COMBIVERT
SAFETY MODULE TYPE 5

ELEVATOR APPLICATION SAFETY MANUAL | **FIRMWARE 5.5.0.8**

Original Manual
Document 20430837 US 02

1 Preface

The hardware and software described in this document are products of KEB America, Inc. The information contained in this document is valid at the time of publishing. KEB reserves the right to update this document in response to misprints, mistakes or technical changes.

1.1 Warning Signs and Key Symbols

Certain procedures within this document can cause safety hazards during the installation or operation of the device. Refer to the safety warnings in this document when performing these procedures. Safety signs are also located on the device where applicable. A safety warning is marked by one of the following warning signs:

⚠ DANGER

Type and/or source of hazard.

Indicates a hazardous situation which **will result in death or serious injury** if not avoided.

- Measures to avoid the hazard.
- Can be supplemented by an additional warning sign or symbol.

⚠ WARNING

Type and/or source of hazard.

Indicates a hazardous situation which **may result in death or serious injury** if not avoided.

- Measures to avoid the hazard.
- Can be supplemented by an additional warning sign or symbol.

⚠ CAUTION

Type and/or source of hazard.

Indicates a hazardous situation which **may result in minor or moderate injury** if not avoided.

- Measures to avoid the hazard.
- Can be supplemented by an additional warning sign or symbol.

NOTICE

Type and/or source of information.

Indicates a situation that **may result in damage to the product or other property** if not avoided.

- Measures to avoid the hazard.
- Can be supplemented by an additional symbol.

Used for informational messages or recommended procedures.

Reference to further documentation with link and QR Code:
https://www.kebamerica.com/elevator-support/

1.2 More Symbols

Symbol	Description
▶	Action step
➡	Cross-reference to further information
•	Enumerations/unordered lists
1.	Procedure/ordered list
Link	Internal reference hyperlink
Link	External website hyperlink
✓	Condition
RU21	Parameter name or parameter index
COMBIVERT	Glossary entry
	Mandatory: Refer to instruction manual/booklet
	General mandatory action sign
	General warning sign
	Warning: Electricity hazard
	Warning: Crushing by moving parts
	Warning: Hot surface

1.3 Laws and Requirements

KEB Automation KG has certified the product against the US, Canadian and European standards. Additionally, KEB Automation KG provides the EC declaration of conformity that the product complies with the essential safety requirements.

The UL, CSA and CE marks are located on the name plate when applicable. The EC declaration of conformity can be downloaded on demand via our website.

Further information is provided in the *Appendix*.

1.4 Warranty

KEB provides a limited warranty on all products. This warranty can be found in the terms and conditions at our website.

KEB America, Inc. North America terms and conditions:
https://www.kebamerica.com/terms-and-conditions/

KEB Automation KG Europe terms and conditions:
https://www.keb-automation.com/terms-conditions

Further agreements or specifications require written confirmation from KEB America, Inc.

1.5 Support and Liability

It is not possible to cover every potential application of our device in a single manual. If you require further information or if problems occur which are not covered in this document, you can request the necessary information via KEB America, Inc. or the local KEB Automation KG agency.

The use of our products in the target application is beyond our control and therefore exclusively the responsibility of the controller OEM, system integrator or customer.

The information contained in this document, as well as any user-specific advice in spoken or written form or generated through testing, is provided to the best of our knowledge and is considered for informational purposes only. KEB America, Inc. bears no responsibility or liability for the accuracy of the information listed above, nor for any violation of industrial property rights committed by a third-party in relation to this information.

Selection of the most suitable product for any given application is the responsibility of the controller OEM, system integrator or customer.

Evaluation of the product can only be performed by the machine manufacturer in combination with the application. Any tests performed must be repeated every time any part of the hardware or software is modified, or any time the unit adjustment is changed.

1.6 Copyright

The customer may use the information contained within this document for internal purposes only. The copyright of this document is held by KEB America, Inc. and remains valid in its entirety.

This KEB product or parts thereof may contain third-party software, including free and/ or open-source software. If applicable, the license terms of this software are contained in the instructions for use. The instructions for use are already available to you, can be downloaded free of charge from the KEB website or can be requested from the respective KEB contact person.

Other wordmarks or/and logos are trademarks (™) or registered trademarks (®) of their respective owners and are listed in a footnote at the first occurrence.

1.7 Validity of this manual

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

- Is only valid in conjunction with the instructions for use (control and/or power part).
- Supplements the complete Safety module Type 5 instruction manual. For further information, refer to the complete *Safety Module Type 5 instruction manual*.
- Contains safety-related supplements and requirements for operation in the elevator application only.
- Contains only supplementary safety instructions.
- Supplements existing standards. The basic and application standards must still be observed.

1.8 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 elevator control system.
- Detection of hazards and risks of the electrical drive technology.
- Knowledge of *Standards for Elevator Application Functional* Safety.

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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).
LSB	Sets the least significant bit in a group of bits.
MSB	Sets the most significant bit in a group of bits.
MTTF	Mean service life until failure (Mean Time to Failure).
PFD	PFD (Probability of Failure on Demand) is a measure of the failures per demand in accordance with IEC 61508. It is used to determine the reliability of safety-related systems.
PFH	The PFH value (Probability of Failure on Demand per Hour) indicates the average probability of a dangerous failure per hour.
SBC	Safe Brake Control
STO	Safe Torque Off

Standards for Elevator Application Functional Safety

ASME A17.1-2022 / CSA B44:22	Safety Code for Elevators and Escalators includes Requirements for Elevators, Escalators, Dumbwaiters with Automatic Transfer Devices
CSA B44.1:22 / ASME A17.5-2022	Elevator and escalator electrical equipment
CSA C22.2 No. 274:17 (R2021)	Adjustable speed drives
EN 60204-1	Safety of machinery – Electrical equipment of machines – Part 1: General Requirements
EN 61800-5-2	Adjustable speed electic power drive systems – Part 5-2: Safety requirements - Functional
EN 81-20:2020	Safety rules for the construction and installation of lifts: Lifts for the transport of persons and goods - Part 20: Passenger and goods passenger lifts
EN 81-50:2020	Safety rules for the construction and installation of lifts: Examinations and tests - Part 50: Design rules, calculations, examinations and tests of lift components
IEC 60664-1:2020	Insulation coordination for equipment within low-voltage supply systems - Part 1: Principles, requirements and tests
IEC 61131-2	Standard for programmable controllers - Part 2: Equipment requirements
UL 840	Insulation coordination including clearances and creepage distances for electrical equipment
UL 61800-5	STANDARD FOR SAFETY Adjustable Speed Electrical Power Drive Systems: – Part 5-1: Safety Requirements – Electrical, Thermal and Energy

2 Safety Instructions

The products are developed and built according to 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

Stay safe! Stay informed!

- ▶ Read the instruction manual prior to operating the device.
- ▶ Follow all safety and warning instructions.
- ▶ If you are unsure of any part of these instructions, please contact KEB prior to operating the device.

2.1 Installation

⚠ DANGER

Rick of electrical shock!

Electrical voltage at terminals and in the device!

- ✓ For any work on the device:
- ▶ Switch off the supply voltage.
- ▶ Secure it against switching on.
- ▶ Wait until all drives have stopped so that no regenerative energy can be generated.
- ▶ Await capacitor discharge time (min. 5 minutes). Measure DC voltage at the terminals.
- ▶ Never bridge upstream protective devices, nor for test purposes.

⚠ DANGER

Risk of electric shock!

Avoid improper installation of safety technology!

- ▶ The safety functions may only be installed and put into operation by qualified personnel which are trained in safety technology.
- ▶ Check the safety functions and error responses and generate an acceptance report after installation.

⚠ CAUTION

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

Movement of the axis due to load!

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

NOTICE

Unpredictable consequences for personnel and machine!

Automatic restart when STO is no longer triggered.

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

▶ Ensure by external measures that the drive restarts only after confirmation.

NOTICE

Malfunction due to incorrect dimensioning of the current source!

▶ Consider all input currents of the used safety functions.

▶ If several safety modules are connected, the external 24 Vdc power supply must be able to 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 listed in section *Standards for Elevator Application Functional Safety*.

⚠ DANGER

Risk of electric shock!

Continue mains voltage with active STO function!

▶ Always switch off the power supply before working on the device.

▶ Await discharge time.

Without a functioning mechanical brake, an active STO function results in no controlled motor torque and thereby uncontrolled behavior of the motor. Additional protective devices must be installed (e.g. emergency brake) if damage to persons or property can occur.

⚠ DANGER

Uncontrolled motor in the event of a fault!

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

▶ Block access to the hazardous area.

▶ Wait until the mechanical system stops.

2.3 Maintenance

⚠ WARNING

Failure of safety functions! No protection!

✓ To ensure the safety permanently:

▶ The safety functions must be checked in regular intervals.

▶ The intervals result from the risk analysis.

▶ 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, its preconfiguration and use in the elevator application.

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	21.12.2022	02	03.2026	

Table 3.1 *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. Previous parameter lists of firmware 5.5.0.8 can still be downloaded to the safety module.

Table 3.2 *Firmware modification notes*

NOTICE

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

- The material number corresponds with the numerical code above.
- The FS logo is printed on the nameplate.

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 activated or released by an error.

3.3 Classification of the Safety Features

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)	The drive is switched off by two-channel switch off of commutation of the power semiconductors. After triggering the function, the drive coasts down. The final stop position of the motor depends on the speed and the active torque in the system.	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)	This function provides safe output signals to control one or two external brakes or contactors.	SIL 3	PL e
		PFH $5.7 \cdot 10^{-11}$	Category 3
		PFD $4.96 \cdot 10^{-6}$	$MTTF_D$ >1550 a

Table 3.3 *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.

3.5 Environmental and Operating Conditions

- *EN81-20* clause 5.10.3.2.2 “Devices used in safety circuits”, specifies the environmental conditions shall be considered pollution degree 3 and over voltage category III. The creepage and clearance distances within the electrical safety device shall be based on these environmental conditions and the nominal circuit voltage. Additionally, the standard states that spacings based on pollution degree 2 are acceptable when the overall device is enclosed in an IP5x enclosure.
- The F6 Elevator Drive Controller is designed according to pollution degree 2 and over voltage category III requirements. Therefore, it is necessary that the drive controller be mounted in an overall IP5x enclosure to fulfill the requirement according to *EN81-20*.
- The operating ambient temperature range is -10°C to 45°C.
- When using an external power supply for the control, the valid supply range is 24 Vdc +/- 10%.

4 Installation

4.1 Terminal X2B

PIN	Name	Function
1	FUNC1.1	Reserved – No function
2	FUNC1.2	
3	SBC.1	Safe Brake Control
4	SBC.2	
5	STO.1	Safe Torque Off
6	STO.2	
7	Out1	STO Confirmation
8	Out2	SBC Confirmation

Table 4.1 *Terminal X2B*

The voltages of all inputs and outputs refer to the 0 V of the F6 elevator drive control board. The pin assignment of the control terminals is described in the respective manual of the F6 elevator drive.

4.1.1 Wiring of the Terminal

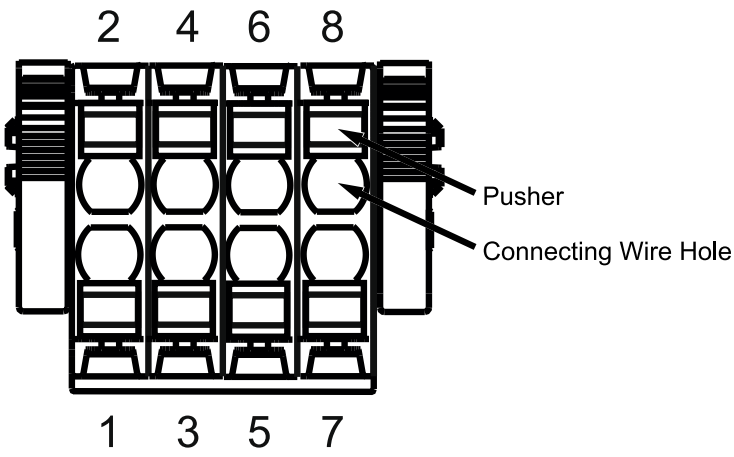


Figure 4.1 *Assembly of the terminal X2B*

1. Press pusher by hand. Insert connecting wires into the respective hole, so that no single wires can be seen from the outside or bend outward. Resistance initially must be overcome when inserting. Release the pusher.
2. Check that the connecting wire is fixed and cannot 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 up to 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 mm² / 21	10 mm	12 mm
0.75 mm² / 19	12 mm	14 mm
1.00 mm² / 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 mm² / 25…16	10…12 mm
Stranded wire (rigidly and flexibly)	

- KEB generally recommends the use of wire-end ferrules in industrial environments.
- A safe clamping cannot 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

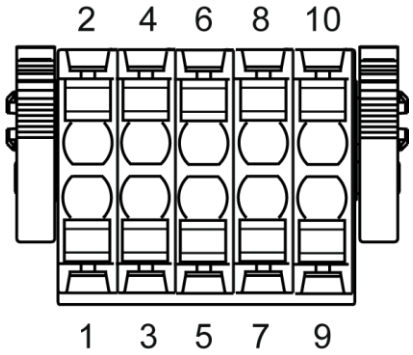
The maximum short-term starting current of the input is limited to 30 mA.

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

4.2 Brake Output Terminal



I/O	X1C Terminals	Function
BR+	1	Positive solid-state brake output
BR-	2	Negative solid-state brake output
0 V	3	0 V brake supply reference
24 Vout	4	24 V brake supply
BCF1	5	Brake Feedback Input 1
BCF2	6	Brake Feedback Input 2
Reserved	7/8	No Function
TA1	9	Motor Temp Sensor + (Not Safe)
TA2	10	Motor Temp Sensor - (Not Safe)

The outputs BR+ and BR- incorporate freewheeling diodes which allow the output to directly drive inductive DC loads without the need for additional snubber circuits.

4.3 Status LEDs

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.

Table 4.2 *LED displays of the safety module*

5 Safety Module Configuration

The safety module is preconfigured for operation in elevator control systems. This configuration does not require any field adjustment or customization of specific functions. The configuration of the safety module is loaded at the factory and is not user editable afterwards. The factory configuration and function of the safety module is described in the following sections.

5.1 Factory Functional Definition

5.1.1 Safe Inputs

Each safe input consists of two channels. The channels are configured for equivalent reaction, meaning each channel must see the same signal (+24 Vdc for active ON state). It is allowed to have a short discrepancy (tolerance) in timing between the two channels. The tolerance time of the safety inputs is configured for 500 mSec. However, if the signals on the two channels require 500 mSec to become congruent, that will result in a delay of the lift start sequence by that amount of time.

In addition, there is a filter time for the inputs which helps to filter out disturbances caused by relay contact bounce or other signal disturbance. The filter time is configured for 30 mSec.

Input 3 will be configured as the first Safe Torque Off (STO) input. Additionally, it will be configured as a second (SBC) input. This second function is required to meet *A17.1/B44* elevator code, clause 2.26.9.2, which requires that the means used to disable alternating current flow from the motor shall also force the removal of power from the brake circuit.

Input 2 will be configured as the Safe Brake Control (SBC) and secondly as (STO). This safety input will be driven by the safety circuit as defined by A17.1/B44 clause 2.26.2. Per clause 2.26.9.3 and 2.26.8.2, the electrical protective devices of the safety circuit must control both the means of blocking alternating current flow to the motor and well as blocking the flow of power in the brake circuit. Likewise, *EN81-20*, clauses 5.11.2.1.1, and 5.11.2.4 require when an electric safety device listed in Annex A is operated, shall initiate an immediate stop and prevent further operation. By connecting the safety circuit to this input, the requirements of both elevator codes are satisfied.

Input 3 will remain without function.

5.1.2 Safe Outputs

The outputs are driven by both safety CPUs using an AND hardware connection.

Output 1 is configured to provide feedback for the STO function. The output will become active when the STO function is active, i.e. flow of alternating current to the motor is blocked.

Output 2 is configured to provide feedback for the SBC function. The output will become active when the SBC function is active, meaning the brake output BR+ and BR- is disabled and the brake is in the safe state.

Both signals can be used by the elevator control to confirm the change of state in the safety circuit between runs as required by both elevator codes. If the state does not change between runs, further operation must be blocked by the elevator controller.

5.1.3 Brake Output Function

The brake outputs BR+ and BR- activate when all the following conditions are met.

- STO is released
- SBC is released

The elevator application in the Drive Control commands brake release after the following conditions are met:

- Hardware direction (start) signal is given, or serial direction (start) bit is set.
- Motor phase current check is passed.
- Induction motor flux control indicates rated motor flux.
- Brake release delay timer has expired.

When the brake outputs BR+ and BR- are active, they are tested for short circuits originating either internally or externally to the drive. The test is administered minimally once after each switch off of the brake output (engagement of the brake), or once every one minute, if the brake output of the F6 elevator drive control remains energized, i.e. in case of prolonged low speed operation. The test is administered by proofing each output (BR+ and BR-). During the proofing sequence, the safety module must identify a change in the state of the solid-state output. If the output proof fails, the safety function STO and SBC are activated, and the elevator drive control enters a "Safe" state.

Additionally, the current flow between BR+ and BR- is monitored for either an overload condition or open circuit condition. If the current exceeds 3.3 amps, the safety module will trigger an error response and display the error in parameter DG90 System Status. If the output current is below 100 mA for longer than 100 mSec, indicating an open circuit, a warning message will be generated and will also be available in parameter DG90. This will however not result in a “Safe” state, as the assumption in this case, is that the brake or contactor is not connected.

5.1.4 Brake Feedback Inputs

The brake feedback inputs are designated to be connected to the brake switches or possibly the auxiliary contacts of contactors. The brake switches and feedback inputs are only single channel and are not considered safe. They are to be used for functional confirmation purposes specifically in the case of UCM function described in *EN81-20*, clause 5.6.7.3. Together, with the function of the elevator application in the drive controller, these inputs can be used to support the UCM requirement of the elevator system.

The inputs are configured with a filter in the safety module to minimize disturbances on the brake feedback signals. This input filter is configured to 100 mSec.

The status of the inputs can be monitored through parameter DG89.

5.2 Status of the Safety Module

The status of the safety module along with error messages are displayed in parameter DG90 - System Status. Additionally, DG91 logs the history of events.

5.2.1 DG89 – Safety I/O

The two-channel input and output status are 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 also include 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 always represent the result of all existing states, considering the current settings.

The displays shown in the following tables are possible:

Display	Meaning	Signal type (Internal / External)	Affected interface
Reserved	Input 1, channel 1 is set	External	➡ *Table 4.1 Terminal X2B*
Reserved	Input 1, channel 2 is set	External	➡ *Table 4.1 Terminal X2B*
SBC	Input 2, channel 1 is set	External	➡ *Table 4.1 Terminal X2B*
SBC	Input 2, channel 2 is set	External	➡ *Table 4.1 Terminal X2B*
STO	Input 3, channel 1 is set	External	➡ *Table 4.1 Terminal X2B*
STO	Input 3, channel 2 is set	External	➡ *Table 4.1 Terminal X2B*
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	Refer to manual control unit – e.g. terminal X1C
BrakeFB2	Feedback line brake feedback channel 2 is set	External	Refer to manual control unit – e.g. terminal X1C

Table 5.1 *Status of the safety module - Displays 'I/O Status' (input channels)*

Display	Meaning	Signal type (internal / external)	Affected interface
STO Out	Control output 1 is set by CPU1	External	➡ *Table 4.1 Terminal X2B*
STO Out	Control output 1 is set by CPU2	External	➡ *Table 4.1 Terminal X2B*
SBC Out	Control output 2 is set by CPU1	External	➡ *Table 4.1 Terminal X2B*
SBC Out	Control output 2 is set by CPU2	External	➡ *Table 4.1 Terminal X2B*
Brake Out1	Control brake output 1 is set	External	Refer to manual control unit – e.g. terminal X1C
Brake Out2	Control brake output 2 is set	External	Refer to manual control unit – e.g. terminal X1C
Relay Out1	Control relay output 1 is set	External	Refer to manual control unit – e.g. terminal X2A
Relay Out2	Control relay output 2 is set	External	Refer to manual control unit – e.g. terminal X2A
VTRP.1	Driver voltage supply (upper half bridge) channel 1 is set	Internal	Power output UVW
VTRP.2	Driver voltage supply (upper half bridge) channel 2 is set	Internal	Power output UVW
VTRM.1	Driver voltage supply (lower half bridge) channel 1 is set	Internal	Power output UVW
VTRM.1	Driver voltage supply (lower half bridge) channel 2 is set	Internal	Power output UVW

Table 5.2 *Status of the safety module - Displays "I/O status" (output channels)*

5.3 Configuration Settings for Elevator Application

The following configuration is loaded at the factory. In order to confirm that the configuration had been correctly loaded without errors or changes, parameter DE41 displays the CRC code of the configuration. The valid code for this configuration is “21BEB750”. If any other code is displayed in DE41, that indicates the safety module is not configured correctly according to this document.

NOTICE

- When the configuration code in DE41 does not match the code stated above, the F6 Elevator Drive Controller should not be used and should be returned to the factory for service.

Name	Description	Unit	Pre-configuration
Filter times of the safety and diagnostic inputs (➡ *Filter time for safety and diagnosis inputs*)			
Filter time of the function 1 input	Filter time for debouncing of input signals at input channel "Safety function 1"	s	0.03
Filter time of the function 2 input	Filter time for debouncing of input signals at input channel "Safety function 2"	s	0.03
Filter time of the function 3 input	Filter time for debouncing of input signals at input channel "Safety function 3"	s	0.01
Filter time of the brake feedback inputs	Filter time for debouncing the brake feedback inputs	s	0.10
Function 1 Hardware input configuration (➡ *Hardware input configuration (function 1-3)*)			
First linked safety function	First linked safety function	-	0
Second linked safety function	Second linked safety function	-	0
Status of the inputs	Status of the inputs	-	Equivalence
Tolerance time for the input	Tolerance time for the input	s	0.50
Function 2 Hardware input configuration (➡ *Hardware input configuration (function 1-3)*)			
The first linked safety function	The first linked safety function	-	SBC
Second linked safety function	Second linked safety function	-	STO
Status of the inputs	Status of the inputs	-	Equivalence

Name	Description	Unit	Pre-configuration
Tolerance time for the input	Tolerance time for the input	s	0.50
Function 3 Hardware input configuration (➡ *Hardware input configuration (function 1-3)*)			
The first linked safety function	The first linked safety function	-	STO
Second linked safety function	Second linked safety function	-	SBC
Status of the inputs	Status of the inputs	-	Equivalence
Tolerance time for the input	Tolerance time for the input	s	0.50
Configuration of the hardware outputs (➡ *Hardware output configuration*)			
Output 1 configuration	Assignment (bitwise)	-	1:STO
Configuration of output 2	Assignment (bitwise)	-	2:SBC
Configuration relay output	Assignment (bitwise)	-	0
Switch on delay time	Outputs 1 and 2 and the relay output are switched on with delay to the switching condition	s	0,0
SBC: Safe brake control (➡ *Functional description safe brake control (SBC)*)			
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) (➡ *Functional description safe brake control (SBC)*)	-	On
Brake feedback input 1 Input configuration (➡ *Configuration parameters of the brake feedback inputs*)			
First activation level	Selection of the physical input state to execute the first assigned function	-	0
First assigned diagnosis function	The first assigned diagnosis function of the input	-	0
Second activation level	Selection of the physical input state to execute the second assigned function	-	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

Name	Description	Unit	Pre-configuration
Brake feedback input 2 Input configuration (➡ *Configuration parameters of the brake feedback inputs*)			
First activation level	Selection of the physical input state to execute the first assigned function	-	0
First assigned diagnosis function	The first assigned diagnosis function of the input	-	0
Second activation level	Selection of the physical input state to execute the second assigned function	-	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

Table 5.3 *Parameter list safety module type 5*

6 Operating condition of the safety module Normal Operation

The operating and error state can be checked in COMBIVIS via the KEB safety editor. The status and error messages of the safety module are also displayed in the lift parameter DG90 System Status and logged in parameter DG91 Status Log.

6.1 Global Operating Condition

The operating condition of the safety module is divided into different stages. The global status of the safety module displays the different states for the safety module.

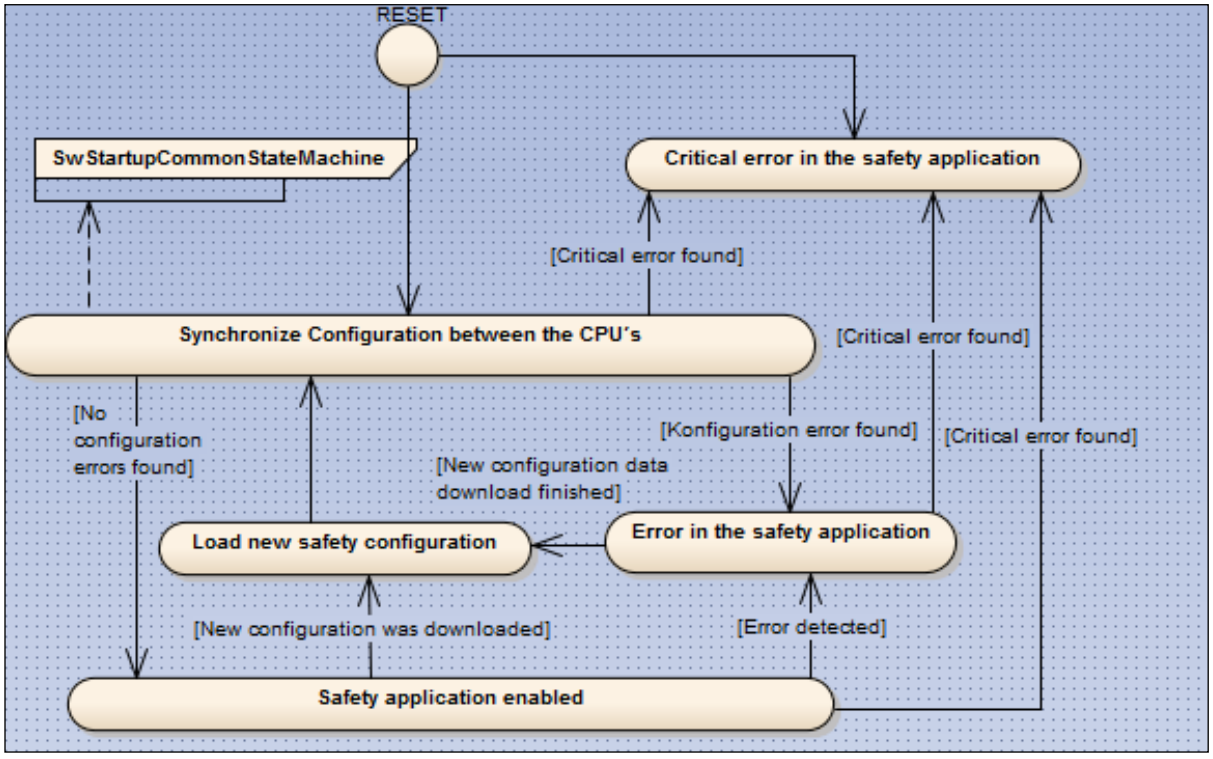


Figure 6.1 *Global status of the safety module*

Reset:

This is the status when the safety module is switched on. The safety module executes 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 executes the safety function STO and the outputs are switched off. This status is permanent and can be reset 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 reset 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. *Figure 6.2 Booting the safety module* displays the different states of the safety module when starting.

Software is initialized:

This status indicates that the software has been initialized. 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. Therefore, the time slot must be synchronized.

Start the synchronization of the configuration:

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

Complete the synchronization of the configuration:

Now the configuration is transferred to the other CPU.

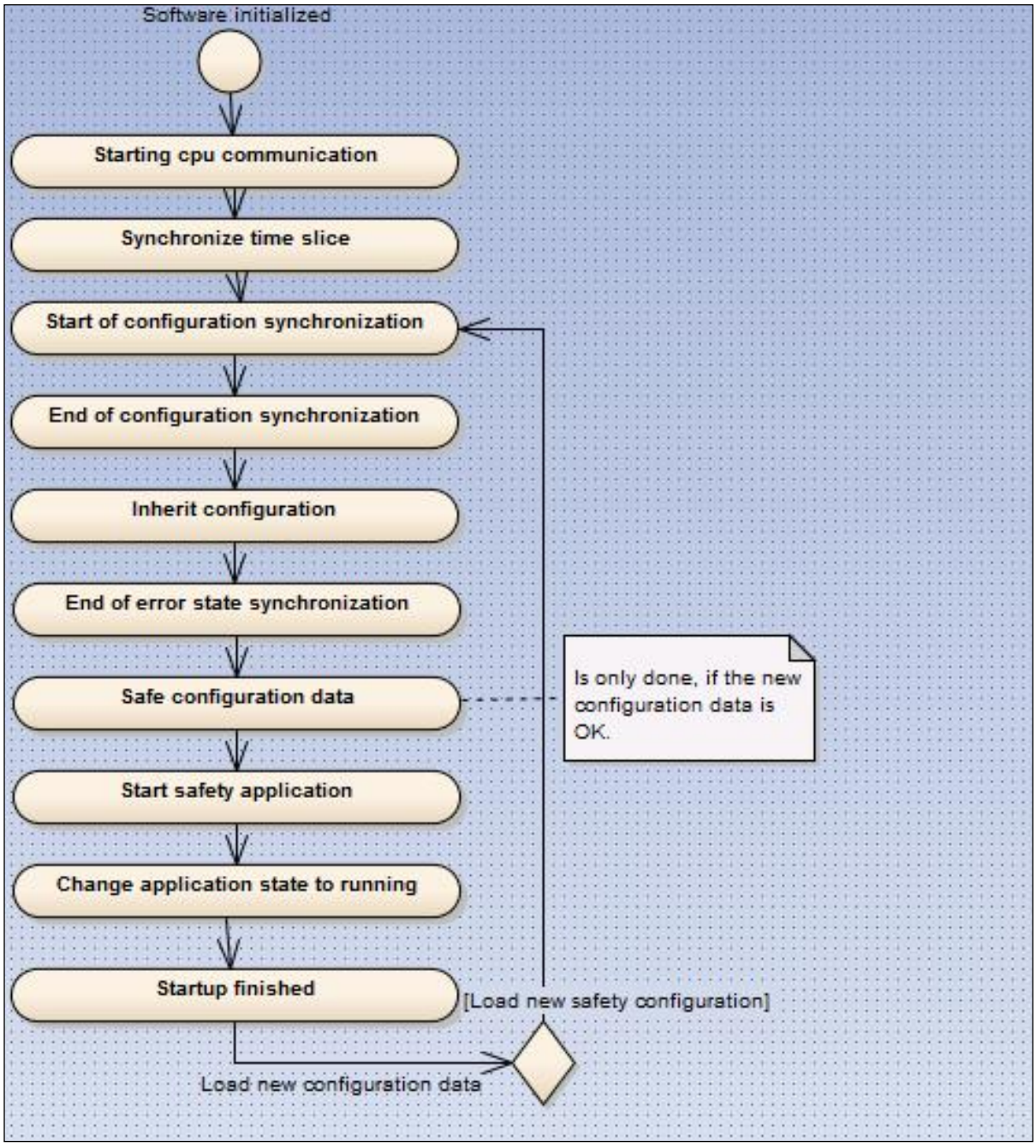


***Figure 6.2** Booting the safety module*

Configuration data transfer:

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

Complete the synchronization 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 has no error.

Start the safety software:

The safety software can now be started; the configuration data is 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 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 must be considered depending on the selected configuration. These are briefly presented in this section. 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, 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 section *Functional description of the safety functions*. 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)*).

(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*).

8 Inputs (configuration / parameter)

The safety module has three configurable two-channel inputs.

8.1 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 conditionally delayed by the filter time:

Table 8.1 displays the configuration options:

Parameter	Value	Unit
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

Table 8.1 *Filter time for the safety inputs (input configuration)*

Parameterization

- Filter time of Function 1 inputs
- Filter time of Function 2 inputs
- Filter time of Function 3 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.

8.2 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 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 period	10.000000	s
Test signal pulse strength	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 Function 1 inputs	Off	-
Check of the test-signal for the Function 2 inputs	Off	-
Table 8.2 *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.

8.3 Hardware input configuration (function 1-3)

Table 8.3 displays the parameters for the hardware safety inputs Function 1, Function 2 and Function 3.

Parameter	Value	Unit
Function 1 Hardware Input Configuration		
First assigned safety function	No function assigned	-
Second assigned safety function	No function assigned	-
Status of the inputs	Equivalent	-
Safety input tolerance time	0.500	s
Function 2 Hardware Input Configuration		
First assigned safety function	SBC Safe brake control	-
Second assigned safety function	STO Safe torque off	-
Status of the inputs	Equivalent	-
Safety input tolerance time	0.500	s
Function 3 Hardware Input Configuration		
First assigned safety function	STO Safe torque off	-
Second assigned safety function	SBC Safe brake control	-
Status of the inputs	Equivalent	-
Safety input tolerance time	0.500	s

***Table 8.3** Parameters for the STO safety input*

Configuration

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)*).
- **SBC:**
  The safety function "Safe Brake Control" is executed (➡ *Functional description safe brake control (SBC)*).
- **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.

Status of the inputs:

The input state between the two channels is equivalent:

- As an equivalent, the two safety inputs must always be switched the same. It is not allowed to supply a channel with 24 V input voltage and the other channel with 0 V. The safety function is triggered if the input voltage is 0 V.
- Deviations above the set tolerance time (refer to parameter below) from the set state equivalent result in the safe state.

Tolerance time of the inputs:

The inputs are designed with two channels. This can cause a channel to be switched earlier or later than the second channel. A tolerance time of 0.5 seconds ensures that this does not immediately result in an error.

8.4 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

8.5 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.

8.5.1 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

Table 8.4 *Brake feedback input configuration parameters*

Parameterization

- **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. The following diagnostic functions are available:
  - **Hardware input deactivated:**
    The input is not assigned with any diagnostic function.

The "safe" function is not activated in general because the use of these feedback inputs is optional. Regardless, the function of the input can be configured as brake switch monitors in support of the UCM "uncontrolled movement" detection function. For further information, refer to section *10.4.1 Brake Switch Inputs*.

9 Outputs (configuration / parameter)

9.1 Hardware output configuration

The safety module has 2 digital outputs:

- **Output 1 configuration:** STO feedback
- **Output 2 configuration:** SBC feedback

Output	Function	Description
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.

Table 9.1 *Output configuration*

10 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.

10.1 Priority of the Safety Functions

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

Priority	Description
0	STO is executed, modulation not released (➡ *Functional Description Safe Torque off (STO)*).

Table 10.1 *Priority of the safety functions of the safety module*

10.2 Functional Description Safe Torque off (STO)

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

STO status can be monitored through parameter DG89. Bits 13, 14 and 19, 20 will become active when the STO function is released.

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 avoided by using STO.

In case of error or request, the power semiconductor of the drive module is switched off, and the motor is not supplied, which causes a rotation or torque. The unit can be safe-switched off and/or remain if an error occurs.

⚠ DANGER

Risk of electric shock!

Continue mains voltage with active STO function!

- ▶ Always switch off the power supply before working on the device.
- ▶ Await discharge time.

10.2.1 Emergency Stop According EN 60204

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

- ✓ Stop category 0
- ▶ “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

▶ The drive restarts if function STO is no longer released. To comply with *EN 60204-1*, it must be ensured by external measures that the drive restarts only after confirmation.

Without mechanical brake, the motor will coast to a stop. Additional protective devices must be installed (e.g. locking systems) if damage to persons or property can occur.

⚠ DANGER

Uncontrolled motor in the event of a fault!

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

▶ Block access to the hazardous area.

▶ Wait until the mechanical system stops.

⚠ DANGER

Jerking of the drive in the event of a fault!

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

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

▶ 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 behavior 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.

10.2.2 Response time function activation STO function

- Maximum switch ON delay time: < 4 ms
- Maximum switch OFF delay time: < 4 ms

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).*

10.3 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, refer to manual for the control unit) and switch off in two channels.

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

Different diagnostic functions are provided for testing the brake output (➡ *Brake Actuation Confirmation*) and following.

10.3.1 Requirements for the brake

Voltage Supply	The voltage of the brake must agree with the specification of the 24 V input voltage. The maximum internal voltage drop of 1.2 V at 2 A must be observed.
Max. Current	2 A
Free-wheeling Circuit	Integrated in the internal circuit

The safe brake control is exclusively defined for brakes which are engaged in de-energized conditions. 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!

- Use brakes which are engaged at power-off state.

NOTICE

Check the brake!

- A check of the brake cannot be done completely by the safety module.
- Functions are provided by the safety module that support the user when checking the brake system (➡ *Brake Actuation Confirmation*) and the application examples for it.

⚠ DANGER

Observe safety regulations!

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

10.3.2 Activation of the safety function SBC

The circuit operates on two channels. The brake can only be opened by the functionality of the F6 Elevator Drive. If the safety function SBC is no longer executed. Then, opening the brake is displayed in the status parameter DG90.

10.3.3 Response time function activation SBC function

- **Maximum switch on delay time:** < 4 ms
- **Maximum switch off delay time:** < 5 ms

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 (refer to chapter Reaction Times).*

10.3.4 Status of the SBC function

The current flowing through the brake output 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!

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

⚠ WARNING

No automatic switch-off in case of undercurrent!

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

- In the case of measured insufficient brake current, a switch-off of the modulation must be initiated by the higher-level control system. Modulation is not switched off automatically.

The voltage supply for switching the brake is monitored. If the voltage is outside 24 V ±10 %, an error is output in the error status.

For further information, refer to section *Brake Actuation Confirmation*.

10.3.5 Monitoring of the SBC function

The internal solid-state switches are tested while the brake is released at an interval of 60 seconds. Additionally, the switches are checked continuously while the brake is engaged.

To carry out the test, the signals of the brake outputs are checked by briefly switching off.

NOTICE

Testing the brake output shall not engage the brake!

- Select suitable brake with longer response time.
- Alternatively, if the brake output is driving a contactor or relay, the response must be longer than 10 mSec.

With this monitoring, a short circuit condition to either 24 V or 0 V will be detected. If the safety module detects an error, the safe state (➡ *Safe Condition*) is set.

NOTICE

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

- The maximum diagnosis time is 6 ms.
- In error case, this results in a turn-off time of 6 ms diagnosis time plus 5 ms shutdown delay; 11 ms in total.

For further information, refer to chapter *Reaction Times* and section *Brake* .

10.3.6 Configuration parameters of the safety function SBC

The following table displays the configuration parameters for the SBC function:

SBC: Safe brake control		
Parameter	**Value**	**Unit**
Coupling of SBC with STO	OFF	-
Measurement of the brake current	On	-

Table 10.2 *SBC Parameters*

Parameterization

Coupling of SBC with STO:
If state STO is activated for a safety function, then the brake output is switched off simultaneously. The brake engages.

The coupling is switched off because the safe inputs are configured with dual functions of STO and SBC.

Measurement of the brake current:
The brake output current is measured. If a current higher than 3.3 A is measured, the safety module is transferred into the safe state.

10.4 Brake Actuation Confirmation

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 when the brake output is switched. 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 mechanically engaged or released. The feedback inputs can be used to monitor a brake switch which indicates whether the brake is released or engaged. The feedback input can also be used to monitor the brake contactor which may be driven by the 24 Vdc brake output.

10.4.1 Brake Switch Inputs

Parameter LI20 controls the function of the brake switch feedback inputs on X1C. One or two inputs can be used to monitor the status of the brake switch, or an auxiliary contact on the brake contactor. In addition, this parameter determines the method required to reset the fault. The brake switch inputs are normally active inputs, meaning the input is normally active during the idle state. In this way, the presence of the signal is confirmed prior to the start of operation.

During the idle state, the input must be active. If not, a brake switch failure error will be triggered.

During the start of the run, the input must become inactive within the time period set by LT01 + LT03 + 500 mSec. If not, a brake switch failure error will be triggered.

During the run, the brake switch input should be inactive. If during the run the input becomes active, the run is allowed to be completed. In this case, upon switch-off of the STO inputs, a brake switch failure error will be triggered.

Setting	Description	NUM
Input Active		
Function off	Neither brake switch inputs are active.	0
Brake switch input 1 active	The brake switch input X1C.5 is functionally active.	1

Brake switch input 2 active	The brake switch input X1C.6 is functionally active	2
Fault Response		
General reset	Brake switch faults will automatically reset up to the number of times adjusted in LX01.	0
3 Auto resets	The brake switch fault will only reset three times, regardless of the LX01 setting.	4
Forced reset	A manual reset of the fault on the drive is required. Even after a power cycle, no auto reset is possible. Parameter CH00 Forced Fault Reset will change to a value of 3. It must be manually reset to a value of 0.	8
Default = General reset (0)		

10.4.1.1 Brake Release Confirmation

When LI20 bits 0 or 1 are set, the drive checks to see if the brake opens or closes within a set amount of time via the feedback inputs, otherwise a brake switch failure fault will occur.

The timers are defined as:

Starting:

t = LT01 + LT03 + 2.5

= Brake Release Delay + Speed Start Delay + 2.5 s

Default = 0.05 s + 0.70 s + 2.5 s = 3.25 s

Stopping:

t = LT10 + LT12

= Brake Drop Delay + Current

Default = 0.10 s + 0.50 s = 0.60 s

Two feedback inputs can be programmed for the brake switch. During stop, the switches should be in the closed state and open during the run. If the brake switch is open during Mode = Idle, then a brake switch failure fault will also occur. If during the run, the brake switch closes, the brake switch failure fault will not occur immediately, but will wait until the end of the run. This prevents entrapment of passengers within the elevator. Once the system returns to “Mode = Idle”, the brake switch fault will be triggered.

The fault response to a brake switch failure can be programmed independent from the normal fault response. The adjustment is made in parameter LI20 bits 2 and 3. When bits 2 and 3 are not set, the fault response is the same as all standard faults. Auto reset is determined by the count adjusted in LX01.

When bit 2 (+4) is set, three auto resets of a brake switch fault are permitted. On the fourth fault, a manual fault reset either via the digital inputs or serial/CAN control word is required to put the unit back in operation.

When bit 3 (+8) is set, after one feedback input failure, the drive enters a forced fault reset mode. In this mode, a manual fault reset via digital input or control word is not

possible. Furthermore, a power off cycle will also not reset the fault. In this case, the user must force-reset the fault through parameter CH00.

NOTICE

- In order to comply with EN81.20 clauses 5.6.7.3, 5.9.2.2.2.3 a), and 5.11.1.4, parameter LI20 bit 3 (+8) must be set to ON.

10.4.1.2 Brake Switch Failure Forced Reset

Parameter CH00 Forced Fault Reset, will identify which fault has triggered the forced reset. Also, through this parameter, the forced reset fault may be reset by entering a value of 11.

Motor Type		Setting Options	NUM	Range		Units		Default	Pass Level
Ind.	PM			Min.	Max.	Imp.	Met.		
RW	RW	**Forced Fault Reset**		0	11	-	-	0	User
		No Forced Fault Reset	0						
		Brake Switch 1 Fault Open	1						
		Brake Switch 2 Fault Open	2						
		Brake Switch 1 Fault Closed	3						
		Brake Switch 2 Fault Closed	4						
		Unintended Motion Fault	5						
		Reserved	6						
		Reserved	7						
		Reserved	8						
		Reserved	9						
		Reserved	10						
		Reset Fault	11						

Values 1 through 9 are set internally by the lift application to indicate which fault was triggered.

The value of 11 is set by the user to reset the forced reset fault.

The value of 0 indicates there is no active forced reset fault.

11 Wiring Examples

11.1 SM5 Interface A17.1

11.1.1 Method 1: Motor Contactor Replacement

- STO via motor contact control signal
- SBC via safety chain

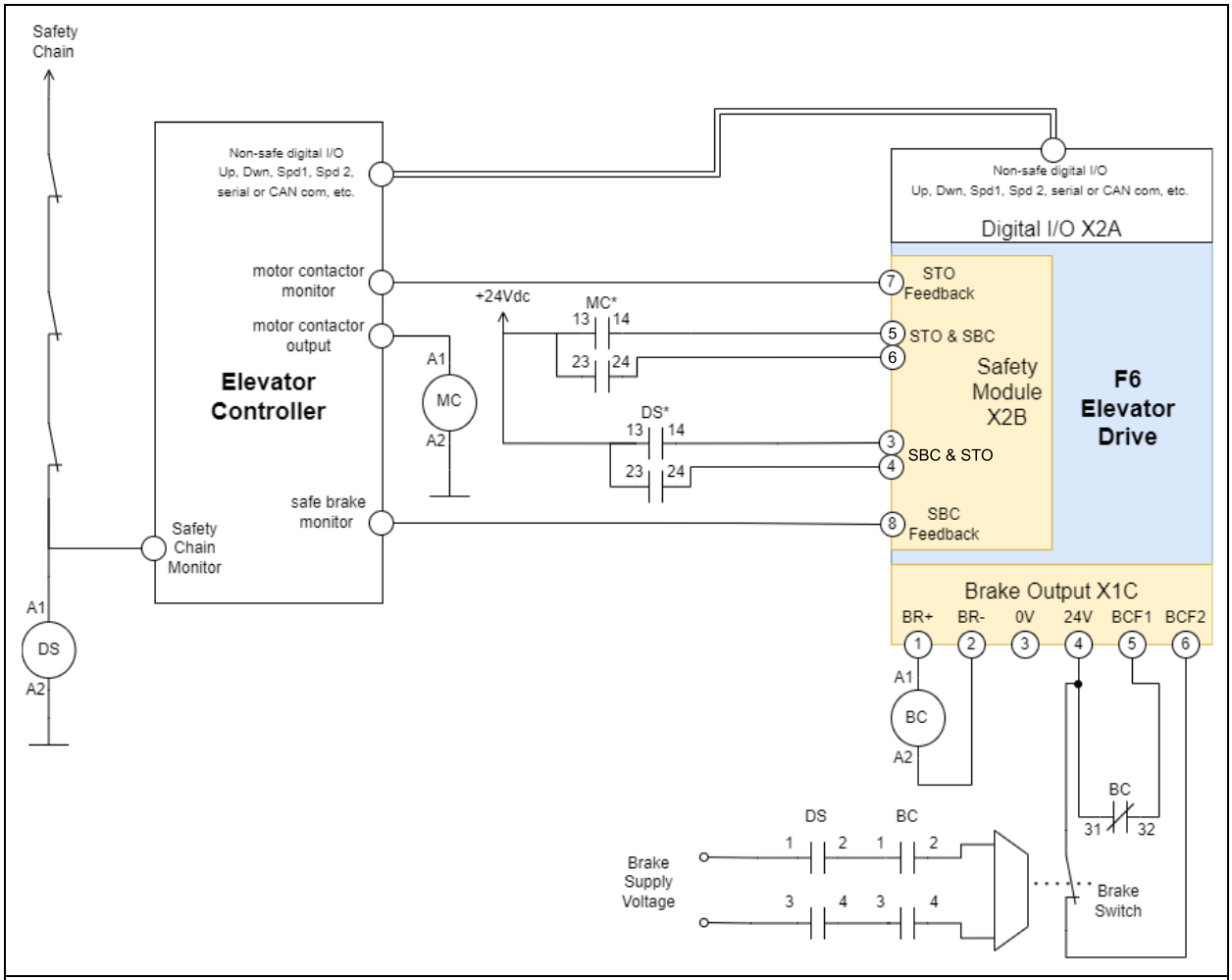


Figure 11.1 *A17.1 Motor contactor replacement*

** The MC relay must be force-guided or safety relays DS and BC are contactor.*

11.1.2 Method 2: Solid State Dual Channel STO Control

- STO - dual channel solid state safety output from elevator controller
- SBC - control via contactor and safety chain

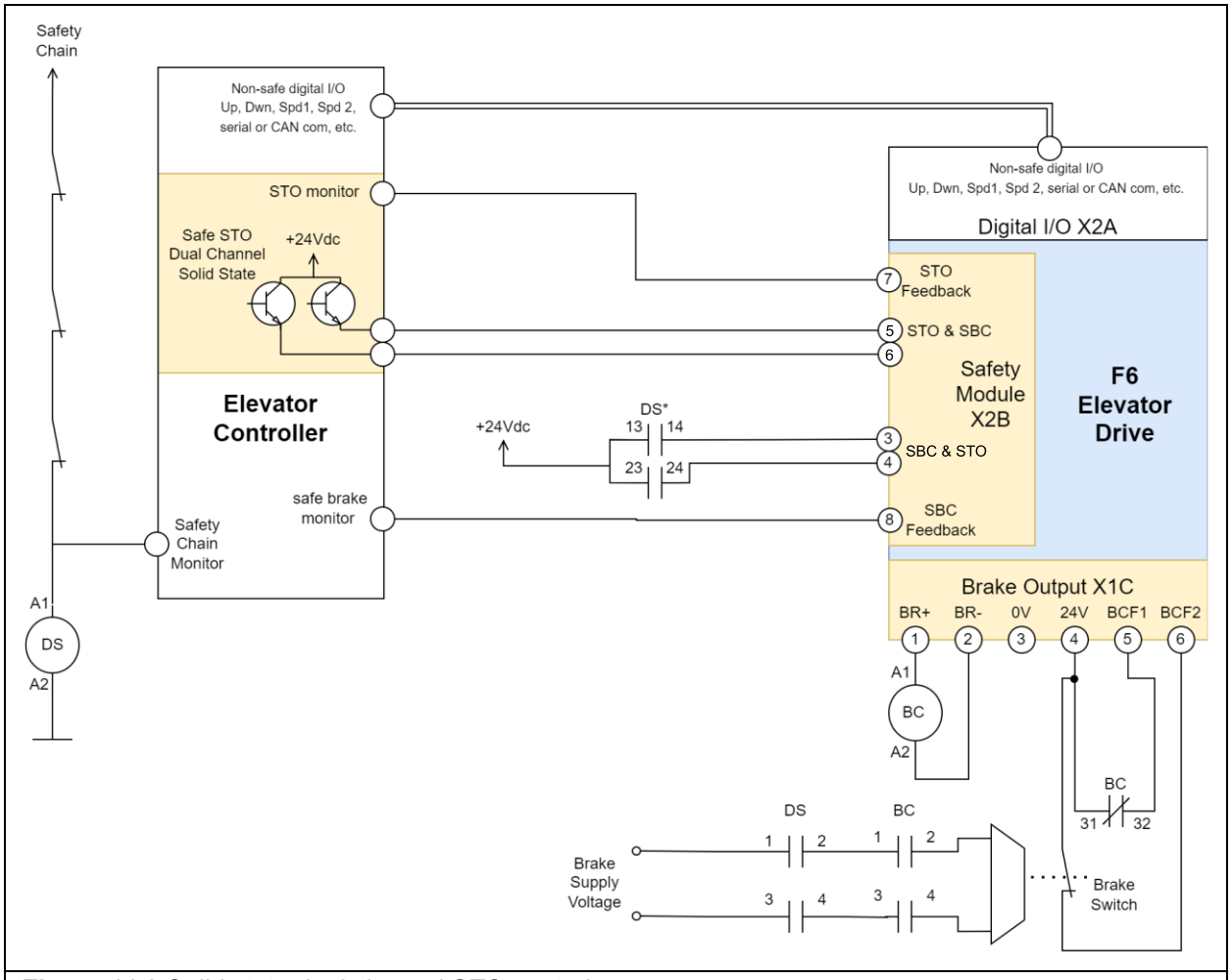


Figure 11.2 *Solid state dual channel STO control*

** The DS and BC relays are contactors.*

11.1.3 Method 3: Full Solid State Dual Channel STO and SBC Control

- STO - dual channel solid state safety output from elevator controller
- SBC - dual channel solid state safety output from elevator controller

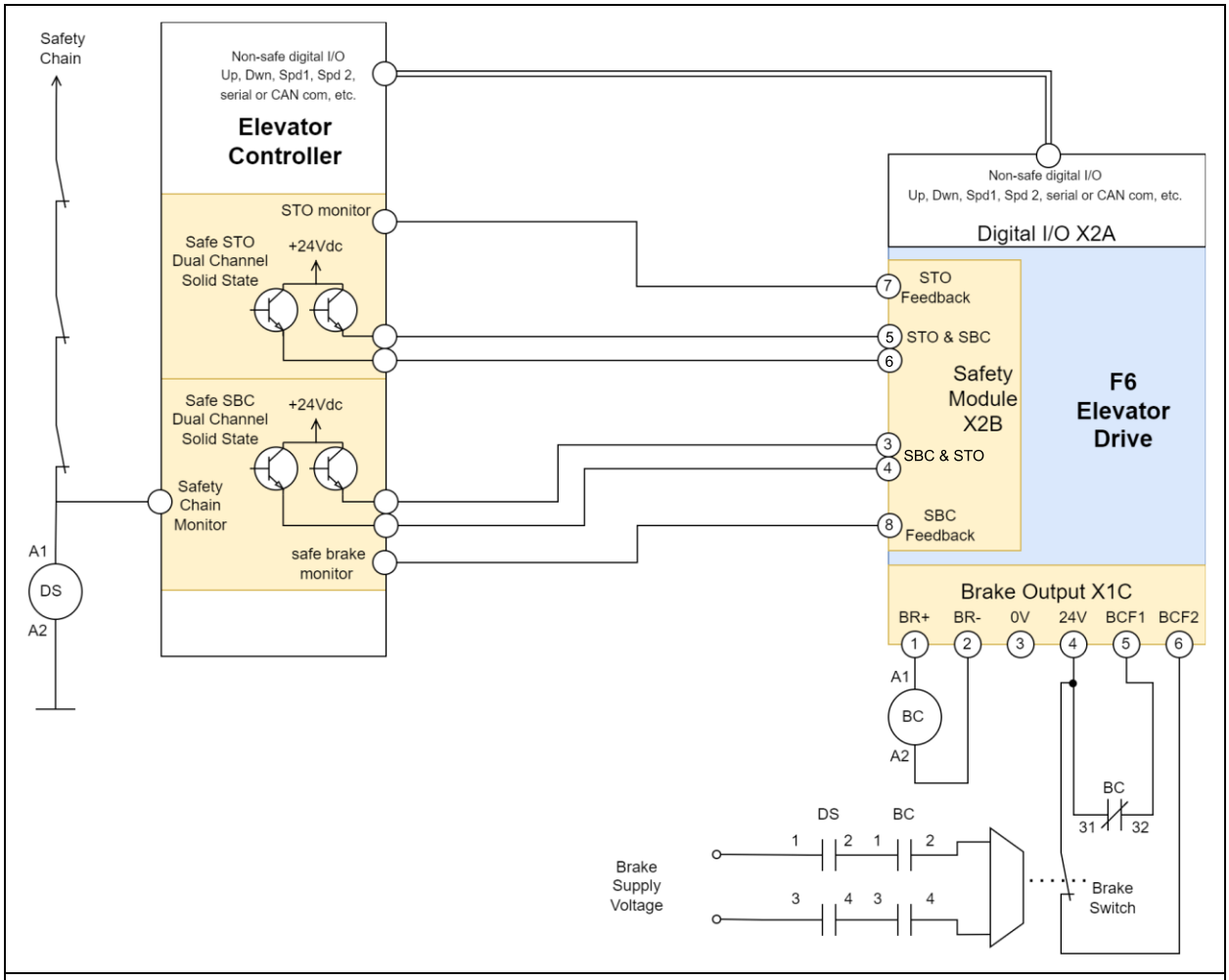


Figure 11.3 *Full solid state dual channel STO and SBC control*

** The DS and BC relays are contactors.*

11.1.4 Method 4: Full Solid State Dual Channel STO and SBC Control with 24 Vdc Brake

- STO - dual channel solid state safety output from elevator controller
- SBC - dual channel solid state safety output from elevator controller

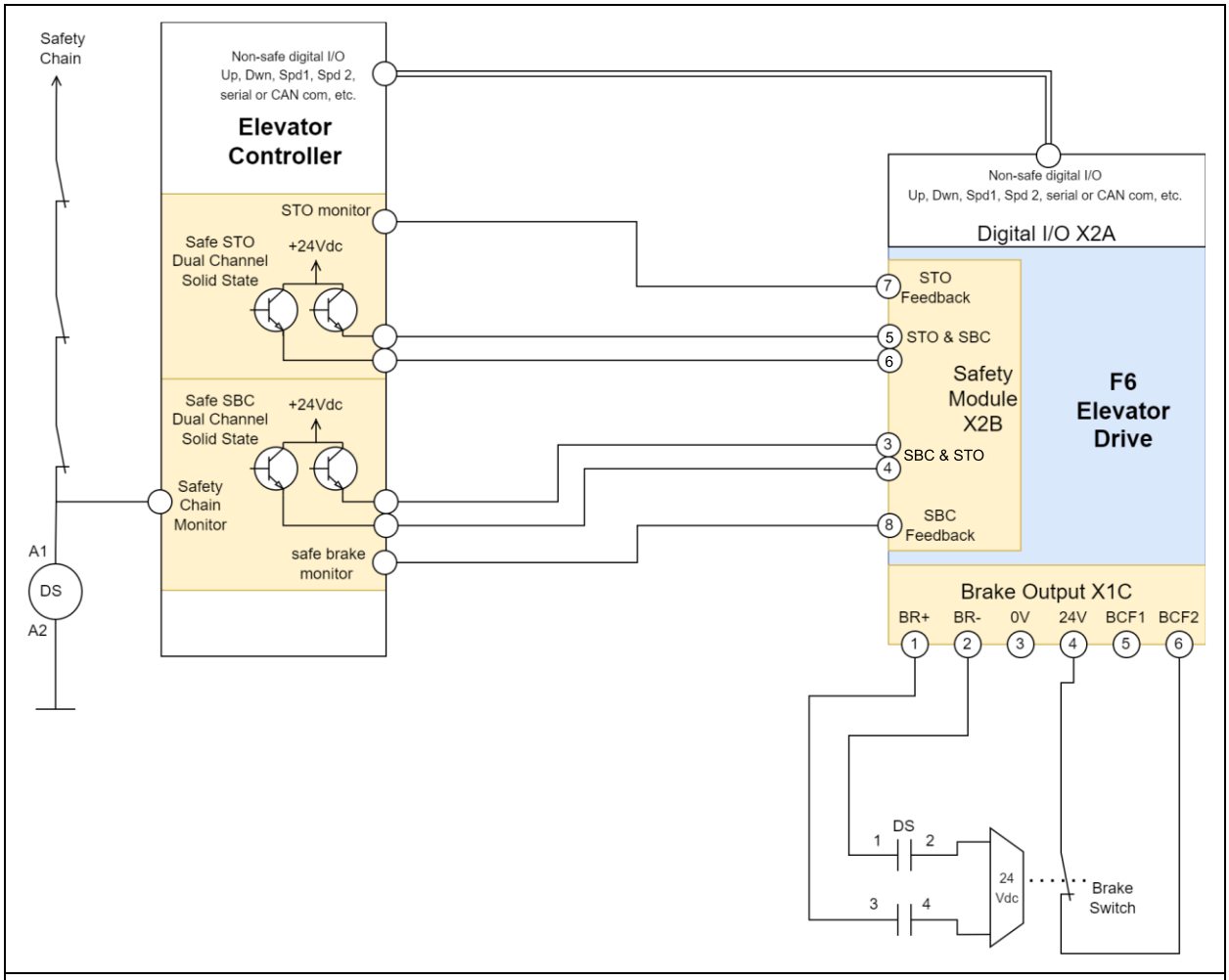


Figure 11.4 *Full solid state dual Channel STO and SBC control with 24 Vdc brake*

** The DS relay is a contactor.*

11.2 SM5 Interface EN81

11.2.1 Method 1: Motor Contactor Replacement

- STO via motor contactor control signals, SBC via brake contactor control signals.
- The MR1 relay is a standard relay. Signal congruence is checked via the dual channel STO input. Signals must match within 500 mSec second of switching.
- BC1 and BC2 are normal brake contactors. SBC is a standard relay. Signal congruence is checked via the dual channel SBC input. Signals must match within 500 mSec second of switching.
- BC2 could also be used to drive the hydraulic value.
- The status of the STO and SBC safety functions are monitored by controller using the feedback signals.

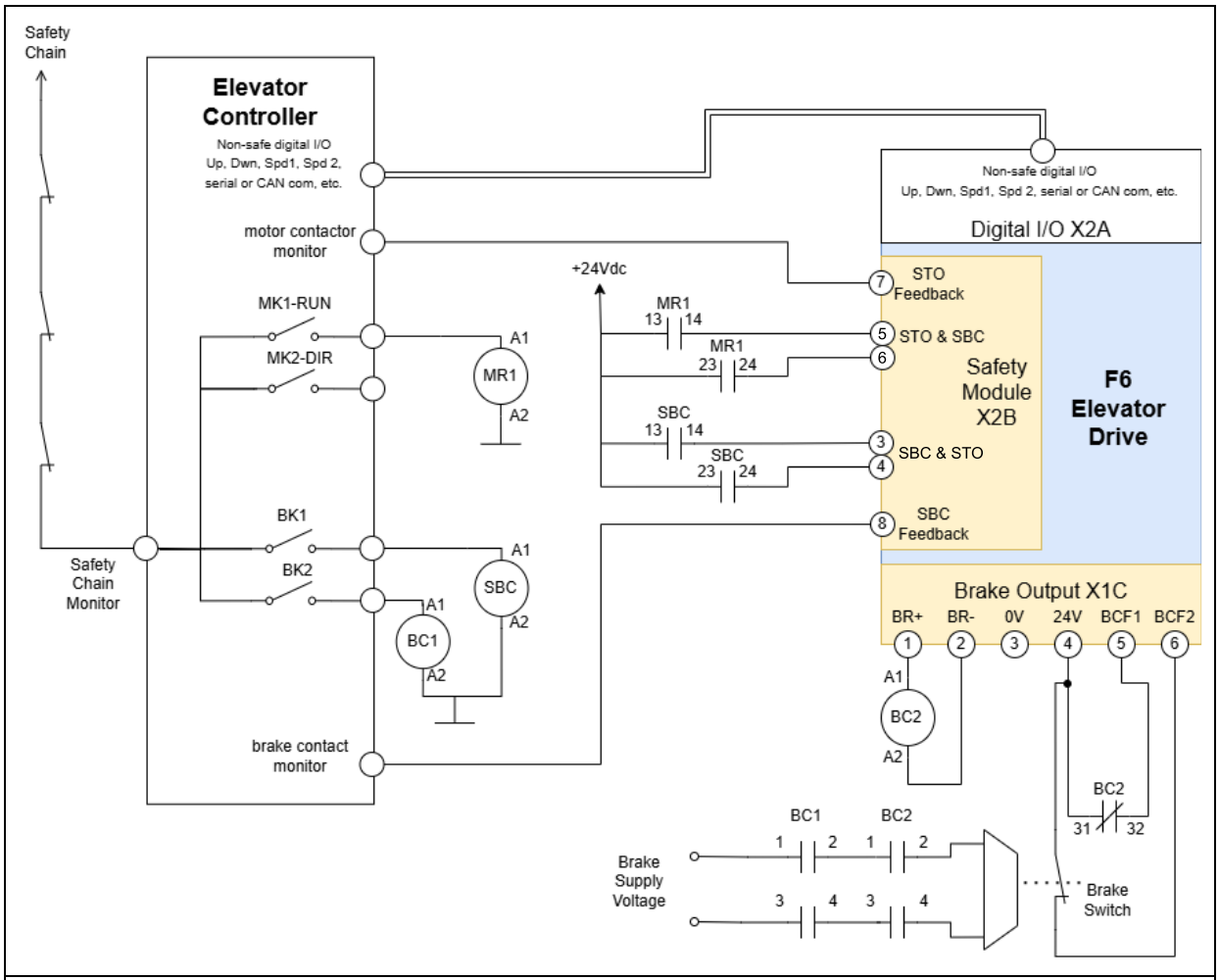


Figure 11.5 *EN81 Motor contactor replacement*

11.2.2 Method 2: Motor Contactor Replacement with 24 Vdc Brake

- STO via motor contactor control signals, SBC via brake contactor control signals.
- The MR1 relay is a standard relay. Signal congruence is checked via the dual channel STO input. Signals must match within 500 mSec of switching.
- BC1 is a normal brake contactor. SBC is a standard relay. Signal congruence is checked via the dual channel SBC input. Signals must match within 500 mSec of switching.
- The status of the STO and SBC safety functions are monitored by controller using the feedback signals.

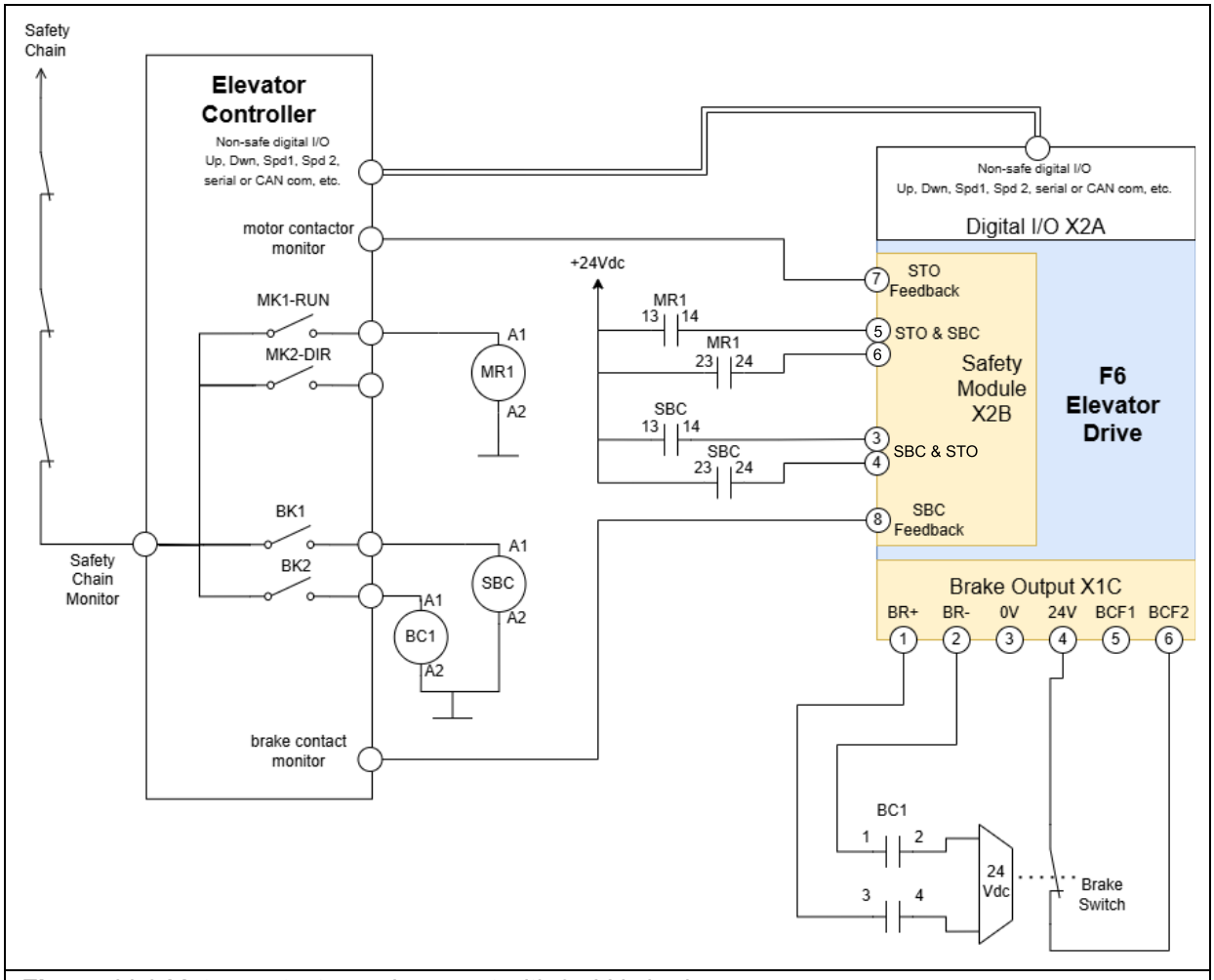


Figure 11.6 *Motor contactor replacement with 24 Vdc brake*

11.2.3 Method 3: Solid-state STO Control, SBC by Safety Chain

- STO via dual channel safety output, SBC via brake contactor control signals.
- The dual channel safety output from the controller must provide 24 Vdc when the output is active. Signal congruence is checked via the dual channel STO input. Signals must match within 500 mSec second of switching.
- BC1 and BC2 are normal brake contactors. SBC is a standard relay. Signal congruence is checked via the dual channel SBC input. Signals must match within 500 mSec second of switching.
- BC2 could also be used to drive the hydraulic value.
- The status of the STO and SBC safety functions are monitored by controller using the feedback signals.

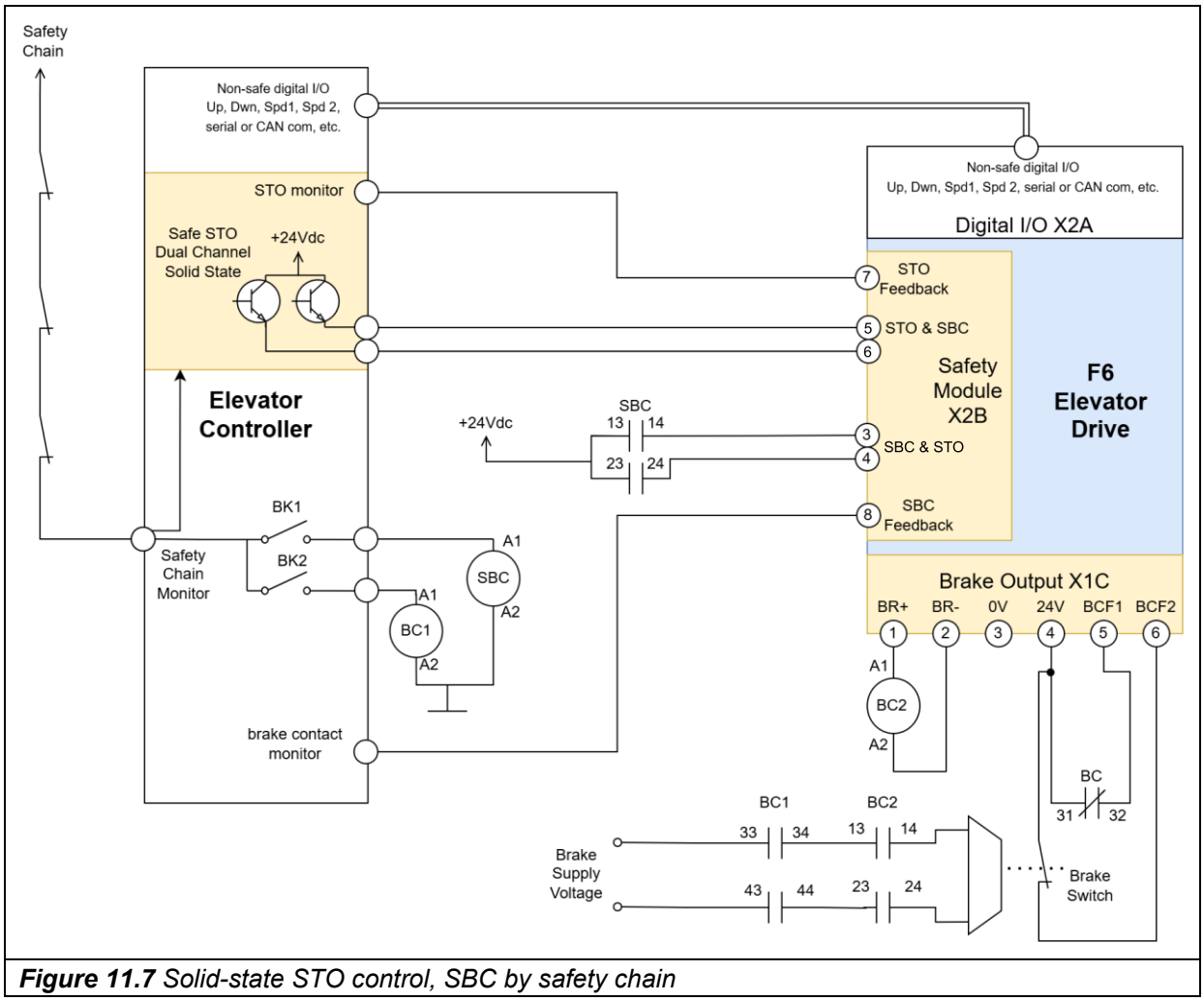


Figure 11.7 *Solid-state STO control, SBC by safety chain*

12 Acceptance Tests and Configuration Check

The final acceptance and validation of the safety functions shall be performed to ensure the complete elevator system is safe for use. While some tests can be performed in advance by the control manufacturer, other tests must be carried out in the field.

12.1 Method of the Acceptance Tests

The acceptance test is used to validate the configured safety function with regard to the system behavior. To this end, the limits of the safety function are triggered systematically, and the error response is recorded.

12.2 Inspector

A person must be determined as inspector or AHJ (Authority Having Jurisdiction), who is able to carry out the test due to their technical training and knowledge of the safety requirements.

12.3 Protocol of the acceptance test

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

12.4 Execution of the acceptance test

The following shall be documented as part of the execution of the acceptance test:

- Description of the system.
- Documentation of the system and safety devices.
- Document the safety module software version, and configuration CRC code.
- Check functionality of the used safety functions (functional test):
  - STO: Check function “Safe torque off”.
  - SBC: Check function “Safe brake control”.
- Document the results of the functional tests.
- Declare the safety functions valid for use in the report.
- Note the name of the inspectors including signature.
- A copy of the report shall remain with the controller.

13 Maintenance and modifications at the safety module

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

NOTICE

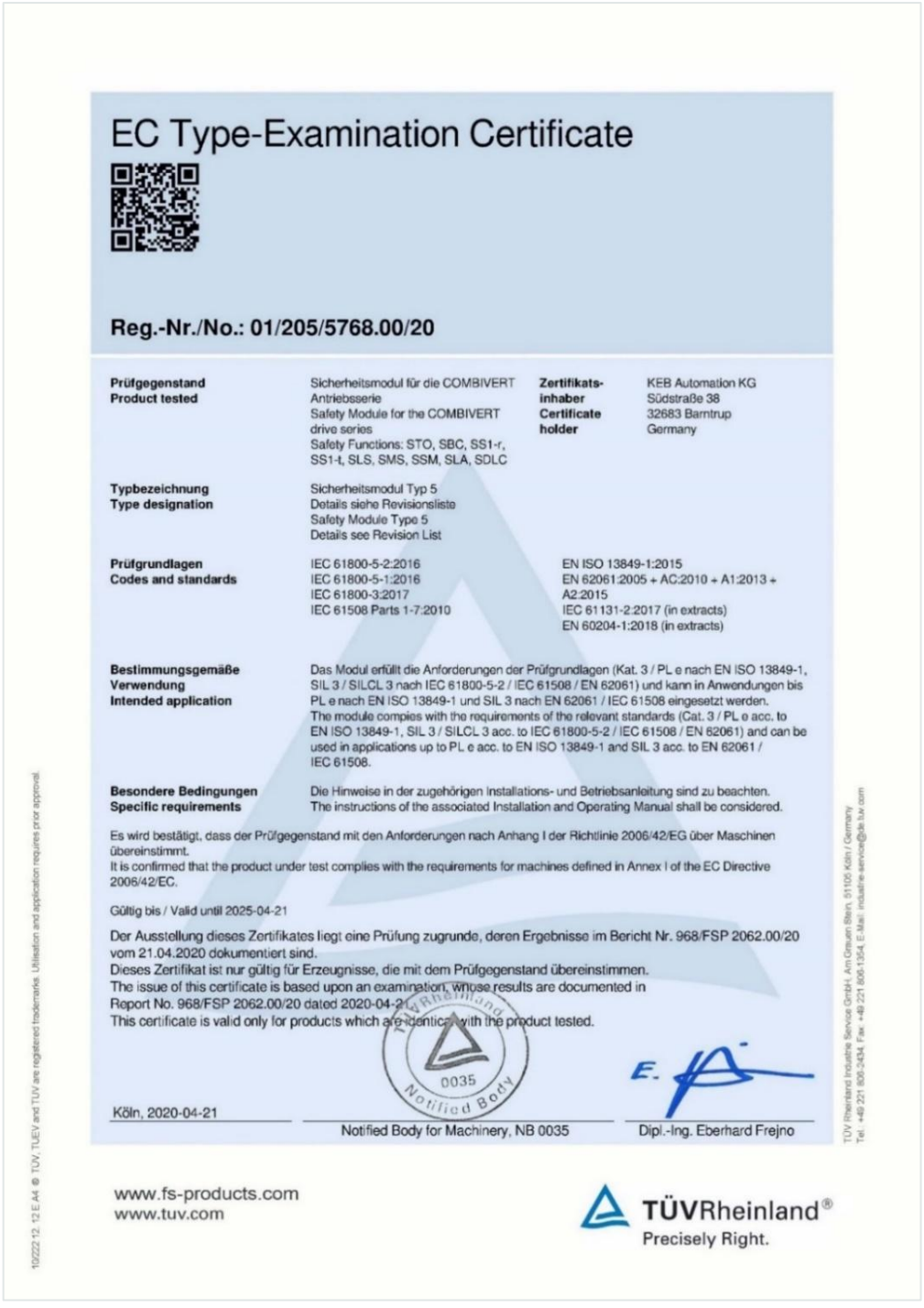
Manipulations!

- Any manipulation of the components within the F6 Elevator Drive, results in the invalidation of the functional safety certification and any implied warranty by KEB.

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

14 Appendix

14.1 Appendix A: 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 complies 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.

Köln, 2020-04-21

Notified Body for Machinery, NB 0035

Dipl.-Ing. Eberhard Frejno

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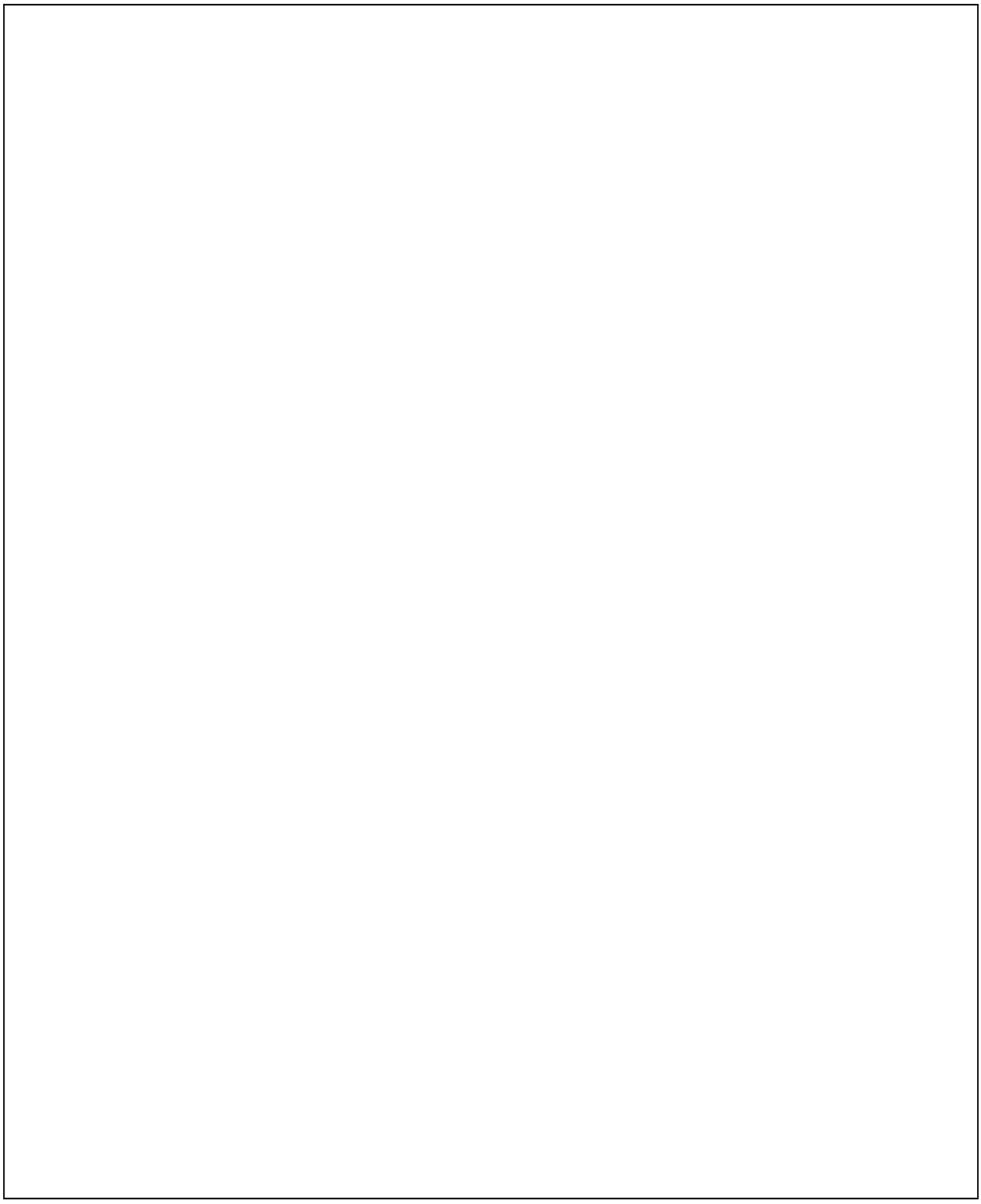
14.2 Appendix B: Declaration of Compliance F6 Elevator Drive



15 Annex: Acceptance Test Form Template

The following form can be used to document the acceptance test:

Date	
Inspector Name	
Inspection Authority / Organization	
F6 Elevator Drive Model Number	
F6 Elevator Drive Serial Number	
Job Site Information or Type Test	

Comments regarding the tests

Upon successful completion of tests 1 through 7 on the following pages, this document certifies that the functional safety mechanisms within the KEB F6 Series Elevator Drive are operating correctly. When used as described, these functions fulfill the code requirements listed in the sections below.

EN81 – 20	**A17.1 / B44**
5.9.2.2.2.3 a) 2), 5.9.2.2.2.3 e)	2.26.9.3.1, 2.26.9.3.2
5.9.2.5.4 d),	2.26.9.4
5.9.3.4.4	2.26.9.6.1, 2.26.9.6.2
5.11.2.1.1	2.26.8.1, 2.26.8.2
5.11.2.4	

Signed: _____ Date: _____

Name: _____ Stamp:

Test Number	Test Title	Safety Module Firmware Validation
1	**Test Objective**	Confirm the firmware installed in the safety module is the correct version.
	Process	Using the keypad/operator on the drive or the KEB COMBIVIS PC software, navigate to the parameters DE42 VFD – Safety Software Version and DE43 VFD- Safety Software Date. Read the values and record them below under “Actual Result”.
	Expected Result	DE42 = 5.5.0.8, DE43 = 21.12.2022
	Actual Result	
	Pass / Fail	PASS ☐ FAIL ☐

Test Number	Test Title	Safety Module Configuration Validation
2	**Test Objective**	Confirm the safety module has been configured correctly. Note: this configuration is performed at the factory.
	Process	Using the keypad/operator on the drive or the KEB COMBIVIS PC software, navigate to the parameter DE41 VFD – Safety CRC. Read the value and record it below under “Actual Result”.
	Expected Result	DE41 = 21BEB750
	Actual Result	
	Pass / Fail	PASS ☐ FAIL ☐

Test Number	Test Title	STO validation
3	**Test Objective**	Confirm the STO (Safe Torque Off) safety function blocks current flow to the motor.
	Process	1. Prepare the elevator and controller such that it is possible to run on inspection. 2. Remove both STO signal wires from terminal connection X2B.5 and X2B.6. 3. Install an AC current meter on one of the output phases of the drive. 4. Attempt to operate the elevator on inspection.
	Expected Result	• Drive mode Parameter DG50 remains at 0:IDLE. • The motor brake shall not release. • The STO output, terminal X2B.7 shall remain at 24 V indicating the STO function is active. • The AC motor current shall remain less than one amp.
	Actual Result	
	Pass / Fail	PASS ☐ FAIL ☐

Test Number	Test Title	STO Chanel Congruence Test
4	**Test Objective**	Confirms the signal congruence test between the two STO channels.
	Process	1. Prepare the elevator and controller such that it is possible to run on inspection. 2. Remove the STO signal wire from terminal connection X2B.5. 3. Install an AC current meter on one of the output phases of the drive. 4. Attempt to operate the elevator on inspection. 5. Repeat the test replacing the signal wire in terminal X2B.5 and removing the signal wire in terminal X2B.6.
	Expected Result	• Drive mode parameter DG50 remains at 0:IDLE. • System status parameter DG90 should display “4449:Tolerance time for Function 1 input expired”. • The motor brake shall not release. • The STO output, terminal X2B.7 shall remain at 24 V indicating the STO function is active. • The AC motor current shall remain less than one amp. • The FS ST LED color should change to RED indication a safety fault. • The repeated test should yield the same results.
	Actual Result	
	Pass / Fail	PASS ☐ FAIL ☐
	Notes	Because this test triggers a safety fault, the drive will need to be power cycled to clear the fault and continue.

Test Number	Test Title	SBC Validation
5	**Test Objective**	Confirm the SBC (Safe Brake Control) safety function prevents the brake from releasing.
	Process	1. Prepare the elevator and controller such that it is possible to run on inspection. 2. Remove both SBC signal wires from terminal connection X2B.3 and X2B.4. 3. Install a DC voltmeter on the brake control outputs BR+(X1C.1), BR-(X1C.2). 4. Attempt to operate the elevator on inspection.
	Expected Result	• Drive mode Parameter DG50 remains at 0:IDLE. • The motor brake shall not release. • The SBC output, terminal X2B.8 shall remain at 24 V, indicating the SBC function is active. • The DC voltmeter measuring the brake output at BR+ and BR- shall indicate a voltage less than 0.5 V.
	Actual Result	
	Pass / Fail	PASS ☐ FAIL ☐

Test Number	Test Title	SBC Channel Congruence Test
6	**Test Objective**	Confirms the signal congruence test between the two SBC channels.
	Process	1. Prepare the elevator and controller such that it is possible to run on inspection. 2. Remove the SBC signal wire from terminal connection X2B.3. 3. Install a DC voltmeter on the brake control outputs BR+(X1C.1), BR-(X1C.2). 4. Attempt to operate the elevator on inspection. 5. Repeat the test replacing the signal wire in terminal X2B.3 and removing the signal wire in terminal X2B.4.
	Expected Result	• Drive mode parameter DG50 remains at 0:IDLE. • System status parameter DG90 should display “4417:Tolerance time for Function 2 input expired”. • The motor brake shall not release. • The SBC output terminal X2B.8 shall remain at 24 V, indicating the SBC function is active. • The DC voltmeter measuring the brake output at BR+ and BR- shall indicate a voltage less than 0.5 V. • The FS ST LED color should change to RED indication a safety fault. • The repeated test should yield the same results.
	Actual Result	
	Pass / Fail	PASS ☐ FAIL ☐
	Notes	Because this test triggers a safety fault, the drive will need to be power cycled to clear the fault and continue.

Test Number	Test Title	SBC BR+ Output Test
7	**Test Objective**	Confirms the state monitor of the BR+ (X1C.1) brake output.
	Process	1. This test is conducted with the elevator in the idle state. It is not necessary to operate the elevator for this test. 2. Add a signal wire to the BR+ (X1C.1) circuit and then momentarily connect it to the +24 V supply at terminal X1C.4.
	Expected Result	• Drive mode parameter DG50 remains at 0:IDLE. • System status parameter DG90 should display 7025:Error in the brake+ safety output. • The motor brake shall not release. • The SBC output terminal X2B.8 shall remain at 24 V, indicating the SBC function is active. • The FS ST LED color should change to RED indication a safety fault.
	Actual Result	
	Pass / Fail	PASS ☐ FAIL ☐
	Notes	Because this test triggers a safety fault, the drive will need to be power cycled to clear the fault and continue.

Test Number	Test Title	Brake Monitoring Test
8	**Test Objective**	Confirms the state monitor of the BR- (X1C.2) brake output.
	Process	1. This test is conducted with the elevator in the idle state. It is not necessary to operate the elevator for this test. 2. Add a signal wire to the BR- (X1C.2) circuit and then momentarily connect it to the 0 V supply at terminal X1C.3.
	Expected Result	• Drive mode parameter DG50 remains at 0:IDLE. • System status parameter DG90 should display “7026:Error in the brake- safety output”. • The motor brake shall not release. • The SBC output terminal X2B.8 shall remain at 24 V, indicating the SBC function is active. • The FS ST LED color should change to RED indication a safety fault.
	Actual Result	
	Pass / Fail	PASS ☐ FAIL ☐
	Notes	Because this test triggers a safety fault, the drive will need to be power cycled to clear the fault and continue.

Test Number	Test Title	SBC BR- Output Test
9	**Test Objective**	Confirms the functionality of the brake feedback inputs (X1C.5) and (X1C.6). The functionality is optional and therefore must be activated through programming parameter LI20. The test assumes feedback input X1C.5 is programed as a brake feedback input.
	Process	• This test is conducted with the elevator in the idle state. It is not necessary to operate the elevator for this test. • Verify LI20 is set to a value of 9 (1:BRK SW 1 Active + 8: Forced Reset). • The input requires a normally active signal (NC brake switch) while the elevator is in the idle state. Under this condition, the elevator drive should be in the idle state with no indicated faults. 1. To start the test, remove the signal wire at terminal X1C.5. 2. Replace the signal wire into terminal X1C.5 in order to attempt to reset the fault. 3. Attempt manual reset via the elevator control. 4. Turn the supply voltage off, wait for the drive to completely power down, then switch the supply voltage back on. 5. Navigate to parameter CH00 and enter the value “11:Reset Fault”.
	Expected Result	1. After removal of the wire, the drive shall trigger a fault indicating “Brake switch 1 faulted open”. 2. Replacement of the wire shall not change the fault condition of the drive. 3. Manual reset via the elevator control shall not clear the fault condition from the drive. 4. Power cycling the supply voltage shall not clear the fault condition from the drive. 5. After entering 11:Reset Fault in parameter CH00, the fault condition of the drive shall clear, and normal operation shall resume.
	Actual Result	
	Pass / Fail	PASS ☐ FAIL ☐

	Notes	• This test can be repeated for the second feedback input XC1.6. • In this case, LI20 shall be set to a value of 10 (2:BRK SW 2 Active + 8: Forced Reset). • The brake switch signal shall be wired to terminal XC1.6. • The wire removed to conduct the test is the wire on terminal XC1.6. • The error message shall be “Brake switch 2 faulted open”. • All other expected results shall be the same.

16 Revision History

Version	Description	Date
00	Preliminary version	04/2025
01	• Updated technical language and specifications throughout. • Updated wiring example diagrams.	04/2026
02	• Updated cover image and format. • Updated technical specifications throughout.	05/2026

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