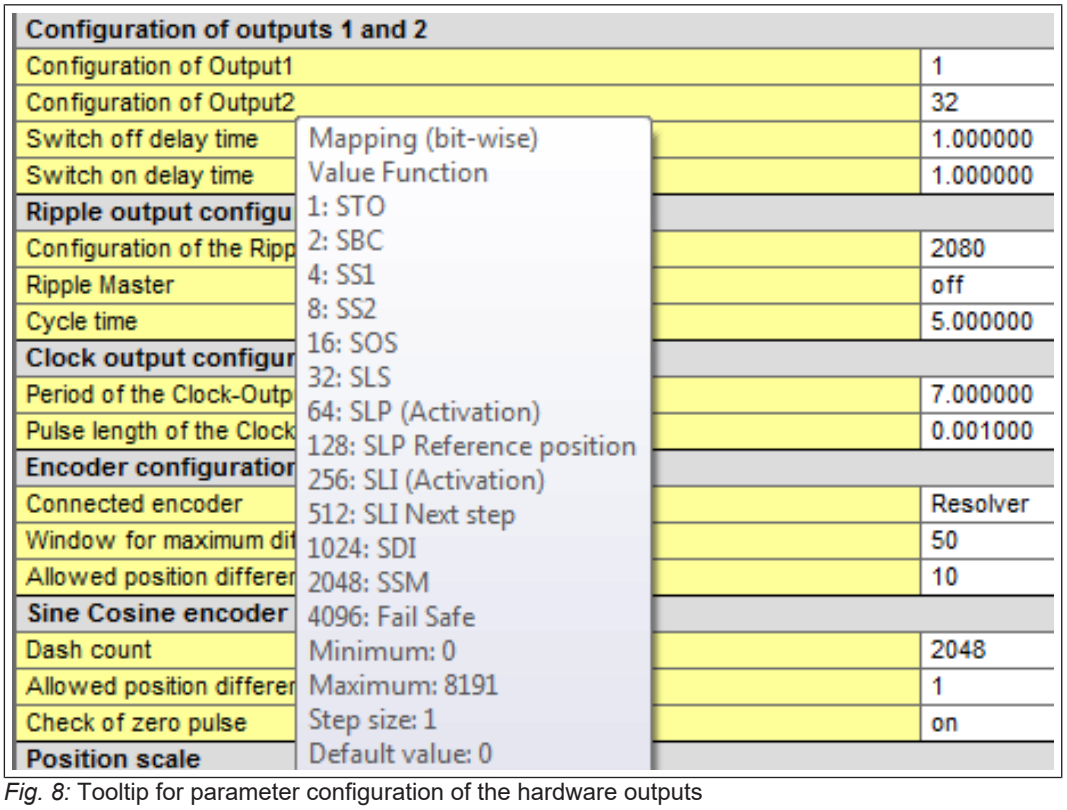


Fig. 8: Tooltip for parameter configuration of the hardware outputs

5.2.1 Download of new configuration data

The new parameterisation can be transferred to the safety module via the "download" button, if the logged-in user has sufficient rights. With the download the safety module checks again if the parameters are correctly configured. If an error is detected during the transfer of the configuration data, the data are not accepted and the safety module changes into error state. Then the errors can be read out from the range protocol (≡▶ Read out of errors [▶ 31]) and remedied.

5.2.2 Read out of existing configuration information from the safety module

If the logged-in user has sufficient rights, then configuration information can be read out from the safety module. It is sufficient to click the button "upload". After the completion of the readout process, the existing configuration is displayed in the configuration editor.

5.2.3 Import and export of configuration information

Configuration information can be imported or exported. Click the button "import/export“ and select an option.

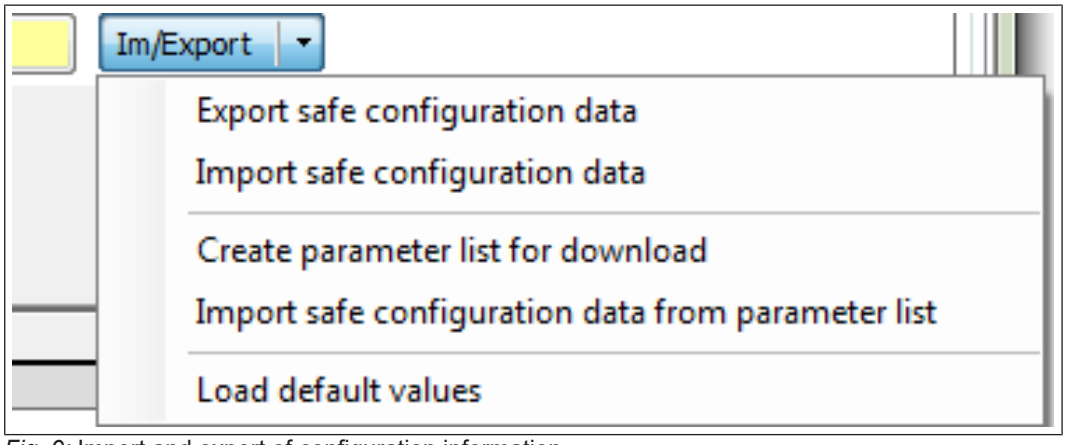


Fig. 9: Import and export of configuration information

5.2.3.1 Export of safe parameter data

The adjusted configuration data can be exported into a file via this menu item. These data can be imported again into another project. A change of the data in the file is not possible, since otherwise the import of data can not be executed.

5.2.3.2 Import of safe parameter data

Configuration data from a previously exported file can be imported again via this menu item. The data are displayed in the configuration editor after the import. The editor for the configuration data is write protected after the import. The write protection can be removed by a right-click in the editor and the option "unlock".

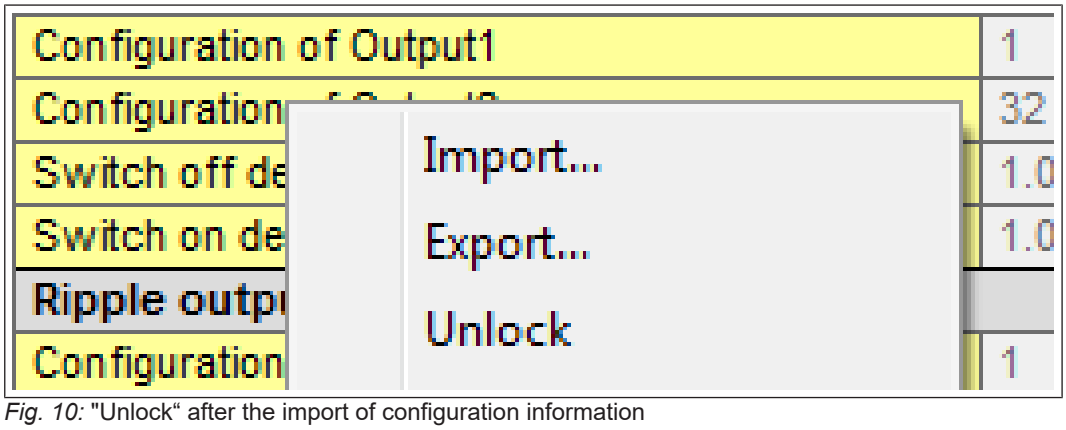


Fig. 10: "Unlock“ after the import of configuration information

An import is only possible with the same firmware version (e.g. firmware version 5.5.0.8).

5.2.3.3 Generate parameter list for download

A download list is generated here, which can be transferred without the configuration editor COMBIVIS into the safety module. The download list can not be edited without the configuration editor, otherwise the download of the configuration data is rejected by the safety module. The download list is not human-readable.

5.2.3.4 Import safe parameter data from parameter list

Hereby a previously created download list is imported back into the configuration editor. The data are displayed in the configuration editor after the import.

An import is only possible with the same firmware version (e.g. firmware version 5.5.0.8).

5.2.3.5 Load default values

This loads the default values for all safety-oriented parameters. This is useful to restart the safety-oriented parameterization from a defined state in case of an unknown state of the configuration.

By loading the default values, the default values are not automatically transferred in the safety module. The acceptance of the values always requires an explicit download.

5.3 Status of the safety module

The status of the safety module can be displayed in the "Status" tab (≡► Status of the safety module [▶ 28]). If the safety module is in error state is displayed in the status of the control of COMBIVERT with parameter ru01 = "55“ (error safety module).

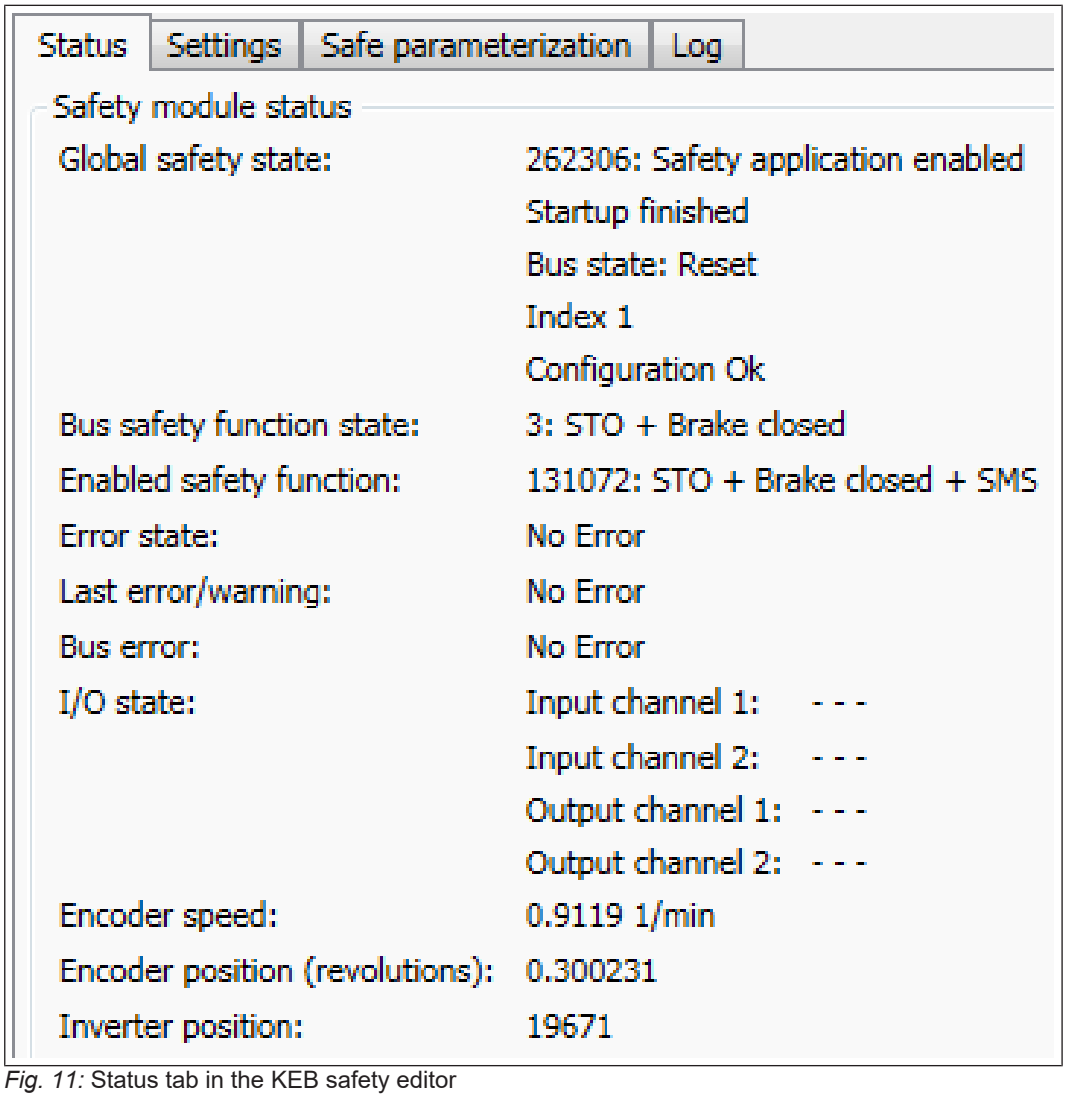


Fig. 11: Status tab in the KEB safety editor

General safety state:

Provides information if the safety module works properly and whether the configuration has any faulty entries. Details (≡► Configuration state and configuration transfer [▸ 48]).

Bus safety function state:

Provides information which safety function was requested by the safe bus system.

Activated safety functions

List of safety functions currently activated as summarized result of the state of the digital inputs and FSoE data. (AND operation with simultaneous configuration of functions via FSoE and digital inputs (≡► Transmitted process data (Safe master to the safety module) [▸ 103]).

Error state:

The error status provides information whether there is an error. The error cause can be detected by the displayed error text (≡► Status of the safety module [▸ 29])(≡► [▸ 27]) (≡► [▸ 27]).

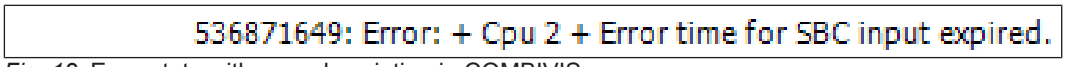


Fig. 12: Error state with error description in COMBIVIS

Last error / warning notice:

The last detected error is displayed here, and all errors are also recorded in the error log.

Bus error:

The last bus error which has been detected during the communication with the safe master is displayed here.

I/O state:

The two-channel input and output status is displayed here. The input status is the logical status of the inputs to the safety module.

All outputs influenced by the safety module are listed in the output status. Besides the digital outputs of the safety module, these include also the brake control and if necessary the relay output on the control board as well as the internally switched supply of the driver voltages.

The displayed switching states can be influenced by various inputs and outputs or parameters and they always represent the result of all existing states, considering the current settings.

In order that the brake can be released (switching the brake output), an input configured for SBC must be switched on at the safety module and co00 bit 15 1 must be set to in the unit parameters of the COMBIVERT. Only then the brake output will be switched.

The displays shown in the following tables are possible:

Display	Meaning	Signal type (internal / external)	Affected interface
FUNC1.1	Input 1, channel 1 is set	External	(≡▶ Terminal X2B [▶ 18])
FUNC1.2	Input 1, channel 2 is set	External	(≡▶ Terminal X2B [▶ 18])
FUNC1.1	Input 2, channel 1 is set	External	(≡▶ Terminal X2B [▶ 18])
FUNC2.2	Input 2, channel 2 is set	External	(≡▶ Terminal X2B [▶ 18])
FUNC3.1	Input 3, channel 1 is set	External	(≡▶ Terminal X2B [▶ 18])
FUNC3.2	Input 3, channel 2 is set	External	(≡▶ Terminal X2B [▶ 18])
RelayFB1	Feedback line positive-driven relay is set (recognition by CPU1)	Internal	
RelayFB2	Feedback line positive-driven relay is set (recognition by CPU2)	Internal	
BrakeFB1	Feedback line brake feedback channel 1 is set	External	See manual control unit – e.g. terminal X1C
BrakeFB2	Feedback line brake feedback channel 2 is set	External	See manual control unit – e.g. terminal X1C

Tab. 7: Status of the safety module - Displays 'I/O Status' (input channels)

Display	Meaning	Signal type	Affected interface

		(internal / external)	
Out1.1	Control output 1 is set by CPU1	External	(≡► Terminal X2B [▷ 18])
Out1.2	Control output 1 is set by CPU2	External	(≡► Terminal X2B [▷ 18])
Out2.1	Control output 2 is set by CPU1	External	(≡► Terminal X2B [▷ 18])
Out2.2	Control output 2 is set by CPU2	External	(≡► Terminal X2B [▷ 18])
Brake Out1	Control brake output 1 is set	External	See manual control unit – e.g. terminal X1C
Brake Out2	Control brake output 2 is set	External	See manual control unit – e.g. terminal X1C
Relay Out1	Control relay output 1 is set	External	See manual control unit – e.g. terminal X2A
Relay Out2	Control relay output 2 is set	External	See manual control unit – e.g. terminal X2A
VTRO.1	Driver voltage supply (upper half bridge) channel 1 is set	Internal	Power output UVW
VTRO.2	Driver voltage supply (upper half bridge) channel 2 is set	Internal	Power output UVW
VTRU.1	Driver voltage supply (lower half bridge) channel 1 is set	Internal	Power output UVW
VTRU.1	Driver voltage supply (lower half bridge) channel 2 is set	Internal	Power output UVW

Tab. 8: Status of the safety module - Displays "I/O status" (output channels)

Actual speed encoderless:

The speed of the drive determined by the safety module is displayed here.

5.4 Read out of the log data

Read out of the log data can be done via the Log tab. There are different types of log data which can be read out. The readout process is started by selecting one or more buttons and then clicking the "Update" button.

The log data are based on the clock on the safety module(≡► Real-time Clock [▷ 24]).

From KEB COMBIVIS version 6.5 it is possible to limit the number of log entries to be read out to an individually definable number per category. The "Limit" selection field is used for this purpose. Hereby the transmission time is reduced accordingly. This is helpful, if only the last entry is interesting.

5.4.1 Read out of errors

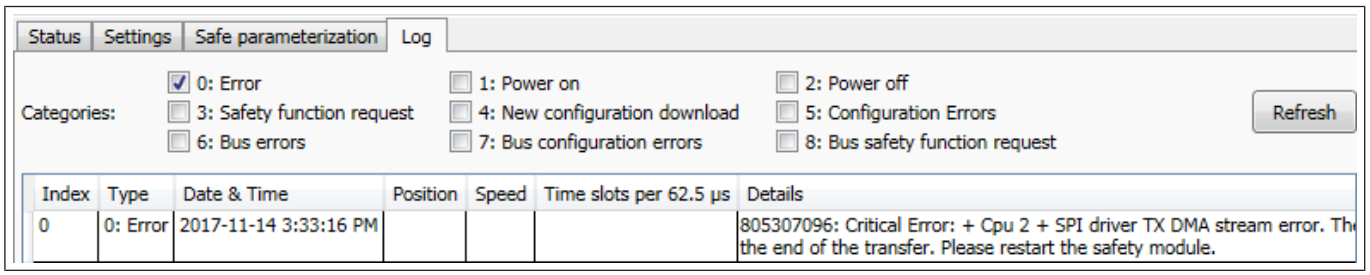


Fig. 13: Error time, error number and description

To read out errors, the respective category must be marked in the "Potocol" tab.

5.4.2 Read out of switch-on sequences

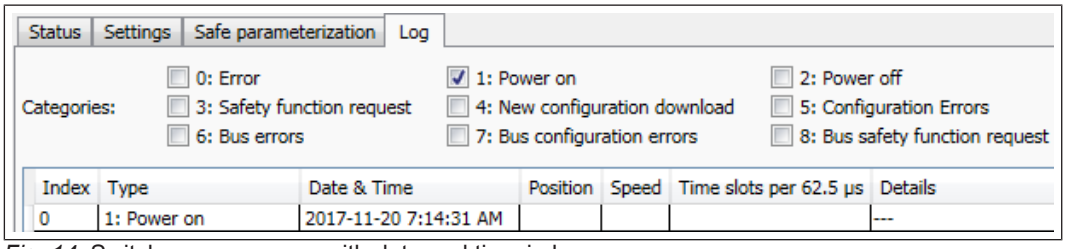


Fig. 14: Switch-on sequences with date and time in log

To read out switch-on times, the button "Switch on" must be set in the "Protocol" tab.

5.4.3 Read out of switch-off sequences

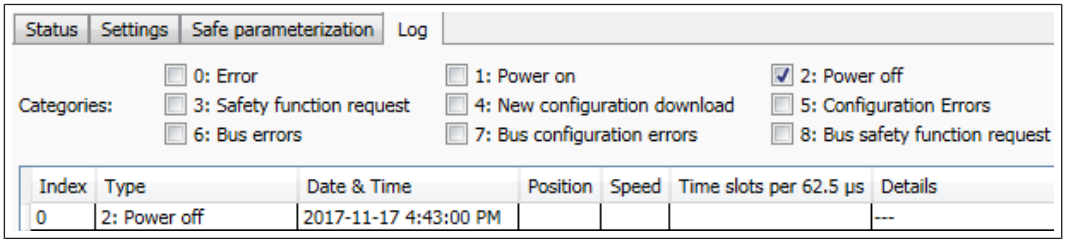


Fig. 15: Switch-off sequences with date and time in log

For read out of the switch-off sequences, press the button "switch-off" in the "Protocol" tab.The switch-off time is to 5 minutes precisely.

5.4.4 Read out of requirements for safety functions

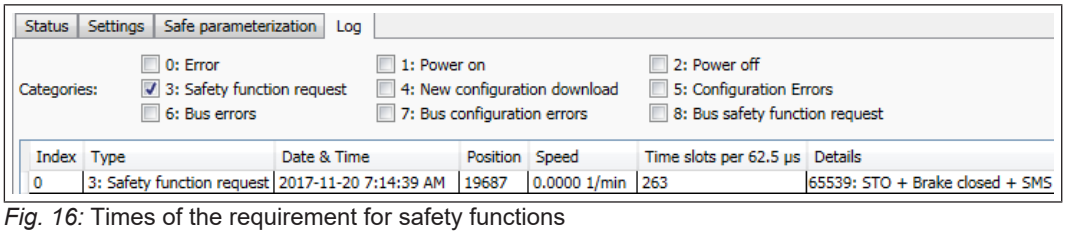


Fig. 16: Times of the requirement for safety functions

To read out requests of safety functions, the "Safety function execution time" switch must be set in the "Protocol" tab.

5.4.5 Read out of the time to assume new configuration data

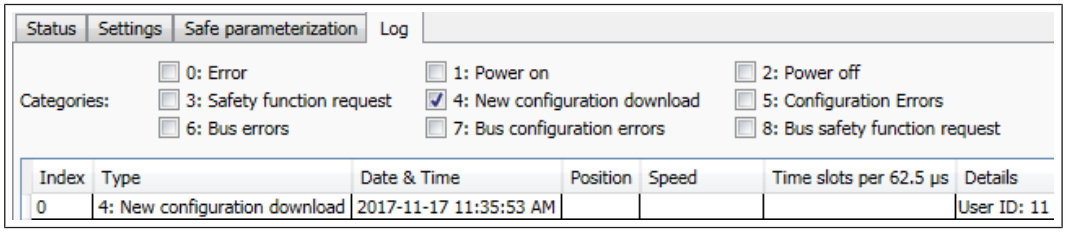


Fig. 17: Transfer time of new configuration data

For read out of transfer times of new configuration data, press the button "transfer time of the new configuration“ in the "Protocol" tab. The transfer time and the user-ID are displayed in the protocol.

5.4.6 Read out of configuration errors

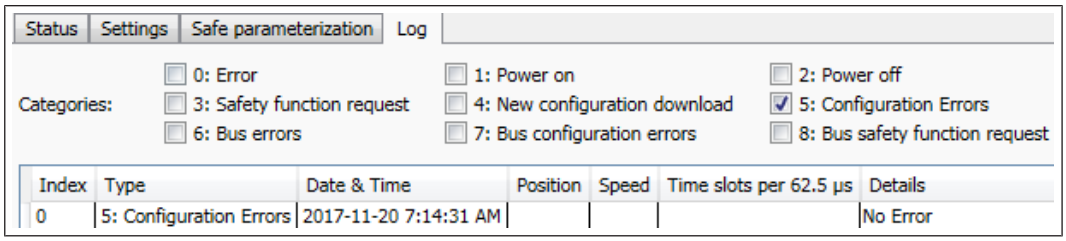


Fig. 18: Time, error number and description of configuration errors

To read out configuration errors, the switch "Configuration error" must be set in the tab "Protocol".

The configuration errors are deleted at a restart of the safety module and the old functional configuration without configuration errors is restored.

5.4.7 Read out of bus errors

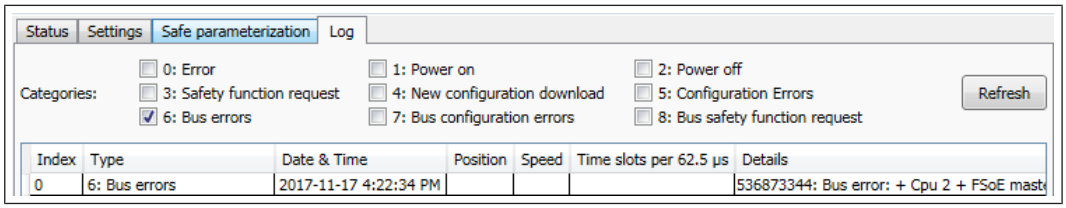


Fig. 19: Bus error with date and time in log

To read out bus errors, "Bus error" switch must be set in the tab "Protocol“.

5.4.8 Read out of bus configuration errors

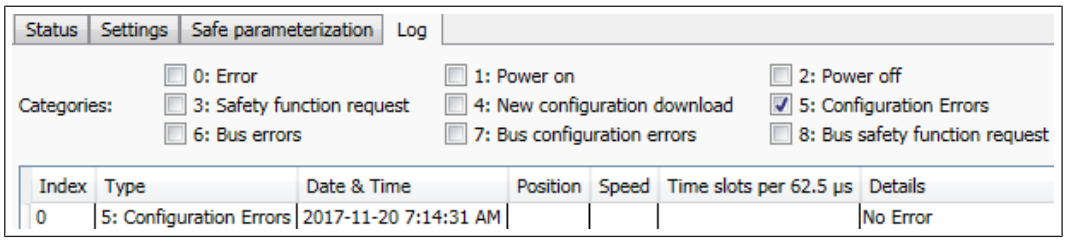


Fig. 20: Bus configuration errors with date and time in log

For read out of bus configuration errors, "Bus configuration error" switch must be set in the "Protocol" tab.

Time slots are used to precisely define the time of occurrence of an event at the same time.

5.4.9 Bus request of safety functions

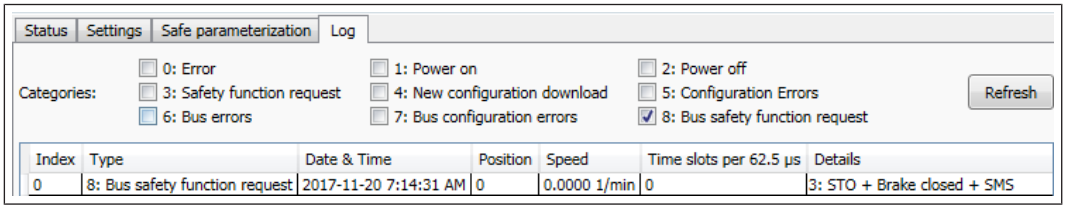


Fig. 21: Bus request of safety functions in log

To read out the requests for safety functions via the safe bus system, the switch "Bus request for safety functions" must be set in the "Protocol" tab.

5.5 Parameter List

Name	Note	Unit	Minimum	Maximum	Default
Filter times of the safety and diagnostic inputs (≡► Filter time for safety and diagnosis inputs [▸ 51])					
Filter time of the function 1 input	Filter time for debouncing of input signals at input channel "Safety function 1"	s	0	0,1	0,01
Filter time of the function 2 input	Filter time for debouncing of input signals at input channel "Safety function 2"	s	0	0,1	0,01
Filter time of the function 3 input	Filter time for debouncing of input signals at input channel "Safety function 3"	s	0	0,1	0,01
Filter time of the brake feedback inputs	Filter time for debouncing the brake feedback inputs	s	0	0,1	0,01
Clock signal Input configuration (≡► Configuration of the clock signal for the inputs [▸ 51])					
Test signal period time	Period time of the used external test signals (e.g. of a clock output) to check the connection. The setting is valid for all inputs	ms	1	10000	10000
Test signal pulse length	Pulse time of the used external test signals (e.g. of a clock output) to check the connection. The setting is valid for all inputs	µs	500	1000	1000
Check of the test signal for function 1 inputs	If active, the function 1 inputs are checked for the test signal				off

Check of the test signal for function 2 inputs	If active, the function 2 inputs are checked for the test signal				off
Check of the test signal for function 3 inputs	If active, the function 3 inputs are checked for the test signal				off
Checks the test signal of the brake feedback inputs	When activated, the brake feedback inputs are checked for the set test signal		(≡► 9.2 [▷ 51])		off
Function 1 Hardware input configuration (≡► Hardware input configuration (function 1-3) [▷ 52])					
First linked safety function	The first linked safety function of the input		0	=> (≡► 9.3 [▷ 52])	STO
Second linked safety function	The second linked safety function of the input. This safety function is activated simultaneously with the first configured safety function		0	=> (≡► 9.3 [▷ 52])	0
Status of the inputs	The relative status of the two input channels		antivalent	equivalence	equivalence
Tolerance time for the input	During the tolerance time the status between the two input channels may differ	s	0	1,0	0,01
Function 2 Hardware input configuration (≡► Hardware input configuration (function 1-3) [▷ 52])					
The first linked safety function	The first linked safety function of the input		0	(≡► 9.3 [▷ 52])	SBC
Second linked safety function	The second linked safety function of the input. This safety function is activated simultaneously with the first configured safety function		0	(≡► 9.3 [▷ 52])	0
Status of the inputs	The relative status of the two input channels		antivalent	equivalence	equivalence

Tolerance time for the input	During the tolerance time the status between the two input channels may differ	s	0	1,0	0,01
Function 3 Hardware input configuration (≡► Hardware input configuration (function 1-3) [▷ 52])					
The first linked safety function	The first linked safety function of the input		0	(≡► 9.3 [▷ 52])	0
Second linked safety function	The second linked safety function of the input.		0	(≡► 9.3 [▷ 52])	0
Status of the inputs	The relative status of the two input channels		antivalent	equivalence	equivalence
Tolerance time for the input	During the tolerance time the status between the two input channels may differ	s	0	1,0	0,01
Configuration of the hardware outputs (≡► Hardware output configuration [▷ 56])					
Output 1 configuration	Assignment (bitwise)		0	32768	0
Configuration of output 2	Assignment (bitwise)		0	32768	0
Configuration relay output	Assignment (bitwise)		0	32768	0
Switch on delay time	Outputs 1 and 2 and the relay output are switched on with delay to the switching condition	s	0	1	0,0
Brake output Eco mode (≡► Brake output Eco Mode [▷ 57])					
PWM delay	Delay time between brake release and the time from which the PWM signal is output.	ms	0	3000	3000
Duty cycle of the PWM signal	The pulse-pause ratio when Eco mode is activated, according to which the effective voltage at the brake output is set.	%	50	100	100
Configuration of the encoderless mode (≡► Encoderless speed measurement [▷ 58])					
Encoderless mode	Activation / deactivation of encoderless speed measurement		0	1	off
Number of pole pairs	The number of pole pairs of the motor		1	90	2

Speed scan time	Parameter specifies the time over which the engine speed average is calculated.	ms	0,5	8	4
PT1 filter time of the speed calculation	Parameter specifies the time of the PT1 filter for the speed calculation.	ms	0,0	256,0	20,0
Keep speed value in case of modulation disabled or STO	This parameter can be used to define the behaviour of the speed measurement if the detection of the output frequency is not possible.		off	on	off
Motor current limit breakdown torque	Permitted maximum current in percent of the upper range value of the drive controller at which the connected motor is not tilted	%	0,25	90,0	50,0
Allowed position difference between the two logic channels	In encoderless operation, two independent logic channels are evaluated to calculate the actual values at the motor. This is the maximum allowable position difference for the two logic units.		1	1440	360
Maximum time for the position difference between the two channels	The maximum time period in which the position difference between the two logic units may be exceeded.	ms	1	1000	0
Allowed speed difference frequency to current (diagnosis)	In encoderless operation, two independent logic units are evaluated to calculate the actual values at the motor. This is the allowed speed difference of the calculated speed between the two logic units. This is used for diagnosis.	rpm	0	120000	50
Permitted time difference between frequency and current (diagnosis)	In encoderless operation, two independent logic units are evaluated to calculate the actual val-	ms	0	60000	200

	ues at the motor. This is the permitted time difference between the two logic units				
Hysteresis of the electrical current	Window in 'Number of Timerticks' for the modulation factor of the output voltage by 0, from which an evaluation of the duty cycles of the half-bridge drivers is possible.	%	0,25	5	2
Hysteresis of the control setting	Window in % of full scale of the current of the drive controller around 0, from which an evaluation of the encoderless speed is possible.		0	1000	10
SBC: Safe brake control (≡► Functional description safe brake control (SBC) [▶ 66])					
Coupling of SBC with STO	On: The SBC function is activated when the STO function is executed.				off
Measurement of the brake current	The measurement of the brake current can be activated (switched on) chapter (≡► 12.4 [▶ 66])				on
SS1: Safe stop 1 (≡► Functional description safe stop 1 (SS1) [▶ 68])					
Selection of the type of the function	Possible types of functions: Type r and t Type r Type t				Type r and t
Deceleration	Specification of the monitoring ramp. Speed change in the time period of delta t.	1/s²	0,01	60000	0,01
Negative tolerance	The allowed negative tolerance to the ramp	rpm	0	120000	0,0
Positive tolerance	The allowed positive tolerance to the ramp	rpm	0	120000	0,0
Time window of speed deviation	If the deviation of the velocity is greater than the tolerance and longer than the specified	s	0	600	0,0

	time window existed, the STO function is executed				
Type t time	Time period till the STO function is activated	s	0	600	0,0
SLS: Safely-limited speed (≡► Functional description safe limited speed (SLS) [▶ 73])					
Upper speed limit	If the speed exceeds the upper speed limit, then the error function will be activated. This is the limit value for the positive direction of rotation.	rpm	0	120000	120000
Lower speed limit	If the speed falls below the lower speed limit, then the error function will be activated. This is the limit value for the negative direction of rotation.	rpm	-120000	0	-120000
Tolerance time	Within this time an exceeding of the speed limits is ignored.	s	0	60	0,0
Error function	Selection of the function that is executed when the limit is passed.		STO	SS1	STO
SSM: Safe speed monitor (≡► Functional description safe speed monitoring (SSM) [▶ 75])					
Upper speed limit	If the speed exceeds the upper speed limit, then the error function will be activated. This is the limit value for the positive direction of rotation.	rpm	0	120000	120000
Lower speed limit	If the speed falls below the lower speed limit, then the error function will be activated. This is the limit value for the negative direction of rotation.	rpm	-120000	0	-120000
Hysterese	If the speed exceeds the speed level + hysteresis, then the output condition of the function is activated. At underrun of speed	rpm	0	120000	0,0

	level - hysteresis, the output is disabled.				
Monitoring always active	At "off" the speed monitoring has to be activated via an input. At "on" it is always active and an input configured for the same safety function is ignored.				off
SDLC: Safe door lock monitoring (≡► Functional description Safe Door-Lock Control (SDLC) [▶ 86])					
Deceleration	Setting the delay	1/s²	0	60000	0,0
Upper speed deviation of the deceleration phase	Upper speed deviation during the deceleration phase.	rpm	0	120000	0,0
Lower speed deviation of the deceleration phase	Lower speed deviation during the deceleration phase.	rpm	0	120000	0,0
Activation speed of the DC braking phase	If the speed falls below this value, monitoring of the DC braking phase starts.	rpm	0	10000	0,0
DC braking time	Duration of the DC braking phase to be checked.	ms	0	100000	1000
Lowest current during DC braking phase in percent of full scale	DC current that must not be fallen below during the braking phase. Specification in percent of full scale.	%	0	100	15
Allowed angle difference during DC braking phase	Maximum allowed angular difference of the motor during DC braking phase.	°	0	360	180
Safe time period until drive standstill	Time period until the door is unlocked. The drive comes to standstill without braking. (Minimum load conditions)	ms	0	$3,6 * 10^6$	$3,6 * 10^6$
Activates "safe time to standstill" after starting the safety software	Switching on or off the behaviour for the safe time to standstill after switching on the device. If activated, the door lock is not released before the configured time has expired once.		0	1	on
SMS: Safe maximum speed (≡► Functional description safe maximum speed (SMS) [▶ 77])					

Upper speed limit	If the speed exceeds the upper speed limit, then the error function will be activated. This is the limit value for the positive direction of rotation.	rpm	0	120000	120000
Lower speed limit	If the speed falls below the lower speed limit, then the error function will be activated. This is the limit value for the negative direction of rotation.	rpm	-120000	0	-120000
Tolerance time	Within this time an exceeding of the speed limits is ignored.	s	0	60	0,0
Error function	Selection of the function that is executed when the limit is passed.		STO	SS1	STO
SLA: Safely limited acceleration (≡► Function description safe limited acceleration (SLA) [▷ 79])					
Upper acceleration limit	The upper acceleration limit of the safely limited acceleration in forward direction (clockwise rotation).	1/s²	0	$1•10^{-6}$	0
Lower acceleration limit	The lower acceleration limit of the safely-limited acceleration in reverse direction (counter-clockwise rotation).	1/s²	$-1•10^{-6}$	0	0
Error function	Selection of the function that is executed when the limit is passed.		STO	SS1	STO
Brake feedback input 1 Input configuration (≡► Configuration parameters of the brake feedback inputs [▷ 54])					
First activation level	Selection of the physical input state to execute the first assigned function		0	1	0
First assigned diagnosis function	The first assigned diagnosis function of the input		0	2	0
Second activation level	Selection of the physical input state to execute the second assigned function		0	1	0

Second assigned diagnosis function	The second assigned diagnosis function of the input. This diagnosis function is activated simultaneously with the first configured diagnosis function		0	2	0
Brake feedback input 2 Input configuration (≡► Configuration parameters of the brake feedback inputs [▷ 54])					
First activation level	Selection of the physical input state to execute the first assigned function		0	1	0
First assigned diagnosis function	The first assigned diagnosis function of the input		0	2	0
Second activation level	Selection of the physical input state to execute the second assigned function		0	1	0
Second assigned diagnosis function	The second assigned diagnosis function of the input. This diagnosis function is activated simultaneously with the first configured diagnosis function		0	2	0
BCF1: Brake feedback check 1 (≡► Function description brake feedback test 1/2 (BCF1/BCF2) [▷ 84])					
Maximum active period of this function without test	When the warning time has expired, the safety function set under 'Feedback 1 Warning' or 'Feedback 2 Warning ' is activated.	min	1	525600	525600
Maximum delay time brake test start to successful check feedback	Time within a reaction can be detected on the feedback signal after switching the brake.	ms	0	65535	0
Reaction after maximum delay time has elapsed	Assignment (bitwise)		0	31	0
BCF2: Brake feedback check 2 (≡► Function description brake feedback test 1/2 (BCF1/BCF2) [▷ 84])					
Maximum active period of this function without test	When the warning time has expired, the safety function set under 'Feedback 1 Warning' or 'Feedback 2 Warning ' is activated.	min	1	525600	525600

Maximum delay time (brake test start until successful feedback test)	Time within a reaction can be detected on the feedback signal after switching the brake.	ms	0	65535	0
Reaction after maximum delay time has elapsed	Assignment (bitwise)		0	31	0
FB1W: Feedback 1 Warning (≡► Functional description feedback warning 1/2 (FB1W/FB2W) [▶ 85])					
Reaction when this diagnosis function is activated	Reaction when the feedback warning function is activated.				No reaction
Delay time from function activation until the error reaction	The time from the activation of the feedback function until the error reaction.	min	0	525600	0
Error reaction after delay time has elapsed	Reaction of the feedback function after error response time has elapsed.				No reaction
FB2W: Feedback 2 Warning (≡► Functional description feedback warning 1/2 (FB1W/FB2W) [▶ 85])					
Reaction when this safety function is activated	Reaction when the feedback warning function is activated.				Set warning in error state
Delay time from function activation until the error reaction	The time from the activation of the feedback function until the error reaction.	min	0	525600	0
Error reaction after delay time has elapsed	Reaction of the feedback function after error response time has elapsed.				No reaction
BR1P: Brake output test 1 Plus (≡► Function description brake output test 1 plus/minus (BR1P/BR1M) [▶ 82])					
Test execution mode	In automatic mode the brake output is executed after the test interval has expired.		0	1	Automatic brake output test
Reaction after the test interval has expired (manual mode)	Error reaction if no test was executed within the test interval.		0	2	No reaction
Feedback channel	The feedback channel to be switched off during a test.		0	2	No feedback channel selected
Test interval length	The length of the test interval in minutes.	min	1	525600	30
Maximum testlength	The length of the test in milliseconds.	ms	0	10000	0
BR1M: Brake output test 1 minus (≡► Function description brake output test 1 plus/minus (BR1P/BR1M) [▶ 82])					

Test execution mode	In automatic mode the brake output is executed after the test interval has expired.		0	1	Automatic brake output test
Reaction after the test interval has expired (manual mode)	Error reaction if no test was executed within the test interval.		0	2	No reaction
Feedback channel	The feedback channel to be switched off during a test.		0	2	No feedback channel selected
Test interval length	The length of the test interval in minutes.	min	1	525600	30
Maximum testlength	The length of the test in milliseconds.	ms	0	10000	0
Bus settings (≡► Safety over EtherCAT® (FSoE) [▶ 91])					
Bus type	This is the selection of the safe bus type. The selection parameters are "No bus“ or "FSoE“.		0	1	no bus
Safety module address	Safety module address in the safe fieldbus		0	65535	0
Safe bus data length	If a safe bus system has been selected, the length of the safe data must be adjusted.		6	19	11

Tab. 9: Parameter list safety module type 5

see also

Parameter encoderless speed measurement [▶ 61]

6 Operating condition of the safety module

The operating and error state can be checked in COMBIVIS via the KEB safety editor (≡► Status of the safety module [▷ 27]).

6.1 Global operating condition

The operating condition of the safety module is divided into different stages. The global status of the safety module (≡► [▷ 44])(≡► [▷ 44])displays the different states for the safety module.

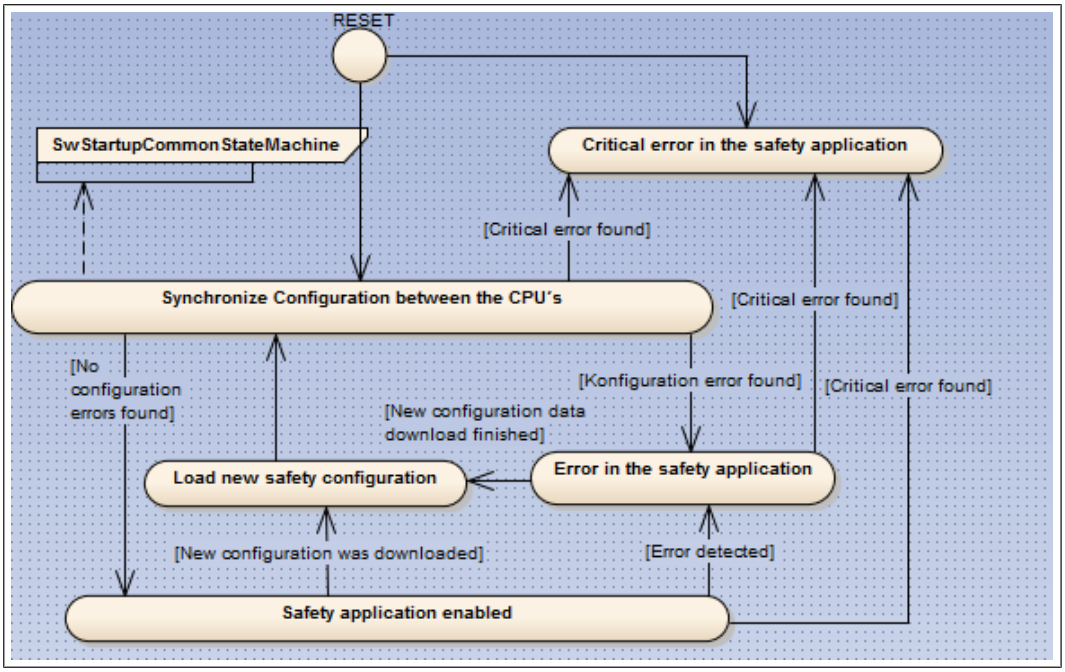


Fig. 22: The global status of the safety module

Reset:

This is the status when the safety module is switched on. The safety module performs the safety function STO.

Synchronize configuration between the CPUs:

The safety module has two independent CPUs. After the configuration has been loaded, it must be transferred to the two CPUs and checked. In this status, the safety module executes the safety function STO and the outputs remain switched off.

Safety operation released:

The safety module is ready to carry out safety operations.

Critical error in the safety module:

A critical error has been detected in the safety module. The detected error can be checked in status safety module. The safety module performs the safety function STO and the outputs are switched off. This status is permanent and can be left only by a power on reset.

Error in the safety module:

A non-critical error has been detected in the safety module, e.g. a configuration error. The state can be left by downloading a new configuration or by power on reset.

Loading of new safety configuration:

New configuration data were transferred to the safety module. Now the new configuration data are complete and in the next step the safety module tries to validate the configuration data.

6.2 Start of the safety module and transfer of new configuration data

Starting the safety module and the appropriate software is divided into different states. (≡► Start of the safety module and transfer of new configuration data [▷ 46]) displays the different states of the safety module when starting.

Software is initialised:

This status indicates that the software has been initialised. The configuration data is read from the memory.

CPU communication is started:

The safety module has two CPUs. The data communication between the two CPUs must be functional in order to exchange configuration data.

Synchronize time slot:

The two CPUs of the safety module must run synchronously. Therefor the time slot must be synchronised.

Start the synchronisation of the configuration:

Now the configuration is provided for the synchronisation from one to the other CPU of the safety module.

Complete the synchronisation of the configuration:

Now the configuration is transferred to the other CPU.

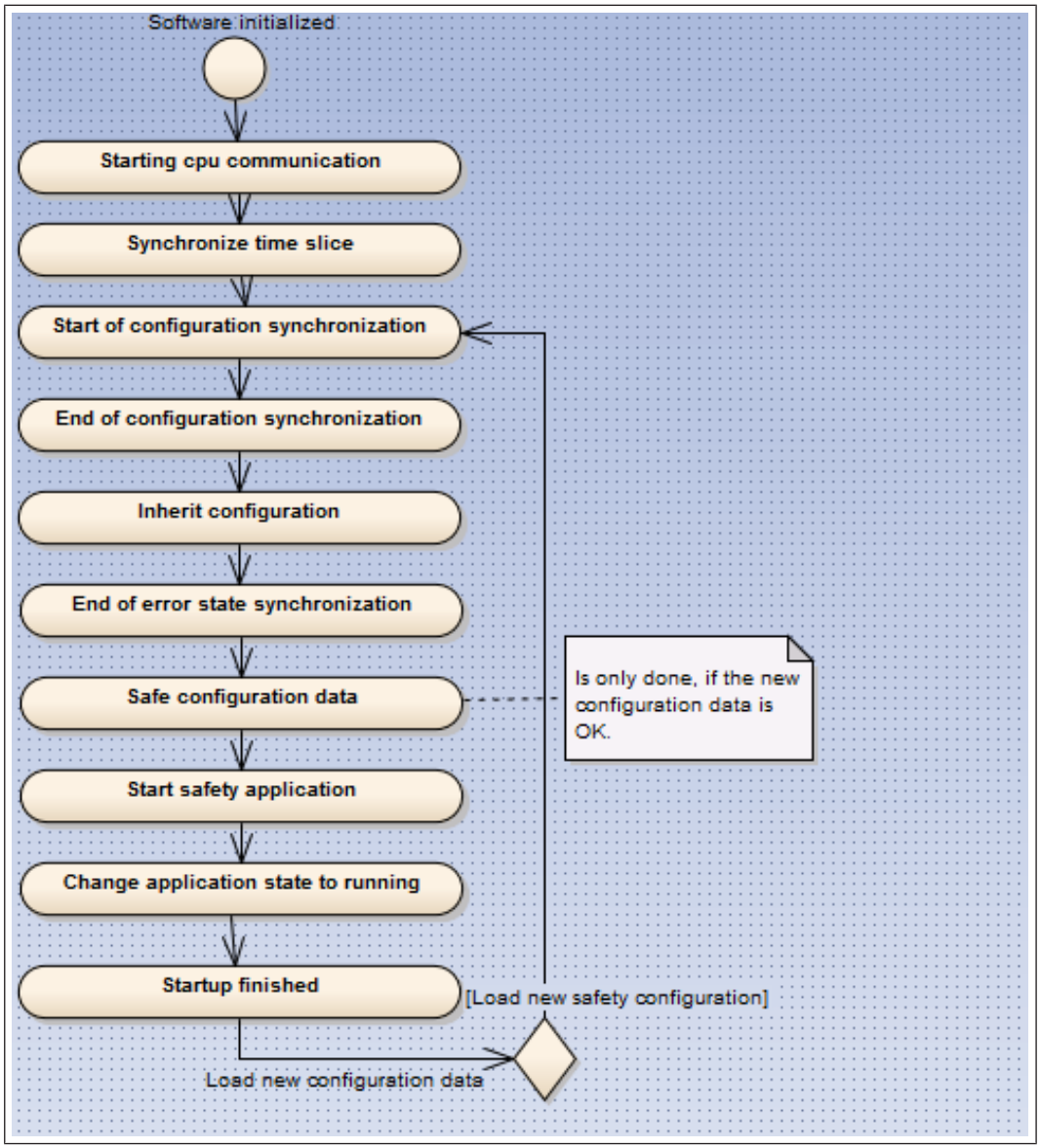


Fig. 23: Booting the safety module

Configuration data transfer:

The configuration transfer is complete. The configuration data are now checked for plausibility.

Complete the synchronisation of the error status:

Configuration errors have been provided after configuration data transfer and are now exchanged between the two CPUs.

Safe the configuration data:

These data are now saved if the configuration data have no error.

Start the safety software:

The safety software can be started now, the configuration data are available.

Change the application status to safety operation released:

The general operating mode is changed now to safety operation released. The general operating mode is changed to error in the safety module if an error was detected in the configuration.

Booting the safety module completed:

The safety module is now able to carry out safety operations.

7 Configuration state and configuration transfer

7.1 Configuration state

The configuration status displays whether new configuration data are error-free. Configuration state of the safety module displays the different states of the safety module.

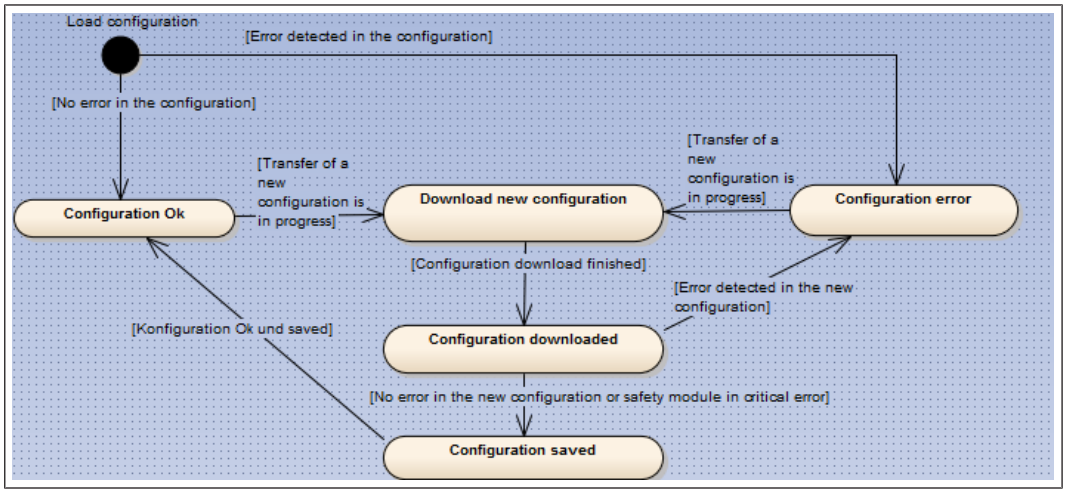


Fig. 24: Configuration state of the safety module

Load configuration:

The configuration data are loaded from the non-volatile memory.

Download of the new configuration:

Just download new configuration data.

Configuration stored:

Configuration data were downloaded, are error-free and were stored in non-volatile memory. Or the safety module is in state "Critical error in the safety module“. Then, the new configuration is stored without checking the correctness. This is done with the next start of the safety module.

Configuration is incorrect:

The configuration is incorrect and is not stored. The configuration error can be read in the configuration log.

Configuration OK:

The configuration has been downloaded, checked and is error-free. The configuration has been stored.

7.2 Create configuration data for different machines

Configuration data for different machines can be equipped with a safety module address. An address between 0 and 65535 can be configured individually for each safety module. If a configuration is downloaded to the safety module, the new configuration is accepted only if the addresses are conform.

The safety module address is displayed in the configuration data in (≡► Create configuration data for different machines [▶ 49])(≡► [▶ 48])(≡► [▶ 48]).

Setting the security module address (≡► Identification (safety module address) [▶ 24]).
(≡► Identification (safety module address) [▶ 24])

Fieldbus parameter		
Safety address	0	

Fig. 25: Safety module address in the configuration data

8 Reaction times

For the design of the safety functions in the application the (worst-case) response times must be considered in order to estimate when a certain action or event will trigger a required, safety-oriented reaction (latest) (also Process Safety Time - PST).

There are different reaction times $tr_{(A)}$ to $tr_{(F)}$ for different events, which have to be considered depending on the selected configuration. These are briefly presented here, details can be found in the following specified chapters.

(A) Reaction time function activation

From the time of an input change or status change to the activation of a subsequent function. This time is mainly determined by the internal software process of the firmware of the safety module. This also includes the hardware delay time of a digital input and, if necessary, also the hardware switch-off delay time of an output (external digital output or internal output, e.g. driver voltage supply for the STO function). This time is referring to the respective safety function in the functional descriptions in (≡► Functional description of the safety functions [▶ 63]) . If required, the response time for switching on and off can be assessed separately.

(B) Response time input filter (software)

Time that an input signal triggers a reaction delayed by the physical level change due to a configured software-based filtering. This time can be zero if no filtering is used (≡► Reaction time input filter (Software) [▶ 54]).

(C) Response time speed determination

Time from the physical limit being exceeded until a safety function monitoring the physical variable is triggered (e.g. exceeding the speed formed from the output frequency until the safety function SLS is triggered) (≡► Functional description encoderless speed measurement [▶ 58]) => formula 2.

(D) Response time output filter (software)

Time that an output signal delays the physical level change due to a configured software-based filtering. This time can be zero if no filtering is used (≡► Hardware output configuration [▶ 56]).

(E) Response time relay

Due to its special mechanical characteristics, the optional safety relay has longer switching times than the digital outputs. The following applies to the relay response time: $tr_{(E)}$ = *60 ms*

Tolerance time of the safety function

Some safety functions additionally offer an adjustable tolerance time in their configuration options, during which a detected limit violation does not yet trigger the safety function. (e.g. SS1-r) This is described in the respective function description in (≡► Functional description of the safety functions [▶ 63]) .

For the use of the safety-oriented bus system Safety over EtherCAT and its reaction and watchdog times (≡► Response time (FSoE watchdog) [▶ 92]).

9 Inputs (configuration / parameter)

The safety module has three configurable two-channel inputs.

9.1 Filter time for safety and diagnosis inputs

A filter time can be configured for each safety input and the diagnosis inputs, which serves to suppress interferences at the input. A change of the input status is conditional delayed by the filter time.

Figure "Filter time for the safety inputs (input configuration)" displays the configuration options.

Parameter	Wert	
Filter time of the safety and diagnostic inputs		
Filter time of the "Function 1 input"	0.010000	s
Filter time of the "Function 2 input"	0.010000	s
Filter time of the "Function 3 input"	0.010000	s
Filter time of the brake feedback inputs	0.010000	s

Fig. 26: Filter time for the safety inputs (input configuration)

Parameterisation

- **Filter time of function1- inputs**
- **Filter time of function2- inputs**
- **Filter time of function3- inputs**
- **Filter time of the brake feedback inputs**

Specification of the filter time for the respective input in seconds. A change of the signal at the input is only detected by the safety module after this time.

The filter time has a direct effect on the response time of a safety function requested at this input and must be considered.

9.2 Configuration of the clock signal for the inputs

If required, the inputs of the safety module can be operated with external signals overlayed with test pulses. This enables cross-circuit and external power supply detection by the safety module. The form of the test signal must then be configured in the safety module in order to prevent an unintentional request of a safety function by a test pulse.

If a test signal has been configured for the inputs, the safety module monitors the set period and pulse length of the test signal; If no test pulse or no sufficiently long test pulse is detected after the set test pulse period, the module changes into the safe state. The test signals on the individual channels of an input are also monitored for simultaneity. If a test signal is detected simultaneously on both channels, the safety module detects a cross circuit between the inputs and changes into the safe state.

Parameter	Value	Unit
Test signal input configuration		
Test signal period	10.000000	s
Test signal pulse length	0.001000	s
Check of the test-signal for the STO-Inputs	off	
Check of the test-signal for the SBC-Inputs	off	
Check of the test-signal for the Function1-Inputs	off	
Check of the test-signal for the Function2-Inputs	off	

Fig. 27: Clock signal Input configuration

Parameterization

- **Test signal period time:**
  Test signal time reference. An interruption of the input signal is expected once within this time.
- **Test signal pulse length**
  The duration of the test pulse (also 'dark time' or similar). During the test the signal is switched off for this time.
- **Check of the test signal for the function 1 inputs**
- **Check of the test signal for the function 2 inputs**
- **Evaluation of the test signal for the 3 inputs function**
  Activation of the test signal monitoring for the respective two-channel input.
- **Evaluation of the test signal for the brake feedback inputs**
  Activation of the test signal monitoring for the brake feedback inputs. There are two options:
  - **„Brake feedback inputs 1+2 with cross circuit detection“:**The test pulse evaluation is activated and a cross circuit detection occurs between the two brake feedback inputs. The safety module checks the timing of the test pulses. A cross circuit is detected if a test pulse occurs simultaneously on both channels.
  - **„Separate for brake feedback inputs 1+2“:**The test pulse evaluation is activated. Simultaneous test pulses on both brake feedback inputs are permissible. This setting is useful, for example, if the test pulses are generated from different sources that are not synchronized with each other.

9.3 Hardware input configuration (function 1-3)

Figure (≡► Hardware input configuration (function 1-3) [▶ 52]) displays the parameters for the hardware safety inputs "Function 1", "Function 2" and "Function 3".

Parameter	Wert	Einheit
Funktion 1 Hardware Eingangskonfiguration		
Erste verknüpfte Sicherheitsfunktion	STO Sicher abgeschaltetes Drehmoment	
Zweite verknüpfte Sicherheitsfunktion	Hardwareeingang deaktiviert	
Status der Eingänge	Äquivalent	
Toleranzzeit für den Eingang	0.010000	s
Funktion 2 Hardware Eingangskonfiguration		
Erste verknüpfte Sicherheitsfunktion	SBC Sichere Bremsenansteuerung	
Zweite verknüpfte Sicherheitsfunktion	Hardwareeingang deaktiviert	
Status der Eingänge	Äquivalent	
Toleranzzeit für den Eingang	0.010000	s
Funktion 3 Hardware Eingangskonfiguration		
Erste verknüpfte Sicherheitsfunktion	Hardwareeingang deaktiviert	
Zweite verknüpfte Sicherheitsfunktion	Hardwareeingang deaktiviert	
Status der Eingänge	Äquivalent	
Toleranzzeit für den Eingang	0.010000	s

Fig. 28: Parameters for the STO safety input

Parameterisation

First linked safety function / second linked safety function:

Up to two safety functions, which are triggered by the input can be selected here. If two inputs are assigned with the same function, they are AND linked. The following safety functions are available:

- **no function:**
  The safety input is not assigned with a safety function.
- **STO:**
  The safety function "Safe Torque off" is executed (≡► Functional description Safe Torque off (STO) [▸ 64]).
- **SBC:**
  The safety function "Safe brake control" is executed (≡► Functional description safe brake control (SBC) [▸ 66]).
- **SS1:**
  The safety function **"**Safe stop 1" is executed (≡► Functional description safe stop 1 (SS1) [▸ 68]).
- **SLS:**
  The safety function "Safely limited speed" is executed (≡► Functional description safe limited speed (SLS) [▸ 73]).
- **SSM:**
  The safety function "Safe speed monitoring" is executed (≡► Functional description safe speed monitoring (SSM) [▸ 75]).
- **SDLC:**
  The safety function "Safe door lock monitoring" is executed (≡► Functional description Safe Door-Lock Control (SDLC) [▸ 86]).
- **SLA:**
  The safety function "Safely limited acceleration" is executed (≡► Function description safe limited acceleration (SLA) [▸ 79]).
- **Reset fail safe:**
  If a safety function detects an error, e.g. because limits have been exceeded, then the fail safe bit is set in the status. This error can be reset by means of a configured input.
- **Index selection Bit 0:**
  Many safety functions have an index and can thus be configured several times. At runtime, a changeover can then be made via a configured input or via FSoE.
- Index selection bit 0 controls the first bit (‚LSB').
- **Index selection Bit 1:**
  Many safety functions have an index and can thus be configured several times. At runtime, a changeover can then be made via a configured input or via FSoE.
- Index selection bit 1 controls the second bit.
- **Index selection Bit 2:**
  Many safety functions have an index and can thus be configured several times. At runtime, a changeover can then be made via a configured input or via FSoE.
- Index selection bit 2 controls the third bit (‚MSB').
- **BCF 1 / BCF 2 ("Brake Check Feedback")**
  The function monitors the status change on the feedback lines of the brake control and provides an adjustable reaction after a configured period of time has elapsed (≡► Function description brake feedback test 1/2 (BCF1/BCF2) [▸ 84]).
- **FB1W / FB 2 W („Feedback – Warning")**
  (≡► Functional description feedback warning 1/2 (FB1W/FB2W) [▸ 85])
- **BR1P / BR1M ("Brake Test Request")**
  Manual request to perform a brake test (≡► Function description brake output test 1 plus/minus (BR1P/BR1M) [▸ 82]).

Status of the inputs:

The input state between the two channels is antivalent or equivalent:

- At equivalent the two safety inputs must always be switched the same. It is not allowed to supply a channel with 24V input voltage and the other channel with 0V. The safety function is carried out if the input voltage is 0V.
- Both channels are controlled with opposite logic at 'antivalent'. The following applies:
  - If channel 1 (e.g. Func1.1) is supplied with a voltage of 24V and channel 2 (e.g. Func1.2) is simultaneously supplied with a voltage of 0V, the safety function is not executed.
  - If channel 1 (e.g. Func1.1) is supplied with a voltage of 0V and channel 2 (e.g. Func1.2) is simultaneously supplied with a voltage of 24V, the safety function is executed.
- Deviations above the set tolerance time (see parameter below) from the set state equivalent or antivalent lead to the safe state

Tolerance time of the inputs:

The inputs are designed with two channels. This can cause that a channel is switched earlier or later than the second channel. Enter a tolerance time here to ensure that this does not immediately result in an error.

9.4 Reaction time input filter (Software)

The response time $tr_{(B)}$ of the input filters is determined by the configurable times described above. It results in (if necessary differently configurable for each input):

$tr_{(B)}$ = filter time + pulse length of the test signal

9.5 Functional description brake feedback input 1/2

The brake feedback lines can be assigned to different diagnosis functions. The activation level defines at which input level a reaction is executed.

9.5.1 Configuration parameters of the brake feedback inputs

Parameter	Value
Brake feedback 1 input configuration	
First activation level	Active at low-level
First assigned diagnosis function	No feedback assigned
Second activation level	Active at low-level
Second assigned diagnosis function	No feedback assigned
Brake feedback 2 input configuration	
First activation level	Active at low-level
First assigned diagnosis function	No feedback assigned
Second activation level	Active at low-level
Second assigned diagnosis function	No feedback assigned

Fig. 29: Brake feedback input configuration parameters

Parameterisation:

- **Activation level:**
  The activation level of the linked diagnosis functions can be „Active at low level“ or „Active at high level“.

- **First linked diagnostic function**
  Second linked diagnostic function
  Defines the diagnostic function that is activated when the activation level is applied to the feedback input (≡► Terminal brake [▸ 19])
  The following diagnostic functions are available:
  - **Hardware input deactivated:**
    The input is not assigned with any diagnostic function.
  - **Check BCF1 brake feedback 1:**
    If the activation level is reched, the diagnostic function BCF1 is executed (≡► Function description brake feedback test 1/2 (BCF1/BCF2) [▸ 84]).
  - **BCF2 Brake Check Feedback 2:**
    If the activation level is on, the diagnostic function BCF2 is executed (≡► Function description brake feedback test 1/2 (BCF1/BCF2) [▸ 84]).

10 Outputs (configuration / parameter)

10.1 Hardware output configuration

The safety module has 2 configurable digital outputs and optionally a safe relay output on the control board for networking the safety module with other safety components.

The following figure displays the parameters of the output configuration.

Parameter	Value	Unit
Configuration of outputs 1 and 2		
Configuration of Output1	1	
Configuration of Output2	32	
Switch off delay time	1.000000	s
Switch on delay time	1.000000	s

Fig. 30: Parameters of the output configuration

Parameterisation

- **Output 1 configuration:**
- **Output 2 configuration:**
- **Configuration relay output:**
  The output can be switched on when safety functions are executed. The following values can be combined in any bit-coded way and set as output configuration. The output configuration is then "OR-linked".
  Example: If the output shall be set when the SLS or SSM functions are executed, value 8 must be set for activation via the SLS function and value 16 for activation via the SSM function. The total value is 24 (bit-coded).

The following options are available:

Value	Plaintext	Note
0	No function	The output is not used.
1	STO	The output is switched on when the safety function STO is executed.
2	SBC	The output is switched on if the safety function SBC is executed.
4	SS1	The output is switched on when the safety function SS1 is executed.
8	SLS	The output is switched on when the safety function SLS is executed.
16	SSM	The safe output is switched off if the value of the parameterized speed plus hysteresis is exceeded. The safe output is only set if the value falls below the parameterized speed plus hysteresis.
32	SDLC	When the safety function SDLC is executed, the output is switched on.
64	SDLCDR	If the safety function SDLC is executed and the condition for door release is fulfilled, the output is switched on.
128	Error safety function	If an error occurred during the execution of a safety function, then the output is switched on.
256	SLA	The output is switched on when the safety function SLA is executed.
512	BCF1	When diagnosis function BCF1 is executed, the output is switched on.
1024	BCF2	When diagnosis function BCF2 is executed, the output is switched on.
2048	FB1W	When the diagnosis function FBW1 is executed, the output is switched on.
4096	FB2W	When the diagnosis function FBW2 is executed, the output is switched on.
8192	BR1P	When diagnosis function BR1P is executed, the output is switched on.
16384	BR1M	When diagnostic function BR1M is executed, the output is switched on.
32768	SMS	The output is switched on when the safety function SMS is executed.

65535	*no*	Maximum value. Output is switched on when any of the listed conditions is active.

Tab. 10: Output configuration

- **Switch-on delay:**
  This delays the switching on of the output if the safety function is activated. The switch-on delay affects output 1, output 2 and the relay output.

10.2 Brake output Eco Mode

The power input of an open brake can be reduced by the output of a PWM voltage at the brake output. When switching on the brake/relay, the coil must be energized with rated voltage until the switch-on state is safely reached. This duration is set by parameter "PWM delay". After the PWM delay has expired, the PWM is activated with the set control setting and a period length of 50 µs.

Brake output eco-mode		
PWM startup delay	3000	ms
Duty cycle of the PWM signal	100	%

Fig. 31: Brake output Eco mode - Configuration in COMBIVIS

Further information (≡► Functional description safe brake control (SBC) [▶ 66]) and (≡► Brake test [▶ 82])

Parameterisation

- **PWM delay:**
  The brake output signal is initially switched on permanently. After the delay, the pulse width modulation is activated.
- **Control setting of the PWM:**
  The control setting indicates the voltage reduction at the brake in %. (Relation of switch-on time to switch-off time)

11 Encoderless speed measurement

11.1 Functional description encoderless speed measurement

The speed is determined via a position difference measurement of the electrically output frequency. The following boundary conditions are necessary:

The motor must be able to follow the changes of the output frequency of the drive controller at any operating point.

The drive controller has to modulate and output control settings must be greater than a modulation factor hysteresis window.

Output currents must be higher than a current hysteresis window.

No external forces that can accelerate the motor may act on the motor.

Functions which can trigger inadmissible jumps in the output electrical transformation position must remain deactivated. This affects the functions "(software and) hardware current control" (is37) and the function "Speed search" (dd16).

If the motor is not controlled, the speeds cannot be determined, they can only be assumed. The behaviour in this case is configurable.

If no external forces act on the motor, the speeds in motor operation can only be lower than the last determined level.

For certain motor types, e.g. synchronous reluctance motors, an appropriate current must be impressed by the functional parameterization of the drive controller in order to enable the diagnosis or to prevent a response of the diagnosis functions.

The electrical transformation position of the output frequency of each logic channel is determined via the control settings and the output currents.

This transformation position is compared as position between the logic channels. If the position is smaller than the permitted position difference, the determined value is considered plausible and the speed is determined by the following formula:

$$n = \frac{\text{position(k) - position(k- speed scan time)}}{\text{speed scan time} \bullet \text{number of pole pairs}}$$

NOTICE

Slip of the asynchronous motor!

The slip of an asynchronous motor remains unconsidered with the determined speed!

a) In motor operation, the slip-afflicted speed of the motor is always lower than the encoderless measured speed.

b) If, for example, SLS is activated during deceleration (regenerative operation), the slip for the speed limit must be considered.

The speed scan time determines the position difference over an adjustable period, resulting in an average speed value. With a speed jump, the actual speed is only reached after the speed scan time.

The speed determined via the speed scan time can be smoothed via a PT1 filter. The PT1 time causes a delay of the speed change. Thereby at a speed jump the actual speed is reached only after the speed PT1-time is reached.

Since the speed is determined from the output voltage, the delay to the mechanically emitted speed can be corrected by the mechanical time constant, the stator time constant and in addition for asynchronous / synchronous reluctance motors by

the rotor time constant. A speed change is therefore detected based on the output voltage before it has actually been mechanically adjusted. This represents a significant advantage when considering the reaction time compared to a conventional feedback system.

The delay time of the speed determination results in:

delay time = (speed scan time) + (PT1 time) - (stator time constant) - (mechanical time constant) (-(rotor time constant))

NOTICE

Response time of the safety functions!

a) The response time of the safety functions SS1, SLS, SMS, SSM, SLA and SDLC is directly related to the speed detection settings.

b) Higher scan times provide a smooth speed, but also a slower response time of the safety functions(≡► Reaction times [▶ 50]).

11.2 Limits of encoderless speed measurement

The safety module type 5 can detect electrical output frequencies and perform an internal diagnosis about the detected speeds. The implemented procedures result in different maximum detectable speeds (significantly influenced by the switching frequency).

At low switching frequencies, only lower maximum output frequencies can be evaluated by the safety module.

The maximum output frequency that can be evaluated by the safety module type 5 results from table:

Switching frequency	Basis T_p	Switching frequency group (Parameter is22)	Maximum Output frequency
1.25 kHz	100 µs	3	250 Hz
1.5 kHz	83.3 µs	2	300 Hz
1.75 kHz	71.4 µs	1	350 Hz
2 kHz	62.5 µs	0	400 Hz
2.5 kHz	100 µs	3	500 Hz
3 kHz	83.3 µs	2	600 Hz
3.5 kHz	71.4 µs	1	700 Hz
4 kHz	62.5 µs	0	800 Hz
5 kHz	100 µs	3	1000 Hz
6 kHz	83.3 µs	2	1200 Hz
7 kHz	71.4 µs	1	1400 Hz
8 kHz	62.5 µs	0	1600 Hz
10 kHz	100 µs	3	1666.67 Hz
12 kHz	83.3 µs	2	2000Hz
14 kHz	71.4 µs	1	2333.33 Hz
16 kHz	62.5 µs	0	2666.67 Hz

Tab. 11: Limits for the output frequency depending on the switching frequency

Depending on the used drive controller and selected parameterization, further restrictions may apply to the switching frequency. Observe the installation instructions of the power unit and the programming manual!

Due to internal processes in the software, it is possible with certain configuration constellations that the following error messages are triggered when switching the modulation on and off:

Error code: 2952793234 (CPU1), 805309586 (CPU2)

- Error during phase check in encoderless mode.
- The trigger level for the current switching frequency has been exceeded.
- An error has occurred in one or more phases.

Restart the safety module. Contact KEB Support if the error persists.

Error code: 2952793460 (CPU1), 805309812 (CPU2)

- Error in encoderless mode.
- The internal timer over capture error has occurred.

Remedy:

Update the software to version 5.5.0.8 with date code ".21.12.2022".

The safety functionality of the device is not affected by the update.

Selection of the switching frequency

The switching frequencies used by the drive controller can be influenced by parameterization. Among others, a minimum switching frequency can be configured, see the parameter description of the 'inverter specific parameter' group (is) in the programming manual of the control unit.

11.3 Parameter encoderless speed measurement

Configuration of the encoder less mode		
Encoder less mode	Off	
Number of pole pairs	2	
Speed scan time	4	ms
PT1-filter-time for speed calculation	20.000000	ms
Keep speed value in case of modulation disabled or ST	off	
Motor current breakdown torque	50.000000	%
Allowed position difference between the two logic chann	360	°
Maximum time for the position difference between the tw	0	ms
Allowed speed difference frequency to current (diagnosis	50.000000	1/min
Allowed time difference frequency to current (diagnosis)	200	ms
Hysteresis of the electrical current	2.000000	%
Hysteresis of phase control	10	

Fig. 32: Configuration of the speed measurement

- **Encoderless mode:**

The speed determination can be switched off with the parameter. Speed-related safety functions are no longer available.

Configurations that contain speed-related safety functions are rejected or lead to the safe state if encoderless speed measurement is not active. The safety module reacts as follows:

- Generation of a configuration error when digital inputs are configured with speed-based safety functions (e.g. SLS).
- Initiation of the safe state if the speed-related safety functions are not deactivated immediately after starting the FSoE bus when using FSoE. However, the use of an FSoE process data assignment that contains the control bits for speed-related safety functions is permitted.

- **Number of pole pairs:**

Number of pole pairs of the connected motor

- **Speed scan time:**

Time reference to determine the position difference.

- **PT1 filter time of the speed calculation:**

The determined speed can be smoothed by a PT1 filter. The filter is inactive for 0.0 ms to less than 1.0 ms, the filter is active for 1.0 ms to 256.0 ms.

- **Keep speed value in case of modulation disabled or STO**

The encoderless detection of the speed is based on the detection of the output frequency of the drive converter. This parameter can be used to define the behaviour of the speed measurement if the detection of the output frequency is not possible (e.g. because the modulation was switched off during operation by removing the modulation release and the drive coasts down).

The following settings are possible:

- **Off" Set speed to zero**
  The speed is set to the value 0 rpm. With this setting, speed-oriented functions will immediately show the response defined for a speed of 0 rpm when the modulation is switched off. The actual shaft speed can differ from 0 rpm, depending on the conditions under which the modulation is switched off. In this case, suitable measures must be implemented on the application.
- **"On" Last valid value**
  The last determined speed is maintained. Speed-oriented functions use the last speed as actual speed and continue to work. This also applies if an index change occurs (e.g. change to another SLS limit; if the function is triggered by the new limit in relation to the last speed, the parameterized reaction occurs). Due to the necessary boundary conditions, it is impossible that the actual shaft speed is higher than the last detected speed. By means of 'Fail-Safe Acknowledge' or an appropriate configured input, the current speed is also set to zero. (e.g. in order to be able to start again after exceeding a speed limit).

- **Motor current limit breakdown torque**

Permitted maximum current in percent of the upper range value of the drive controller at which the connected motor is not tilted.

The upper range value of the current detection can be read in parameter de80 of the drive controller. Depending on the power unit, the upper range value is in the range of factor 2-3 above the maximum current of the power unit. The set final value range must be validated during start-up.

- **Permitted position difference between the two logic channels:**

The safety module has two independent channels for evaluating the position data and for determining the speed. There may be minor deviations between the two channels. The total accumulated positions in both channels are continuously summed up and compared. Should problems arise during operation, this value can be adjusted. A value of 360° is entered here as standard.

- **Maximum time for the position difference:**

Period of time wherein the position difference may be exceeded before going into the safe state.

- **Allowed speed difference frequency to current:**

The speed is determined from the modulation factor and the currents and compared with each other. This parameter defines the speed tolerance of the diagnosis.

- **Permitted time difference between frequency and current:**

Period of time wherein the speed deviation may be exceeded before going into the safe state.

Hysteresis of the current values:

Window in % of full scale of the current of the drive controller around 0, from which an evaluation of the encoderless speed is possible. If the current (amount of alpha/beta transformation) is within the window, the speed formed by the currents is assumed to be no longer detectable and the speed formed by the current values is assumed to be zero. (This can cause a deviation from the speed formed by the voltage vectors, which triggers an error).

This current limit is also used to check the sum of the phase currents.

The default value is 2%.

Hysteresis of the control setting:

Window in 'Number of Timerticks' for the modulation factor of the output voltage by 0, from which an evaluation of the duty cycles of the half-bridge drivers is possible. A timer tick corresponds to a duration of approx. 14 ns.

If a cyclic duration factor is within the window, the speed formed from the control settings is assumed to be no longer detectable and the speed is assumed in accordance with the setting under,**Keep speed value in case of modulation disabled or STO**‘.

The default value is 10. The value should only be changed in consultation with KEB.

12 Functional description of the safety functions

The safety module type 5 fulfils the safety functions listed in this chapter according to EN 61800-5-2 as well as other safety functions.

12.1 Priority of the safety functions

STO always has the highest priority. The other safety functions all have the same priority.

Priority	Meaning
0	STO is executed, modulation not released (≡► Functional description Safe Torque off (STO) [▶ 64]).

Tab. 12: Priority of the safety functions of the safety module

12.2 Status of the safety module

The status of the safety module can be read out with parameter sb29 "safety mod. status word" of the COMBIVERT (from software version 2.5 also with sb40). The parameter is bit-coded according to the table (≡► Status of the safety module [▶ 63]):

Bit	Condition	Meaning
0	Status	"1" ÷ error in the safety module
1	Status	"0" ÷ STO is executed, modulation not enabled (≡► Functional description Safe Torque off (STO) [▶ 64]).
2	Status	"0" ÷ SBC is executed. Brake closed (≡► Functional description safe brake control (SBC) [▶ 66]).
3	Status	"1" ÷ SS1 is executed (≡► Functional description safe stop 1 (SS1) [▶ 68])
4	Status	"1" ÷ SLS is executed (≡► Functional description safe limited speed (SLS) [▶ 73])
5	Status	"1" ÷ SSM is executed (≡► Functional description safe speed monitoring (SSM) [▶ 75])
6	Status	"1" ÷ SDLC is being executed (≡► Functional description feedback warning 1/2 (FB1W/FB2W) [▶ 85])
7	Status	"1" ÷ SDLC Door Release is executed (≡► Functional description feedback warning 1/2 (FB1W/FB2W) [▶ 85])
8	Status	"1" ÷ Fail Safe. The limit of an active safety function has been breached.
9	Status	"1" ÷ SLA is executed (≡► Function description safe limited acceleration (SLA) [▶ 79])
10	Status	"1" ÷ BCF1 is executed (≡► Function description brake feedback test 1/2 (BCF1/BCF2) [▶ 84])
11	Status	"1" ÷ BCF2 is executed (≡► Function description brake feedback test 1/2 (BCF1/BCF2) [▶ 84])
12	Status	"1" ÷ FB1Warning is executed (≡► Functional description feedback warning 1/2 (FB1W/FB2W) [▶ 85])
13	Status	„1“ ÷ FB2Warning wird ausgeführt (≡► Functional description feedback warning 1/2 (FB1W/FB2W) [▶ 85])
14	Status	"1" ÷ BR1P Test is executed (≡► Function description brake output test 1 plus/minus (BR1P/BR1M) [▶ 82])
15	Status	"1" ÷ BR1M Test is executed (≡► Function description brake output test 1 plus/minus (BR1P/BR1M) [▶ 82])
16	Status	"1" ÷ SMS is executed (≡► Functional description safe maximum speed (SMS) [▶ 77])

Tab. 13: Status of the safety module

see also

- Functional description Safe Torque off (STO) [▶ 64]

12.3 Functional description Safe Torque off (STO)

The safety-related disconnection according to STO is reached by a two-cannel opto-coupler blockage. This ensures that supply of the opto-couplers also is not possible at STO execution. If the opto-couplers are not longer supplied, no IGBT can be controlled and thus no energy can be supplied to the drive.

• STO status is displayed in status bit 1.

Installation work or troubleshooting can be necessary in hazard areas, whereby protective devices such as line- or motor contactors shall not be activated. The safety function STO can be used there. Depending on the application the use of line or motor contactors can be void by using STO.

In case of error or request, the power semiconductor of the drive module are switched off and the drive is not supplied, which causes a rotation or torque (in case of a linear drive movement or force). The unit can be safe switched off and/or remain if an error occurs.

⚠ DANGER

Continue mains voltage with active STO function!

Electric Shock

a) Always switch off the power supply before working on the device.

b) Await discharge time.

12.3.1 Emergency stop according EN 60204

By using suitable safety switchgear units, stop category 0 according to EN 60204-1 can be reached by the STO function in the system.

✓ Stop category 0

a) „uncontrolled stop“, i.e. stop by immediate removal of power to the actuators.

Emergency stop according to EN 60204-1 must be functional in all operating modes of the drive module. The reset of emergency stop may not lead to an uncontrolled start of the drive.

✓ Restart only after confirmation

a) The drive restarts if function STO is no longer released. In order to comply with EN 60204-1, it must be ensured by external measures that the drive restarts only after confirmation.

Without mechanical brake the drive leads to coast; motor is free-wheeling. Additional protective devices must be installed (e.g.locking systems) if damage to persons or property can occur.

⚠ DANGER

Motor coast in the event of a fault

Danger to persons

✓ If there is a danger to persons after the motor control has been switched off by STO:

a) Block access to the hazardous area.

b) Wait until the drive stops.

⚠ DANGER

Jerking of the drive in the event of a fault

Danger to persons

✓ In case of double malfunction it can lead to unwanted jerk. The rotation angle is depending on the number of poles of the selected drive and the gear ratio.

a) Switch off the supply voltage before carrying out any work on the machine.

b) Await capacitor discharge time (min. 5 minutes). Measure DC voltage at the terminals.

Calculation of the jerk:

$$\text{Rotation angle of the jerk } W_R\ [°] = \frac{180°}{\text{Pole-pair number p} \bullet \text{gear reduction ratio g}}$$

The probability of the jerk is < 1.84 *10^{-15} 1/h.

This behaviour can occur either by a short circuit of the IGBTs or by interconnection (also short circuit) of the control drivers. The error should be regarded as critical, if the drive remains in STO status.

12.3.2 Response time function activation STO function

Maximum switch on delay time: < 4ms

Maximum switch off delay time: < 4ms

Additionally to the response time for function activation, the following response times must be considered for the STO function:

Response time type	$tr_{(A)}$ Function	$tr_{(B)}$ Input filter	$tr_{(C)}$ Speed determination	$tr_{(D)}$ Output filter	$tr_{(E)}$ Relay	$tr_{(F)}$ Tolerance time
STO	YES	YES	NO	NO*	NO*	NO

*Not to be considered for the STO function. However, STO can be configured as switching condition. The delay time must be observed by the function defined for the output.

(≡▶ Reaction times [▶ 50])

12.4 Functional description safe brake control (SBC)

The safety module can use the SBC function to monitor the control of the brake output on the control board (for connection details, see manual for the control unit) and switch off in two channels.

The two-channel capability is achieved diversely by means of a high-side switch and a low-side switch.

Different diagnostic functions are provided for testing the brake output (≡► Brake test [▸ 82]) and following.

Further information (≡► Brake output Eco Mode [▸ 57]).

12.4.1 Requirements for the brake

Voltage supply	The voltage of the brake must agree with the specification of the 24V input voltage, the maximum internal voltage drop of 1.2V at 2A must be observed.
max. current	2 A
Free-wheeling circuit	integrated in COMBIVERT

The safe brake control is exclusively defined for brakes which are active in de-energized condition. These brakes are opened by applying a voltage, so that a single fault, such as the failure of the power supply, may not lead to the loss of the safety function.

⚠ DANGER

Power-off braking!

a) Use brakes which are closed at power-off state.

A classification of the entire brake system inclusive mechanical brake to SIL 3 and PL e must be evaluated depending on the used brake. Brakes are considered as components with relatively high error probability. A test interval for the brake is set depending on the manufacturer specified error probability of the used brake and depending on the application.

NOTICE

Check the brake!

a) A check of the brake can not be done completely by the safety module.

b) Functions are provided by the safety module that support the user when checking the brake system (≡► Brake test [▸ 82]) and the application examples for it.

⚠ DANGER

Observe safety regulations!

a) The valid safety regulations must be observed independent of the use of a safety-oriented braking system (e.g. prohibition of staying under suspended loads).

12.4.2 Activation of the safety function SBC

The circuit operates on two channels. The brake can only be opened by the control in COMBIVERT if the safety function SBC is no longer executed. Then opening the brake is displayed with „Brake status“ in status bit 2 (1 means brake open).

12.4.3 Response time function activation SBC function

Maximum switch on delay time: < 4ms

Maximum switch off delay time: < 5ms

Additionally to the response time function activation, the following reaction times must be considered for the function:

Response time type	$tr_{(A)}$ Function	$tr_{(B)}$ Input filter	$tr_{(C)}$ Speed determination	$tr_{(D)}$ Output filter	$tr_{(E)}$ Relay	$tr_{(F)}$ Tolerance time
SBC	YES	YES	NO	NO*	NO*	NO

*Not to be considered for the SBC function. However, SBC can be configured as switching condition. The delay time must be observed by the function defined for the output.

(≡▶ Reaction times [▶ 50])

12.4.4 Setting of status bits by the SBC function

The current flowing through the brake is measured at brake release. The following bits are set depending on the measurement:

Current measurement	Bit
>3.3 A	The error is output in the error state.
<100 mA	A warning is output in the error state.

NOTICE

Note the reaction time of the brake!

a) Since the current increases slowly at high brake inductance, the error response time is max. 100 ms to a current <0.1A.

⚠ WARNING

No automatic switch-off in case of undercurrent!

Avoid overload in case of wire breakage of the brake control.

a) In the case of a detected insufficient brake current, a switch-off of the modulation must be initiated by the parameterization of the COMBIVERT control unit or the higher-level control system. Modulation is not switched off automatically.

The voltage supply for switching the brake is monitored. Status bit 0 is set if the voltage is outside 24 V ±10 %. Also an error is output in the error status.

see also

Brake test [▶ 82]

12.4.5 Monitoring of the SBC function

The internal switches are tested at brake release according to the set interval on their switching ability.

For this purpose the signals of the brake outputs are checked by briefly switching off.

NOTICE

Testing the brake output shall not engage the brake!

a) Select suitable brake.

Thus a monitoring of the wiring of short circuit to 24V respectively 0V is given. If the safety module detects an error, the safe state (≡► Safe condition [▶ 17])is set.

NOTICE

Observe reaction time due to diagnosis and switch-off time!

a) The maximum diagnosis time is 6 ms.

b) In error case this results in a turn-off time of 6ms diagnosis time plus 5ms shut-down delay, 11ms in total.

see also

Reaction times [▶ 50]

Brake test [▶ 82]

12.4.6 Configuration parameters of the safety function SBC

Parameter	Value	Unit
SBC: Safe brake control		
Coupling of SBC with STO	off	
Measurement of the brake current	on	

Fig. 33: SBC Parameters

The above figure shows the configuration parameters for the SBC function.

Parameterisation:

- **Coupling of SBC with STO:**
  If state STO is reached for a safety function, then also the brake output is switched off simultaneously with "on". The brake closes.
- **Measurement of the brake current:**
  The brake output current is measured if this option is set to "on" (default). If a current higher than 3.3 A is measured, the safety module is transferred into the safe state.

12.5 Functional description safe stop 1 (SS1)

The safety function SS1 can be executed in two ways

SS1-r (Monitoring of a speed ramp)

SS1-t (Monitoring of a time to standstill)

The function SS1 is executed as index function. Up to eight different limits can be configured and selected via an index selection.

Depending on the software version of the drive controller, further reactions to the triggering of SS1 can be configured. Configurations of the drive controller have no influence on the behaviour of the safety module.

12.5.1 Activation of the safety function SS1

The circuit operates on two channels. The safety function of the control of the COMBIVERT can only be left, if both hardware inputs are voltage supplied or if a corresponding status change has been received via a safe bus system. The SS1 status is displayed in the status bit **3**.

12.5.2 Configuration parameters of the safety function SS1

SS1: Safe stop 1 [1]		
Selection of the type of the function	Type r and type t	
Deceleration	0.010000	1/s²
Negative tolerance	0.000000	1/min
Positive tolerance	0.000000	1/min
Time window of speed deviation	0.000000	s
Type t time	0.000000	s

Fig. 34: Configuration parameters for the safety function SS1

12.5.3 Response time function activation SS1 function

Maximum switch on delay time: < 4ms

Maximum switch off delay time: < 4ms

Additionally to the response time function activation, the following reaction times must be considered for the function:

Response time type	$tr_{(A)}$ Function	$tr_{(B)}$ Input filter	$tr_{(C)}$ Speed determination	$tr_{(D)}$ Output filter	$tr_{(E)}$ Relay	$tr_{(F)}$ Tolerance time
SS1-r	YES	YES	YES	NO*	NO*	YES
SS1-t	YES	YES	NO	NO*	NO*	NO

*Not to be considered for the SS1 function. However, SS1 can be configured as switching condition. The delay time must be observed by the function defined for the output.

(≡► Reaction times [▸ 50])

12.5.4 Emergency stop according EN 60204

By using suitable safety switchgear units, stop category 1 according to EN 60204-1 can be reached by the STO function in the system.

Stop category 1

This concerns to „controlled stop“, i.e. power to the actuators is retained to apply braking until the stop is achieved. The energy is only interrupted (STO) when the standstill has been reached.

12.5.5 Description of the SS1- r function

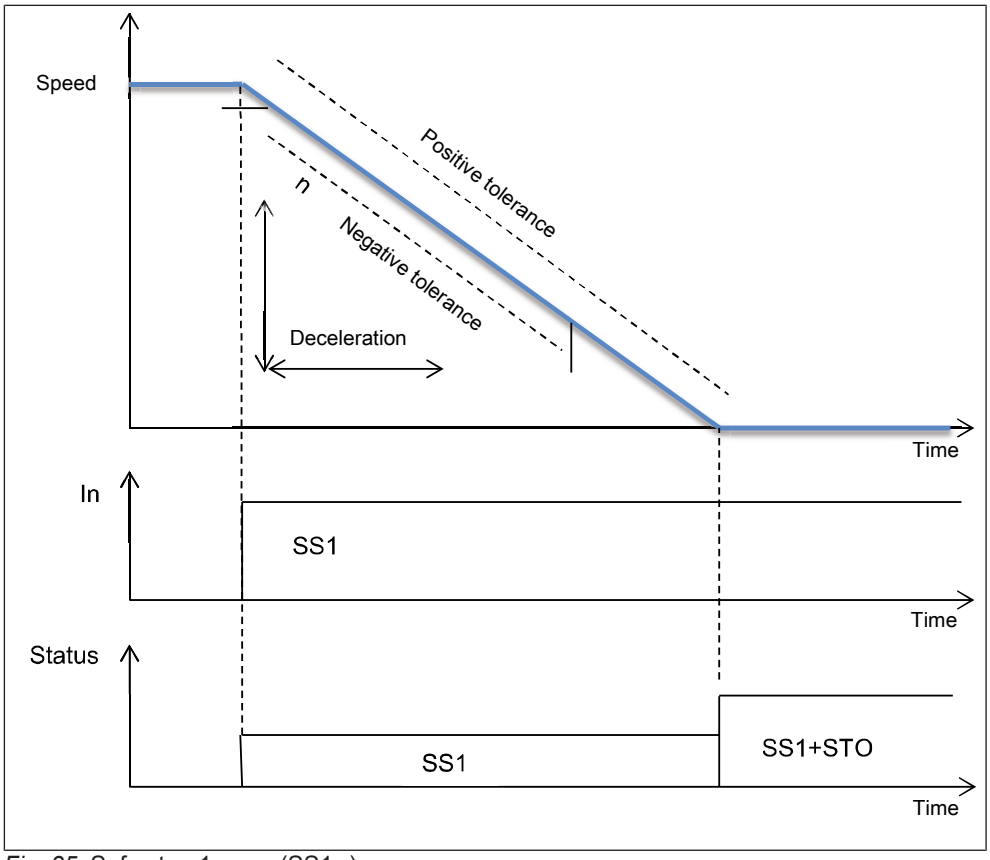


Fig. 35: Safe stop 1 ramp (SS1-r)

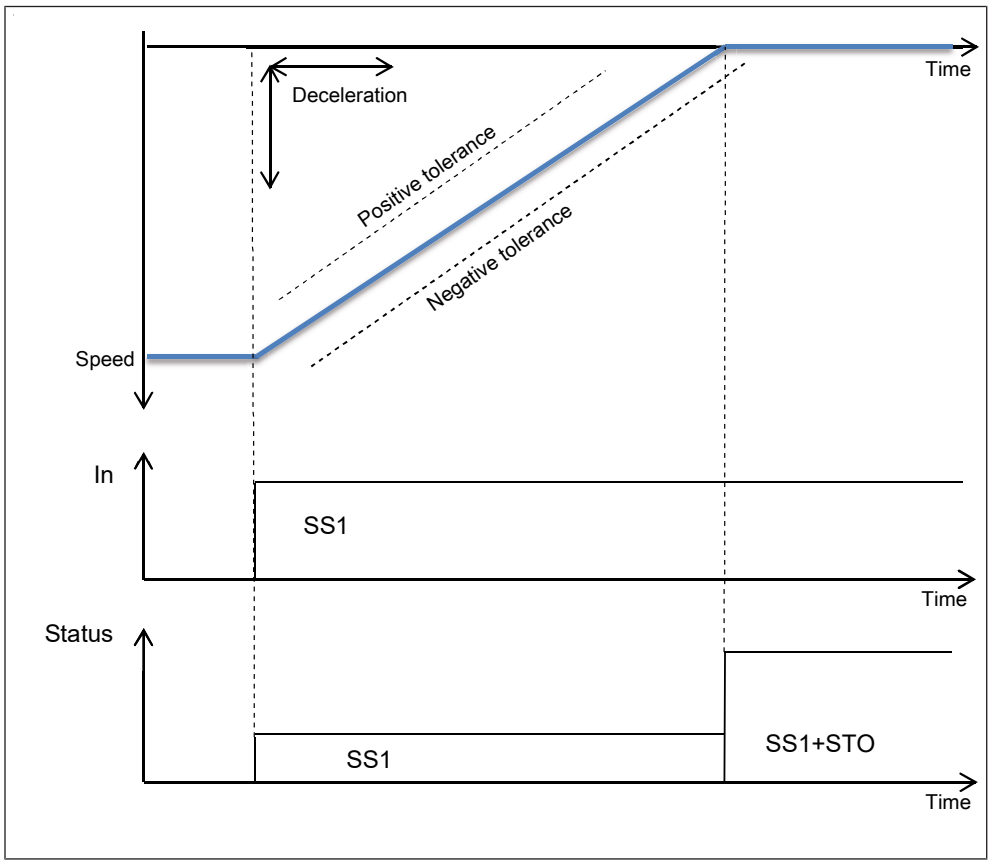


Fig. 36: Safe stop 1 ramp (SS1-r) with negative speed as start value

The brake ramp is monitored after triggering of the function.

For monitoring the braking ramp, the deceleration is monitored. State STO is assumed after reaching the standstill.

Errors are faded out via a parameter, which defines a max. tolerable time for short-term deviations from the tolerance window.

Parameterization:

- **Deceleration:**
  Permits the monitoring of the ramp which decelerates the motor of the COMBIVERT.
- **Time window for speed deviation**:
  Permits a deviation of the motor from the ramp for the adjusted time. The STO safety function is executed if the time is exceeded. The counter is incremented when the speed is outside the speed limit. The counter is decremented when the speed is back within the speed limit.
- **Negative and positive tolerance:**
  Allows to define a range, in which speed deviations are tolerated by the ramp (e.g. for slip in asynchronous motors).
- **Selection of the function type**:
  The SS1-r and SS1-t function can be activated here, or only SS1-r

If the tolerance range is left longer than the defined time in the time window, it is changed into state STO.

⚠ WARNING

Parameterize negative tolerance correctly!

a) The negative tolerance of the deceleration ramp must be set by way that the entire system can follow this maximum permissible ramp.

b) The motor must be able to follow the changes of the output frequency of the drive controller at any operating point (≡► Functional description encoderless speed measurement [▶ 58]).

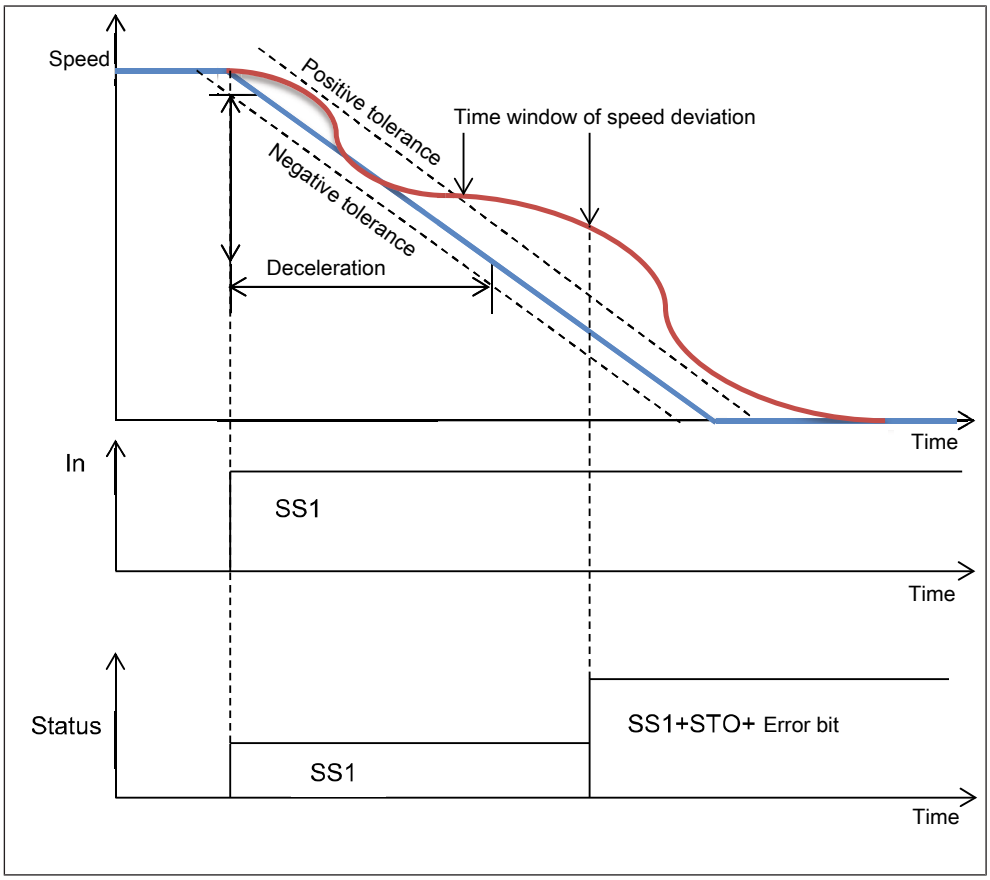


Fig. 37: SS1-r Safety function with faulty ramp

12.5.6 Description of the SS1- t function

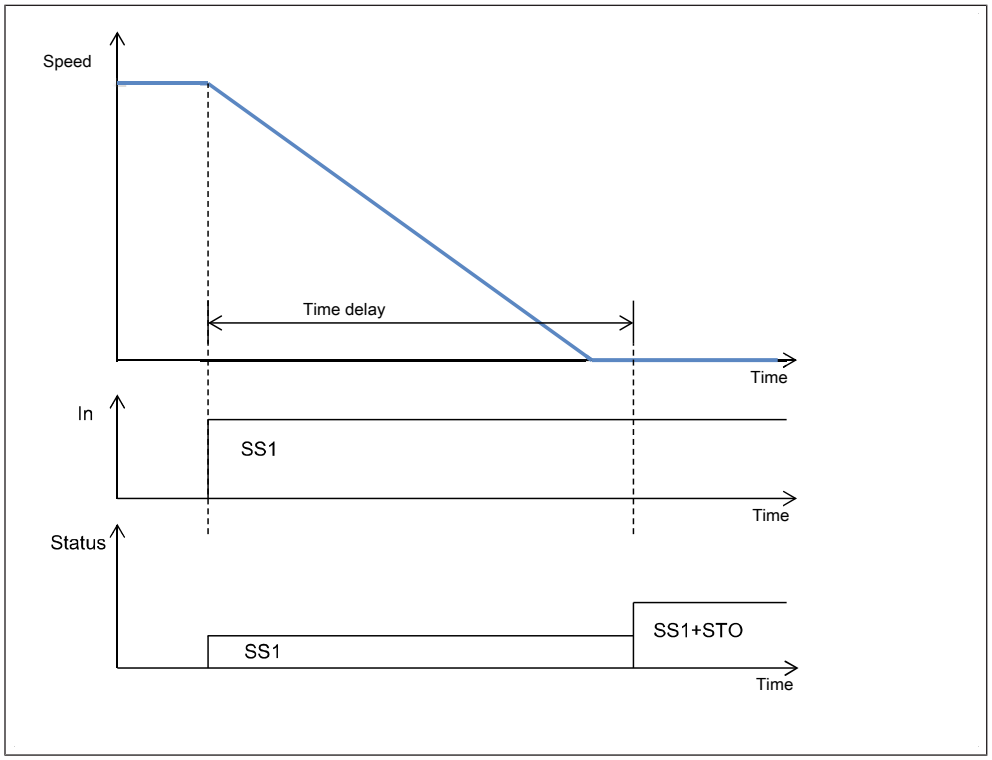


Fig. 38: SS1-t Functional description

After tripping of function SS1, the drive is decelerated due to the effect of the drive control. State STO is assumed after expiration of the configurable time "time period upto safety function".

Parameterization

- **Type –t time:**
  If the entered time period has expired, the safety function STO is executed. A ramp is not monitored here. The speed must not necessarily zero after the delay time has expired, the change to the STO state occurs without further testing.
- **Selection of the function type**:
  Here the SS1-r and SS1-t function can be activated, or only SS1-t.
  If both are active, STO is executed as soon as the ramp or the time delay (whichever occurs first) has expired.

12.6 Functional description safe limited speed (SLS)

The SLS safety function ensures that the drive does not exceed a maximum speed.

Errors are faded out via a further parameter, which defines a max. tolerable time for short-term deviations of the tolerance window.

An adjustable error function is triggered in error case.

The SLS function is executed as index function. Up to eight different limits can be configured and selected via an index selection.

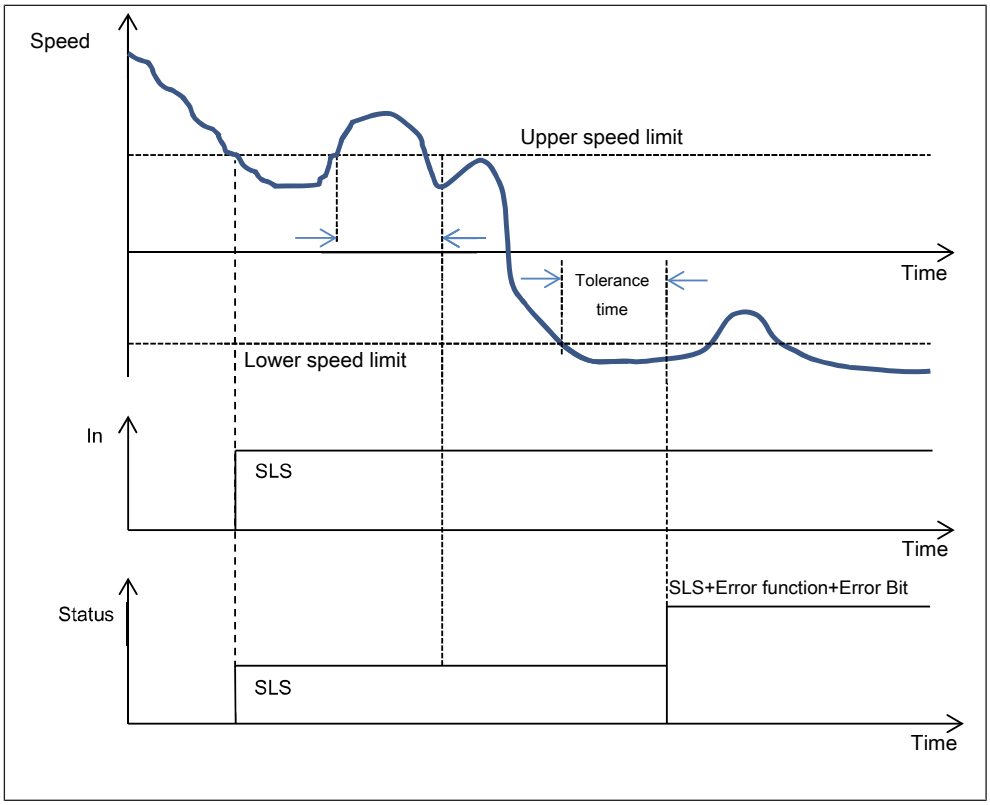


Fig. 39: Safely limited speed (Safely limited speed - SLS)

12.6.1 Activation of the safety function SLS

The circuit operates on two channels. The safety function of the control of the COMBIVERT can only be left, if both hardware inputs are voltage supplied or if a corresponding status change has been received via a safe bus system. The **SLS status** is displayed in status bit 4.

12.6.2 Configuration parameters of the safety function SLS

SLS: Safely-limited speed [1]		
Upper speed limit	120000.000000	1/min
Lower speed limit	-120000.000000	1/min
Tolerance time	0.000000	s
Error function	STO	

Fig. 40: Configuration parameters for the safety function SLS

Parameterization

- **Upper speed limit:**
  The maximum permitted speed in forward direction.
- **Lower speed limit:**
  The minimum permissible speed in reverse direction.
- **Tolerance time:**
  This is the time within the upper or lower speed limit shall be exceeded. The counter is incremented when the speed is outside the speed limit. The counter is decremented when the speed is back within the speed limit.

- **Error function:**
  When exceeding the adjusted maximum speed by the tolerance time, this error function is executed. STO or SS1.

12.6.3 Response time function activation SLS function

Maximum switch on delay time: < 4ms

Maximum switch off delay time: < 4ms

Additionally to the response time function activation, the following reaction times must be considered for the function:

Response time type	$tr_{(A)}$ Function	$tr_{(B)}$ Input filter	$tr_{(C)}$ Speed determination	$tr_{(D)}$ Output filter	$tr_{(E)}$ Relay	$tr_{(F)}$ Tolerance time
SLS	YES	YES	YES	NO*	NO*	YES

*Not to be considered for the SLS function. However, SLS can be configured as switching condition. The delay time must be observed by the function defined for the output.

(≡► Reaction times [▸ 50])

12.7 Functional description safe speed monitoring (SSM)

The safety function provides a safe output signal if the speed does not exceed a defined value. The safe output is switched off if the value of the parameterized speed plus hysteresis is exceeded. The safe output is only set if the value falls below the parameterized speed plus hysteresis.

The function SSM is executed as index function. Up to eight different limits can be configured and selected via an index selection.

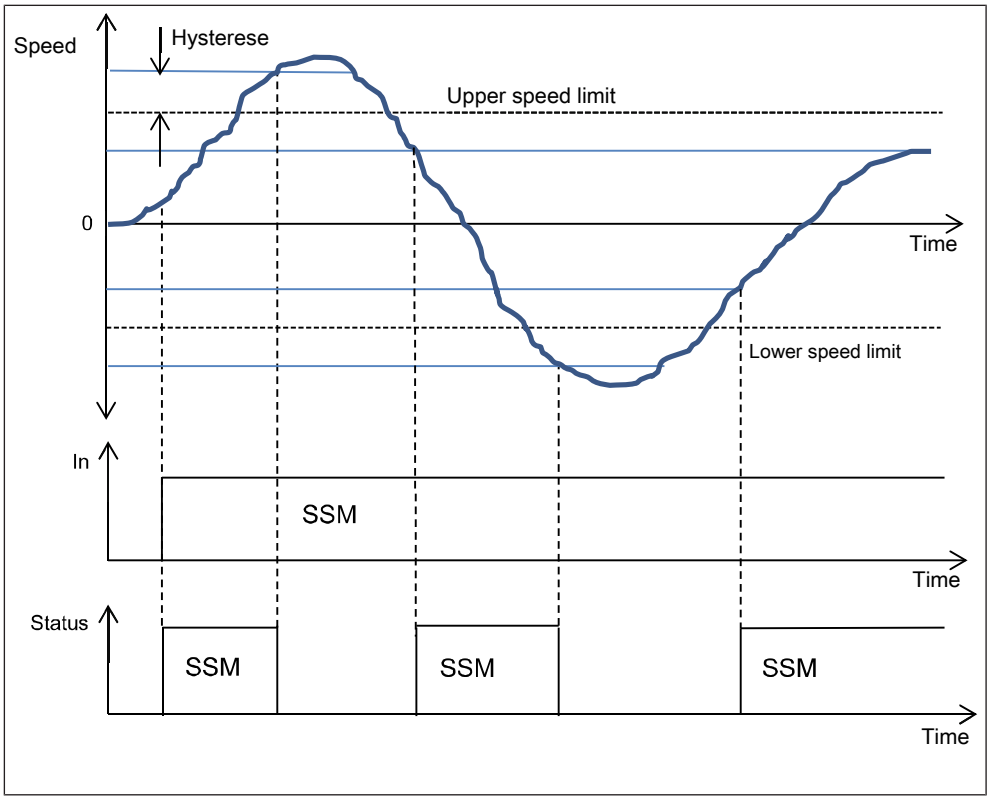


Fig. 41: Safe speed monitoring (Safe Speed Monitor – SSM)

12.7.1 Activation of the safety function SSM

The circuit operates on two channels. The safety function of the control of the COMBIVERT can only be left, if both hardware inputs are voltage supplied or if a corresponding status change has been received via a safe bus system. The SSM status is displayed in status bit 5.

12.7.2 Configuration parameters of the SSM function

Parameter	Wert	Einheit
SSM: Sichere Geschwindigkeitsüberwachung [1]		
Obere Geschwindigkeitsgrenze	45000.000000	1/min
Untere Geschwindigkeitsgrenze	-45000.000000	1/min
Hysterese	0.000000	1/min
Überwachung immer aktiv	aus	

Fig. 42: Configuration parameter for die safety function SSM

Parameterization

- **Upper speed limit:**
  The upper speed level when the SSM status shall be set. This value is checked with positive direction of rotation (forward)

- **Lower speed limit:**
  The lower speed level when the SSM status shall be set. This value is checked with negative direction of rotation (reverse)
- **Hysteresis:**
  The SSM status is reset on exceeding the hysteresis + speed level. The SSM status is set again if the speed limit – hysteresis is fallen below.
- **Monitoring always active:**
  The speed level can be monitored even without the configuration of an input for the function SSM.

12.7.3 Response time function activation SSM function

Maximum switch on delay time: < 4ms

Maximum switch off delay time: < 4ms

Additionally to the response time function activation, the following reaction times must be considered for the function:

Response time type	$tr_{(A)}$ Function	$tr_{(B)}$ Input filter	$tr_{(C)}$ Speed determination	$tr_{(D)}$ Output filter	$tr_{(E)}$ Relay	$tr_{(F)}$ Tolerance time
SSM via dig. output	YES	YES	YES	YES	NO	NO
SSM via relay	YES	YES	YES	YES	YES	NO

(≡▶ Reaction times [▶ 50])

12.8 Functional description safe maximum speed (SMS)

The SMS safety function ensures that the drive does not exceed a maximum speed.

Errors are faded out via a further parameter, which defines a max. tolerable time for short-term deviations of the tolerance window.

An adjustable error function is triggered in error case.

The function SMS is executed as index function. Up to eight different limits can be configured and selected via an index selection.

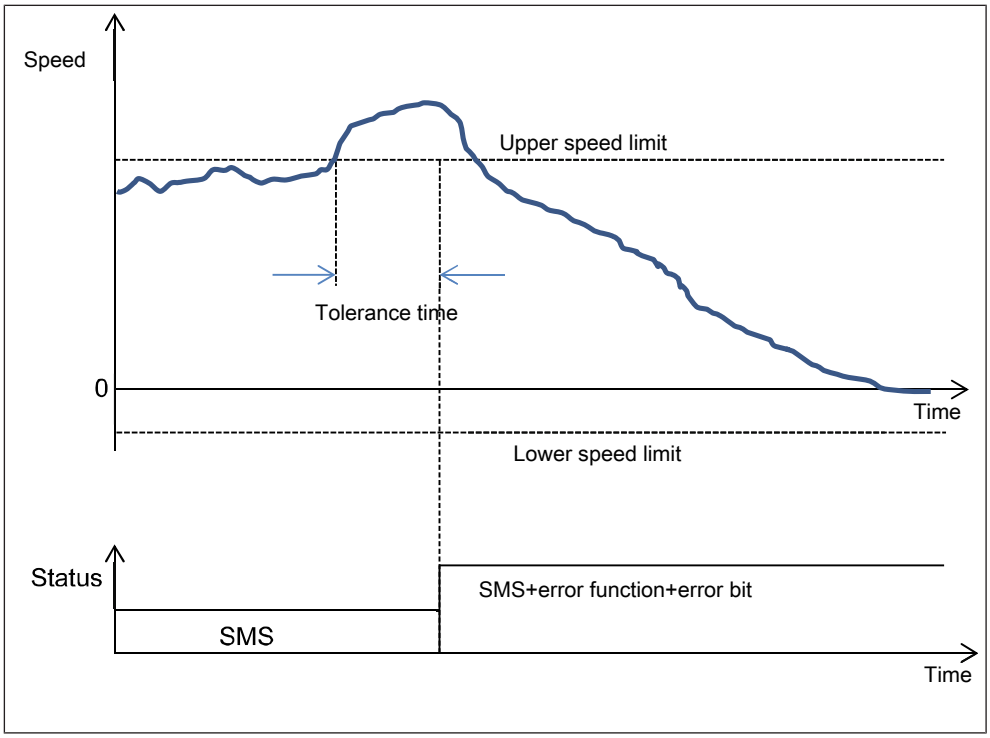


Fig. 43: Safe maximum speed (SMS)

12.8.1 Activation of the safety function SMS

SMS is always activated. If the speed limits are set that they correspond to the maximum permissible speed of the safety module, SMS is effectively switched off. The SMS status is displayed in parameter SMS status in status bit 16.

12.8.2 Configuration parameter of the safety function SMS

Parameter	Value	
SMS: Safe maximum speed [1]		
Upper speed limit	120000.0000	1/min
Lower speed limit	-120000.0000	1/min
Tolerance time	0.000000	s
Error function	STO	

Fig. 44: Configuration parameter for the safety function SMS

Parameterization

- **Upper speed limit:**
  Maximum permissible speed for the positive direction of rotation.
- **Lower speed limit:**
  Maximum permissible speed for the negative direction of rotation.
- **Tolerance time:**
  This is the time within the maximum or minimum speed shall be exceeded. The counter is incremented when the speed is outside the speed limit. The counter is decremented when the speed is back within the speed limit.

- **Error function:**
  When exceeding the adjusted maximum speed by the tolerance time, this error function is executed. STO or SS1.

12.8.3 Response time function activation SMS function

Maximum switch off delay time: < 4ms

Additionally to the response time function activation, the following reaction times must be considered for the function:

Response time type	$tr_{(A)}$ Function	$tr_{(B)}$ Input filter	$tr_{(C)}$ Speed determination	$tr_{(D)}$ Output filter	$tr_{(E)}$ Relay	$tr_{(F)}$ Tolerance time
SMS	YES	NO	YES	NO*	NO*	YES

*Not to be considered for the SSM function. However, SSM1 can be configured as switching condition. The delay time must be observed by the function defined for the output.

(≡► Reaction times [▸ 50])

12.9 Function description safe limited acceleration (SLA)

The SLA safety function ensures that the drive does not exceed a maximum speed. This applies both to the positive and the negative direction of rotation.

An adjustable malfunction is executed in error case.

The function SLA is executed as index function. Up to eight different limits can be configured and selected via an index selection.

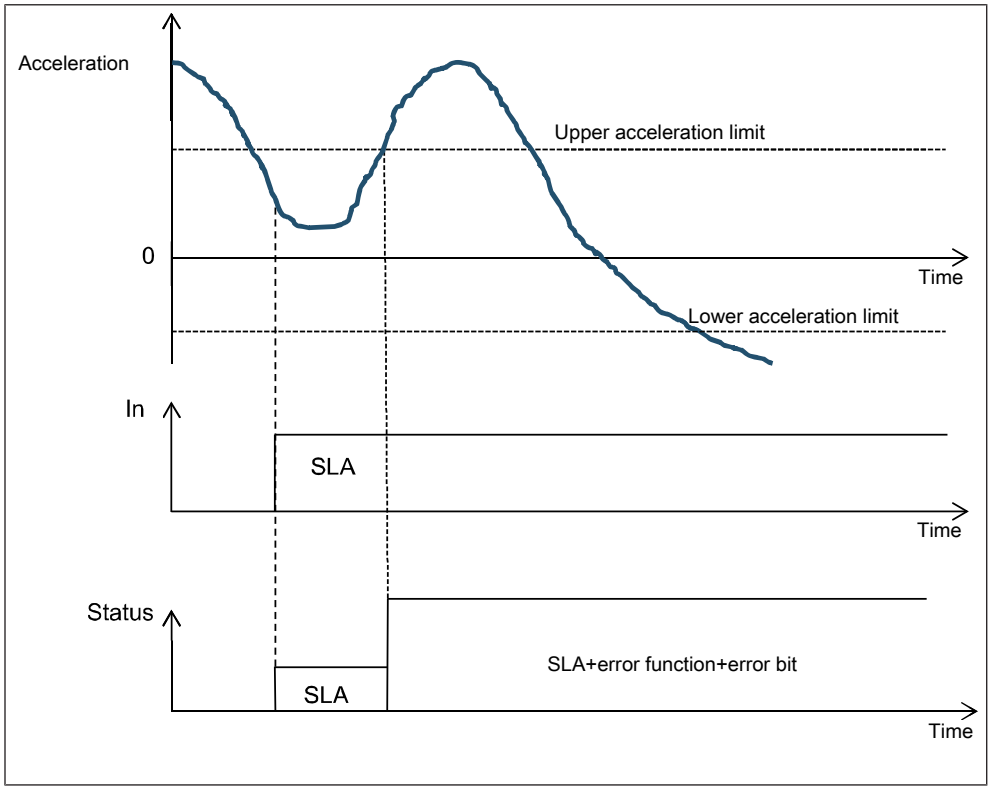


Fig. 45: Safe maximum acceleration (Safe maximum acceleration - SLA)

The acceleration is calculated on the basis of the determined speed or the speed difference to the last scanning step. The following formula is checked:

Acceleration limit	$* \frac{250\ \mu s}{10^6 \frac{\mu s}{s}} * 60s > v_t - v_{t-1}$
= Acceleration limit	$* 0,015\ s^2 > v_t - v_{t-1}$

The difference "v_t - v_{t-1}" is formed by the safety module in a 250us grid and checked against the regulation.

Example:

With an upper speed limit of 2000 1/s², the differential speed per calculation step size shall not exceed 30 rpm.

In order to use the SLA function, increased filter times may be necessary to determine the speed. Lower filter times are to be expected in the open-loop "v/f mode".

The filter times for speed measurement affect the response times and resolutions of all speed-based safety functions.

12.9.1 Activation of the safety function SLA

The circuit operates on two channels. The safety function of the control of the COMBIVERT can only be left, if both hardware inputs are voltage supplied or if a corresponding status change has been received via a safe bus system. The SLA status is displayed in status bit 9.

12.9.2 Configuration parameter of the safety function SLA

Parameter	Value	Unit
SLA: Safely-limited acceleration [1]		
Upper acceleration limit	0.000000	1/s²
Lower acceleration limit	0.000000	1/s²
Error function	STO	

Fig. 46: Configuration parameter for the safety function SLA

Parameterization

- **Upper acceleration limit:**
  The maximum permitted acceleration when accelerating the drive in both directions.
- **Lower acceleration limit:**
  The minimum permitted acceleration when decelerating the drive in both directions.

- **Error function:**
  This error function is carried out if the upper acceleration limit is exceeded, or if the lower acceleration limit is fallen below. STO or SS1.

12.9.3 Response time function activation SLA function

Maximum switch on delay time: < 4ms

Maximum switch off delay time: < 4ms

Additionally to the response time function activation, the following reaction times must be considered for the function:

Response time type	$tr_{(A)}$ Function	$tr_{(B)}$ Input filter	$tr_{(C)}$ Speed determination	$tr_{(D)}$ Output filter	$tr_{(E)}$ Relay	$tr_{(F)}$ Tolerance time
SLA	YES	YES	YES	NO*	NO*	NO

*Not to be considered for the SLA function. However, SLA can be configured as switching condition. The delay time must be observed by the function defined for the output.

(≡► Reaction times [► 50])

12.9.4 Diagnosis of the SLA function

The log can be evaluated in order to recognize which acceleration has been detected by the safety module.

Position	Speed	Time slots per 62.5 µs	Details
261856	253.5122 1/min	13647	66179: STO + Brake closed + Fail safe + SLA + SMS
-2147483648	252.7471 1/min	13643	513: STO + Brake open + SLA + SMS

Fig. 47: Figure : Log entries for the SLA safety function

As soon as acceleration above the set limits is detected, 2 log entries are generated. The top log entry of the example shows the triggering of SLA with the Fail Safe Bit and the lower log entry shows the status of the module in the previous calculation step (250us before the limit violation of the SLA function was detected).

The acceleration can be calculated from the data as follows

$$\text{Acceleration} = \frac{v_t - v_{t-1}}{60\ s * \frac{250\ \mu s}{10^6 \frac{\mu s}{s}}} = \frac{v_t - v_{t-1}}{0,015\ s^2}$$

In this example that means:

$$\text{Acceleration} = \frac{v_t - v_{t-1}}{0,015\ s^2}$$

$$= \frac{253{,}5122\ \text{rpm} - 252{,}7471\ \text{rpm}}{0,015\ s^2} = \frac{0,7651}{0,015\ s^2} = 51,0067\ \frac{1}{s^2}$$

The set upper acceleration limit in this example was 50 1/s² and the function has triggered.

The position at the time v_{t-1} is not recorded. Therefore it is always displayed with the final value range of -2147483648.

12.10 Brake test

The functionality of an open brake must be checked cyclically. This test is provided with the functions described in this chapter.

The brake outputs (plus/minus) at the safety module are always checked for their deactivation capability if the brake output is controlled. The channels are checked individually and cross circuits and external power supplies are detected. If required, feedback signals can also be used to check whether the brake is switched off, this extends the diagnosis to the circuit section connected to the brake outputs, including the wiring and the switch device.

NOTICE

Unintended engage of the brake!

If the feedback signals are included in the test, the brake will engage during a test.

a) Take the brake test into account in your application.

b) The brake test must be carried out at a time suitable for the respective application.

c) Select a suitable interval for the brake test.

d) If possible, use the option of testing the brake in the application cycle (already existing cyclic interruptions of the operation wherein the brake can be tested.

It is also possible to set the time of the brake test manually via appropriate configured input channels and the safety module has to monitor the time frame defined for this. It is also possible to define a time after which the module issues a warning that the brake test has become due and thus the brake test is controlled by a higher-level control.

Wiring and parameterization examples for the different options can be found in chapter (≡► Wiring examples brake output [▷ 111]).

Further information (≡► Brake output Eco Mode [▷ 57]) and (≡► Functional description safe brake control (SBC) [▷ 66])

see also

Reaction times [▷ 50]

12.10.1 Function description brake output test 1 plus/minus (BR1P/BR1M)

The test interval, the test length and the type of execution (automatic / manual) must be parameterized. In manual mode, different reactions can be selected and the test can be controlled via an external signal, independent of the control signal. If the feedback shall be included in the diagnosis, a feedback function must be assigned to the tests.

If the maximum test length is configured to zero, the feedback function is not checked. In this case, depending on the brake, the test can be carried out so quickly that the brake does not engage during the test. The test is immediately

completed in this operating mode when the safety module has detected the internal voltage threshold for switching off the signal. A diagnosis of a downstream circuit is not possible with this test mode.

If a test length other than zero is set, the respective control signal for the set time is switched off and a status change triggered by this is expected at the configured feedback function. A detected status change at the selected readback function ends the test.

If the tests are requested at the same time in both control paths, first the BR1P test and then the BR1M test is executed. If the BR1M test has been requested and the BR1P test is also requested during execution, the BR1M test is terminated first.

The two status bits BR1P and BR1N display the test status of the two brake output channels. The bits are set when the test is started (in automatic mode) or recognized as due (manual mode) and reset when a successful test has been performed.

If the brake test fails, the safety functions STO and SBC are executed and the drive is brought into the safe state.

12.10.1.1 Configuration parameters of the diagnosis function BR1P

The diagnosis function is described here as an example, using the parameters for the brake channel BR1Plus. The descriptions also apply analog for the other channel BR1Minus.

BR1P: Brake 1 output plus test		
Test execution mode	Automatic brake output tes	
Reaction after the test interval has expired (manual mod	No reaction	
Feedback channel	No feedback channel sele	
Test interval length	30	min
Maximum testlength	0	ms

Fig. 48: Configuration parameters for the diagnosis function BR1Plus / BR1Minus

Parameterisation

- **Test execution mode:**
  The test can be done automatically or manually.
  In automatic mode, the brake test is carried out after the test interval.
  If no test is carried out within the test interval in manual mode, the programmed response is executed.
- **Reaction after the test interval (manual mode):**
  If the test interval has expired and the mode is manual, the parameterized reaction is executed.
  The following reactions are available:
  - **No reaction:**
    After the test interval has expired, the status bits 'BR1P and BR1N are set to signal that the brake test is pending. There is no further reaction.
  - **Test of the brake output:**
    After the test interval, the brake test is carried out immediately and automatically and the brake output is switched off. There must be a reaction at the configured readback channel. A connected brake may engage during the test.

  - **STO Safe torque off and error safety function (fail safe):**
    After the test interval has expired, the safety function STO is executed (≡► Functional description Safe Torque off (STO) [▶ 64])and the drive is brought into the safe state.

- **Feedback channel:**
  The following feedback channels are available:
  - **No feedback channel selected:**
    Without a feedback channel, the BCF1 / BCF 2 function cannot be carried out properly. Only possible with 'maximum test length'= 0 ms.
  - **Brake feedback 1 (BCF1):**
    The parameterisation of brake feedback input 1 is described in chapter (≡► Functional description brake feedback input 1/2 [▶ 54]) .
  - **Brake feedback 2 (BCF2):**
    The parameterisation of brake feedback input 2 is described in chapter (≡► Functional description brake feedback input 1/2 [▶ 54]) .

Test interval length:
Defines the time between two tests. If a test is carried out (manually or automatically) or the brake is closed, the test interval is restarted. The reaction after the interval expires is determined separately.

- **Maximum test length:**
  Maximum length of the test.
  - If this value is configured to 0, the drop-out of the brake control signal is only checked internally and leads to a safe state in error case. With this setting, the test can be performed depending on the used brake without engaging the brake.
  - If a test length longer than 0 is set, a feedback channel must also be selected, otherwise the configuration will be rejected. A brake output test successfully acknowledged by the feedback signal ends the test. After this time without status change at the feedback signal, the module changes into the safe state.

12.10.2 Function description brake feedback test 1/2 (BCF1/BCF2)

A diagnosis function is implemented for checking the brake feedback, the status changes at the feedback input can be checked with it. The feedback function generates an internal signal which is used by the brake test functions BR1P and BR1M depending on the setting. Hardware inputs (brake feedback inputs on the control card (≡► Functional description brake feedback input 1/2 [▶ 54]) or safe inputs of the safetymodule (≡► Hardware input configuration (function 1-3) [▶ 52]) or a signal supplied via the safe bus system are possible as inputs. The selected input supplies then the internal status signal, depending on the selected logic.

A permissible delay time can be set for the evaluation of the feedback signal.

An adjustable error function is executed in error case.

12.10.2.1 Configuration parameters of the diagnosis function BCF1/BCF2

BCF1: Brake Check Feedback 1		
Maximum active period of this function without test	525600	min
Maximum delay time (brake test start to successful chec	0	ms
Reaction after "Maximum delay time" has elapsed	0	

Fig. 49: Configuration parameters for the diagnosis function BCF1/2

Parameterisation

- **Maximum active period of this function without test:**
  If the feedback function remains active for longer than this period (i.e. the brake is open), the additional function FB1 Warning / FB2 Warning is executed (≡► Functional description feedback warning 1/2 (FB1W/FB2W) [▶ 85]). This signal can be used by the control to adapt or prepare a suitable state for carrying out the brake test.
- **Maximum delay time (brake test start until successful feedback test:**
  Time between status change of the brake output and status change of the feedback line.
- **Reaction after the "maximum delay time":**
  If the test has not been carried out successfully, the error reaction set here is executed. The following values can be combined as desired and set as an error response.
  Example: STO and FailSafe shall be triggered. If both functions shall be activated, then value 1 must be added for STO and value 16 for "Error safety function". The error reaction value is therefore 17.
  The following reactions are possible:
  - No reaction
  - STO
  - SBC
  - SS1
  - SDLC
  - „Error safety function“

Value	Plaintext	Error response
0	No function	No safety function is triggered.
1	STO	After the maximum time has expired, the safety function STO is executed (≡► Functional description Safe Torque off (STO) [▶ 64]).
2	SBC	After the maximum time has expired, the safety function SBC is executed (≡► Functional description safe brake control (SBC) [▶ 66]).
4	SS1	After the maximum time has expired, the safety function SS1 is executed (≡► Functional description safe stop 1 (SS1) [▶ 68]).
8	SDLC	After the maximum time has expired, the safety function SDLC is executed (≡► Functional description Safe Door-Lock Control (SDLC) [▶ 86]).
16	Error safety function	After the maximum time has expired, the safety function "Error safety function" is executed.

12.10.3 Functional description feedback warning 1/2 (FB1W/FB2W)

The feedback warning function is activated via the adjustable, corresponding feedback function in a time-dependent parameterizable manner. While the function is active, an adjustable reaction is triggered which can be used to recognize the upcoming expiration of the configured brake test interval (early) and to initiate a test or a switching cycle. After the set delay time has expired, a parameterized error reaction is executed.

The status is displayed in status bit 12 or 13.

12.10.3.1 Configuration parameter of the safety function FB1W/FB2W

FB1W: Feedback 1 Warning		
Reaction when this diagnosis function is activated	No reaction	
Delay time from function activation until the error reactio	0	min
Error reaction after delay time has elapsed	No reaction	

Fig. 50: Parameter FB1W/FB2W

Parameterization

- **Reaction when this diagnosis function is activated:**
  - No reaction (only FB1W status or FB2W status is set)
  - Warning in error state
  - Warning in error state and STO
  - Error safety function (fail safe)
- **Delay time from function activation until the error reaction:**
  Up to 525600 minutes can be adjusted for the delay from function activation to error reaction.
- **Error reaction after the delay time has expired:**
  - No reaction
  - STO
  - SS1
  - STO & Error safety function (fail safe)
  - Error in error state

12.11 Functional description Safe Door-Lock Control (SDLC)

The SDLC safety function monitors the controlled deceleration and braking of the drive. After successfully detected standstill, the door lock is released.

The SDLC safety function sequence is divided into two monitoring phases.

Phase 1 - delay phase

Phase 2 – DC braking phase

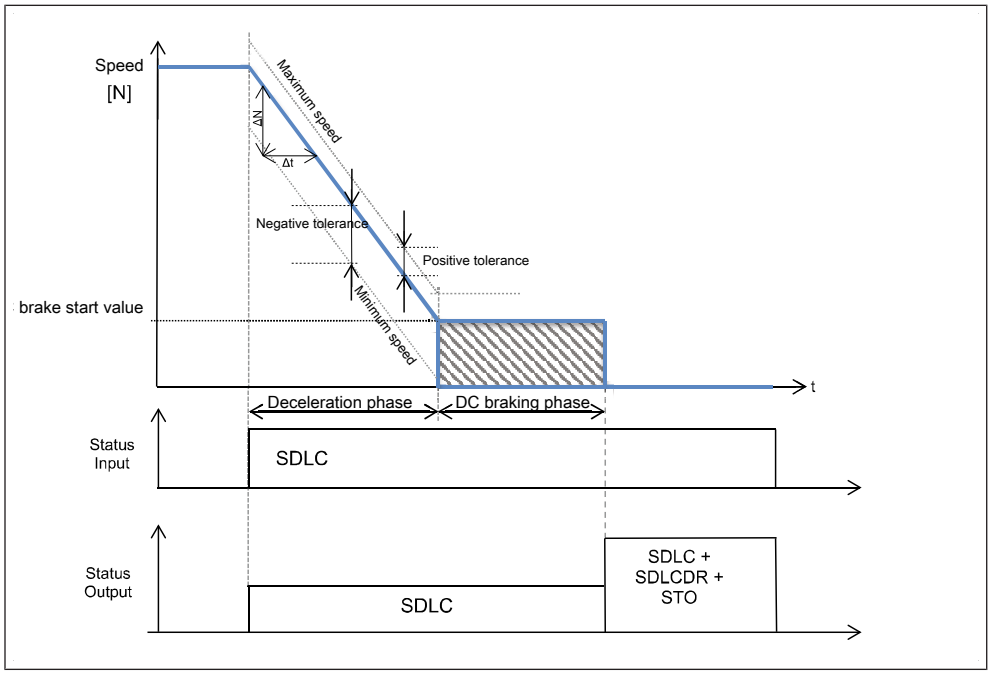


Fig. 51: Safe Door-Lock Control (Safe Door-Lock Control - SDLC)

First of all the speed delay is monitored. If the drive speed falls below the DC braking start value, the system changes into the DC braking phase. In the DC braking phase, the DC current is monitored for a minimum value to be maintained and the motor position may only deviate by the configured position difference.

If both phases are passed through without errors, SDLCDR and STO are set. The circuit operates on two channels. The safety function of the control of the COMBIVERT can only be left, if both hardware inputs are voltage supplied.

If the upper tolerance limit is exceeded or the lower tolerance limit is not reached during the deceleration phase, error bits (Fail Safe) and STO are set.

If the speed exceeds the value "DC braking start value + positive tolerance" during the DC braking phase, error bits (Fail Safe) and STO are set.

The output can be reset via input FSA (Fail Safe Acknowledge).

The period of the DC braking phase is restarted when

- the configured DC current mean value is fallen below.
- the permitted position deviation is exceeded.

If the period passes without errors, SDLC, SDLCDR and STO are set.

The SDLC function is executed as index function. Up to eight different setting groups can be configured and selected via an index selection.

If the DC braking phase is not successfully completed, the safe standstill time becomes active. If the modulation of the drive is switched off, the safe standstill time expires, after expiration the door is unlocked.

12.11.1 Activation of the safety function SDLC

The circuit operates on two channels. The safety function of the control of the COMBIVERT can only be left, if both hardware inputs are voltage supplied or if a corresponding status change has been received via a safe bus system. The SDLC status is displayed in status bit 6. The state SDLC Door release is displayed in status bit 7.

12.11.2 Restart protection after SDLC

After the request for the SDLC function is deactivated, the drive also leaves the STO state. Resetting the emergency stop must not lead to an uncontrolled start of the drive (EN 60204).

⚠ WARNING

Restart only after confirmation!

The drive restarts when the STO function is no longer requested as a result of the SDLC function.

a) In order to comply with the EN 60204-1 standard, it must be ensured by taking external measures that the drive does not start without prior manual confirmation.

b) For example, the CiA state machine can be evaluated edge-controlled.

c) Alternatively, the STO state can be maintained externally, e.g. via terminal using a safety relay combination or via the safety-oriented bus system.

see also

Functional description encoderless speed measurement [▶ 58]

12.11.3 Configuration parameters of the safety function SDLC

SDLC: Safe door lock control [1]		
Deceleration	0.000000	1/s²
Positive tolerance during deceleration phase	0.000000	1/min
Negative tolerance during deceleration phase	0.000000	1/min
Drive speed when DC brake starts	0.000000	1/min
DC braking period	1000	ms
Lowest current during DC braking phase in percent of ful	15	%
Allowed angle difference during DC braking phase	180	°
Safe time period until drive standstill	3600000	ms
Activates "safe time period until drive standstill" after saf	on	

Fig. 52: Parameter function SDLC

Parameterization

- **Deceleration:**
  Delay during the deceleration phase.
- **Upper speed deviation of the deceleration phase:**
  This speed limit must not be exceeded during the deceleration phase.
- **Lower speed deviation of the deceleration phase:**
  This speed limit may not be fallen below during the deceleration phase.

NOTICE

Avoid tipping the motor.

a) Do not set the deceleration too long.

- **Activation speed of the DC braking phase:**
  If the determined speed falls below this value, the function changes to the DC braking phase.

- **DC braking time:**
  After the activation speed has fallen below, the check of the set braking period starts. The period set here must correspond to the period configured in the functional part; due to the current rise time and control characteristics, it should be configured longer in the functional part than in the safety-oriented part.
- **Lowest current value of the DC braking phase in percent of the upper range value:**
  The DC current must not fall below this value during the braking phase. Specification in % of the upper range value. If this value is fallen below, the DC braking time timer is restarted.

The upper range value of the current detection can be read in parameter de80 of the drive controller. Depending on the power unit, the upper range value is in the range of factor 2-3 above the maximum current of the power unit. The set final value range must be validated during start-up.

- **Permitted angle difference of the DC braking phase:**
  Maximum allowed angular difference of the motor during DC braking phase. If the angle difference exceeds or falls below the angle difference, the current angle is taken over and the DC braking time timer is restarted.
- **Safe time to standstill:**
  Period in which the drive comes to a standstill under minimum load conditions without active braking and the door can be unlocked. The time measurement is active when there is no modulation of the drive controller. A configuration of the parameter to 0 ms deactivates the function. Under safety aspects, the "Safe time to standstill" must be longer than the DC braking time, otherwise the configuration is rejected.
- **Exclusive "Safe time to standstill" after starting the safety software:**
  If the SDLC safety function is requested when the safety software is restarted, the release signal will be triggered only after "safe time to standstill" has expired. If the option is selected, "Safe time to standstill" must be configured longer than 0 ms, otherwise the configuration is rejected. This function is useful in order to prevent unintentional release of a Door-Lock if a controlled slow-down cannot be performed in the application.

12.11.4 Notes on the monitoring phases

The timing of the individual phases is not monitored. The detected speed is always used to determine the phases.

The DC braking is also recognized as successfully completed if, after a delay up to the „Activation speed of the DC braking phase", it still takes some time until DC braking has been carried out successfully for the configured time.

Accelerations are permitted within the configured deviations of the ramp.

Skipping the DC braking phase: Set the parameter "DC braking time" to 0.

Skipping the deceleration phase: Set the parameter "Activation speed of the DC braking phase" to a value below the actual speed at activation.

Depending on the used motor type, restrictions from the functional part may apply when using DC braking. Please refer to the instructions in the programming manual of the control unit.

13 Safety over EtherCAT® (FSoE)

13.1 General

Safety over EtherCAT is a safety-oriented fieldbus technology based on master-slave architecture. The fieldbus system is set up by means of a configuration tool ("EtherCAT Configurator"). This section describes the configuration of the safety module type 5 using KEB COMBIVIS studio 6 and TwinCAT 3 as examples; the procedure for TwinCAT 2.11 is similar.

The safety module has been successfully tested as Safety over EtherCAT slave by the independent "EtherCAT Technology Group" and bears the marking "Safety over EtherCAT® Conformance tested". The drive controller is "EtherCAT Conformance tested“.

Device description files (EtherCAT Slave Information (ESI)) are required for the operating tools TwinCAT and COMBIVIS studio 6 with CODESYS Safety for the operation as FSoE slave.

13.2 Setting the fieldbus address

The address is specified in two places: In addition to the non-safety-oriented adjustable identification address (adjustable via the tab 'Settings' of the Safety Module Editor) (≡► Identification (safety module address) [▶ 24]) the fieldbus address setting in the safe parameterisation data is required for operating the safe bus. Both addresses must be identical.

The identification address should always be set before downloading safe configuration data, since after the configuration download the address from the safe configuration is compared with the set identification address and the safety module changes into the error state if the addresses do not match. Downloading a configuration with an identical, expected fieldbus address resets the error state.

13.3 Bus settings in the safety module editor in COMBIVIS

Parameter	Value	Unit
Bus general options		
Bus type	FSoE	
Safety address	10	
Safety bus data length	11	

Fig. 53: Safety module address in the configuration

Parameterization

- **Bus type:**
  This is the selection of the safe bus type. The selection parameters are „without bus“ or „FSoE“.
  - Without bus means that no safe bus system is used and the safety module is controlled only via the inputs.
  - „FSoE“ means that the Safety over EtherCAT® bus system is used.
- **Safety module address:**
  The safety module address must agree with the fieldbus address, which is set in the safety module. By default this address is set to the value 0 (invalid).
  - Minimum valid address: 1
  - Maximum valid address: 65535

- **Safe bus data length:**
  If a safe bus system has been selected, the length of the safe data can be adjusted here. This length must agree with the configuration in the safe control. In the case of FSoE, only the following settings are permissible:
  - 6 Byte
  - 7 Byte
  - 11 Byte
  - 15 Byte

13.4 Response time (FSoE watchdog)

In a safety system, the total response time is produced of the following partial response times:

Signal processing in the sensor

Signal processing in the KEB safety module

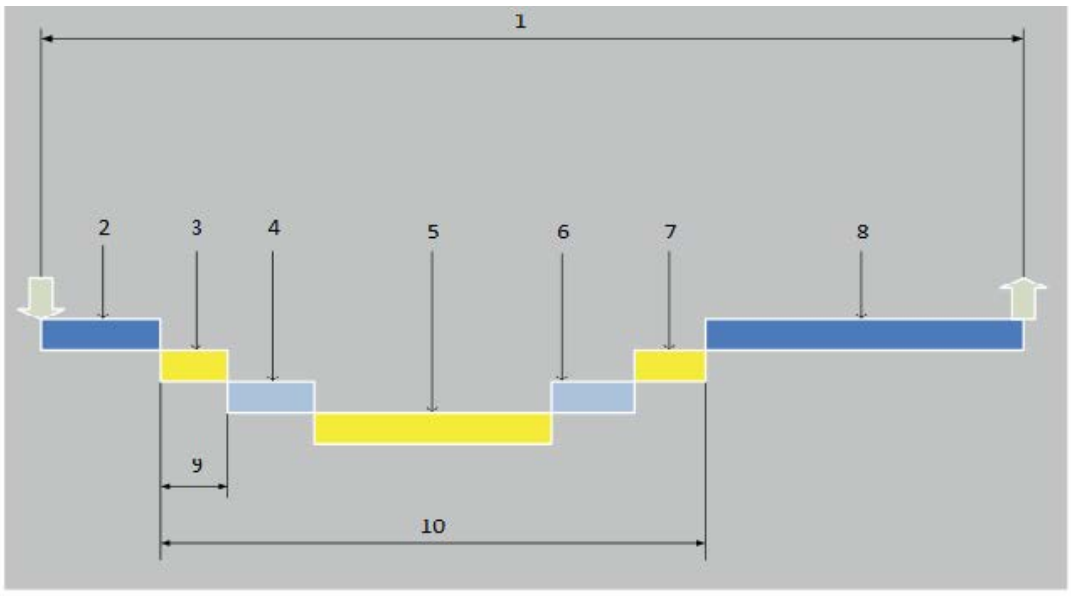
Data run time of the input data on the EtherCAT bus between KEB safety module and safe PLC.

Program run time in the safe PLC

Data run time of the output data on the EtherCAT bus between Safety PLC and KEB safety module.

Signal processing in the KEB safety module.

Signal processing in the actuator



1	total response time	6	transmission of the frame via EtherCAT
2	signal processing by sensor	7	signal processing by safe I/O module
3	signal processing by safe I/O module	8	signal processing by actuator
4	transmission of the frame via EtherCAT	9	safe response time of the module
5	safe PLC program runtime	10	safe response time by system

Fig. 54: Response time safety module version 5

⚠ CAUTION

Observe the run times of the field bus and the cycle time of the Safety PLC for the safe response time!

a) For designing the safe response time, the run times of the field bus and the cycle time of the Safety PLC must be included in the calculation of the safe response time.

The minimum FSoE watchdog time of the safety module is 1ms.

The technically achievable minimum watchdog time is primarily defined by the complete device and is therefore described in the manual of the respective control unit.

13.5 Integration of the safety module type 5 in TwinCAT 3

13.5.1 Installation of the description file for the drive controller

In order that the drive controller can be used with the safety module type 5 in TwinCAT, the EtherCAT® description file must be imported into TwinCAT.

The ESI file is delivered with COMBIVIS. On a computer with installed COMBIVIS you will find the files for TwinCAT at:

„C:\<Installationsverzeichnis>\KEB\COMBIVIS_6\KEB\EtherCAT\“

✓ **Determine installation directory**

a) Right click on the COMBIVIS icon.

b) Click on Properties.

c) The installation directory is displayed in the line "Target"

The following files are required:

KEB_X6_Safety_Type_5.xml

KEB_custommodules.xml

KEB_standardmodules.xml

New or missing description files can be obtained via COMBIVIS or via the KEB homepage.

NOTICE

Device descriptions in TwinCAT 3!

a) After the new file is available in the installation directory above, TwinCAT must be closed completely and opened again. The simple "Reload Device Descriptions" in TwinCAT is not sufficient.

see also

Brake test [▶ 82]

13.6 Adding a KEB drive controller with safety module type 5

Add an EtherCat® master by right-hand click->*Add New Item* under I/O Devices.

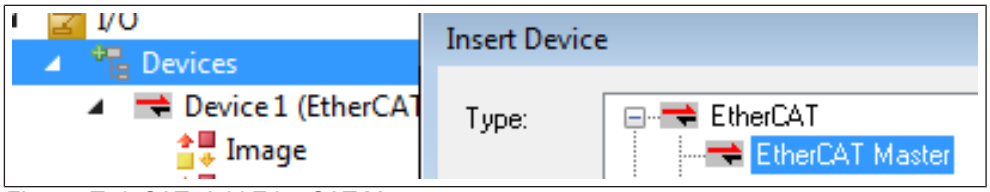


Fig. 55: TwinCAT: Add EtherCAT Master

Right-hand click to perform a scan. If the drive controller is correctly connected and ready for operation, it should be found then.

Fig. 56: TwinCAT: Scan for EtherCAT devices

Alternatively the KEB drive controller can be added with right-hand click on the EtherCAT® Master and „*Add New Item*“.

13.6.1 Selection of a FSoE module configuration

KEB offers several module configurations with different FSoE data assignments. These can be selected individually for the respective application.

Please also chapter (≡► FSoE Modul configuration according to ID [▶ 103]) for the selection of the module description.

Procedure for selecting a module configuration:

Double-click on the drive controller.

Click the "Slots" tab in the new tab.

Select the safety module slot.

A view with the available modules should be displayed now.

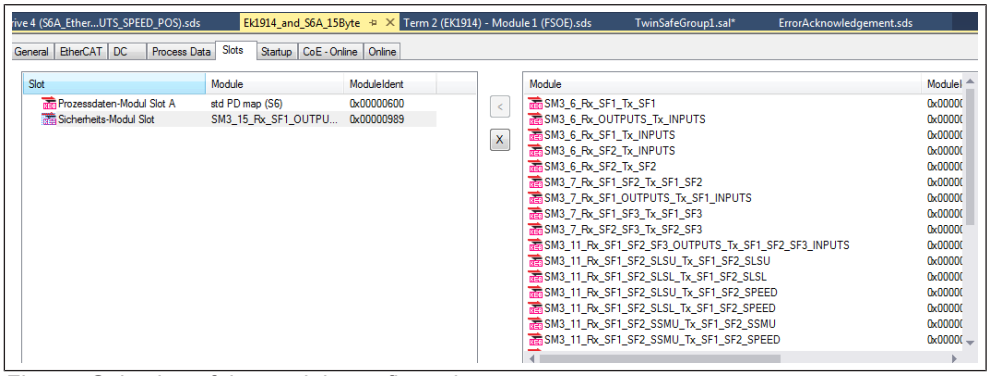


Fig. 57: Selection of the module configuration

Select a module description and accept with the "<" button.

A standard process data description can additionally be mapped in the process data module slot A.

Then the overview in TwinCAT should look similar:

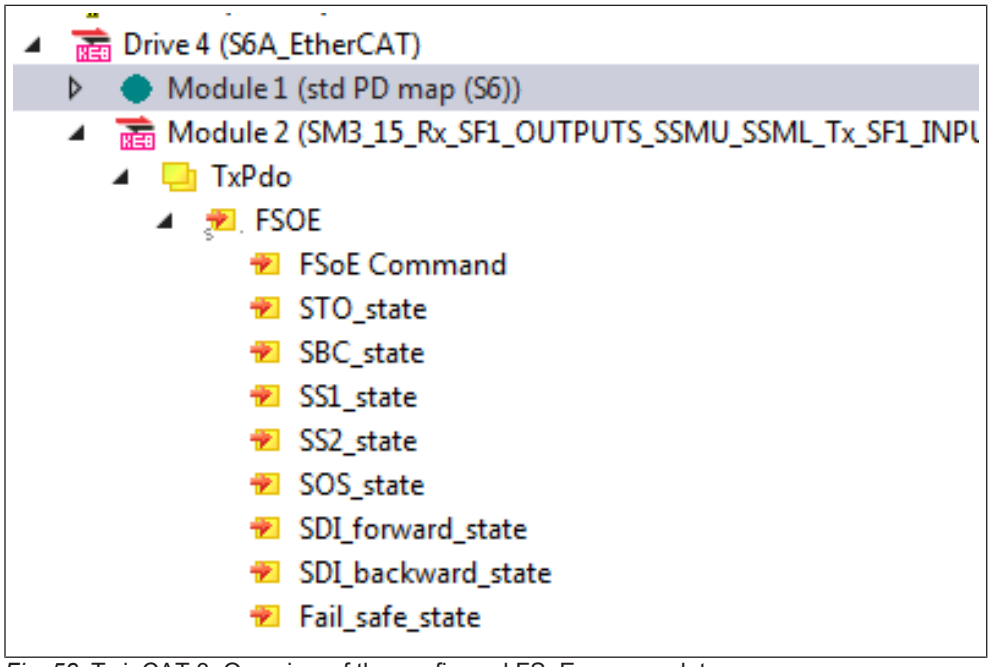


Fig. 58: TwinCAT 3, Overview of the configured FSoE process data

13.6.2 Creating a new safety group

In order that the safety module can be used in the safe control system, a new safety group must be created in TwinCAT.

Procedures:

1. Right-hand click on the "SAFETY" item in the Solution explorer of TwinCAT. Then click on „Add New Item“.
2. Click on „TwinCAT Default Safety Project“ in the following selection dialog.

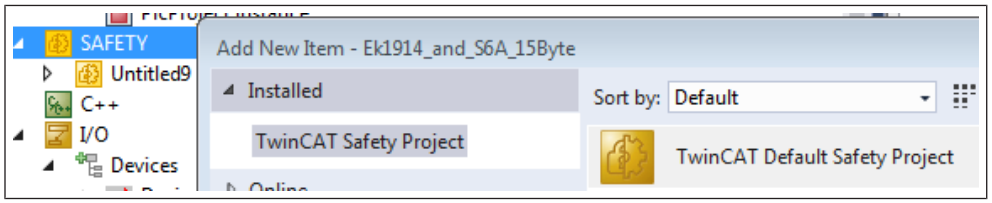
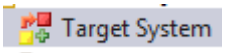


Fig. 59: TwinCAT: Add default safety project

1. Fill in the information in the following menu according to your own specifications.
2. Now a new safety group should be available.
3. Next click on the menu item "Target System".



4. Select the Physical Device:

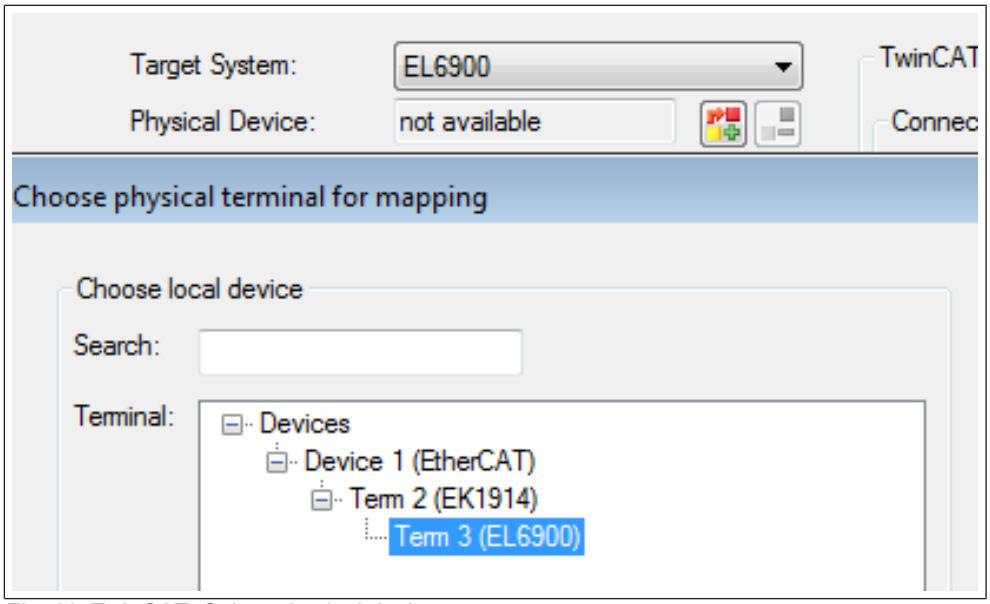


Fig. 60: TwinCAT: Select physical device

1. Then right-hand click on Alias Devices and select the menu item "Import Alias Devices".

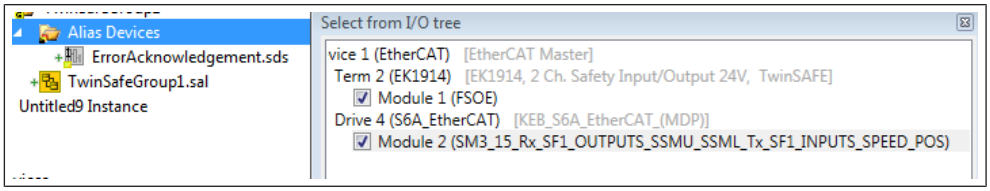


Fig. 61: TwinCAT: Import alias devices

Then select the Alias Devices to be imported and click OK.

The KEB drive controller with the safety module should now be displayed under alias devices.

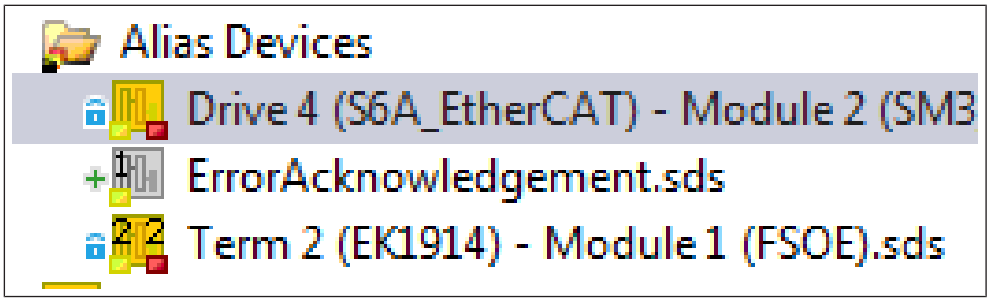


Fig. 62: TwinCAT: Alias devices in the Twinsafe group

With a double click on the drive controller, the linking overview page is displayed. The correct FSoE address should already be entered here, but for security reasons it should be checked again.

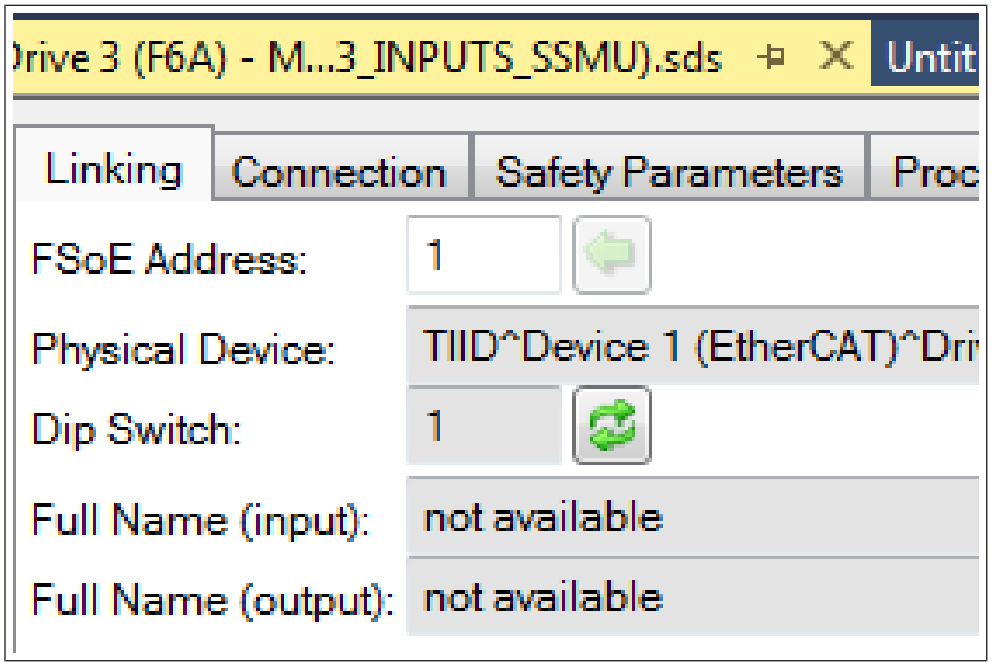


Fig. 63: TwinCAT: Changing the FSoE address

In the "Safety Parameters" tab, the settings must now be made according to chapter (≡► Setting the safe FSoE configuration data [▶ 99]).

13.7 Integration of the safety module type 5 in CODESYS Safety

13.7.1 Installation of the description file for the drive controller

The required description file can be created in COMBIVIS using the process data assistant. When using the KEB COMBIVIS studio 6, the file can be installed directly into the device repository.

13.7.2 Adding a KEB drive controller with safety module type 5

After a PLC has been added, the EtherCAT Master can be added by right-hand click> Add Device (≡► Adding a KEB drive controller with safety module type 5 [▶ 97]).

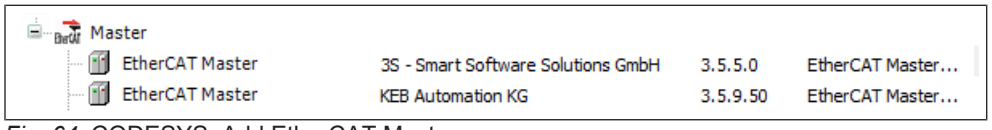


Fig. 64: CODESYS: Add EtherCAT Master

After the EtherCAT Master has been added, the connected drive controllers can be detected with right-hand click and the selection of "Scan for Devices", see (≡► Adding a KEB drive controller with safety module type 5 [▶ 98]).

The scan for devices only works with an ESI file explicitly created for the device revision. Attention, this is not the standard case.

By default, the FSoE module ID is included in the high word of the revision to handle more than one FSoE configuration parallel in the device repository.

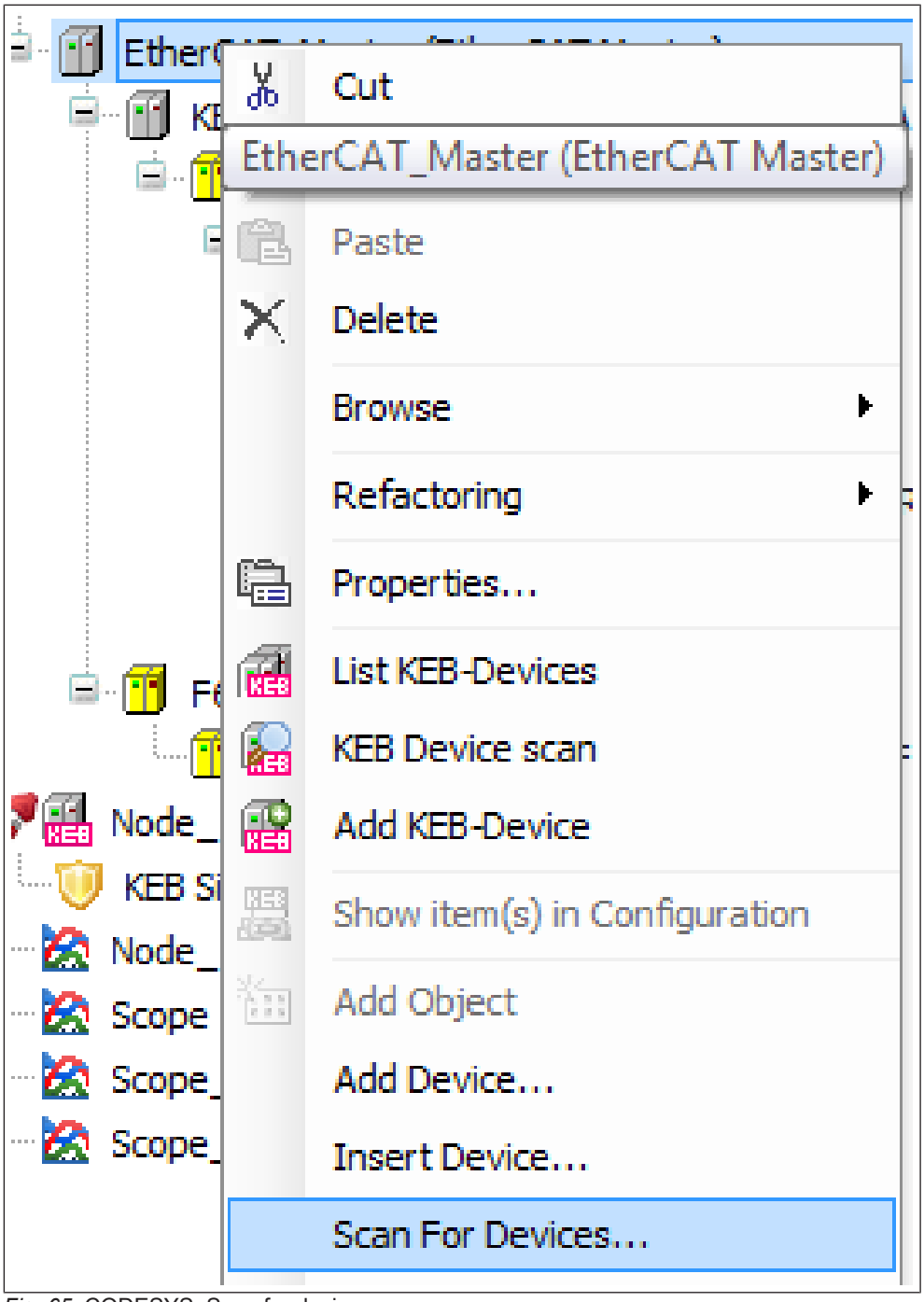


Fig. 65: CODESYS: Scan for devices

Thereby the drive controller with the safety module should be found and added. Furthermore, a connected and ready for operation Safety PLC should also have been detected and added.

The view of the KEB drive controller with the safety module should then look like the figure (≡► Adding a KEB drive controller with safety module type 5 [▶ 99]) .

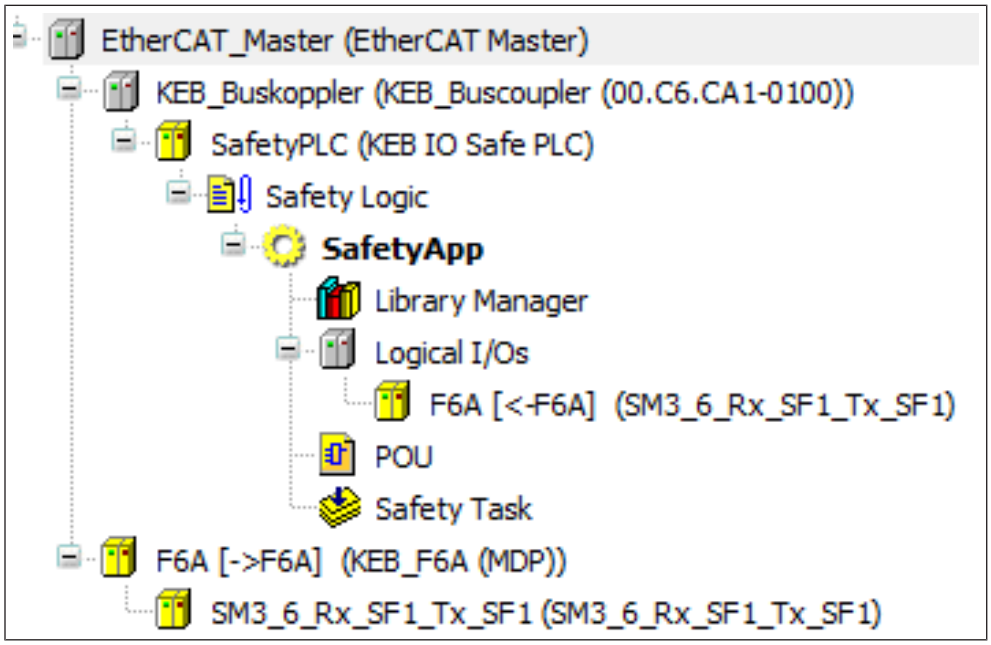


Fig. 66: KEB drive controller with safety module in CODESYS

The safe configuration can be opened by double-click on the drive controller under Logical I/Os. There, the data must be entered according to chapter (≡► Setting the safe FSoE configuration data [▶ 99]) .

13.7.3 Setting the safe FSoE configuration data

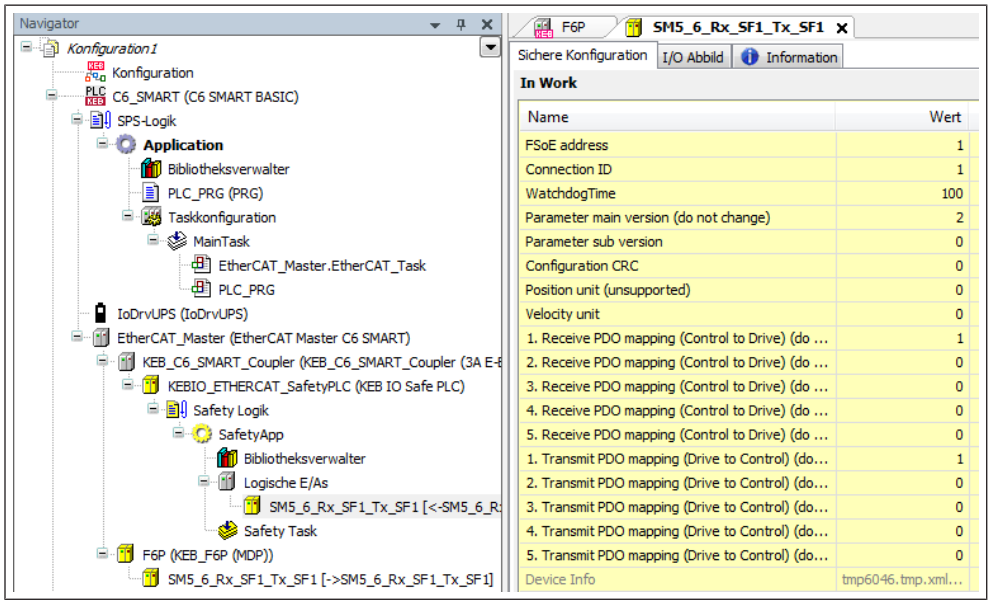


Fig. 67: FSoE Parameters in COMBIVIS (CODESYS safety)

FSoE address:
This is the safety module address set in COMBIVIS.

Connection ID:
This must be a unique address across all safe slaves. (e.g. equal to the FSoE address)

Parameter main version:
This may not be changed.

Parameter sub version:
Here the user can enter an own number for personal purposes (e.g. Configuration version). This sub version can be read out after starting FSoE via CoE from the safety module.

Configuration CRC:
The configuration CRC, which is displayed in the COMBIVIS safety module editor under "Device CRC".

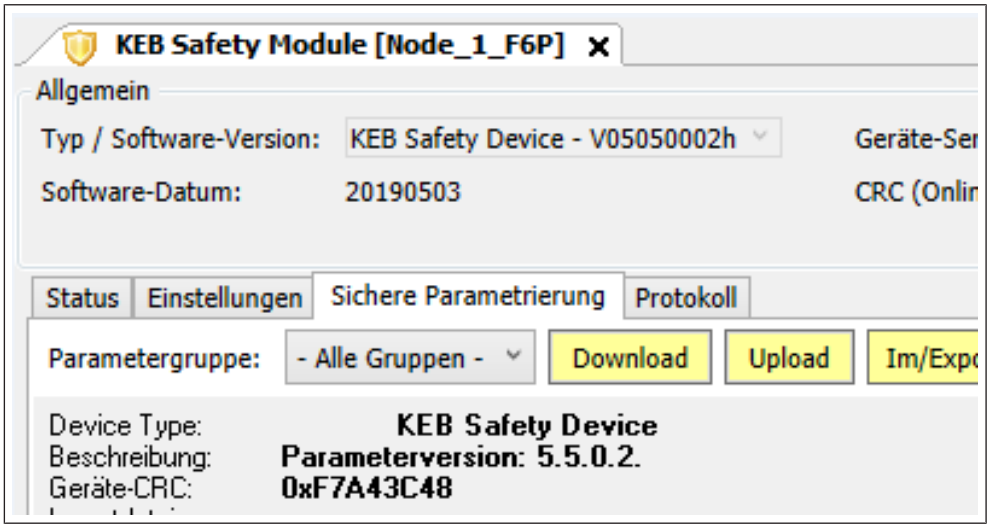


Fig. 68: COMBIVIS Device CRC

Alternatively, the CRC can also be read from the SM group in parameter Safety Device Info.

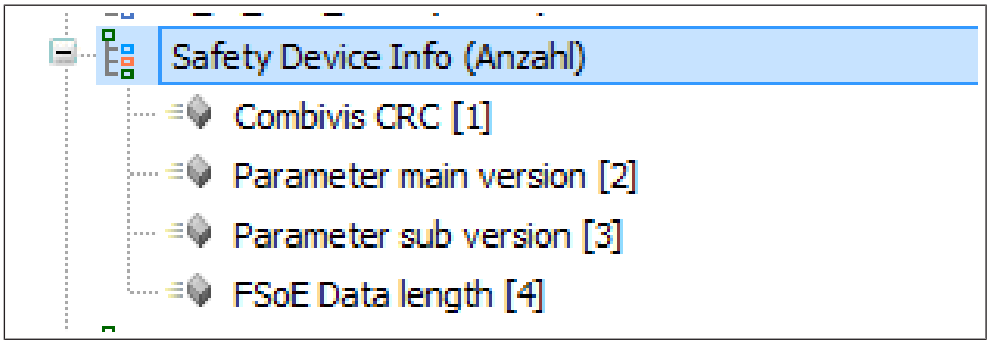


Fig. 69: SM Parameter ‚Safety Device Info' - COMBIVIS CRC

If the CRC does not match when the FSoE communication is started, the boot-up is not carried out by the FSoE slave.

Position Unit:
This parameter is not used for safety module type 5.

Velocity Unit:
The number of bits for the decimal places of the FSoE process data. The default is 0 bit. This means that the scaling amounts full revolutions per minute.

⚠ DANGER

The velocity unit affects the following FSoE data simultaneously:

Speed
SLS upper and lower limit
SSM upper and lower limit

a) If the velocity unit is changed, the mentioned FSoE data must be checked and verified again.

Other settings:
Other settings (if displayed) must not be changed.

13.8 FSoE state machine and check state with COMBIVIS

13.8.1 FSoE Status machine

The illustration shows the (≡► FSoE Status machine [▸ 101])which is implemented in the safety module type 5.

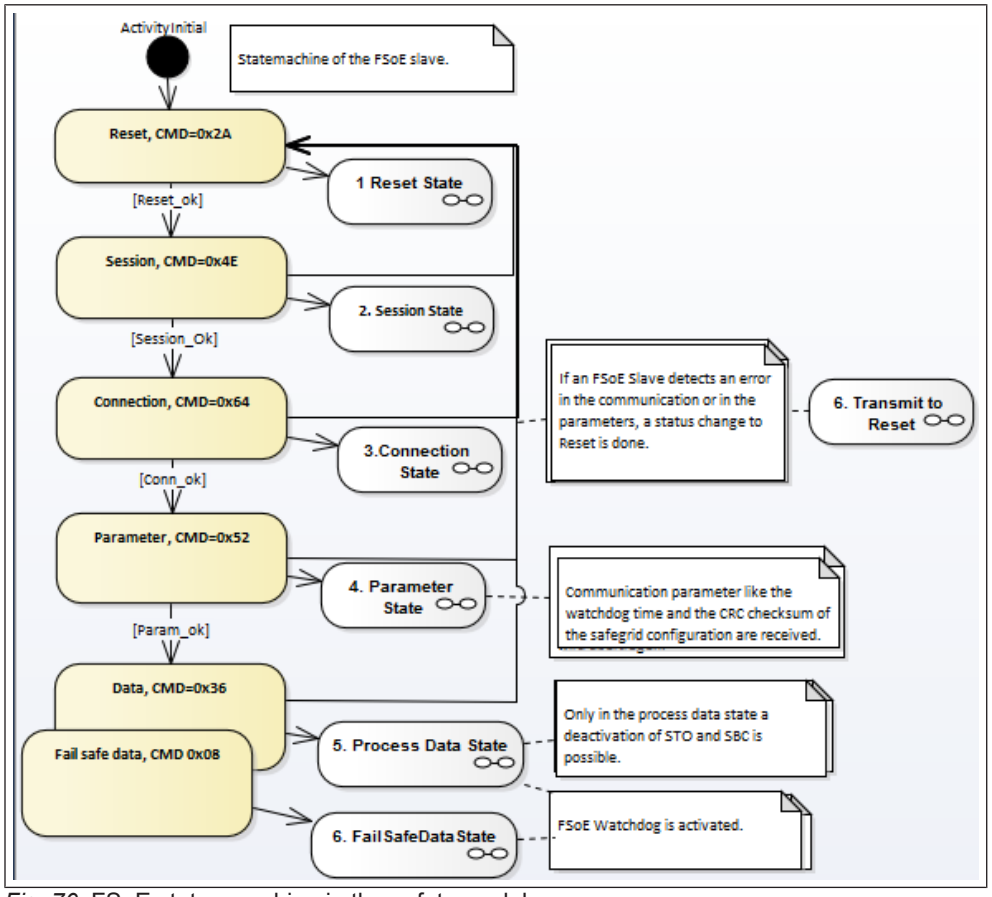


Fig. 70: FSoE status machine in the safety module

The data state and fail safe data state can only be achieved if the bus type FSoE is selected in the safety module configuration. Additionally, there must be no error in the safety module. This is checkable with the safety module status page COMBIVIS safety module editor. Parameter „error state“ should not display an error.

13.8.2 Checking the FSoE state

The FsoE state can be seen in COMBIVIS in the safety module on the status page. Also bus errors, detected by the slave can be seen there.

13.8.3 Bus configuration error

There is a separate category for bus configuration errors on the tab protocol in COMBIVIS.

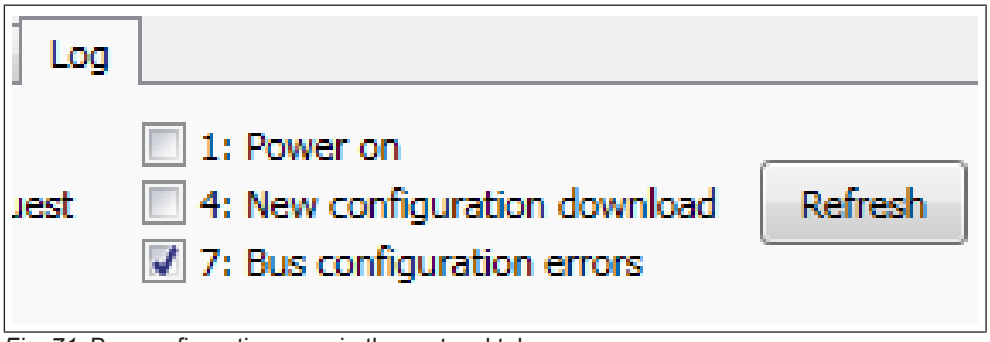


Fig. 71: Bus configuration error in the protocol tab

13.8.4 Bus error

If errors are identified during FSoE operation, these errors will be logged and they can be read out with COMBIVIS in the tab bus errors.

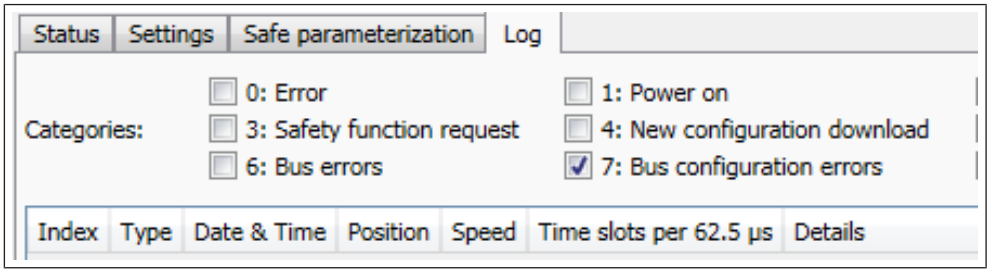


Fig. 72: Bus error Log in COMBIVIS

13.9 FSoE process data

If a module configuration is selected, the following must be observed:

1. If there is no SF1 (Safety Functions 1st Byte) in the module configuration, then a safety input with the safety function STO must be configured. Otherwise the safety function STO can not be left.
2. As long as the FSoE communication is not started, the safety module remains in STO status (Safe torque off). Furthermore, the safety function SBC (Safe brake control) is activated. This is independent of whether an STO or SBC input has been configured.
3. If the configuration "monitoring always active" has been selected at SSM, this monitoring is always active, even if the FSoE communication has not started yet. This is important if the configured speed limits are set to 0. In this case, the SSM status can alternate.

13.9.1 Transmitted process data (Safe master to the safety module)

NOTICE

Transmitted process data (Safe master to the safety module).

a) Safe input data at the safety module always have the extention "_in".

b) The safety functions are 0 active. This means that the safety function is activated when the respective bit has the status 0.

c) If not all functions are used in the application, e.g. only SBC should be activated, then all unused safety functions must be set to status 1.

d) Parallel to the FSoE process data, the inputs of the safety module can also be configured with safety functions. The FSoE inputs and the digital inputs are then AND linked: To leave the respective safety function, the digital input and the corresponding bit must be set in the FSoE data.

e) If a safety function is requested via the FSoE process data or via the inputs, then this safety function is carried out.

f) The hardware inputs are 1 active (≡► Input State [▸ 106]).

13.9.2 Received process data (safety module to the safe master)

NOTICE

Received process data (safety module to the safe master).

a) Safe output data at the safety module always have the extention „_state“.

b) The status of the safety functions is 1 active. This means, if the safety function is carried out, the respective bit has the status 1.

c) The status of the outputs is 1 active (≡► Output state [▸ 105]).

13.9.3 FSoE Modul configuration according to ID

ID	Pd In Mapping					Pd Out Mapping				
	1. In	2. In	3. In	4. In	5. In	1. Out	2. Out	3. Out	4. Out	5. Out
6 Byte										
#x9A0	SF1	-	-	-	-	SF1	-	-	-	-
#x9A1	OUTPUT	-	-	-	-	INPUT	-	-	-	-
#x9A2	SF1	-	-	-	-	INPUT	-	-	-	-
#x9A3	SF2	-	-	-	-	INPUT	-	-	-	-
#x9A4	SF2	-	-	-	-	SF2	-	-	-	-
7 Byte										
#x9A5	SF1	SF2	-	-	-	SF1	SF2	-	-	-
#x9A6	SF1	OUTPUT	-	-	-	SF1	INPUT	-	-	-
#x9A7	SF1	SF3	-	-	-	SF1	SF3	-	-	-
#x9A8	SF2	SF3	-	-	-	SF2	SF3	-	-	-
11 Byte										
#x9A9	SF1	SF2	SF3	OUTPUT	-	SF1	SF2	SF3	INPUT	-
#x9AA	SF1	SF2	SLSU	-	-	SF1	SF2	SLSU	-	-
#x9AB	SF1	SF2	SLSL	-	-	SF1	SF2	SLSL	-	-
#x9AC	SF1	SF2	SLSU	-	-	SF1	SF2	SPEED	-	-
#x9AD	SF1	SF2	SLSL	-	-	SF1	SF2	SPEED	-	-
#x9AE	SF1	SF2	SSMU	-	-	SF1	SF2	SSMU	-	-
#x9AF	SF1	SF2	SSMU	-	-	SF1	SF2	SPEED	-	-

#x9B0	SF1	SF2	SSML	-	-	SF1	SF2	SSML	-	-
#x9B1	SF1	SF2	SSML	-	-	SF1	SF2	SPEED	-	-
15 Byte										
#x9B2	SF1	SF2	SLSU	SLSL	-	SF1	SF2	SLSU	SLSL	-
#x9B3	SF1	SF2	SF3	OUTPUT	SLSU	SF1	SF2	SF3	INPUT	SPEED
#x9B4	SF1	SF2	SF3	OUTPUT	SLSU	SF1	SF2	SF3	INPUT	SLSU
#x9B5	SF1	SF2	SSMU	SSML	-	SF1	SF2	SSMU	SSML	-
#x9B6	SF1	SF2	OUTPUT	SSMU	-	SF1	SF2	INPUT	SSMU	-

The Ids 0x09A0, 0x09A1, 0x09A2, 0x09A6 are available for operation without configured encoderless mode.

13.9.4 Safety functions

13.9.4.1 SF1 Safety Functions 1st Byte

The following bits are exchanged in this configuration:

Name	Description	Representation	Name
SF1	Safety Functions 1st Byte	Bit 0	STO (Safe Torque off)
		Bit 1	SBC (Safe brake control)
		Bit 2	SS1 (Safe speed 1)
		Bit 3	SLS (Safely-limited speed)
		Bit 4	SSM (Safe speed monitoring)
		Bit 5	SDLC (Safe door lock control)
		Bit 6	SDLC door release (Safe door lock control door release)
		Bit 7	Fail Safe and Acknowledge

Tab. 14: Assignment of the safe process data bytes ‚SF1‘

Bit7 (Fail Safe and Acknowledge) is activated as soon as a violation of a safety function has been detected. The Fail Safe Bit can be reset by setting Fail Safe and Acknowledge to 0 and then back to 1.

If the encoderless mode is switched off, only STO, SBC and SS1-t can be activated in the module configurations "Safety Functions 1st Byte".

- If another safety function is activated, the safety module will enter the FSoE reset state.
- It is necessary to set all other bits of the safety functions to status 1 if the encoderless mode is not configured.
- For SS1, only SS1-t is possible. The selection of the function type when configuring the safety module must be set to "Type t only".

13.9.4.2 SF2 Safety Functions 2nd Byte

The following bits are exchanged in this configuration:

Name	Description	Representation	Name
SF2	Safety Functions 2nd Byte	Bit0	SLA (Safely-limited acceleration)
		Bit1	BCF1 (Brake check feedback 1)
		Bit2	BCF2 (Brake check feedback 2)
		Bit3	FW1 (Feedback warning 1)
		Bit4	FW2 (Feedback warning 2)

		Bit5	BR1+ Test (Brake plus test)
		Bit6	BR1- Test (Brake minus test)
		BIt7	SMS (Safe maximum speed)

Tab. 15: Assignment of the safe process data bytes ‚SF2'

The 'SMS' bit is only present in the data direction to the safety module (output data sent by the safe master) for reasons of compatibility of input and output data. In the output data the bit without function and the safety function SMS are always active.

If the encoderless mode is switched off, SLA and SMS cannot be activated in the module configurations "Safety Functions 2nd Byte".

- If one of the mentioned safety functions is activated, the safety module will go into the FSoE reset state.
- It is therefore necessary to set both bits of the safety functions to status 1 if the encoderless mode is switched off.

13.9.4.3 SF3 Safety Functions 3rd Byte

With this configuration, the following bits are exchanged:

Name	Description	Representation	Name
SF3	Safety Functions 3rd Byte	Bit0	reserved
		Bit1	reserved
		Bit2	reserved
		Bit3	reserved
		Bit4	reserved
		Bit5	Set Bit 0
		Bit6	Set Bit 1
		Bit7	Set Bit 2

Tab. 16: Assignment of the safe process data byte 'SF3'

The index of all safety functions can be switched simultaneously by the 3 index bits (≡▶ Hardware input configuration (function 1-3) [▶ 52]).

13.9.5 Input and output state

The input and output state can also be queried by the safety module if a safety function has been configured for the input or output.

13.9.5.1 Output state

The following bits are exchanged in this configuration:

Output	Output	Bit0	Output 1
		Bit1	Output 2

Tab. 17: Assignment of the safe process data bytes ‚Output'

Hereby the outputs of the safety module can be switched safely in the data direction to the safety module (output data sent by the safe master) respectively the output status of the safety module can be safely detected in the data direction from the safety module (input data sent to the safe master).

NOTICE

Switching outputs!

a) The output can only be switched via FSoE, if it is not configured. If the output is configured, it can not be switched via FSoE.

b) The hardware output outputs 24V when the state of the bit is set to 1.

c) The hardware output is reset when the state of the bit is set to 0.

13.9.5.2 Input State

Input	Input State	Bit0	STO hardware input state
		Bit1	Function 1 hardware input state
		Bit2	Function 2 hardware input state
		Bit3-7	reserved

Tab. 18: Assignment of the safe process data bytes ‚Input State'

Hereby the input state of the safety module can be safe detected.

NOTICE

Hardware input status!

a) The bit for the respective hardware input state is 0 if the input is not supplied.

b) The bit for the respective hardware input state is 1 if the input is supplied with 24V.

c) The filter time of the safety inputs in the configuration of the safety module must be considered. A state change is only carried out after the filter time.

d) The hardware input configuration of the safe inputs of the safe parameterization of COMBIVIS also apply to the FSoE input state. The tolerance time of the inputs and the state of the inputs can be adjusted hereby. If the input is configured to Equivalent, both input channels must have 24V within the tolerance time in order to set the FSoE state of the input to 1.

13.9.6 Dynamic speed limits via FSoE

The upper and lower speed limits of SLS and SSM can be changed via FSoE. The following applies:

⚠ DANGER

Speed limits of SLS and SSM!

a) The upper speed limit should always be higher than the lower speed limit. If this is not the case, there is no acceptable speed and the safety module would always activate the error function and with SLS always set the SSM state in SSM.

b) The upper speed limit must always be higher than 0.

c) The lower speed limit must always be less than 0.

d) If only one limit is set via FSoE, check configuration of COMBIVIS whether the above given condition is fulfilled in every operating case.

e) The hysteresis must also be considered at SSM.

13.9.6.1 SLS (Safely limited speed)

The upper and lower speed limits can be adjusted dynamically via FSoE data.

⚠ DANGER

Speed limits SLS!

a) The SLS bit in SF2 (≡► SF2 Safety Functions 2nd Byte [▶ 104]) must be set to 0 to activate SLS and to activate the transmitted upper and lower speed limits. It is not sufficient if only the limits are written by FSoE.

b) The tolerance time and error function must be configured in the safety module.

c) If a set changeover is used, the error function and the tolerance time must be checked in each set and configured accordingly.

d) The speed limit is a 16 bit value which is dependent on the Velocity Unit parameter (≡► Setting the safe FSoE configuration data [▶ 99]).

13.9.6.1.1 SLSU (Safely-limited speed: upper speed limit)

The upper speed limit for the safety function SLS can be specified herewith.

⚠ DANGER

Speed limits of SLSU!

a) The upper speed limit is continuously transmitted via FSoE if a FSoE configuration with SLSU is selected.

b) The setting for the upper speed limit in the configuration of the safety module therefore has no effects anymore.

c) Also a set changeover has no effects on the upper speed limit.

d) If only FSoE data for the upper speed limit of SLS are exchanged, the lower speed limit is taken from the configuration data.

e) The upper speed limit of FSoE also applies for the case that SLS is activated via an input of the safety module.

13.9.6.1.2 SLSL (Safely-limited speed: lower speed limit)

The lower speed limit for the safety function SLS can be specified herewith.

⚠ DANGER

Speed limits of SLSL!

a) The lower speed limit is continuously transmitted via FSoE if a FSoE configuration with SLSL is selected.

b) The setting for the lower speed limit in the configuration of the safety module therefore has no effects anymore.

c) Also a set changeover has no effects on the lower speed limit.

d) If only FSoE data for the lower speed limit of SLS are exchanged, the upper speed limit is taken from the configuration data.

e) The lower speed limit of FSoE also applies for the case that SLS is activated via an input of the safety module.

13.9.6.2 SSM (safe speed monitoring)

The upper and lower speed limits can be adjusted dynamically via FSoE data.

⚠ DANGER

Speed limits of SSM!

a) The SSM bit in SF1 (≡► SF1 Safety Functions 1st Byte [▸ 104]) must be set to 0 to activate SLS and to activate the transmitted upper and lower speed limits.

b) SSM can also be activated by setting "Monitoring always active" to "on" in the configuration. In this case, any set changeover must be observed.

c) It is therefore not sufficient to write only the limits by FSoE.

d) The hysteresis and "Monitoring always active" must be configured in the safety module.

e) If a set changeover is used, the hysteresis and the monitoring must be checked actively in each set and configured accordingly.

f) The speed limit is a 16 bit value which is dependent on the Velocity Unit parameter (≡► Setting the safe FSoE configuration data [▸ 99]).

13.9.6.2.1 SSMU (Safe speed monitoring: upper speed limit)

The upper speed limit for the safety function SSM can be specified herewith.

⚠ DANGER

Speed limits of SSMU!

a) The upper speed limit is continuously transmitted via FSoE if a FSoE configuration with SSMU is selected.

b) The setting for the upper speed limit in the configuration of the safety module therefore has no effects anymore.

c) Also a set changeover has no effects on the upper speed limit.

d) If only FSoE data for the upper speed limit of SSM are exchanged, the lower speed limit is taken from the configuration data.

e) The upper speed limit of FSoE also applies for the case that SSM is activated via an input of the safety module.

13.9.6.2.2 SSML (Safe speed monitoring: lower speed limit)

The lower speed limit for the safety function SSM can be specified herewith.

⚠ DANGER

Speed limits of SSML!

a) The lower speed limit is continuously transmitted via FSoE if a FSoE configuration with SSML is selected.

b) The setting for the lower speed limit in the configuration of the safety module therefore has no effects anymore.

c) Also a set changeover has no effects on the lower speed limit.

d) If only FSoE data for the lower speed limit of SSM are exchanged, the upper speed limit is taken from the configuration data.

e) The lower speed limit of FSoE also applies for the case that SSM is activated via an input of the safety module.

13.9.7 Speed (Safe speed)

The safe speed as sign-sensitive 16 bit value. The speed is depending on parameter "Velocity Unit" (≡► Setting the safe FSoE configuration data [▸ 99]).

NOTICE

Speed scan time and speed PT1-time!

a) The speed scan time and speed PT1 time in the settings of the Safety Editor of COMBIVIS on the "Safe parameterization" tab for speed measurement must be observed.

⚠ DANGER

Overflow speed value!

a) If the velocity Unit is selected too high, the speed value can overflow.

b) For example, if the velocity unit is set to 0, the FSoE speed is overflow at 32767 rpm and underflow at -32768 rpm.

c) Appropriate measures must be taken to intercept this case. For example, a measure which could be taken is to configure the safe maximum speed (SMS) by way that the speed is safely limited.

13.10 FSoE error identifications

See table 27 and 28 ETG.5001. The following error codes are used by the slave. The exact error cause can be read out in the protocol tab with COMBIVIS.

Error code	Description
0	Reset of the FSoE connection.
1	Invalid command
2	Unknown command
3	Invalid connection ID
4	Invalid CRC error
5	Watchdog expired
6	Error FSoE Slave address (Invalid_ADDRESS)
7	Invalid data
8	Invalid com para length
9	Invalid communication parameter
10	Invalid user parameter length
11	Invalid user parameter
136	Generation of the FSoE status word failed. The status word was different on both CPUs
137	Error in the safety module state. The safety module is in error state or critical error state. FSoE operation is not possible.
138	Safety function error. A safety function should be activated which requires the encoderless mode. The encoderless mode has not been configured.

13.11 Trouble-shooting

13.11.1 The safety module does not answer FSoE data telegrams

1. The bus type was not set to FSoE in the safe configuration in COMBIVIS. Use the manual of the safety module to check whether the bus type is FSoE.

2. A wrong FSoE data length was configured in the safe configuration in COMBIVIS. Use the manual of the safety module to check whether the data length is correct.

13.11.2 The safety module does not change into FSoE data state

1. The device CRC from COMBIVIS does not match the checksum transmitted via FSoE. Check the settings according to chapter (≡► Setting the safe FSoE configuration data [▷ 99]).
2. Safety functions have been activated which require the encoderless mode. Check if it is configured.
3. The FSoE address does not agree with the configuration in COMBIVIS. Use the manual of the safety module to check whether the control and status word length are correct.
4. The watchdog time was set too small. Check according to chapter (≡► Response time (FSoE watchdog) [▷ 92]) whether this is correct.

13.11.3 The state of the safety functions in the safety module is always STO

1. Safety functions are 0 active. This means, if the respective bit for the safety function is set to 0, this function is activated. Many safety functions release STO. If (e.g.) SOS is activated although this safety function is not configured with COMBIVIS, STO is carried out immediately after activation. Check according to chapter (≡► SF1 Safety Functions 1st Byte [▷ 104]), if all safety functions that are not required are set to 1.
2. Check if an input is additionally activated and configured to a safety function.

13.11.4 Which safety function has been set by the fail safe and acknowledge bit

1. If several safety functions are carried out at the same time, it is difficult to recognize which safety function has set the fail safe and acknowledge bit. Use the following procedure:
2. Revoke the request for the safety function. The safety functions displayed on the status page in COMBIVIS or via FSoE are now reduced to the safety functions, which have set the fail safe bit or which are always active.
3. Check the sequence of the safety function and the position and speed in the protocol at safety function execution date. From the position and speed it can usually be concluded which safety function sets the fail safe bit.
4. If safety functions have been activated by inputs or FSoE, the request for safety functions can be checked via FSoE in category "Bus request for safety functions".

14 Wiring Examples

14.1 Example of an interconnection of clock outputs with inputs

In order to detect dangerous external line short circuits between two related inputs and/or to voltage supply potentials, mechanical contact pairs are supplied via phase-shifted clock outputs. The module detects in-phase clock signals and changes into the safe state in this case.

NOTICE

Avoid line short circuits!

a) Since external line short circuits to inputs with the same phase of the clock pulses can not be detected, wiring precautions shall be taken to avoid this error.

14.1.1 Parameterization of the clock inputs

The parameterization of the clock signal inputs are shown in (≡► Parameterization of the clock inputs [▶ 111]) .

Parameter	Value	Unit
Test signal input configuration		
Test signal period	7.000000	s
Test signal pulse length	0.001000	s
Check of the test-signal for the STO-Inputs	on	
Check of the test-signal for the SBC-Inputs	off	
Check of the test-signal for the Function1-Inputs	off	
Check of the test-signal for the Function2-Inputs	off	

Fig. 73: Configuration of the clock signal inputs

14.2 Wiring examples brake output

This section shows examples for the use of the two brake outputs in connection with the brake feedback inputs for different types of wiring. The proposals made here have different advantages, a selection of the suitable variant must always be chosen by the user depending on the requirements of the application.

This list is not exhaustive; other applications not explicitly listed here are also possible and permitted.

14.2.1 Direct control without diagnostics

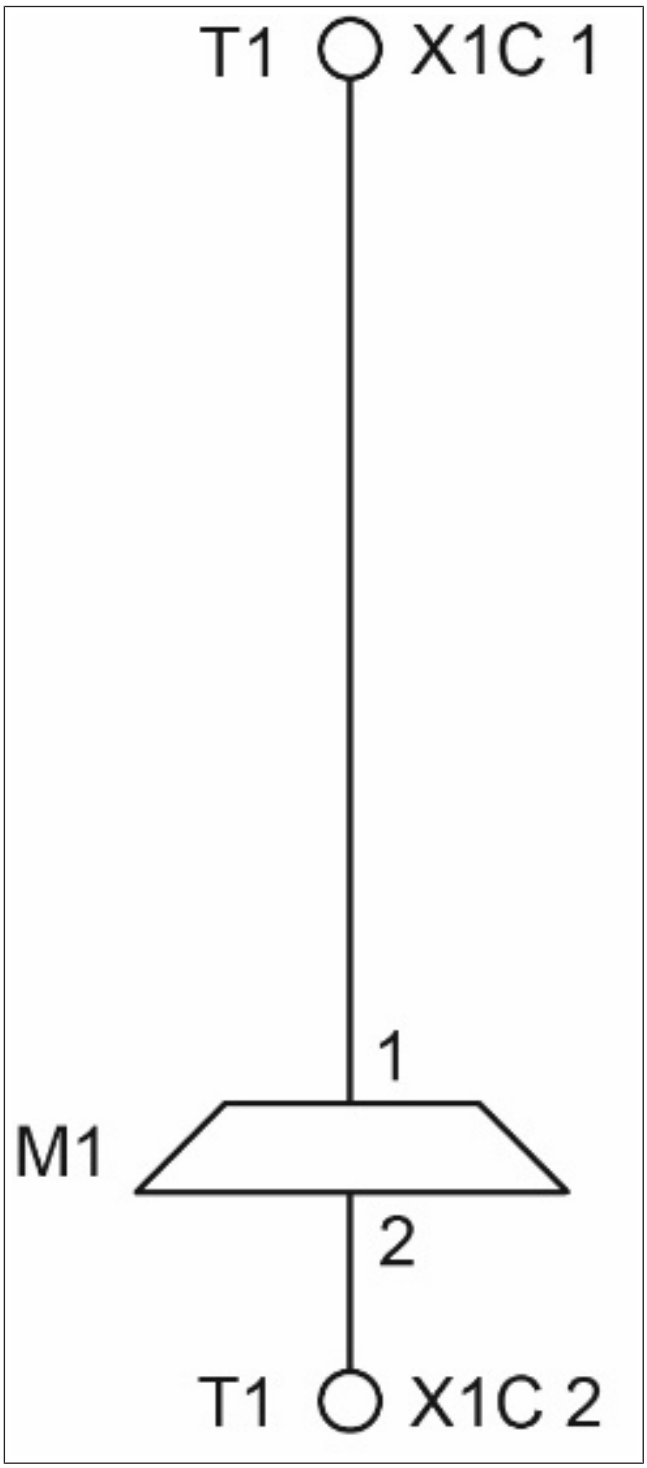


Fig. 74: Wiring proposal „Direct control without diagnostics“

1. Very simple connection.
2. Diagnosis of the control lines by the safety module (cross circuit detection)
3. No evaluation of the actual switching state of the brake

14.2.2 Direct control with diagnostics via microswitch in the brake

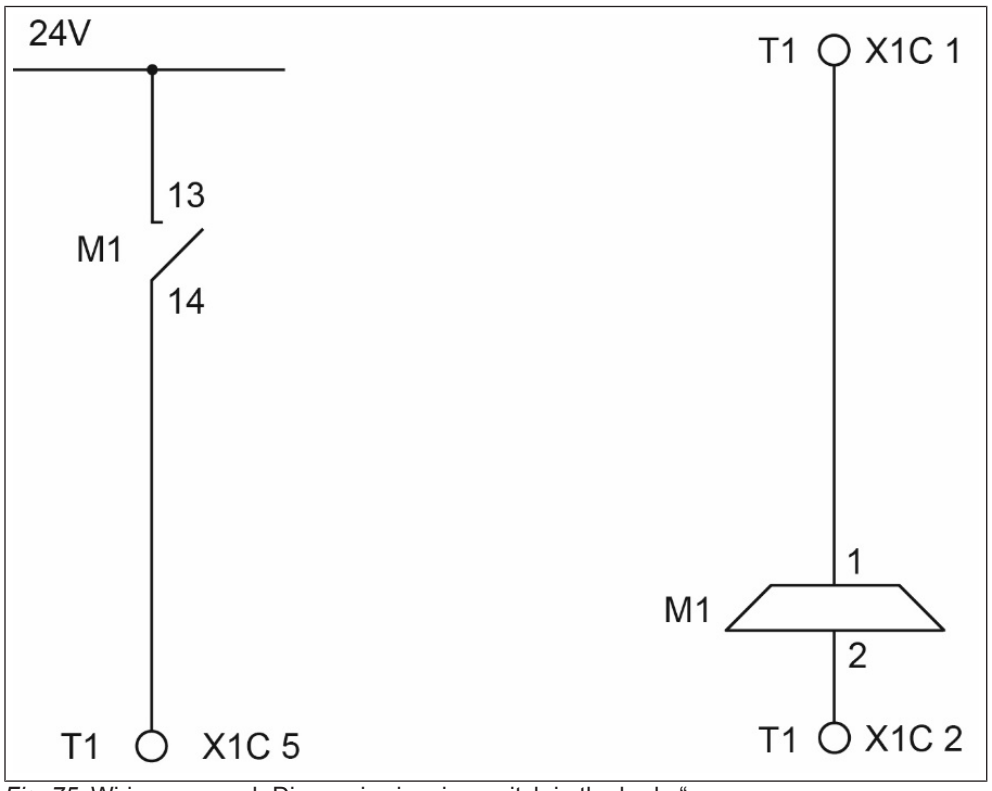


Fig. 75: Wiring proposal „Diagnosis via microswitch in the brake“

1. Very simple connection
2. Diagnosis of the control lines by the safety module (cross circuit detection)
3. Diagnosis of the brake status by the safety module (depending on the brake type, e.g. wear detection possible)

14.2.3 Direct control with diagnosis via antivalent microswitch in the brake

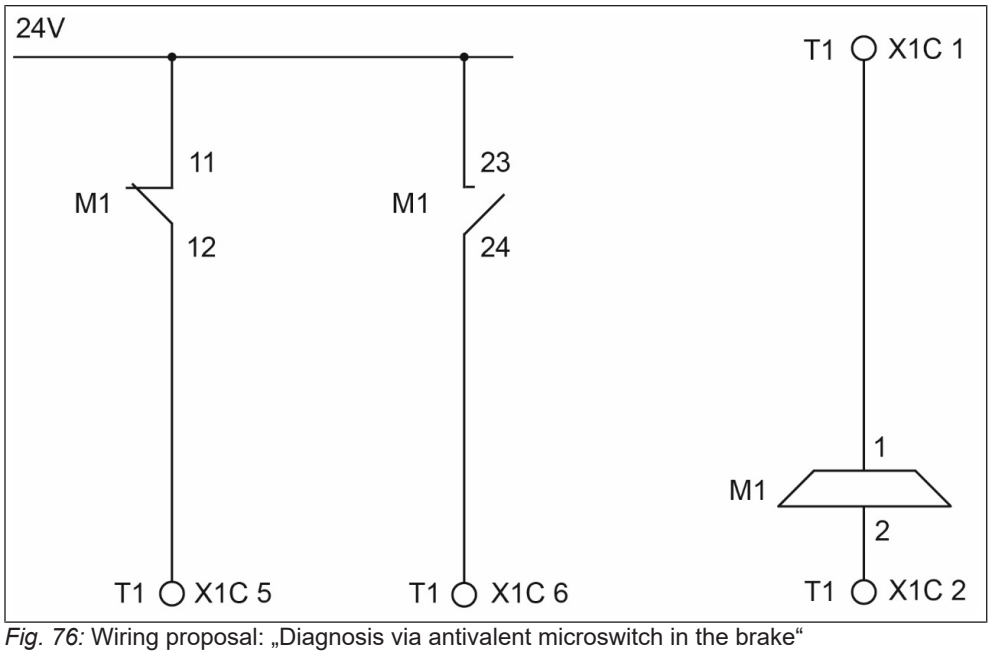


Fig. 76: Wiring proposal: „Diagnosis via antivalent microswitch in the brake“

1. Very simple connection
2. Diagnosis of the control lines by the safety module (cross circuit detection)
3. Diagnosis of the brake status by the safety module (depending on the brake type, e.g. wear detection possible)
4. Differentiated diagnosis of the brake by the position and switching conditions of the microswitches (depending on the used brake)

14.2.4 Single-channel switchgear without diagnosis

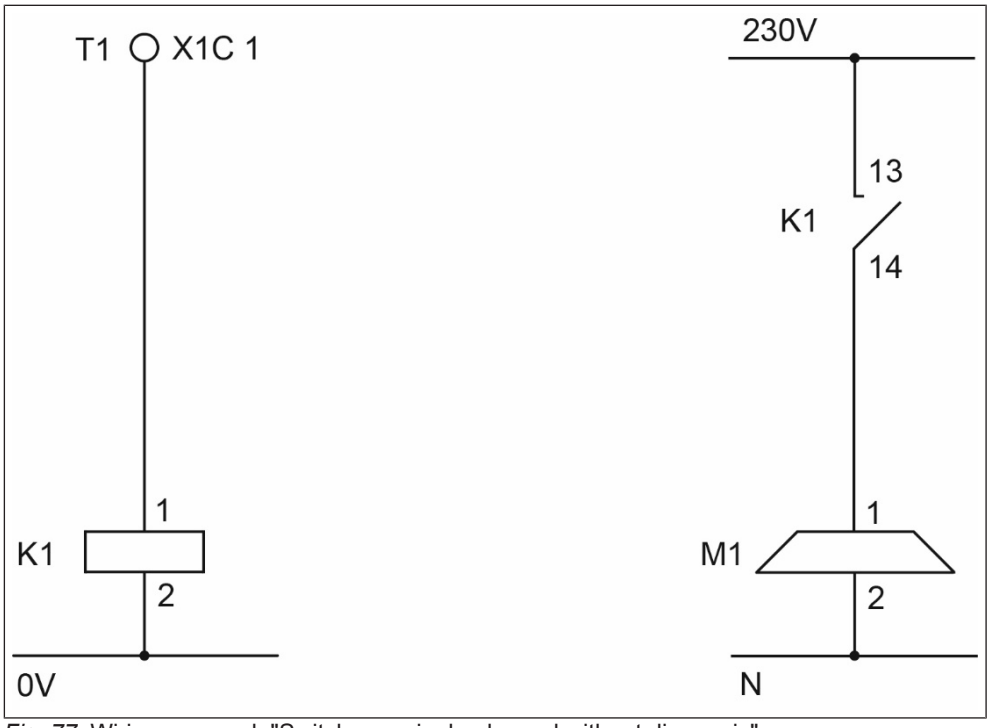


Fig. 77: Wiring proposal: "Switchgear single-channel without diagnosis"

e.g. with 230V brake or 24V brake with increased current demand

1. Single-channel control of the brake
2. Diagnosis of the control lines to the contactor or relay by the safety module (cross circuit detection)

1. No diagnosis of the contactor or relay possible
2. No evaluation of the actual switching state of the brake

14.2.5 Two-channel switchgear without diagnosis

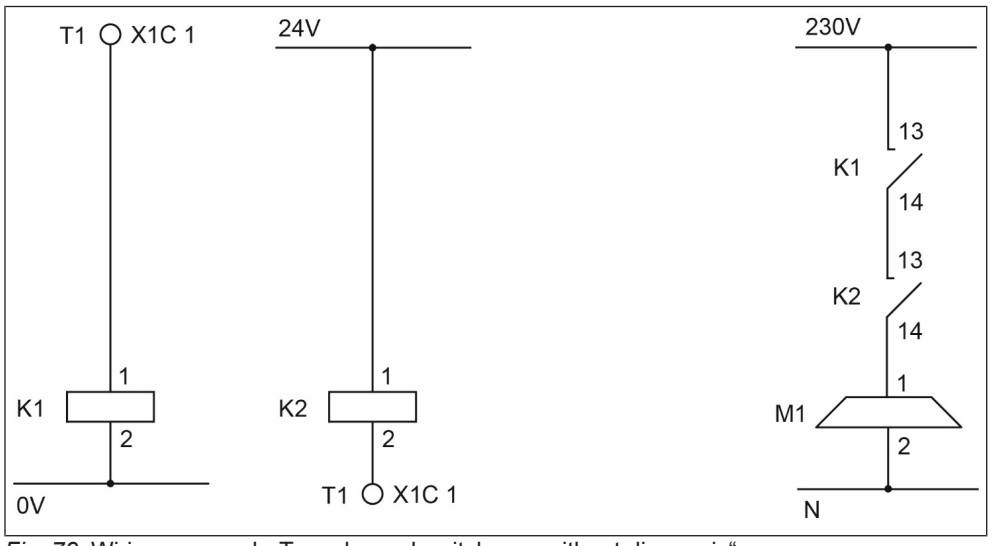


Fig. 78: Wiring proposal: „Two-channel switchgear without diagnosis“

e.g. with 230V brake or 24V brake with increased current demand

1. Two-channel control of the brake
2. Diagnosis of the control lines to the contactor or relay by the safety module (cross circuit detection)
3. No diagnosis of the contactor or relay possible
4. No evaluation of the actual switching state of the brake possible

14.2.6 Dual-channel switchgear with diagnosis via antivalent auxiliary contacts

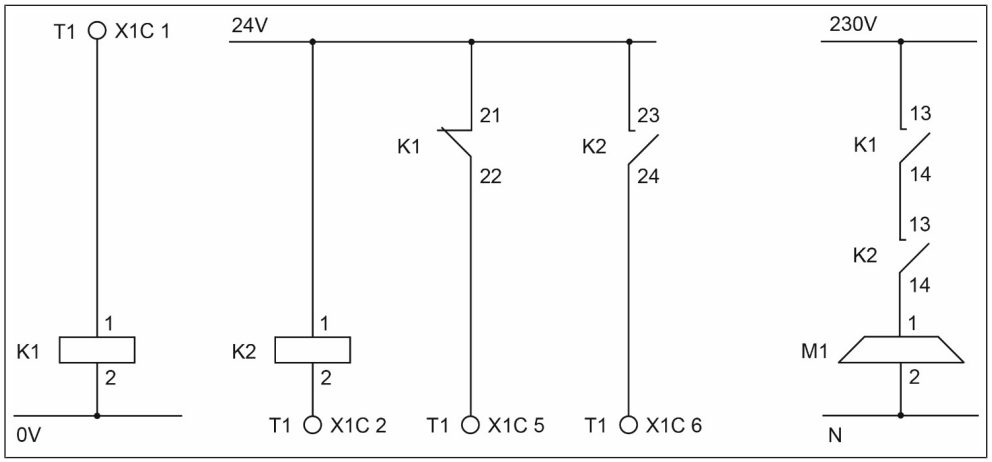


Fig. 79: Wiring proposal: Dual-channel switchgear with diagnosis via auxiliary contacts

e.g. with 230V brake or 24V brake with increased current demand

1. Two-channel control of the brake
2. Diagnosis of the control lines and the contactor or relay by the safety module (cross circuit detection)
3. Diagnosis of the contactors or relays (up to the main switching contacts)

4. No evaluation of the actual switching state of the brake possible

14.2.7 Two independent brakes

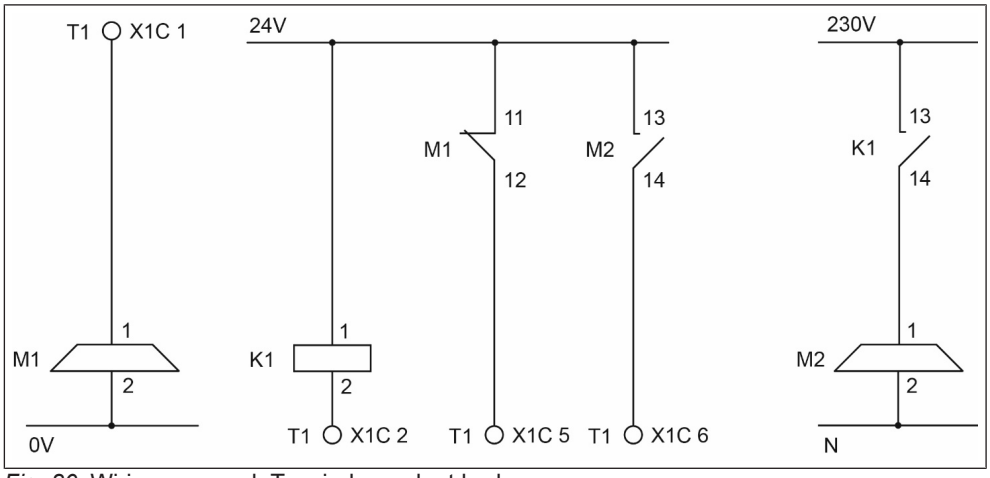


Fig. 80: Wiring proposal: Two independent brakes

15 Acceptance tests and configuration check

DIN EN 61800-5-2 chapter 7.1 point f prescribes a configuration check of the safety functions in cases when the integrity of the configuration of a safety function can not be guaranteed.

COMBIVIS has an integrated configuration tool, which has the acceptance according to IEC 61800-5-2 and thus is suitable to display the configuration error-free and to transfer it to the safety module. It is therefore not necessary to accept the configuration. Nevertheless, the safety functions and the selected limit values must be checked and this must be documented in the acceptance protocol.

15.1 Sense of the acceptance tests

The acceptance test is used to validate the configured safety function with regard to the system behaviour. To this end the limits of the safety function are violated systematically and the error response is recorded. If the configuration is changed, then a new acceptance test must be carried out.

15.2 Inspector

One person must be determined as inspector, who is able to carry out the test due to their technical training and knowledge of the configured safety functions.

15.3 Protocol of the acceptance test

A protocol must be created during execution of the acceptance test.

NOTICE

Configuration changes

a) If configuration parameters are changed, the test must be repeated and the result must be recorded in the test report.

15.4 Execution of the acceptance test and scope of the audit

Documentation of the system and safety devices

Description of the system including overview screen

Document configured safety functions including parameter version and CRC.

Check functionality of the used safety functions (functional test)

STO: Check function "Safe torque off“.

SBC: Check function "Safe brake control“.

SS1: Check function "Safe stop 1“.

SLS: Check function "Safely limited speed “.

SSM: Check function "Safe speed monitoring".

SDLC: Check function "Safe Door-Lock Control“.

SLA: Check function "Safely-Limited Acceleration".

BCF: Function

FB Warning

BR1P

BR1M

SMS

Completion of the test report and record the test results
Document the functional test.
Note the name of the inspectors including signature.
Check the selected user in the safety module including the rights.
Insert the measurement reports and other notations of the test report.

16 Maintenance and modifications at the safety module

Repairs, hardware changes and firmware changes must be carried out only by KEB.

NOTICE

Manipulations!

a) Through an engage into the device, e.g., soldering, replacement of components leads to the cancellation of the safety authorisation and the warranty by KEB.

An exchange of the safety module by the user is not possible. Please contact the support of KEB.

17 Annex to the declaration of conformity

The conformity was confirmed as follows:

see also

EC Type-Examination Certificate Safety module type 5 [▶ 121]

17.1 EC Type-Examination Certificate Safety module type 5

EC Type-Examination Certificate

Reg.-Nr./No.: 01/205/5768.00/20

Prüfgegenstand **Product tested**	Sicherheitsmodul für die COMBIVERT Antriebsserie Safety Module for the COMBIVERT drive series Safety Functions: STO, SBC, SS1-r, SS1-t, SLS, SMS, SSM, SLA, SDLC	**Zertifikats-inhaber** **Certificate holder**	KEB Automation KG Südstraße 38 32683 Barntrup Germany
Typbezeichnung **Type designation**	Sicherheitsmodul Typ 5 Details siehe Revisionsliste Safety Module Type 5 Details see Revision List		
Prüfgrundlagen **Codes and standards**	IEC 61800-5-2:2016 IEC 61800-5-1:2016 IEC 61800-3:2017 IEC 61508 Parts 1-7:2010		EN ISO 13849-1:2015 EN 62061:2005 + AC:2010 + A1:2013 + A2:2015 IEC 61131-2:2017 (in extracts) EN 60204-1:2018 (in extracts)
Bestimmungsgemäße Verwendung **Intended application**	Das Modul erfüllt die Anforderungen der Prüfgrundlagen (Kat. 3 / PL e nach EN ISO 13849-1, SIL 3 / SILCL 3 nach IEC 61800-5-2 / IEC 61508 / EN 62061) und kann in Anwendungen bis PL e nach EN ISO 13849-1 und SIL 3 nach EN 62061 / IEC 61508 eingesetzt werden. The module compies with the requirements of the relevant standards (Cat. 3 / PL e acc. to EN ISO 13849-1, SIL 3 / SILCL 3 acc. to IEC 61800-5-2 / IEC 61508 / EN 62061) and can be used in applications up to PL e acc. to EN ISO 13849-1 and SIL 3 acc. to EN 62061 / IEC 61508.		
Besondere Bedingungen **Specific requirements**	Die Hinweise in der zugehörigen Installations- und Betriebsanleitung sind zu beachten. The instructions of the associated Installation and Operating Manual shall be considered.		

Es wird bestätigt, dass der Prüfgegenstand mit den Anforderungen nach Anhang I der Richtlinie 2006/42/EG über Maschinen übereinstimmt.
It is confirmed that the product under test complies with the requirements for machines defined in Annex I of the EC Directive 2006/42/EC.

Gültig bis / Valid until 2025-04-21

Der Ausstellung dieses Zertifikates liegt eine Prüfung zugrunde, deren Ergebnisse im Bericht Nr. 968/FSP 2062.00/20 vom 21.04.2020 dokumentiert sind.
Dieses Zertifikat ist nur gültig für Erzeugnisse, die mit dem Prüfgegenstand übereinstimmen.
The issue of this certificate is based upon an examination, whose results are documented in Report No. 968/FSP 2062.00/20 dated 2020-04-21.
This certificate is valid only for products which are identical with the product tested.

TÜVRheinland 0035 Notified Body

Köln, 2020-04-21

Notified Body for Machinery, NB 0035

Dipl.-Ing. Eberhard Frejno

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Precisely Right.

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18 Revision history

Edition	Revision	Note
02.06.2020	01	Release version with firmware – V5.5.0.8.
31.08.2020	02	SDLC (p.15) values added. Encoderless mode (p.64) Parameter names adjusted and sequence adapted; new figure inserted; certificate inserted; editorial changes.
21.12.2022	03	Editorial changes by importing into the editorial system.
10.01.2023	04	Chap. 9.3 description extended; Chap. 12.2 software version added; Chap. 12.5.5 section parameterization changed; Chap. 12.11 description changed; Chap. 13.9.1 safety note changed; editorial changes in cross-references and in the glossary.
27.01.2023	05	Chap. 3.1 extended to new firmware; editorial changes in chapter 5; Chap.11.2 Changes to the firmware described; Warning notice in 12.5.5 corrected. Warning notice added in chapter 15.3.

Tab. 19: Revision history

19 Glossary

Application

The application is the intended use of the KEB product.

COMBIVERT

Proper name for a KEB Drive Controller

COMBIVIS

KEB start-up and parameterizing software

Customer

The customer has purchased a product from KEB and integrates the KEB product into his product (customer product) or resells the KEB product (reseller).

DGUV Regulation

Electrical installations and equipment

Directive 2006/42/EC

Machinery Directive

Directive 2014/30/EU

Electromagnetic Compatibility (EMC) Directive

EN 60204-1

Safety of machinery - Electrical equipment of machines - Part 1: General requirements (VDE 0113-1, IEC 44/709/CDV).

EN 61800-5-2

Adjustable speed electrical power drive systems. Part 5-2: Safety requirements - Functional safety (VDE 0160-105-2, UL 61800-5-2, IEC 22G/264/CD)

IEC 60364

Electrical low-voltage installation (DIN VDE 0100)

IEC 61131-2

Programmable logic controllers - Part 2: Equipment requirements and tests (German version DIN EN 61131-2)

IEC 61508

Functional safety of electrical/electronic/programmable electronic safety-related systems.

ISO 13849-1

Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design.

LSB

Sets the least significant bit in a group of bits.

MSB

Sets the most significant bit in a group of bits.

MTTF

Average life time to failure.

PFD

Term used in the safety technology (EN 61508-1...7) for the size of error probability.

PFH

Term used in the safety technology (EN 61508-1...7) for the size of error probability per hour.

SBC

Safe brake control

STO

Safe torque off

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