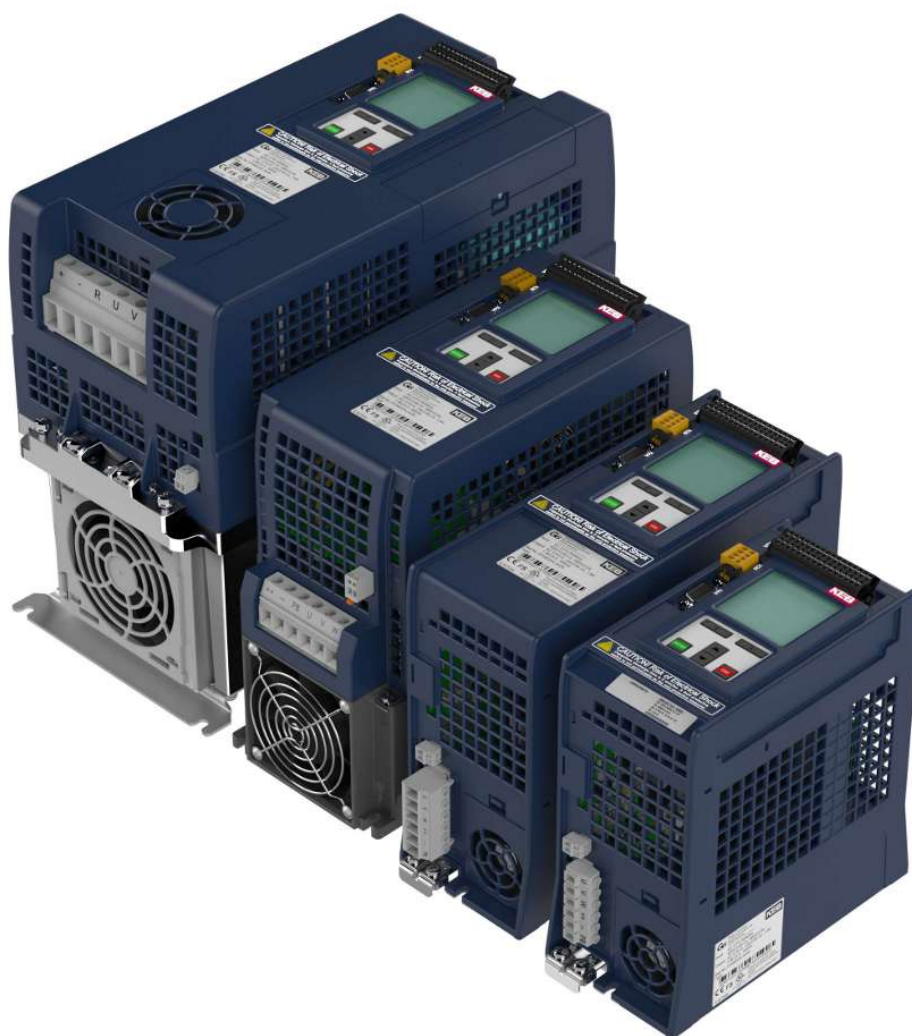




Safety Manual

COMBIVERT G6

SAFETY FUNCTION SSM WITH LEVEL $f=0$ Hz

Translation of the original manual

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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 there-after. There is safety information 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. The barcode is for smartphones, the following link is for online users or for typing.

( <https://www.keb-automation.com/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
(≡► Refe [► 5])	Reference to a chapter, table or picture with page reference
ru21	Parameter name or parameter index
(🌐►)	Hyperlink
<Strg>	Control code
COMBIVERT	Glossary 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-automation.com/terms-conditions>)



Further agreements or specifications require a written confirmation.

1.4 Support

Through multiple applications, not every possible 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 support provided verbally, written or through testing, is made to the best of our knowledge and information regarding intended use of KEB products. However, due to technical changes, any information provided is considered non-binding and is subject to change. This also applies to any violation of industrial property rights of a third-party.

Selection of KEB units in view of their suitability for the intended use must be done 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

The customer may use the instructions for use and other documents accompanying the device or parts thereof for internal purposes. Copyrights are with KEB Automation KG and remain valid in its entirety.

Other word and/or figurative marks are trademarks (™) or registered trademarks (®) of their respective owners.

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.

NOTICE



Use of suitable voltage sources!

Electric shock!

- a) Only use voltage sources with protective separation (SELV/PELV) in accordance with VDE 0100 as per the stated specification.
- b) Pay attention to a sufficient overvoltage category of the voltage supply.
- c) With existing or newly-wired circuits the person installing the device or machine must ensure that the PELV requirements are met.

For a successful operation, please read the following instructions:

- The electrical installation shall be carried out in accordance with the relevant requirements.
- Cable cross-sections and fuses must be dimensioned by the user according to the specified minimum/maximum values for the application.
- For drive controllers that are not isolated from the supply circuit (in accordance with EN 61800-5-1) all control lines must be included in other protective measures (e.g. double insulation or shielded, earthed and insulated).
- When using components without isolated inputs/outputs, it is necessary that equipotential bonding exists between the components to be connected (e.g. by the equipotential line). Disregard can cause destruction of the components by equalizing currents.

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 2006/42/EG and 2014/30/EU; EN 60204-1 must be observed.

WARNING



Wrong parameterization

Unintentional behaviour of the drive

- ✓ During initial start-up or replacement of the drive controller:
 - a) Secure motors against automatic restart.
 - b) Check whether the appropriate parameter list for the application has been imported.
-

WARNING

Software protection functions as sole protection.

Protection function in case of software problems without function.

- ✓ Securing a unit solely with software-supported functions is not sufficient.
 - a) Install external protective measures (e.g. limit switch) that are independent of the drive controller.
-

2.3 Maintenance

DANGER

Unauthorized exchange, repair and modifications

Unpredictable malfunctions

- a) The function of the drive controller is dependent on its parameterisation. Never replace without knowledge of the application.
 - b) Modification or repair is permitted only by KEB Automation KG authorized personnel.
 - c) Only use original manufacturer parts.
 - d) Infringement will annul the liability for resulting consequences.
-

3 Product Description

3.1 Safety function SSM with level f=0 Hz

The following safety manual describes the function of a safe output on the condition that an encoderless drive is brought into standstill. This safe output shall control at internal driven motors e.g. for safety door locking.

The COMBIVERT G6, featuring the SSM safe output with a level of f=0 Hz, meets the requirements for Performance Level c (ISO13849-1) and SIL1 (IEC 61508 & IEC 62061).

In case of proper project design, installation and operation the safety function protects people against injured by moving parts.

FS	NOTICE! Validity of certificates
	Certification of actuators incorporating safety technology from May 2013 onwards is only valid if the material number corresponds to the specified type code and the FS logo is printed on the type plate.

COMBIVERT G6 drive controller with SSM with level f=0 Hz correspond to the following numerical code:

xx	G6	x	x	x	-	xxxx	
							H, I, L

Tab. 1: Product code

3.2 Classification of SSM according IEC 61508

PFH	$2.36 \cdot 10^{-7}$ 1/h
PFD	$4.6 \cdot 10^{-2}$ on demand
Proof-Test-Interval	20 years

For SIL classification in connection with the applications consider the failure rates of the external switch devices for final evaluation.

3.3 Classification of SSM according EN ISO 13849

Category	2
MTTF(D)	>400 years
DC	low

For the classification within a performance level in connection with the applications consider the failure rates of the external switch devices for final evaluation.

4 Safety function SSM with level f=0 Hz

4.1 Functional Description

A switching condition for an output may only be set when the drive is at a safe standstill. This is implemented by the safety function SSM with level f=0 Hz.

In order that the safety function SSM with level f=0 Hz is fulfilled, the drive must be brought into standstill with the following requirements:

- Decelerate the drive with ramp.
- Activate DC braking function (Pn28).
- DC-Bremszeit (Pn30) für mindestens 2 s auslösen (empfohlen: 3 s).
- Adjust DC braking current via DC braking voltage (Pn31) (observe maximum current limits and minimum modulation level).
- The drive must be reliably brought to a standstill in the first 2 s of the DC braking time.
- Deactivation of modulation.
- Message of the standstill via two series-connected relay outputs (see application examples).
- The exact setting instructions can be found on the following pages.

4.2 Adjustment of the deceleration ramps

Deceleration ramps are generated from the ramp time plus s-curve times and the minimum and maximum setpoint. They can be preset separately for both directions of rotation. See the instructions for use or the programming manual for details.

Target setting:

- The drive must **be capable of following** the deceleration ramps (no hardware current control in controlled mode, and no torque limitation in regulated mode during the ramps).
- The minimum current at breakdown torque of the asynchronous motor must be higher than the hardware current limit (E.OC) of the drive controller.
- **After the end of the deceleration ramp the drive must be stopped at maximum occurring inertia within at least 2 seconds by DC braking.**
- If a DC braking time of less than 2 seconds is specified, the output from the 0Hz relay is not reliably set.

4.3 DC braking

DC braking is only possible for open-loop units or in open-loop mode. At closed-loop mode it does automatically switch into the open-loop mode at DC braking.

- With DC braking, the motor is not decelerated via a ramp.
- With DC braking, a rapid deceleration is achieved by applying a DC voltage to the motor windings.
- When DC braking is activated, modulation is switched off.
- When DC braking is activated, the motor deceleration time is allowed to elapse if the braking time is dependent on the actual value.

- When DC braking is activated, DC voltage is applied to the motor (modulation re-enabled).

The following parameters define the function of the DC braking for SSM:

Index	Id-Text	Name	Function
0x241C	Pn28	DC braking mode	defines whereby the DC braking is triggered.
0x241E	Pn30	DC braking time	defines the braking time (either direct or depending on the actual value)
0x241F	Pn31	DC braking max. voltage	Limits the maximum braking voltage
0x2420	Pn32	DC braking start level	"Start level" adjusts the speed/frequency which triggers the DC braking when falling below (depending on Pn28).

4.3.1 Triggering of DC braking

Pn28	DC Brake Mode (0x241C)	
Value	Function	Triggering of DC braking
0	no DC braking	never
1	no direction of rotation + actual value ($\Rightarrow$ Direct setting of the braking time ► 12)	If no direction of rotation is preset and ru02 „ramp output display“ has reached 0 Hz (or 0 min-1) The braking time is independent of the actual value ru02. It is preset directly with Pn30. The DC braking is interrupted when a new rotation setting is given.
2...3	-	Do not use at SSM !
4	no direction of rotation + actual value < Pn32	If no direction of rotation is specified and ru02 'Ramp output display' has fallen below the 'DC brake start value' (Pn32). The braking time is dependent on the actual value ru02. The setting occurs via Pn30 and Pn32. The DC braking is not interrupted when a new rotation setting is given.
5...500		Do not use at SSM !

4.3.2 Adjustment of the braking time

NOTICE

Please note the minimum braking time!

- In order that the safety function SSM is fulfilled, the drive must be brought into standstill within two seconds via DC braking.
- Due to control processes of the braking current, the setting of a braking time of ≥ 3 s is recommended that the DC braking is reliably detected.

4.3.2.2 Setting of the actual value-dependent braking time

Pn30	DC Brake Time (0x241E)
Value	Meaning
0...100.00 s Setting ≥ 3 s (recommended)	The braking time is dependent on the actual value at Pn28 = "4". The braking time behaves according to the following formula: Braking time = (Pn30 $\times$ Pn32) / reference value

The reference value is determined from the adjusted mode in ud02.

ud02	Pn32	Reference value
400 Hz	0...400 Hz	100 Hz
800 Hz	0...800 Hz	200 Hz
4000 min-1	0...4000 min-1	1000 min-1
8000 min-1	0...8000 min-1	2000 min-1
16000 min-1	0...16000 min-1	4000 min-1
32000 min-1	0...32000 min-1	8000 min-1

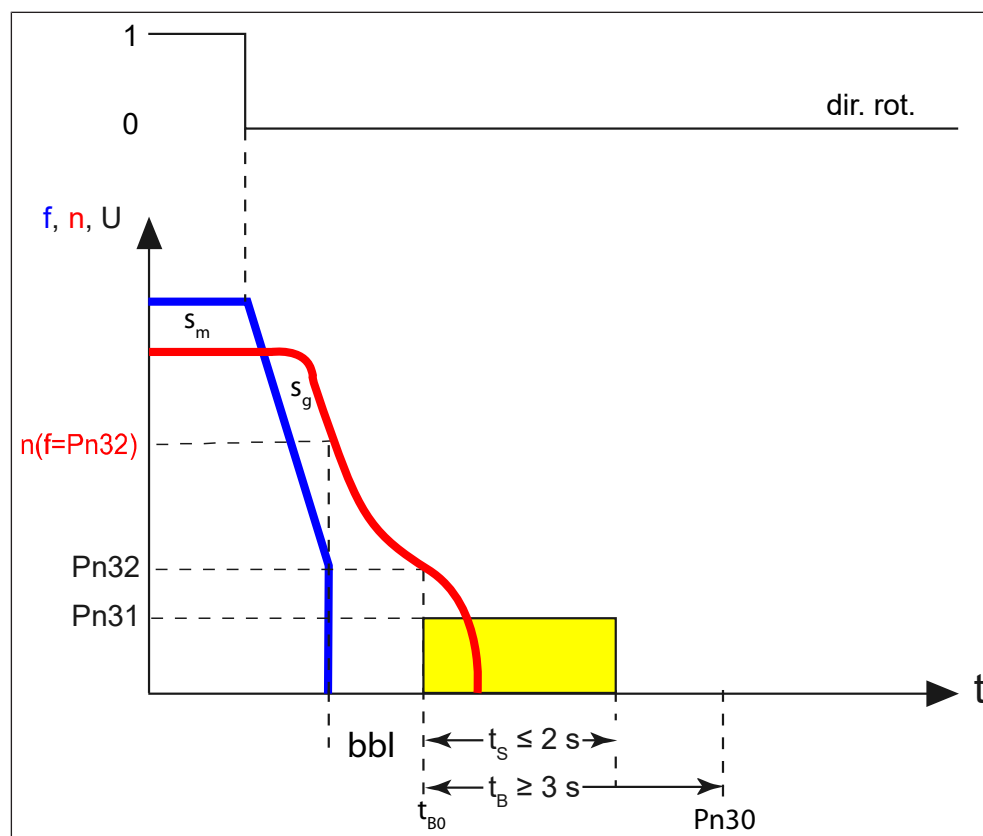


Fig. 2: Braking time dependent on the actual value

dir.rot	Rotation setting	sg	Slip (regenerative)
f	Frequency	Sm	Slip (motor)
n	Speed	tB	Braking time from Pn30
U	Voltage	tB0	Start DC braking
t	Time	Pn31	DC braking max. voltage
bbl	base block time (Motor coasts freely)	Pn32	DC braking start level
tS	Maximum time to motor standstill		
	Range wherein the drive must be in standstill		

4.3.3 Adjustment of the maximum braking voltage

In v/f characteristic control, a DC voltage is applied to the motor.

NOTICE

Motor overheating / drive controller load max. 95 %

Consequences

- The maximum braking voltage (Pn31) must be adjusted to the maximum permissible motor current in order to avoid overheating.
- The motor current can be read out in ru15.
- Additionally the maximum load on the drive controller during DC braking must not exceed 95 %.
- The load can be read out in parameter ru13.

Pn31	DC braking max. voltage (0x241F)
Value	Meaning
0,0...25,5%	The maximum braking voltage is preset with Pn31 "DC braking max. voltage". • 100 % correspond to the mains voltage or the output voltage (uF09). • The permissible current is limited to a maximum of 95 % drive controller utilization (ru13). • At large ratings the maximum braking voltage can lead to overcurrent errors. In this case Pn31 must be reduced.

The real DC braking voltage level can be checked with ru42. The minimum value (ru42) must be $\geq 4\%$.

4.3.4 Adjust start level at actual value dependent DC braking

Pn32	DC brake initial value (0x2420)
Value	Meaning
0...800 Hz or 0...32000 min ⁻¹	Setting of the start level which triggers the DC braking when it's fallen below. The setting is done in speed or frequency depending on ud02.

4.4 Conditions for DC braking

Condition	Description
DC braking	Activation of the DC braking function
	↓
Load	The function must be satisfied at maximum moment of inertia and minimum mechanical braking torque.
	↓
Current	The function must be satisfied at the set current level for output condition 101.
	↓
Frequency	The function must be satisfied from the set frequency/speed (Pn32) onwards and at the slip frequency/speed corresponding to the overcurrent level (E.OC).
	↓
Time	The function must be completed within the specified 2 seconds.
	↓
Standstill	Bring the drive to a standstill

4.5 Setting the relay outputs

The KEB COMBIVERT with Safe Speed Monitoring has three relay outputs on the control::

- Relay output 1: freely definable with switching condition SB 2
- Relay output 2: freely definable with switching condition SB 3
- Relay output 3: f=0 Hz relay

Relay 3 is connected in series with Relay 1 or Relay 2

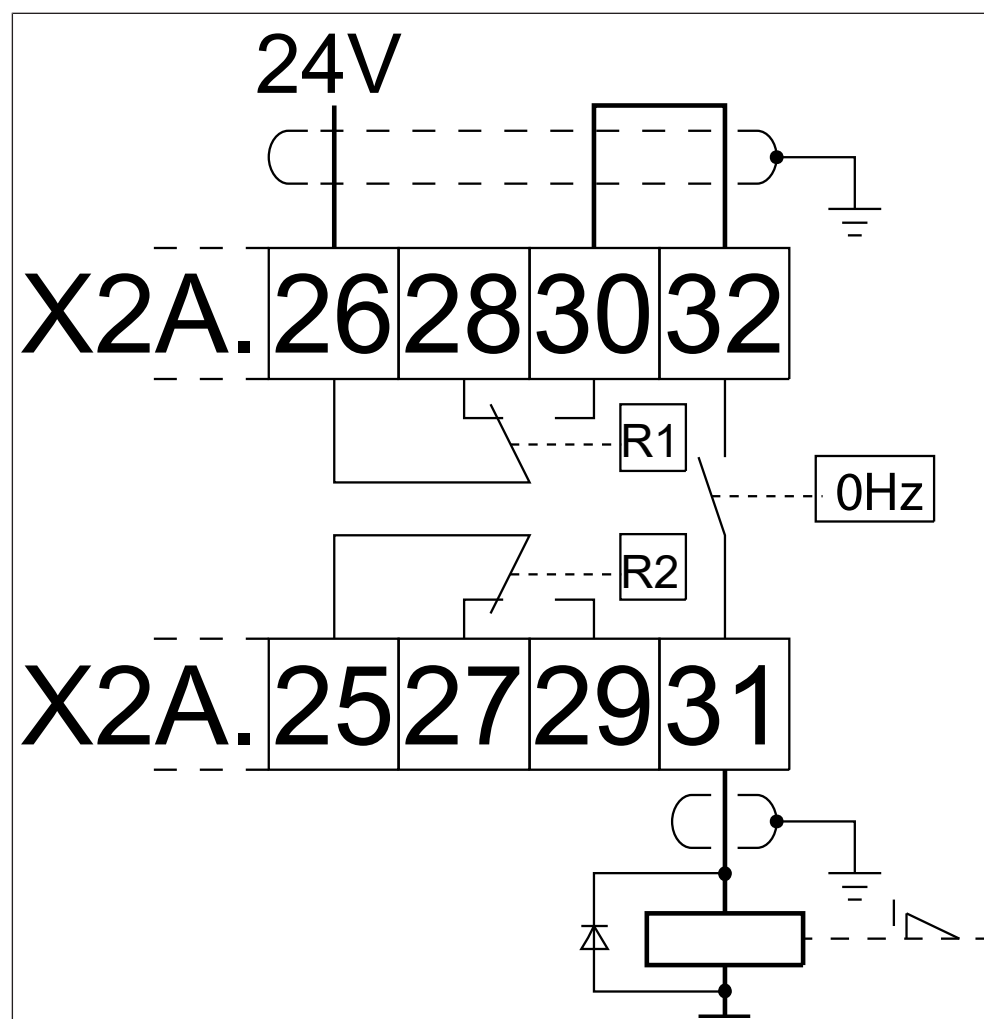


Fig. 3: 0 Hz relay in series with relay 1

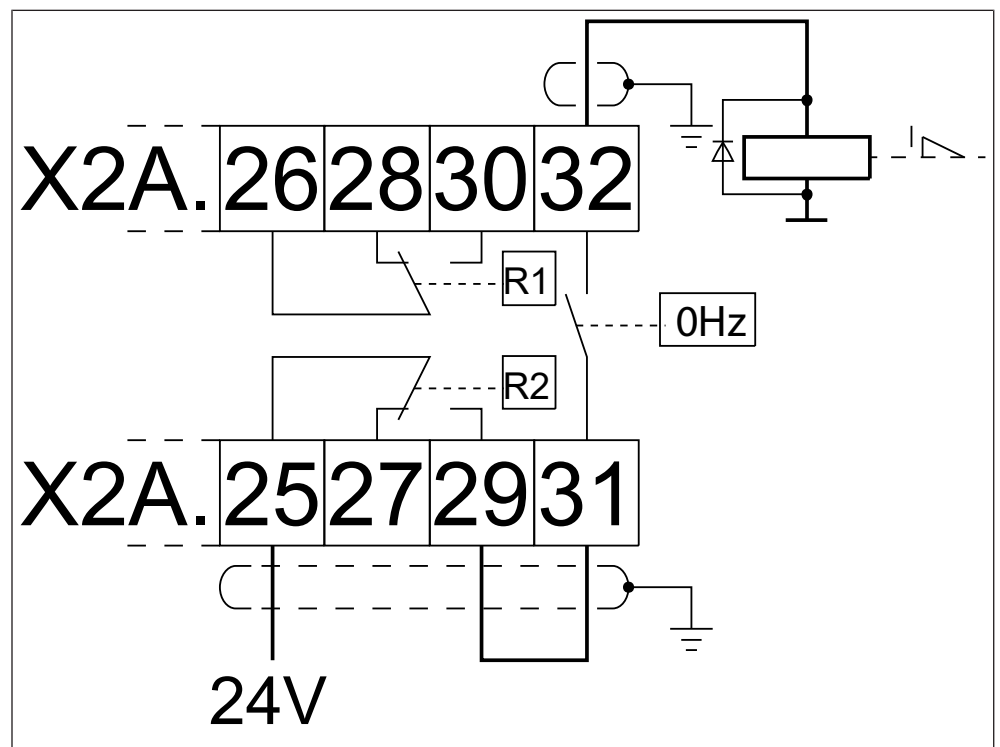


Fig. 4: 0Hz relay in series with relay 2

4.5.1 Relay specifications

Relay	1...3
maximum voltage	DC 30 V
minimum current	DC 0.01 A
maximum current	DC 1 A
maximum number of switching cycles	10 ⁸ mechanical; 500,000 at 1 A and DC 30 V
Other	only ohmic load or free-wheeling path

Tab. 2: Relay Specifications

4.5.2 Parameterisation of relay output 1 or 2

The following adjustments are based on the factory setting. Extensive information on the programming of the digital outputs can be found in the programming manual G6. The settings must be checked/adjusted according to the used relay output.

Output	Relay output 1	Relay output 2
Allocate outputs (do51)	„228“: R1=R1; R2=R2	
Invert outputs (do42)	Do not invert R1 and R2.	
Connect outputs (do41)	Outputs R1 and R2 not AND-connected.	
Select flag	do35=value "4" for flag 2	do36=value "8" for flag 3
Invert flag	do27: Do not invert flag 2.	do28: Do not invert flag 3
Connect flag (do24)	Flag 2 and 3 not AND-connected.	
Allocate flag condition	do18=value "4" for condition 2	do19=value "8" for condition 3
Invert condition	do10: Do not invert condition 2	do11: Do not invert condition 3
Adjust condition	do02: Value "101"	do03: Value "101"
Adjust switching level referring to the rated current	LE02	LE03
	The average value of the apparent current (corresponds to the load) during DC braking must exceed the level safely.	

Tab. 3: Parameterisation of the standard relay output

4.5.2.1 Functional sequence of the output switching condition

The switching condition "101" is set at "Stop after DC braking and current > level". I.e. the switching condition is met when the DC braking is completed and the average value of the apparent current during DC braking was higher than the adjusted level referring to the rated current.

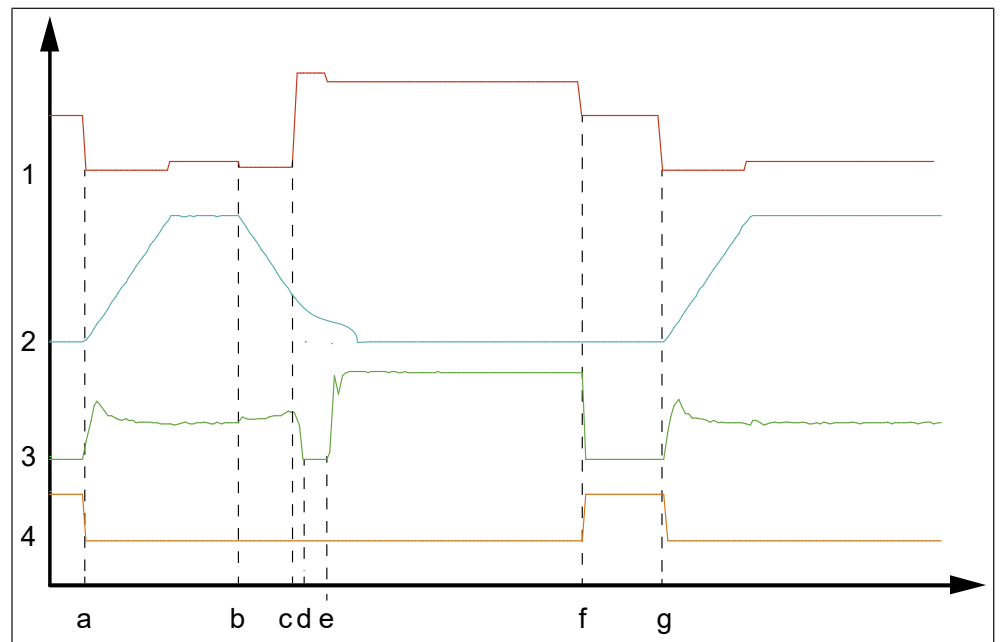


Fig. 5: Functional sequence for setting switching condition 101

1 Drive controller status	2 Actual value
3 Apparent current	4 Condition "101"
a Rotation setting	b Direction of rotation is switched off
c Actual value has reached switch-off value	d Starting of the base-block time (dependent on the braking mode)
e Starting of the DC braking	f The end of the DC braking. Setting of switching condition 101 when the average value of the apparent current exceeds the adjusted level.
g Rotation setting	

4.5.3 Function of relay output 3

Relay output 3 is assigned with a fixed function and can not be parameterized. It is controlled by the safety CPU. The safety CPU measures the pulse width of the power module control. This provides conclusions about the output frequency.

If the pulse width of the power module control does not change for a period of at least two seconds, a frequency of 0 Hz is indicated (stop vector).

Relay output 3 (no contact) is set if there is a frequency of 0 Hz **and** the modulation is switched off.

4.5.3.1 Minimum modulation factor

In order for the frequency of 0 Hz to be determined, a minimum modulation depth $\geq 4\%$ (ru42) must be maintained (dead time = $1.7\mu\text{s}$ without compensation).

4.5.3.2 Minimum frequency

By internally defined limits there is a minimum frequency of 0.04 Hz. Lower frequencies are evaluated as 0 Hz.

4.6 Error message

If an error occurs during operation, the inverter turns into a "safe condition" within 25 ms. ru00 displays "28: Error! Safety function".

The "Error! Safe condition" can only be reset by a power-on reset.

4.7 Application example

The following example shows the wiring of a door locking with safety module and Safe Speed Monitoring (SSM) with level f = 0 Hz.

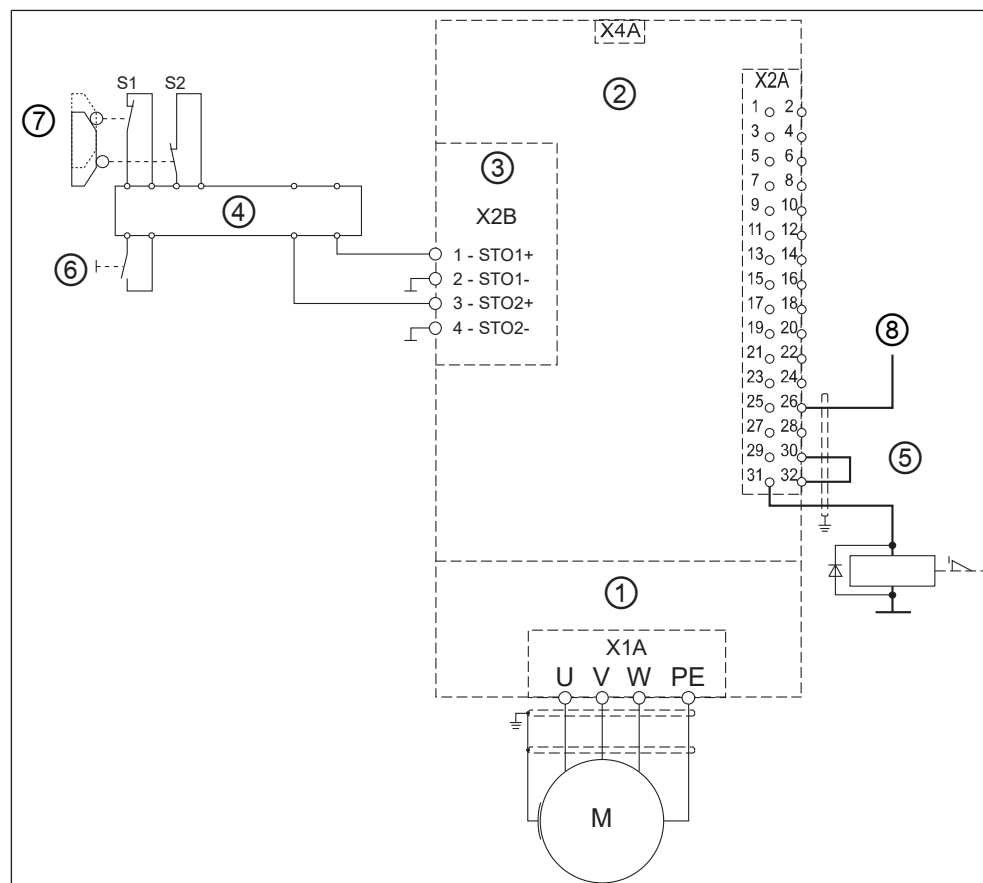


Fig. 6: Wiring example SSM with level 0 Hz in connection with STO

1 Power unit with motor	2 Control Circuit
3 Safety component STO	4 Safety module
5 ext. wiring of the 0 Hz relay with relay 1	6 Acknowledgement
7 Open / Closed	8 24V DC / max. 1A

The following conditions must be observed for the example above:

- The position of the locking system must be checked by the application.
- The wiring must be arranged by way that no cross circuits can control the door locking.
- The switching contact of the relay must be protected against overcurrent by appropriate measures (e.g. fuse).
- If relay output 2 is to be used for the standard function, the terminals must be configured accordingly (⇒ [0 Hz relay in series with relay 2](#) [► 17]) to use.

4.8 Check list for the SSM function

- Function only applicable when no external forces operate at the drive.
- No inductive load at the relay output or use free-wheeling diode.
- No limitation by hardware current limit (uF15) or torque/current limit.
- The minimum current at breakdown torque of the asynchronous motor must be higher than the hardware current limit (E.OC) of the drive controller.
- The motor must follow the deceleration ramp.
- Parameter Pn28 use only value 1 or 4.
- DC braking must bring the motor to a standstill within 2 seconds at maximum mass moment of inertia and minimum mechanical braking torque.
- In DC braking, the current level set for output switching condition 101 must be exceeded (⇒ [DC braking \[► 10\]](#)) and (⇒ [Conditions for DC braking \[► 15\]](#))
- Check the real level of the DC braking voltage with ru42
 - leave sufficient distance to the preset minimum values ($ru42 \geq 4\%$)
 - Observe voltage compensation ($uf09 =$) -> if the DC link voltage rises, the modulation factor decreases
- Check the load during DC braking with ru13. The maximum value shall not exceed 95 %.
- Check the switch-off capability of the relay contacts annually.

5 Certifications and approvals

Current certificates, declarations and revision lists for your product can be viewed or downloaded from our website at the following link:

( keb-automation.com/search)

By entering the article number, you will receive a list of the corresponding documents in the "Certificates" drop-down menu.

If you need help or further documentation, please contact our customer service.

5.1 FS marking

The safety-relevant functions integrated in this product have been developed, implemented and tested in accordance with the applicable standards and guidelines for functional safety. These safety functions were approved as part of a qualified testing and assessment procedure.

The function of the safety-related functions was documented and successfully validated. This ensures that the safety functions fulfil the specified requirements and work reliably under the intended operating conditions.

A corresponding certificate and further information on functional safety are available on our website.

Please note that changes to the product, especially to safety-relevant components, may affect the validity of the acceptance and thus the certificate. In such cases, a re-examination is required.

6 Revision history

Issue	Revision	Note
2013-08	1A	First published version
2014-01	1B	Product description, description minimum current, conditions for the DC braking, operation with free-wheeling diode and error message safety function was expanded.
2014-09	1C	Table 2 free-wheeling path supplemented; max. current of 1A in picture 6 supplemented; check the relay contacts inserted. Chapter 2.3.2.2: Table omitted the information in 1600 and 3200 Hz, and the information of the voltage stabilization in chapter 2.3.3. Chapter 2.2 and 2.3 classification of SSM inserted.
2015-05	1D	Extension to closed-loop systems. Modification of the foreword.
2021-10	04	Changed to document management; Complete editorial revision to the new CI; Function description changed; Aim of the setting p.15 added; Safety note under 3.3.2 extended. Figure 1 and 2 modified; Safety note under 2.5.3 modified; Text Pn31 modified; 2.6 Conditions under load modified; Figure 3 and 4 supplemented by free-wheeling diode; Characteristic curve Figure 5 changed; Checklist added under 3.8; Chapter 4 Standards modified; New certificates have been added.
2026-07	05	Editorial changes. Certificates have been removed from the document.
2026-08	06	Update to the glossary. Editorial changes

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Glossary

Application

The application is the intended use of the KEB product.

COMBIVERT

Proper name for a KEB Drive Controller.

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).

DC-Value

Diagnostic coverage measures the quality of testing and monitoring measures in accordance with ISO 13849-1.

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 61800-5-1

Adjustable speed electrical power drive systems. Part 5-1: Safety requirements - Electrical, thermal and energy requirements (VDE 0160-105-1, IEC 61800-5-1)

HD 60364

Low-voltage electrical installations.

IEC 61508

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

IEC 62061

Safety of machinery - Functional safety of safety-related control systems.

MTTF(D)

The Mean Time To Dangerous Failure is a special form of MTTF. It is required to calculate the PL in accordance with ISO 13849.

PELV

Safe protective extra-low voltage (earthed).

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.

SELV

Safe extra-low voltage (unearthed).

SIL

The safety integrity level is a unit of measurement for quantifying risk reduction in accordance with IEC 61508.

SSM

Safe speed monitor

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Notes

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