

# COMBIVERT



**GB** Installation Manual  
Control Circuit

F5 with Safety Function „STO“

|                 |      |
|-----------------|------|
| Original Manual |      |
| Mat.No.         | Rev. |
| 00F5NES-K000    | 1K   |



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## 1. Preface

### 1.1 General

First we would like to welcome you as a customer of the company Karl E. Brinkmann GmbH and congratulation to the purchase of this product. You have decided for a product on highest technical niveau.

The described hard- and software are developments of the Karl E. Brinkmann GmbH. The enclosed documents correspond to conditions valid at printing. Misprint, mistakes and technical changes reserved.

The instruction manual must be made available to the user. Before working with the unit the user must become familiar with it. This especially applies to the knowledge and observance of the following safety and warning indications. The used pictograms have following significance:

|   |   |  |
|---|---|--|
|    | <b>Danger<br/>Warning<br/>Caution</b>         | Is used, if life or health of the user are endangered or substantial damage to property can occur. |
|   | <b>Attention<br/>observe at<br/>all costs</b> | Is used, if a measure is necessary for safe and trouble-free operation.                            |
|  | <b>Information<br/>Aid<br/>Tip</b>            | Is used, if a measure simplifies the handling or operation of the unit.                            |

Non-observance of the safety instructions leads to the loss of any liability claims. This list is not exhaustive.

### 1.2 Validity and liability

**The use of our units in the target products is outside of our control and therefore lies exclusively in the area of responsibility of the machine manufacturer.**

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

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

Tests can only be done within the application by the machine manufacturer. They must be repeated, even if only parts of hardware, software or the unit adjustment are modified.

Unauthorised opening and tampering may lead to bodily injury and property damage and may entail the loss of warranty rights. Original spare parts and authorized accessories by the manufacturer serve as security. The use of other parts excludes liability for the consequences arising out of.

The suspension of liability is especially valid also for operation interruption loss, loss of profit, data loss or other damages. This is also valid, if we referred first to the possibility of such damages.

If single regulations should be or become void, invalid or impracticable, the effectivity of all other regulations or agreements is not affected.

### 1.3 Copyright

The customer may use the instruction manual as well as further documents or parts from it for internal purposes. Copyrights are with KEB and remain valid in its entirety.

### 1.4 Specified application

The COMBIVERT F5 serves exclusively for the control and regulation of three-phase motors. The operation of other electric consumers is prohibited and can lead to the destruction of the unit. Inverter are components designed for inclusion in electrical installations or machinery.

The used semiconductors and components of KEB are developed and dimensioned for the use in industrial products. If the KEB COMBIVERT F5 is used in machines, which work under exceptional conditions or if essential functions, life-supporting measures or an extraordinary safety step must be fulfilled, the necessary reliability and security must be ensured by the machine builder. The operation of our products outside the indicated limit values of the technical data leads to the loss of any liability claims. The safety function is limited to a service life of 20 years. After this time the unit must be replaced.

### 1.5 Product description

The product family COMBIVERT F5 with safety function STO has been developed for the use in safety-oriented applications. The basic standards as well as application and country-specific standards must be observed furthermore. The standards referred in this manual must be observed supplementary!

The safety function STO according to IEC 61800-5-2 contains:

- Safe torque off (Safe Torque Off - STO)

The safety function meet the requirements in accordance with performance level e (ISO13849-1) and SIL 3 (IEC 61508 and IEC 62061). In case of proper project design, installation and operation the safety function protect people against mechanical damages.



This accompanying instruction manual contains only information for the installation and connection of the control of the KEB COMBIVERT F5, as well as the safety technology.

This manual is only valid in connection with the EMC- and safety instructions as well as the power circuit manual.

COMBIVERT F5 inverter with integrated safety technology correspond to the following numerical code:

| Control HW                   | used  | Inverter     | Control SW                            | Operating mode (ud.02) |
|------------------------------|---|--------------|---------------------------------------|------------------------|
| 1KF5x30-0009<br>2KF5x30-0008 | up to housing size E<br>from housing size G | xxF5Kxx-xxxx | APPLICATION with encoder interface    | MULTI                  |
|                              |   | xxF5Kxx-xx0x | APPLICATION without encoder interface | GENERAL                |
|                              |   | xxF5Lxx-xxxx | ASCL                                  | MULTI                  |
|                              |   | xxF5Pxx-xxxx | SCL                                   | SERVO                  |

|   |                                 |  |   |
|---|---------------------------------|--|---|
|  | <p>Validity of certificates</p> | <p>The certification of controllers with safety technology since 05.2013 is only valid if the material number corresponds with the specified numerical code <b>and</b> the FS logo is printed on the type plate.</p> |  |
|---|---------------------------------|--|---|

## 2. Control

### 2.1 Features of the control

The control provides the following analog and digital functions:

- Hardware allocation of digital and analog inputs and outputs.
- HSP5 interface for the connection with an operator or via special cable (00F50C0-0010) with a PC
- Hardware of the control circuit „safety separated“ according to EN 61800-5-1 (base TN-C/S mains)
- Operation and diagnosis via operator
- Safety function STO (two channel torque off)

### 2.2 Overview

| Control 2KF5xxx-xxxx from G housing |                                      | Control 1KF5xxx-xxxx in D & E housing |                           |
|-------------------------------------|--------------------------------------|---------------------------------------|---------------------------|
|                                     |                                      |                                       |                           |
| X2A                                 | Control terminal strip               | X6B                                   | HSP5 diagnostic interface |
| X2B                                 | Terminal block safety function       | X6C                                   | depending on the operator |
| X3A                                 | Encoder interface channel 1 (option) | X6D                                   |                           |
| X3B                                 | Encoder interface channel 2 (option) | LED1                                  | Inverter state            |
| X4A                                 | HSP5 interface                       |                                       |                           |

### 2.2.1 LED1

If the COMBIVERT F5 is operated without plugged operator, the inverter state can be read from integrated status LED..

| LED status | Function                 |
|------------|--------------------------|
| off        | Unit switched off        |
| on         | Unit ready for operation |
| flashing   | Unit in malfunction      |

### 2.2.2 HSP5 interface X4A

The HSP5 interface X4A serves for the communication with a control operator. A digital operator, interface operator and different fieldbus operators are available for this. To prevent malfunctions, the inverter must be brought into nOP status before connecting / disconnecting the operator (open control release terminal). When starting the inverter, it is started always with the last stored values or factory setting.

A special HSP5 cable (part number 00.F5.0C0-0010) is required for the operation of the KEB COMBIVERT without operator. This cable is connected between HSP5 interface X4A and serial RS232 PC interface (COM1 or COM2). Operation occurs via the program COMBIVIS.



The HSP5 service cable has an integrated level converter. The connection of a serial standard cable would destroy the PC interface.

### 2.2.3 Encoder interfaces X3A, X3B

The COMBIVERT F5 can be equipped optionally with encoder interfaces. Different combinations can be used here according to the requirements. The instruction is made separately according to the installed encoder interfaces.

### 2.2.4 Operators

The COMBIVERT F5 can be equipped optionally with operator. Different control or field bus operators are available here according to the requirements. The instruction is made separately according to the installed operator.

### 2.2.5 Control terminal strip X2A

The control terminal block X2A is designed as double, plug-in terminal block with spring cage connection. It contains 32 pole.

### 2.2.6 Safety terminal block X2B

The safety terminal block X2A is designed as double, plug-in terminal block with spring cage connection. It contains 10 pole.

## 2.3 Connection of the control

The following instructions must be observed at connection:

|   |  |
|---|--|
| <b>Attention</b>  | Prevent EMC malfunctions   |
|  | <ul style="list-style-type: none"> <li>• Use shielded / drilled cables</li> <li>• Lay shield on one side of the inverter onto earth potential</li> <li>• Install control cables and power cables separately (approx. 10...20 cm distance); Kreuzungen im rechten Winkel verlegen</li> <li>• To avoid interferences a separate shielding must be provided for analog and digital control lines. Depending on the use of the relay outputs, an extra shielding is to be used, too.</li> <li>• In case of inductive load on the relay outputs a protective wiring must be provided (e.g. free-wheeling diode)!</li> </ul> |

|  |   |
|--|---|
|  | The terminals of the control terminal strip and the transmitter inputs are securely isolated in accordance with EN 50178. |
|--|---|

### 2.3.1 Assembly of the wires

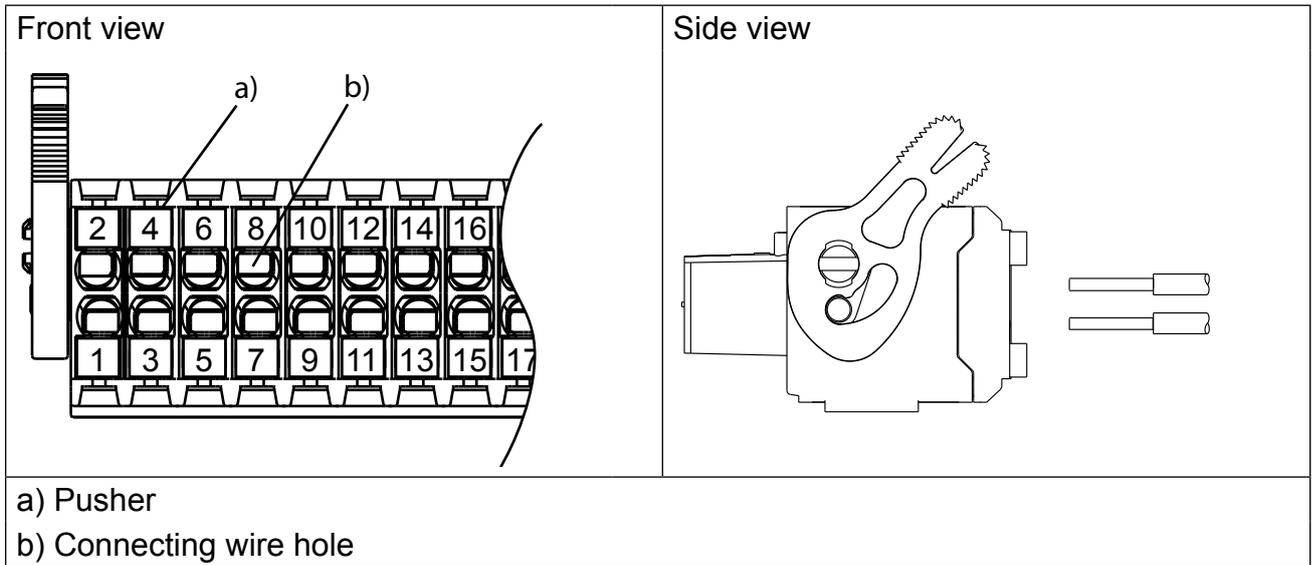
| Cross-section / AWG       | Metal sleeve length | Stripping length |
|---------------------------|---------------------|------------------|
| 0.50 mm <sup>2</sup> / 21 | 10 mm               | 12 mm            |
| 0.75 mm <sup>2</sup> / 19 | 12 mm               | 14 mm            |
| 1.00 mm <sup>2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

**Info**  KEB generally recommends the use of wire-end ferrules in industrial environments.

| Cross-section / AWG                  | Stripping length |
|--------------------------------------|------------------|
| 0.14 1.5mm <sup>2</sup> , 25 16      | 10 mm            |
| Stranded wire (rigidly and flexibly) |                  |

- Press pusher by hand. Insert connecting wires into the respective hole, that no single wires can be seen from the outside or bend outward.  
A first resistance must be overcome when inserting. Release the pusher.
- Check that the connecting wire is fixed and can not be pulled-out. It is important to ensure that the connecting wire and not the insulation is clamped. The connecting wire can also be inserted without pressing the pusher in case of cross-sections upto 1.00 mm<sup>2</sup>.

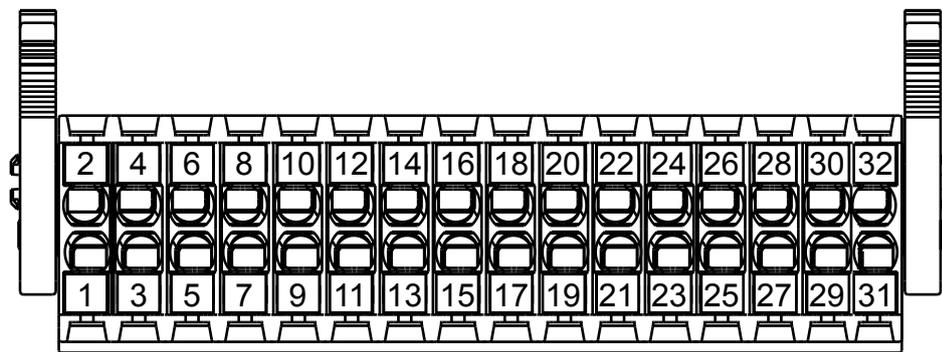
**Attention**  A safe clamping can not be guaranteed when using shorter wire-end ferrules.



## 2.4 Assignment of the terminal strip X2A

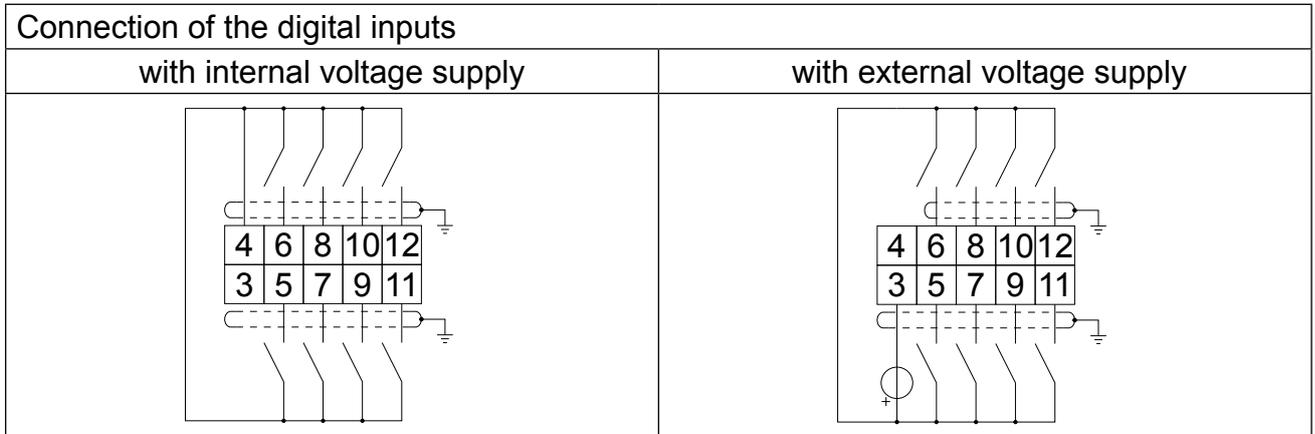
| PIN | Name      | Description  | Specifications   |
|-----|-----------|--|--|
| 1   | 0V        | Digital mass; reference potential for digital inputs/outputs, $U_{in}$ and $U_{out}$ |  |
| 2   | $U_{in}$  | Input external voltage supply  | $U=24\text{ VDC } +20\%/-15\%$<br>$I_{max}=1\text{ A}$   |
| 3   | 0V        | like pin 1   |  |
| 4   | $U_{out}$ | Voltage output for the control of the digital inputs                                 | $U=24\text{ VDC } \pm 25\%$<br>$I_{max}(\text{Pin } 4+32)=100\text{ mA}$   |
| 5   | RST       | Programmable digital inputs (Assignment ex factory see chapter 2.4.1)                | 8 digital inputs according to IEC61131-2 type 1<br>„0“ = -3...5VDC<br>„1“ = 15...30VDC<br>Scan time $\leq 1\text{ ms}$ |
| 6   | ST        |  |  |
| 7   | R         |  |  |
| 8   | F         |  |  |
| 9   | I2        |  |  |
| 10  | I1        |  |  |
| 11  | I4        |  |  |
| 12  | I3        |  |  |

further on next side



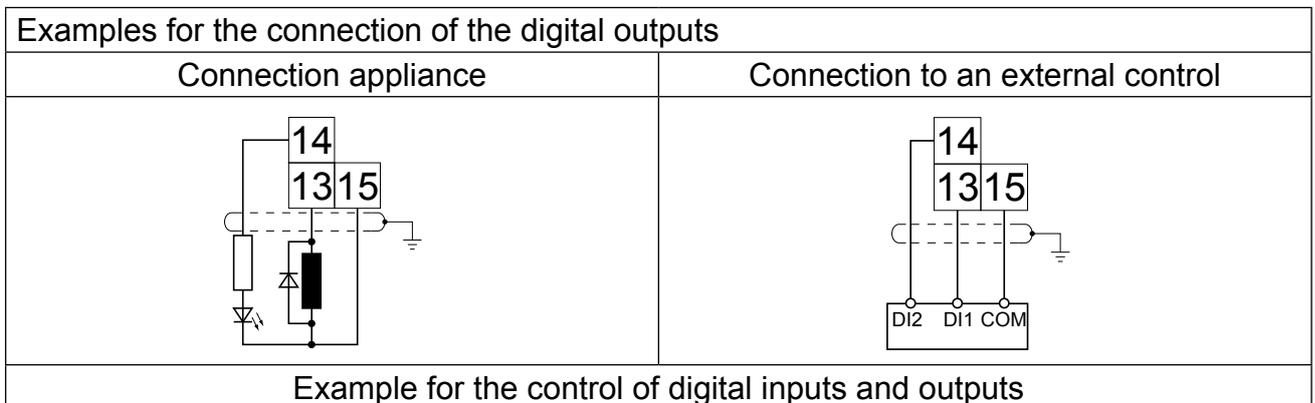
| PIN | Name             | Description   | Specifications  |
|-----|------------------|---|---|
| 13  | O2               | Programmable digital outputs<br>(Assignment ex factory see chapter 2.4.2) | 2 short-circuit proof digital 24 V outputs specified according to IEC61131-2<br>I <sub>max</sub> = 100mA per output<br>Switching of inductive load (without free-wheeling path) up to 300mJ<br>maximum switching frequency = 1kHz |
| 14  | O1               |   |   |
| 15  | 0V               | like pin 1  |   |
| 16  | CRF              | Reference voltage for setpoint potentiometer                              | 10VDC +5%; I <sub>max</sub> = 4 mA  |
| 17  | AN1-             | Programmable analog inputs<br>(Assignment ex factory see chapter 2.4.3)   | 0...±10Vdc (R <sub>i</sub> =55 kΩ)<br>0...±20 mA (R <sub>i</sub> =250 Ω)<br>4...20 mA (R <sub>i</sub> =250 Ω)<br>Resolution: 11 Bit + sign<br>Scan time ≤ 1 ms  |
| 18  | AN1+             |   |   |
| 19  | AN2-             |   |   |
| 20  | AN2+             |   |   |
| 21  | COM              | Analog mass; Reference potential for analog inputs and outputs            |   |
| 22  | ANOUT1           | Programmable analog output 1<br>(Assignment ex factory see chapter 2.4.4) | U=0...±10Vdc (max.11.5Vdc)<br>I <sub>max</sub> =10 mA; Ri = 100 Ω<br>Res:11Bit + sign   |
| 23  | COM              | like Pin 21   |   |
| 24  | ANOUT2           | Programmable analog output 2<br>(Assignment ex factory see chapter 2.4.4) |   |
| 25  | R2-C             | Relay 2 switching contact   | Programmable relay outputs<br>(Assignment ex factory see chapter 2.4.5)<br><br>U <sub>max</sub> = 30Vdc<br><br>I = 0.01...1A  |
| 26  | R1-C             | Relay 1 switching contact   |   |
| 27  | R2-B             | Relay 2 NC contact  |   |
| 28  | R1-B             | Relay 1 NC contact  |   |
| 29  | R2-A             | Relay 2 NO contact  |   |
| 30  | R1A              | Relay 1 NO contact  |   |
| 31  | 0V               | like pin 1  |   |
| 32  | U <sub>out</sub> | like pin 4  |   |

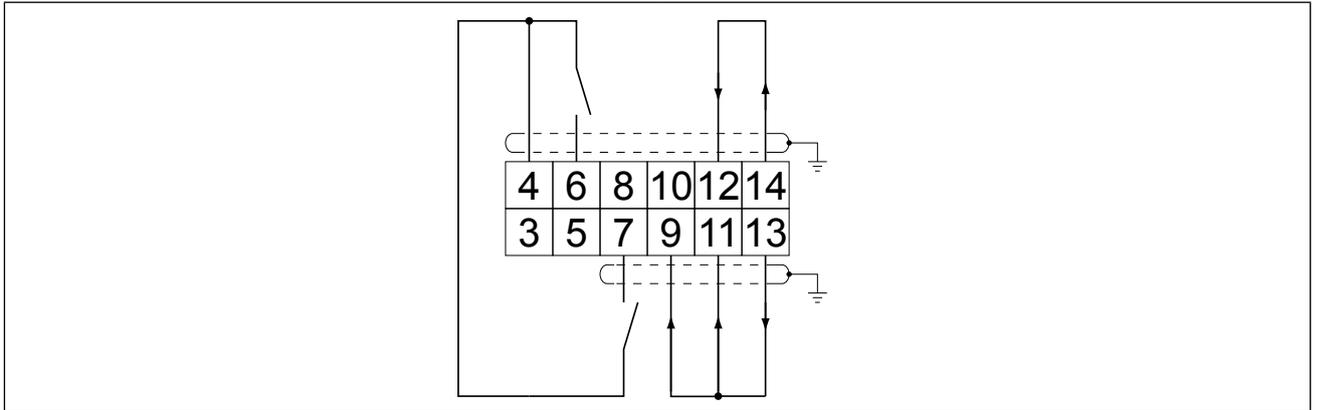
### 2.4.1 Connection of the digital inputs



| Factory setting of the digital inputs |                |                               |                        |                             |                        |
|---------------------------------------|----------------|-------------------------------|------------------------|-----------------------------|------------------------|
| Input                                 | Operating mode | GENERAL                       |                        | MULTI/SERVO                 |                        |
|                                       |                | RST                           |                        | Reset                       |                        |
| ST                                    |                | Control release               |                        | Control release / reset     |                        |
| R                                     |                | Direction of rotation reverse |                        | Limit switch left           |                        |
| F                                     |                | Direction of rotation forward |                        | Limit switch right          |                        |
| I1                                    |                | Step value 1                  | I1+I2=fixed value<br>3 | Step value 1                | I1+I2=fixed value<br>3 |
| I2                                    |                | Step value 1                  |                        | Step value 1                |                        |
| I3                                    |                | External error input (E.EF)   |                        | External error input (E.EF) |                        |
| I4                                    |                | Activates DC braking          |                        | -                           |                        |

### 2.4.2 Connection of the digital outputs





| Factory setting of the digital outputs |                                       |                                       |
|--|---------------------------------------|---------------------------------------|
| Operating mode<br>Input                | GENERAL                               | MULTI/SERVO                           |
| O1                                     | Ready signal                          | Ready signal                          |
| O2                                     | Switch at actual value=setpoint value | Switch at actual value=setpoint value |

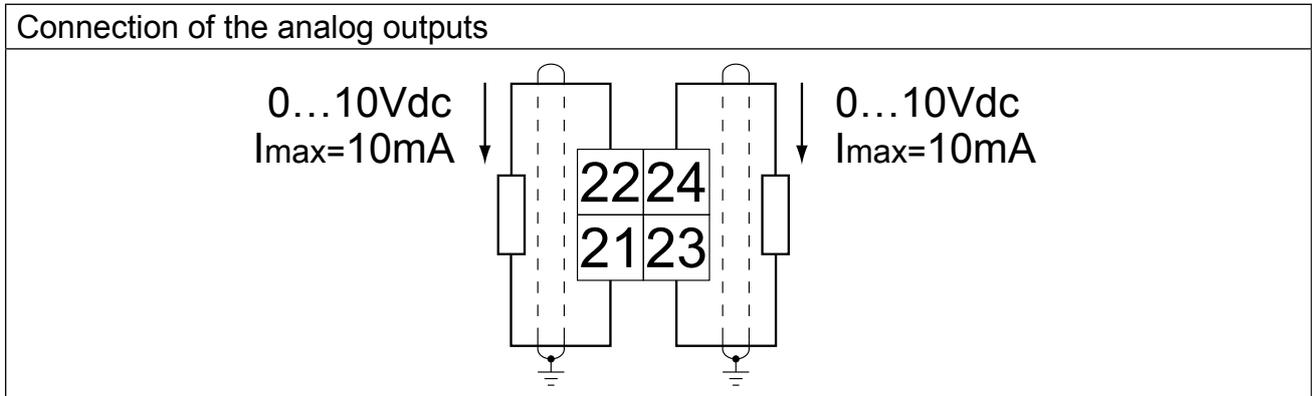
## 2.4.3 Connection of the analog inputs

Examples for the connection of the analog setpoint input

\*) Connect potential equalizing line only if a potential difference of >30V exists between the controls. The internal resistance is reduced to 30 kΩ.

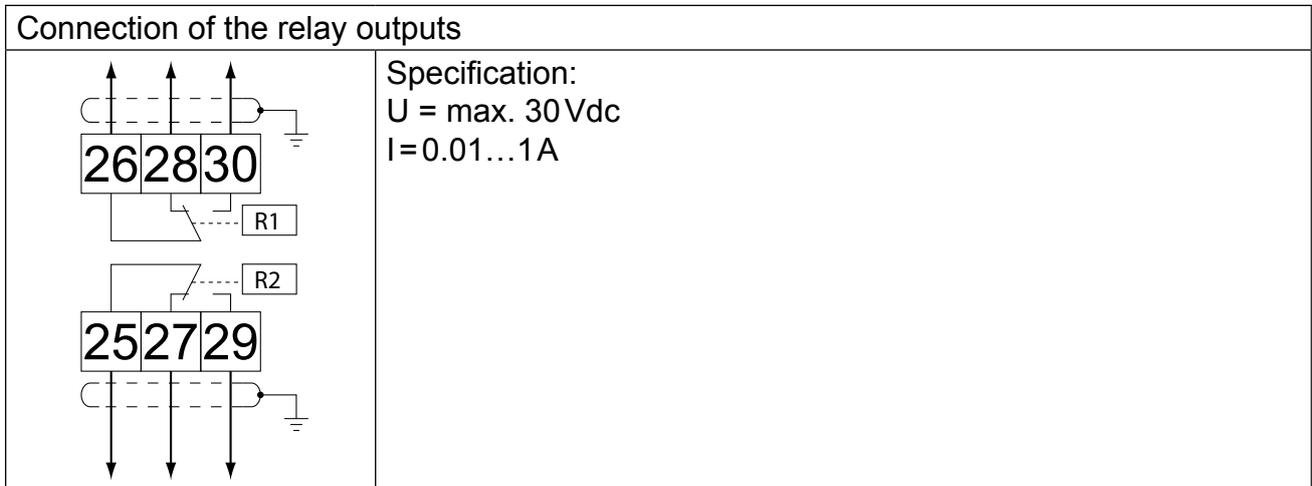
| Factory setting of the setpoint inputs |                                       |  |
|--|---------------------------------------|--|
| Operating mode<br>Input                | GENERAL                               | MULTI/SERVO  |
| AN1                                    | Setting analog setpoint<br>0...±10Vdc | Analog setpoint for<br>speed-controlled operation<br>0...±10Vdc  |
| AN2                                    | —                                     | Analog setpoint for<br>torque-controlled operation<br>0...±10Vdc |

### 2.4.4 Connection of the analog outputs



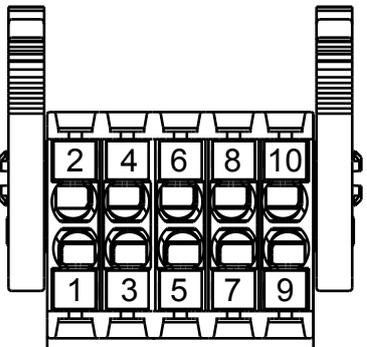
| Factory setting of the analog outputs |                              |                                 |
|---------------------------------------|------------------------------|---------------------------------|
| Operating mode<br>Input               | GENERAL                      | MULTI/SERVO                     |
| AO1                                   | Output frequency 0...100 Hz  | Speed actual value 0...3000 rpm |
| AO2                                   | Apparent current 0...2•IoutN | Apparent current 0...2•IoutN    |

### 2.4.5 Connection of the relay outputs



| Factory setting of the relay outputs |                            |                                     |
|--------------------------------------|----------------------------|-------------------------------------|
| Operating mode<br>Input              | GENERAL                    | MULTI/SERVO                         |
| R1                                   | Fault relay                | Fault relay                         |
| R2                                   | Frequency dependent switch | RUN-Relay<br>(set at modulation on) |

## 2.5 Assignment of the terminal block X2B

| X2B   | PIN | Name    | I/O                 |
|---|-----|---------|---------------------|
|  | 1   | STO1+   | Input STO channel 1 |
|   | 2   | STO1+   |                     |
|   | 3   | STO1-   |                     |
|   | 4   | STO1-   |                     |
|   | 5   | STO2+   | Input STO channel 2 |
|   | 6   | STO2+   |                     |
|   | 7   | STO2-   |                     |
|   | 8   | STO2-   |                     |
|   | 9   | STO-OUT | Output STO          |
|   | 10  | STO-OUT |                     |

The individual channels are designed potential-free, so 24V and 0V can be connected. The inputs are designed by way that safety switchgear units with test pulses (OSSD signals) can be connected. The signals are not evaluated, they are only filtered. The OSSD test interval is limited to 10 ms.

The output STO-OUT at terminal 9/10 is switched against the mass of the control.

### 2.5.1 inputs

#### 2.5.1.1 Specification of the STO inputs

| STO inputs | Status 0 |             | Status 1 |         |
|------------|----------|-------------|----------|---------|
|            | UL [V]   | IL [mA]     | UH [V]   | IH [mA] |
| max.       | 5        | 25          | 30       | 25      |
| min.       | -3       | not defined | 15       | 5       |

The maximum short-term starting current of the input is limited to 300 mA.

#### 2.5.1.2 STO with OSSD signals

The filter time depends on the minimum input voltage and can be specified as follows:

| Input voltage [V] | OSSD pulse width [ms] |
|-------------------|-----------------------|
| 15                | 0.1                   |
| 18                | 0.8                   |
| 20                | 1.1                   |
| 24                | 1.5                   |
| 30                | 1.8                   |

### 2.5.2 Output STO

The short-circuit proof, digital output is specified in accordance with IEC61131-2. The output rated current is 100 mA at 24Vdc. The output is active, if the inputs STO1 and STO2 are set.

### 3. Safety Function STO

|   |                                    |   |
|---|------------------------------------|---|
|  | <p><b>Only Qualified Staff</b></p> | <p>Uncontrolled start of the drive is possible by improper installation of the safety technology. This may cause death, serious bodily injuries or substantial damage to property.</p> <p>Therefore the safety function may only be installed and put into operation by qualified personnel which are trained in safety technology.</p> |
|---|------------------------------------|---|

|   |                                 |  |
|---|---------------------------------|--|
|  | <p><b>Observe Standards</b></p> | <p>The COMBIVERT F5 with safety function must not be started until it is determined that the installation complies with 2006/42/EC (machine directive) as well as the EMC directive (2004/108/EC)(note EN60204).</p> <p>The COMBIVERT F5 with safety function meets the requirements of the Low-Voltage Directive 2006/95/EC. The harmonized standard of the series EN 61800-5-1 (VDE 0160) is used.</p> <p>This is a product of limited availability in accordance with IEC 61800-3. This product may cause radio interference in residential areas. In this case the operator may need to take corresponding measures.</p> |
|---|---------------------------------|--|

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

|   |                              |  |
|---|------------------------------|--|
|  | <p><b>Regular checks</b></p> | <p>In order to ensure permanent security, the function must be checked in regular intervals according to the results of the risk analysis.</p> |
|---|------------------------------|--|

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

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

|   |                              |   |
|---|------------------------------|---|
|  | <p><b>Electric Shock</b></p> | <p>Continue mains voltage with active STO function.</p> |
|---|------------------------------|---|

Compared to the disconnection by line contactors or motor contactors the integrated safety function enables a simple integration of drives to functional groups of a system. Thereby safe torque off can be limited to certain systems. A further advantage is that the recharge and discharge time of the inverter DC link must not be considered. Thus the unit is faster again ready for operation after an interruption.

# Safety Function STO

Regular electromechanical equipment are liable to abrasion. Loss of these equipment occurs by using the STO function and the maintenance costs are reduced.

### Characteristic data for „Safe torque off“

- Power supply for the rotation direction of the motor is interrupted (free-wheeling motor)
- Used when monitoring of standstill is not necessary
- Unintentional starting of the motor is prevented
- No galvanic isolation of the motor from the dc link circuit

### What is realized by the STO function related to EN60204 -1 ?

- Emergency stop can be realized by the STO function, since the mains voltage may remain effective.
- Emergency stop can be realized only in connection with a line contactor, which disconnects the mains voltage!

## 3.1 Emergency stop according EN 60204

By using suitable safety switchgear units, stop category 0 and 1 according to EN 60204 -1 can be reached by the STO function in the system. Note chapter 3.6 for safety switchgear units.

|                 |   |
|-----------------|---|
| Stop category 0 | „uncontrolled stop“, i.e. stop by immediate removal of power to the actuators.  |
| Stop category 1 | „controlled stop“, i.e. power to the actuators is retained to apply braking until the stop is achieved. The energy is switched off at standstill. |

Emergency stop to EN 60204 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.

|   |  |  |
|---|--|--|
|  | <b>Restart only after confirmation</b> | The drive restarts if function STO is no longer released. In order to comply with EN 60204, it must be ensured by external measures that the drive restarts only after confirmation. |
|---|--|--|

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

|   |                                  |   |
|---|----------------------------------|---|
|  | <b>Ensure coast of the motor</b> | If danger to persons occur after switching off the motor control by STO, the entrance to hazard areas must remain closed until the drive stops. |
|---|----------------------------------|---|

|   |                            |  |
|---|----------------------------|--|
|  | <b>Jerks in error case</b> | In case of double malfunction it can lead to unwanted jerk, the rotation angle is depending on the number of poles of the selected drive and the gear ratio. |
|---|----------------------------|--|

Calculation of the jerk:

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

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

### 3.2 Classification of STO according IEC 61508

|                       |                                  |
|-----------------------|----------------------------------|
| PFH                   | 2.6 • 10 <sup>-12</sup> 1/h      |
| PFD                   | 2.3 • 10 <sup>-7</sup> on demand |
| Proof-Test-Interval T | 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 STO according ENISO 13849

|                   |             |
|-------------------|-------------|
| Category          | 4           |
| MTTF <sub>D</sub> | >1000 years |
| DC                | high        |

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

### 3.4 Additional instructions

- The unit must be isolated from mains by main switch when working on parts under voltage.
- Mechanical brakes must be installed additionally if external forces have effect to the drive axis, e.g. vertical axes (hanging loads) or rotary axes with asymmetrical weight distribution.
- For the protection against pollution (pollution degree 2) the installation of the units must be provided in environment with increased protection (e. g. control cabinet IP 54).
- Make sure that no small parts fall into the COMBIVERT during assembly and wiring. This also applies to mechanical components, which can lose small parts during operation.
- Check the safety functions and error responses and generate an acceptance report after installation.
- The start-up can be prevented with interruption of the STO signals. STO may not be released in case of danger according to EN 60204-1. Also note the instructions to the external safety switch devices.
- Dimension the safety application by way that the corresponding input current of the safety functions is available for the inputs (see chapter 2.5.1).

|   |   |  |
|---|---|--|
|  | <p><b>Selection of suitable voltage sources</b></p> | <p>Use for the connection only suitable voltage sources with safe isolation (SELV / PELV) in accordance with VDE 0100 with nominal voltage of 24 Vdc ± 10%. Pay attention on a sufficient over-voltage category of the voltage supply.</p> |
|---|---|--|

### 3.5 Functional Description

The COMBIVERT with integrated safety function meets the following function according to IEC 61800-5-2:

- „Safe torque off" (STO)

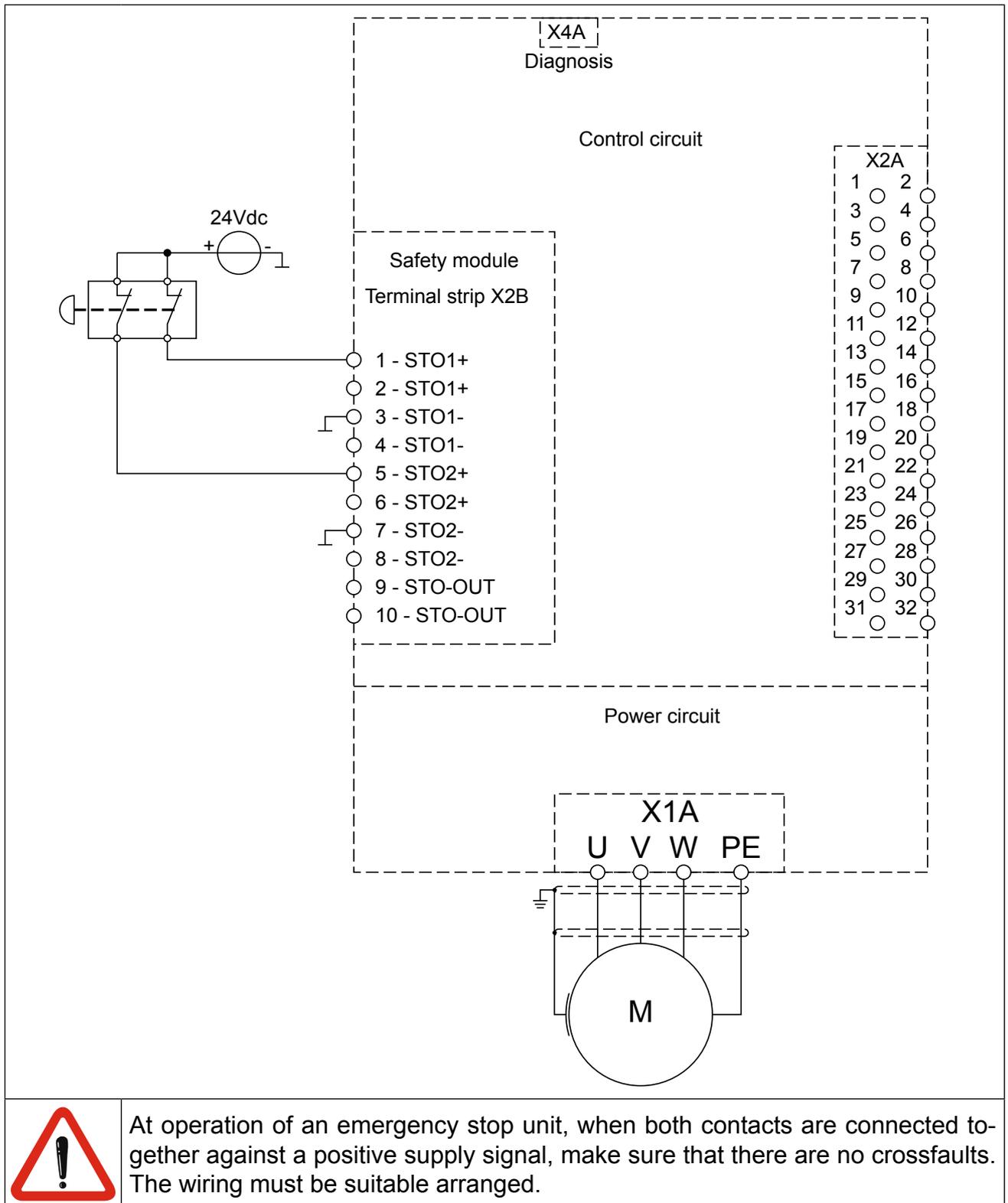
The safety-related disconnection according to STO is reached by a two-channel opto-coupler blockage. The supply of the opto-couplers, which are responsible for the commutation of the connected drive occurs via transformation coupling of the input voltage. This ensures at input voltage loss that no supply of the opto-couplers is possible. If the opto-couplers are not longer supplied, no IGBT can be controlled and thus no energy can be supplied to the drive.

The two channels are reached by way that input STO1 prevents the voltage supply (VTRO) of the upper opto-couplers of the inverter bridge and input STO2 the lower opto-couplers (VTRU).

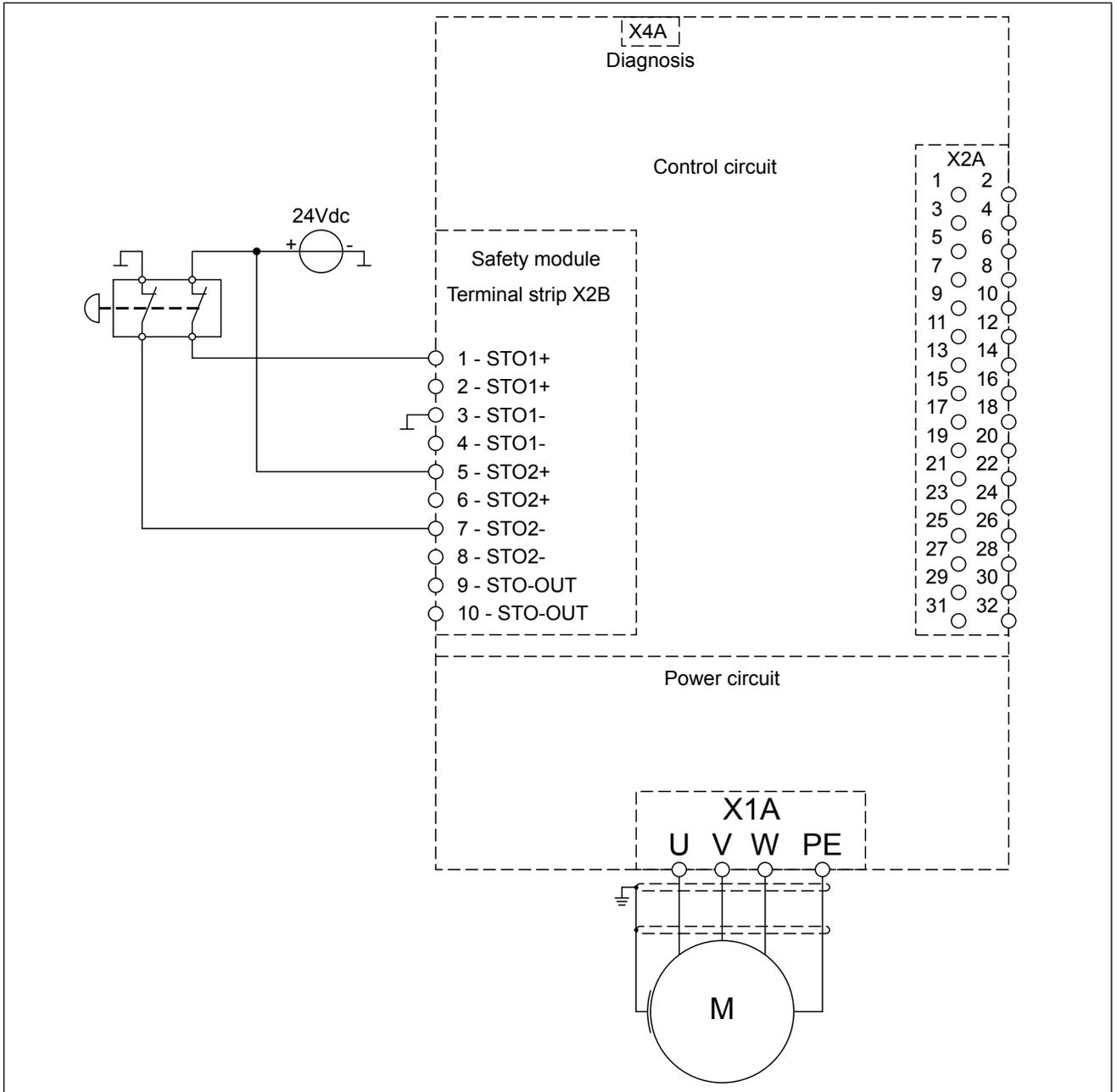
| Technical data of the STO function  |       |
|---|-------|
| Maximum ON delay ( $U_{IN} = 15V$ )                                       | 7 ms  |
| Maximum OFF delay ( $U_{IN}=30V$ ) at                                     |       |
| ... active modulation   | 10 ms |
| ... inactive modulation until safe state of the driver voltage is reached | 50 ms |

### 3.6 Wiring Examples

#### 3.6.1 Direct switching off with emergency stop switch



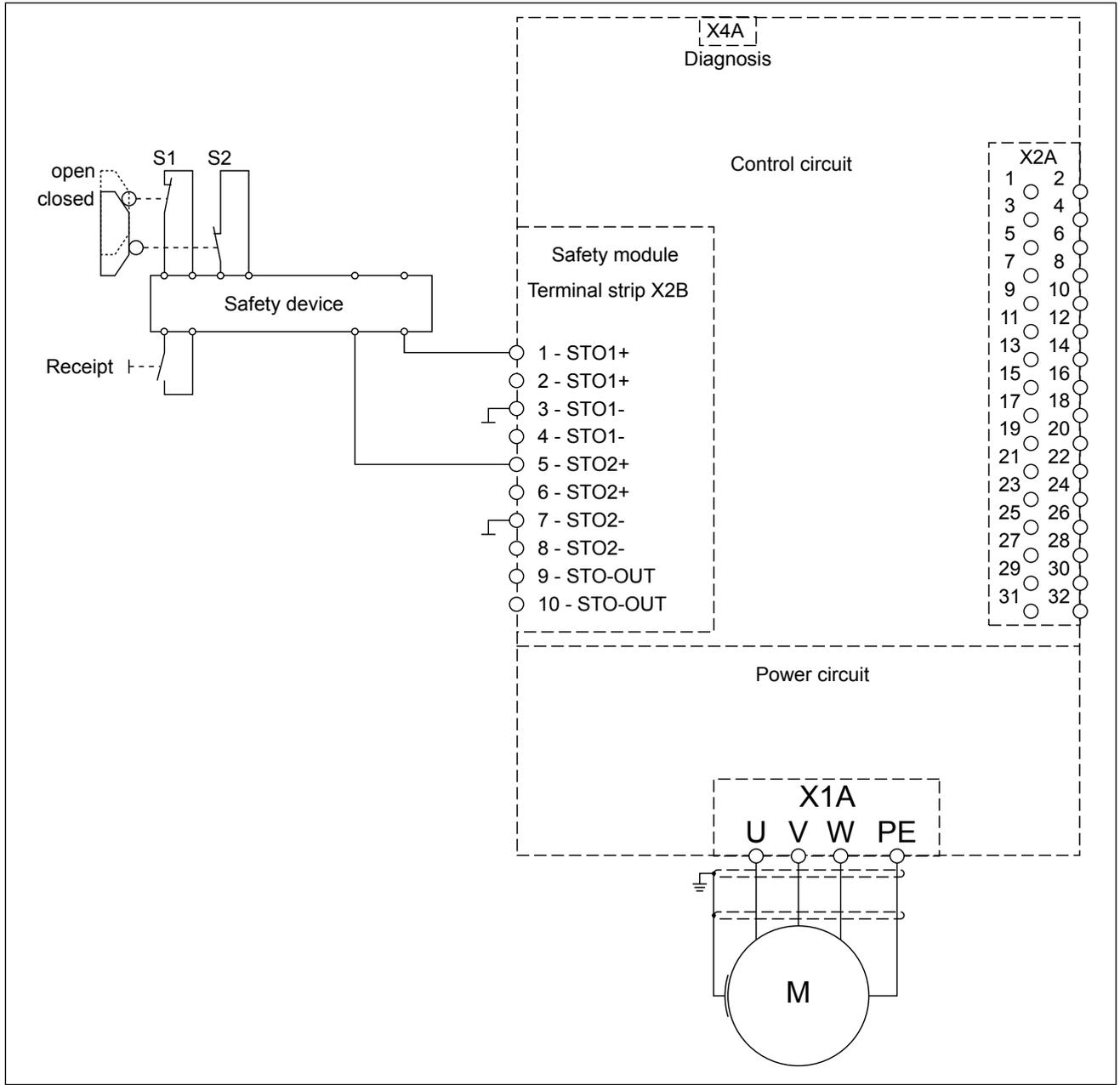
## 3.6.2 Direct switching off with emergency stop switch and monitoring of the wiring



The displayed circuit shows wiring errors in the area of the emergency stop unit and supply line. A possible short circuit on the primary side of the emergency stop switchgear (mass and 24 Vdc) and a short circuit on the secondary side of the unit or within the wiring leads either directly or with closed contacts to a short circuit of the supply, whereby a series-connected 24V fuse triggers.

Besides the two displayed applications with an emergency stop switchgear, other sensors (like door switches etc.) can be used similarly.

3.6.3 Direct switching off by safety module with test pulses

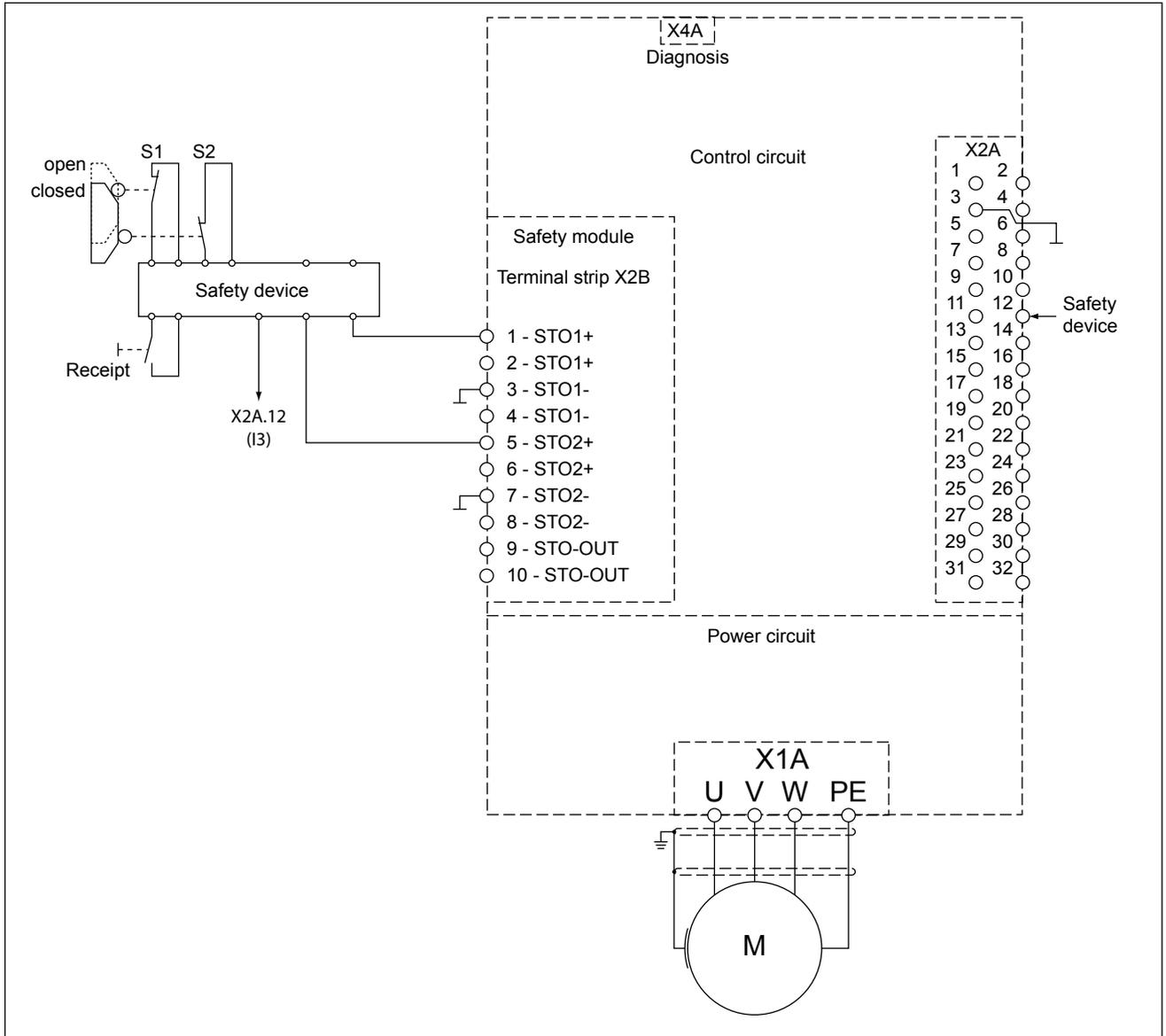


With operation of the emergency stop unit, e.g. by protection door, the release paths of the safety module are disconnected. This leads to the loss of the STO signals (X2B.1 and 5) and thus to energy disconnection of the drive. The safety module makes a consistency check of all signal paths via test signals (OSSD).

# Safety Function STO

## 3.6.4 Wiring SS1

At tripping SS1 (Safe Stop 1) the drive is only disconnected from supply when it has reached a standstill [IEC 61800-5-2]. The stop mode is not directly requested, but the maximum time until reaching the standstill is estimated. This period is loaded in a safe time relay, which disconnects the drive finally from supply.



When pressing the emergency stop unit the drive is stopped with a deceleration ramp via input X2A.12 (I3).

Simultaneously the expiration of the safe time occurs in the safety module. After expiration of the safe period the control signals STO1+ und STO2+ (X2B.1 and 5) are removed and thus the energy supply of the drive is disconnected.

The following adjustments must be done in COMBIVERT for the function „drive stop“:

| Parameter                             | Adjustment  |
|---------------------------------------|---|
| Pn.03 „Reaction to error prog. input“ | 1: quick stopping; modulation off; no automatic restart |

Function: If the selected input becomes active, the drive decelerates with the quick stopping function. The drive changes into status 31 „Error! External input“, when PN.68 is activated (<> 0) and the adjusted time has expired.

## 4. Certification

### 4.1 Annex to the declaration of conformity

Annex to the declaration of conformity EC for systems with functional safety:

|                      |                        |  |
|----------------------|------------------------|--|
| Product designation: | Inverter - type series | xxF5Kxx-xxxx<br>xxF5Lxx-xxxx<br>xxF5Pxx-xxxx |
|----------------------|------------------------|--|

Herewith we declare that the safety module described above corresponds with all relevant regulations of the machinery safety directive 2006/42/EC.

The above mentioned safety module meets the requirements of the following guidelines and standards:

|                              |             |
|------------------------------|-------------|
| • Machinery safety directive | 2006/42/EC  |
| • EMC directive              | 2004/108/EC |
| • Low-Voltage Directive      | 2006/95/EC  |

| EN standards | Output  | Text  | Reference         | Output  |
|--------------|---------|---|-------------------|---------|
| EN 61800-5-1 | 09/2003 | Electrical power drive systems with adjustable speed: security requirements | VDE 0160 Part 105 | 09/2003 |

informative:

|            |         |  |                   |         |
|------------|---------|--|-------------------|---------|
| EN 50178   | 1997    | Installation of high voltage systems with electronic equipment       | VDE 0160          | 04/1998 |
| EN 60664-1 | 2007    | Isolation coordinats for electrical equipment in low-voltage systems | VDE 0110          | 01/2008 |
| EN 61800-2 | 10/1998 | Basic determinations for AC inverter                                 | VDE 0160 Part 102 | 08/1999 |

especially for systems with functional safety additionally:

|                  |              |  |                     |                 |
|------------------|--------------|--|---------------------|-----------------|
| EN 61800-5-2     | 2007         | Electrical power drive systems with adjustable speed: functional safety requirements                       | VDE 0160 Part 105-2 | 04/2008         |
| EN 61508-(1...7) |              | Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1 up to 7 | VDE 0803            | 11/2002         |
| EN 60204-1 +A1   | 2006<br>2009 | Electrical equipment of machines; Part1: General requirements  | VDE 0113-1 +A1      | 2007<br>10/2009 |
| EN 62061         |              | Safety of machinery functional security requirements   | VDE 0113 Part 50    | 10/2005         |
| EN 13849-(1, 2)  |              | Safety of machinery  | –                   | 08/2008         |

The conformity was confirmed by the TÜV Rheinland with the EC type examination 01/205/5141/11.

The number and address of the indicated constitution:

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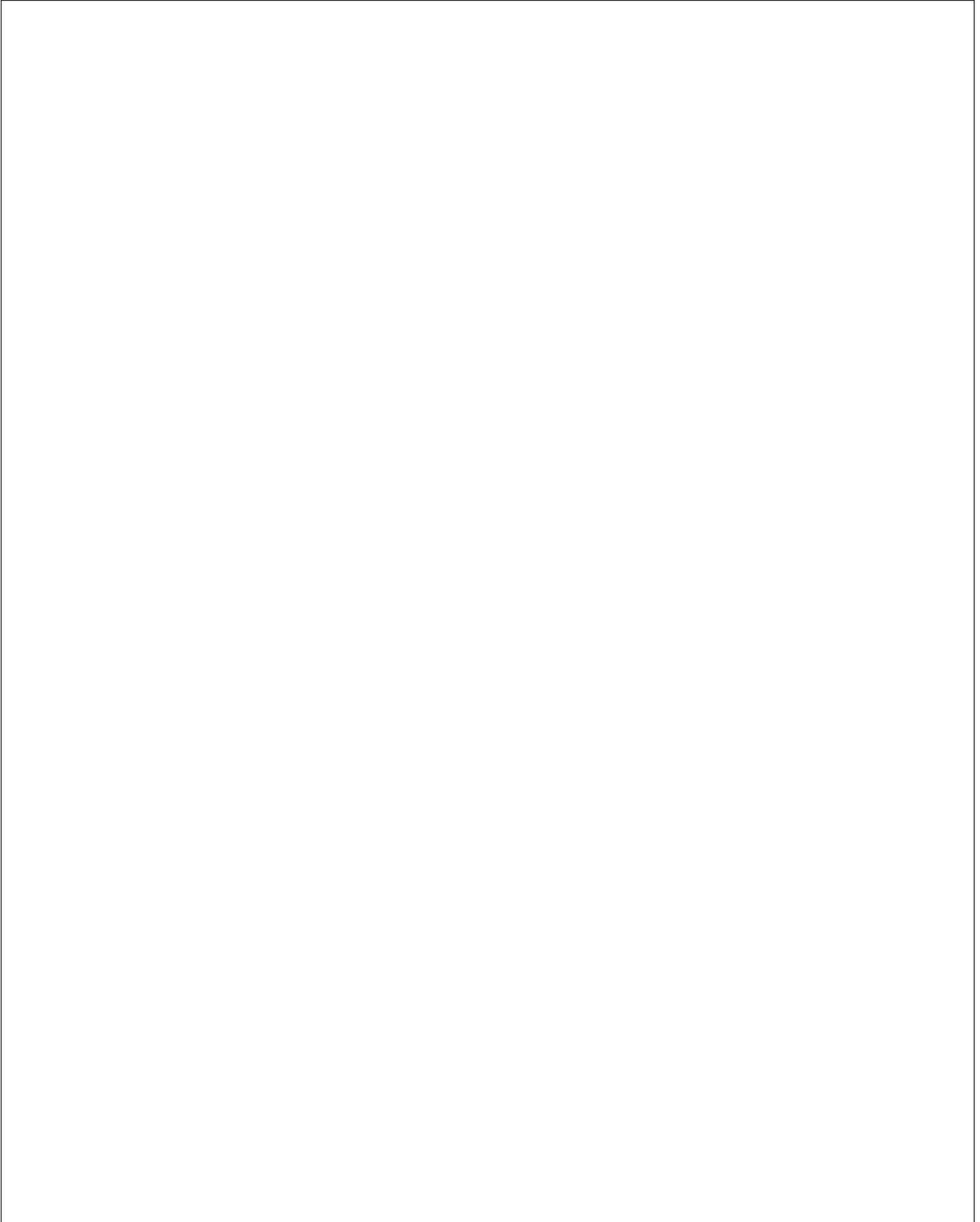
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## Revision history

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### 5. Revision history

| Revision | Date    | Description  |
|----------|---------|--|
| Rev.1D   | 2011-02 | First published version  |
| Rev.1E   | 2011-08 | Correction: Assignment of the terminal strip; Resolution: 11 Bit + sign                                |
| Rev.1F   | 2012-01 | Inscribed certification number; Typing error chapter 3.3.6 in german corrected                         |
| Rev.1G   | 2012-09 | Correction input external voltage supply   |
| Rev.1H   | 2013-03 | FS marking inserted; Terminal blocks changed to new standard; Switching condition output STO corrected |
| Rev.1J   | 2013-09 | New picture on title, strip control wires  |
| Rev.1K   | 2014-07 | Control categorie to categorie and assembly of wire-end ferrule changed                                |





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