

# COMBIVERT F6

INSTRUCTIONS FOR USE | **INSTALLATION F6 HOUSING 9**  
**HIGH SPEED DRIVE**

Translation of the original manual  
Document 20319504 EN 07



# Preface

The hardware and software described in this document are products of KEB. 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.

## Signal words and 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:

|                |  |
|----------------|--|
| <b>DANGER</b>  | Dangerous situation, which will cause death or serious injury if this safety warning is ignored. |
| <b>WARNING</b> | Dangerous situation, which may cause death or serious injury if this safety warning is ignored.  |
| <b>CAUTION</b> | Dangerous situation, which may cause minor injury if this safety warning is ignored.             |
| <b>NOTICE</b>  | Situation, which can cause damage to property if this safety warning is ignored.                 |

### RESTRICTION

Used when the following statements depend on certain conditions or are only valid for certain ranges of values.



Used for informational messages or recommended procedures.

## More symbols

- ▶ This arrow starts an action step.
- / - Enumerations are marked with dots or indents.
- => Cross reference to another chapter or another page.



Note to further documentation.  
<https://www.keb-automation.com/search>



## Laws and guidelines

KEB Automation KG confirms with the EC declaration of conformity and the CE mark on the device nameplate that it complies with the essential safety requirements.

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

## Warranty and liability

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



Here you will find our general sales conditions.

<https://www.keb-automation.com/terms-conditions>



Further agreements or specifications require a written confirmation.

## Support

Although multiple applications are referenced, not every case has been taking into account. If you require further information or if problems occur which are not referenced in the documentation, you can request the necessary information via the local KEB agency.

**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 customer.**

The information contained in the technical documentation, as well as any user-specific advice in spoken and written and through tests, are made to best of our knowledge and information about the intended use. However, they are regarded as being only informal and changes are expressly reserved, in particular due to technical changes. This also applies to any violation of industrial property rights of a third-party. Selection of our units in view of their suitability for the intended use must be done generally by the user.

**Tests can only be done within 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.**

## Copyright

The customer may use the instructions for use as well as further documents or parts from it for internal purposes. Copyrights are with KEB and remain 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.

# Table of Contents

|   |           |
|---|-----------|
| <b>Preface</b> .....                                    | <b>3</b>  |
| Signal words and symbols .....                          | 3         |
| More symbols.....                                       | 3         |
| Laws and guidelines.....                                | 4         |
| Warranty and liability.....                             | 4         |
| Support .....   | 4         |
| Copyright.....  | 4         |
| <b>Table of Contents</b> .....                          | <b>5</b>  |
| <b>1 Basic Safety Instructions</b> .....                | <b>9</b>  |
| 1.1 Target group.....                                   | 9         |
| 1.2 Transport, storage and proper use.....              | 9         |
| 1.3 Installation.....                                   | 10        |
| 1.4 Electrical connection .....                         | 11        |
| 1.4.1 EMC-compatible installation.....                  | 12        |
| 1.4.2 Voltage test.....                                 | 12        |
| 1.4.3 Insulation measurement.....                       | 12        |
| 1.5 Start-up and operation .....                        | 13        |
| 1.6 Maintenance.....                                    | 14        |
| 1.7 Repair .....  | 15        |
| 1.8 Disposal.....                                       | 16        |
| <b>2 Product Description</b> .....                      | <b>17</b> |
| 2.1 Specified application.....                          | 17        |
| 2.1.1 Residual risks .....                              | 17        |
| 2.2 Unintended use.....                                 | 17        |
| 2.3 Product features .....                              | 18        |
| 2.4 Part code .....                                     | 19        |
| 2.5 Nameplate .....                                     | 21        |
| 2.5.1 Configurable options .....                        | 22        |
| <b>3 Technical data</b> .....                           | <b>23</b> |
| 3.1 Operating conditions .....                          | 23        |
| 3.1.1 Climatic environmental conditions.....            | 23        |
| 3.1.2 Mechanical environmental conditions .....         | 24        |
| 3.1.3 Further environmental operating conditions.....   | 24        |
| 3.1.4 Electrical operating conditions.....              | 24        |
| 3.1.4.1 Device classification .....                     | 24        |
| 3.1.4.2 Electromagnetic compatibility.....              | 25        |
| 3.2 Device data of the High Speed Drive devices.....    | 26        |
| 3.2.1 Overview of the High Speed Drive device data..... | 26        |

|   |           |
|---|-----------|
| 3.2.2 Voltage and frequencies for 400V devices .....  | 27        |
| 3.2.2.1 Example of the calculation of the possible motor voltage: .....   | 28        |
| 3.2.3 Input and output currents / overload.....   | 29        |
| 3.2.3.1 Input and output currents / overload air cooler.....  | 29        |
| 3.2.3.2 Input and output currents / overload Fluid cooler (water).....  | 29        |
| 3.2.3.3 Overload characteristic (OL) .....  | 30        |
| 3.2.3.4 Frequency-dependent maximum current (OL2) .....   | 33        |
| 3.2.4 Overview of rectifier data for HSD devices.....   | 39        |
| 3.2.5 Power dissipation at rated operation .....  | 40        |
| 3.2.5.1 Power loss in rated operation Air cooler.....   | 40        |
| 3.2.5.2 Power loss in rated operation Fluid cooler (water).....   | 40        |
| 3.2.6 Fusing of the HSD devices.....  | 41        |
| 3.2.6.1 Fuse protection for AC supply .....   | 41        |
| 3.2.6.2 Fuse protection for DC supply.....  | 42        |
| <b>3.3 General electrical data .....</b>  | <b>43</b> |
| 3.3.1 Switching frequency and temperature.....  | 43        |
| 3.3.1.1 Switching frequencies and temperatures for air coolers .....  | 43        |
| 3.3.1.2 Switching frequencies and temperatures for fluid coolers (water).....                                       | 44        |
| 3.3.2 DC link / braking transistor.....   | 45        |
| 3.3.2.1 DC link / braking transistor.....   | 46        |
| 3.3.3 Continuous thermal current.....   | 47        |
| 3.3.4 Sub-mounted braking resistors .....   | 48        |
| 3.3.5 Fan .....   | 49        |
| 3.3.5.1 Switching behaviour of the fans .....   | 50        |
| 3.3.5.2 Switching points of the fans.....   | 50        |
| <b>4 Installation.....</b>  | <b>51</b> |
| <b>4.1 Dimensions and weights .....</b>   | <b>51</b> |
| 4.1.1 Built-in version air cooler.....  | 51        |
| 4.1.2 Push-through version air cooler IP20, IP54-ready .....  | 52        |
| 4.1.3 Built-in version fluid cooler (water) High-Performance with aluminium heat sink.....                          | 53        |
| 4.1.4 Push-through version fluid cooler (water) High-Performance with aluminium heat sink<br>IP20, IP54-ready ..... | 54        |
| <b>4.2 Control cabinet installation .....</b>   | <b>55</b> |
| 4.2.1 Control cabinet installation .....  | 55        |
| 4.2.2 Devices with transport bracket .....  | 55        |
| 4.2.3 Mounting instructions .....   | 56        |
| 4.2.4 Mounting distances .....  | 57        |
| 4.2.5 Installation of IP54-ready devices .....  | 58        |
| 4.2.6 Control cabinet ventilation.....  | 59        |
| 4.2.7 Airflow of the drive controller .....   | 59        |

|          |   |           |
|----------|---|-----------|
| <b>5</b> | <b>Installation and connection .....</b>                              | <b>60</b> |
| 5.1      | Overview of the COMBIVERT F6.....                                     | 60        |
| 5.2      | Connection of the power unit.....                                     | 63        |
| 5.2.1    | Connection of the voltage supply .....                                | 63        |
| 5.2.1.1  | Terminal block X1A for 400V devices .....                             | 64        |
| 5.2.2    | Protective earth and functional earth.....                            | 65        |
| 5.2.2.1  | Protective earth .....  | 65        |
| 5.2.2.2  | Functional earthing.....  | 65        |
| 5.3      | Mains connection .....  | 66        |
| 5.3.1    | Supply cable.....   | 66        |
| 5.3.2    | AC mains connection.....  | 66        |
| 5.3.2.1  | AC supply 3-phase .....   | 66        |
| 5.3.3    | DC mains connection .....   | 67        |
| 5.3.3.1  | Terminal block X1A DC connection .....                                | 67        |
| 5.3.3.2  | Connection at DC voltage supply.....                                  | 68        |
| 5.3.4    | Connection of the motor .....   | 69        |
| 5.3.4.1  | Wiring of the motor .....   | 69        |
| 5.3.4.2  | Terminal block X1A motor connection .....                             | 70        |
| 5.3.4.3  | Selection of the motor line.....                                      | 71        |
| 5.3.4.4  | Motor cable length and conducted interferences at AC supply .....     | 71        |
| 5.3.4.5  | Motor cable length for parallel operation of motors.....              | 72        |
| 5.3.4.6  | Motor cable cross-section .....                                       | 72        |
| 5.3.4.7  | Interconnection of the motor.....                                     | 72        |
| 5.3.4.8  | Connection of the temperature monitoring and brake control (X1C)..... | 73        |
| 5.3.5    | Connection and use of a braking resistor.....                         | 75        |
| 5.3.5.1  | Terminal block X1A connection braking resistor.....                   | 76        |
| 5.3.5.2  | Verwendung nicht eigensicherer Bremswiderstände .....                 | 77        |
| 5.3.6    | DC-bus connection.....  | 78        |
| 5.3.7    | External heat sink fan supply (FAN).....                              | 80        |
| 5.4      | Accessories .....   | 82        |
| 5.4.1    | Filters and chokes .....  | 82        |
| 5.4.2    | Seal for IP54-ready devices .....                                     | 82        |
| 5.4.3    | Side-mounted braking resistors.....                                   | 82        |
| <b>6</b> | <b>Operation of Liquid-Cooled Devices.....</b>                        | <b>83</b> |
| 6.1      | Water-cooled devices.....   | 83        |
| 6.1.1    | Heat sink and operating pressure .....                                | 83        |
| 6.1.2    | Materials in the cooling circuit .....                                | 83        |
| 6.1.3    | Requirements for the coolant .....                                    | 84        |
| 6.1.4    | Connection of the cooling system .....                                | 86        |
| 6.1.5    | Coolant temperature and moisture condensation .....                   | 87        |
| 6.1.5.1  | Condensation .....  | 87        |

## TABLE OF CONTENTS

|  |           |
|--|-----------|
| 6.1.5.2 Supply of temper coolant.....                  | 87        |
| 6.1.6 Permissible volume flow with water cooling ..... | 88        |
| 6.1.7 Coolant heating .....                            | 89        |
| 6.1.7.1 Coolant heating .....                          | 89        |
| 6.1.8 Typical pressure drop of the heat sink.....      | 90        |
| <b>7 Approvals and certifications .....</b>            | <b>91</b> |
| 7.1 CE marking.....                                    | 91        |
| 7.2 UL certification .....                             | 92        |
| 7.3 Further informations and documentation .....       | 94        |
| <b>8 Revision history .....</b>                        | <b>95</b> |

# 1 Basic Safety Instructions

The products are designed and constructed in accordance with state-of-the-art technology and the recognized safety rules and regulations. However, the use of such devices may cause functional hazards for life and limb of the user or third parties, or damages to the system 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. Violation 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!

- ▶ Read the instructions for use!
- ▶ Observe the safety and warning instructions!
- ▶ If anything is unclear, please contact KEB Automation KG!

## 1.1 Target group

This instruction manual is determined exclusively for electrical personnel. Electrical personnel for the purpose of this instruction manual must have the following qualifications:

- 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 *VDE 0100*.
- Knowledge of national safety regulations.

## 1.2 Transport, storage and proper use

The transport is carried out by qualified persons in accordance with the environmental conditions specified in this manual. Drive controller shall be protected against excessive strains.



### Transport of drive controllers with an edge length >75 cm

The transport by forklift without suitable tools can cause a deflection of the heat sink. This leads to premature aging or destruction of internal components.

- ▶ Transport of drive controllers on suitable pallets.
- ▶ Do not stack drive controllers or burden them with other heavy objects.

## NOTICE

### Damage to the coolant connections

#### Bending of the tubes!

- ▶ Never place the device on the coolant connections




---

**Drive controllers contain electrostatic sensitive components.**

- ▶ Avoid contact.
  - ▶ Wear ESD-protective clothing.
- 

Do not store drive controllers

- in the environment of aggressive and/or conductive liquids or gases.
- with direct sunlight.
- outside the specified environmental conditions.

### 1.3 Installation

**⚠ DANGER**




---

**Do not operate in an explosive environment!**

- ▶ The product is not intended for the use in potentially explosive environment.
- 

**⚠ CAUTION**




---

**Design-related edges and high weight!**

**Contusions and bruises!**

- ▶ Never stand under suspended loads.
  - ▶ Wear safety shoes.
  - ▶ Secure drive controller accordingly when using lifting gear.
- 

To prevent damages to the device:

- Make sure that no components are bent and/or isolation distances are changed.
- The device must not be put into operation in case of mechanical defects.
- Do not allow moisture or mist to penetrate the unit.
- Avoid dust permeating the device. Allow for sufficient heat dissipation if installed in a dust-proof housing.
- Note installation position and minimum distances to surrounding elements. Do not cover the ventilation openings.
- Mount the drive controller according to the specified degree of protection.
- Make sure that no small parts fall into the product during assembly and wiring (drilling chips, screws etc.). This also applies to mechanical components, which can lose small parts during operation.
- Check the reliable fit of the device connections in order to avoid contact resistances and sparking.
- Do not walk-on drive controller.
- Follow all safety instructions!

## 1.4 Electrical connection

### DANGER



#### Voltage at the terminals and in the device!

##### Danger to life due to electric shock !

- ▶ Never work on the open device or never touch exposed parts.
- ▶ For any work on the unit switch off the supply voltage, secure it against switching on and check absence of voltage by measuring at the input terminals.
- ▶ Wait until all drives has been stopped in order that no regenerative energy can be generated.
- ▶ Await capacitor discharge time (5 minutes). Check absence of voltage by measuring at the DC terminals.
- ▶ If personal protection is required, install suitable protective devices for drive converters.
- ▶ Never bridge upstream protective devices (even for testing purposes).
- ▶ Connect the protective earth conductor always to drive converter and motor.
- ▶ Install all required covers and protective devices for operation.
- ▶ The control cabinet shall be kept closed during operation.
- ▶ Residual current: This product may cause a dc current in the protective earth conductor. When a residual current protective device (RCD) or a residual current monitoring device (RCM) is used for the protection against direct or indirect contact, only a RCD or RCM type B is permitted on the power supply side of this product.
- ▶ Drive converters with a leakage current  $> 3.5\text{ mA AC}$  current (10 mA DC current) are intended for a stationary connection. Protective earth conductors must be designed in accordance with the local regulations for equipment with high leakage currents according to *EN 61800-5-1*, *EN 60204-1* or *VDE 0100*.



If personnel protection is required during installation of the system, suitable protective devices must be used for drive controllers.

[www.keb.de/fileadmin/media/Techinfo/dr/tn/ti\\_dr\\_tn-rcd-00008\\_en.pdf](http://www.keb.de/fileadmin/media/Techinfo/dr/tn/ti_dr_tn-rcd-00008_en.pdf)



Installations which include drive controller shall be equipped with additional control and protective devices in accordance with the relevant applicable safety requirements, e.g. act respecting technical equipment, accident prevention rules etc. They must always be complied with, also for drive controller bearing a CE marking.

For a trouble-free and safe operation, please pay attention to 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.
- Connection of the drive converter is only permissible on symmetrical networks with a maximum line voltage (L1, L2, L3) with respect to earth (N/PE) of max. 300V, USA UL: 480 / 277V. An isolating transformer must be used for supply networks which exceed this value! In case of non-compliance the control is not longer considered to be a PELV circuit.
- With existing or newly wired circuits the person installing the units or machines must ensure that the PELV requirements are met.
- For drive converters that are not isolated from the supply circuit (in accordance with [EN 60721-3-2](#)) 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.

### 1.4.1 EMC-compatible installation

Observance of the limit values required by EMC law is the responsibility of the customer.



Notes on EMC-compatible installation can be found here.  
[www.keb.de/fileadmin/media/Manuals/dr/emv/0000neb0000.pdf](http://www.keb.de/fileadmin/media/Manuals/dr/emv/0000neb0000.pdf)



### 1.4.2 Voltage test

Testing with AC voltage (in accordance with [EN 60204-1](#) chapter 18.4) may not be executed, since there is danger for the power semiconductors in the drive controller.



Due to the radio interference suppression capacitors, the test generator will switch off immediately with a current fault.



According to [EN 60204-1](#) it is permissible to disconnect already tested components. Drive controllers of the KEB Automation KG are delivered ex works voltage tested to 100% according to product standard.

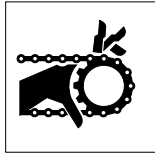
### 1.4.3 Insulation measurement

An insulation measurement (in accordance with [EN 60204-1](#) chapter 18.3) with DC 500V is permissible, if all power unit connections (grid-connected potential) and all control connections are bridged with PE. The insulation resistance of the respective device can be found in the technical data.

## 1.5 Start-up and operation

The start-up (i.e. for the specified application) is forbidden until it is determined that the installation complies with the machine directive; account is to be taken of [EN 60204-1](#).

### ⚠ WARNING



#### Software protection and programming!

##### Hazards caused by unintentional behavior of the drive!

- ▶ Check especially during initial start-up or replacement of the drive controller if parameterization is compatible to application.
- ▶ Securing a unit solely with software-supported functions is not sufficient. It is imperative to install external protective measures (e.g. limit switch) that are independent of the drive controller.
- ▶ Secure motors against automatic restart.

### ⚠ CAUTION



#### High temperatures at heat sink and coolant!

##### Burning of the skin!

- ▶ Cover hot surfaces safe-to-touch.
- ▶ If necessary, attach warning signs on the system.
- ▶ Before touching, check the surface and coolant lines.
- ▶ Before working let the unit cool down.

- During operation, all covers and doors shall be kept closed.
- Use only approved accessories for this device.
- Never touch terminals, busbars or cable ends.

### ⚠ CAUTION



#### High sound level during operation!

##### Hearing damage possible!

- ▶ Wear hearing protection!

### NOTICE

#### Continuous operation (S1) with load > 60% or from a rated motor power of 55 kW!

##### Premature ageing of the electrolytic capacitors!

- ▶ Mains choke with  $U_k = 4\%$  absolutely necessary.



If a drive controller with electrolytic capacitors in a DC link has not been in operation for more than one year, observe the following instructions.

[www.keb.de/fileadmin/media/Techinfo/dr/tn/ti\\_dr\\_tn-format-capacitors-00009\\_en.pdf](http://www.keb.de/fileadmin/media/Techinfo/dr/tn/ti_dr_tn-format-capacitors-00009_en.pdf)



### **Switching at the output**

Switching between motor and drive controller is prohibited for single drives during operation as this may trigger the protection gear of the device. Function ‚speed search‘ must be activated if switching can not be avoided. Speed search may only be triggered after closing the motor contactor (e.g. by switching the control release).

Connecting and disconnecting is permissible with multiple motor drives if at least 1 motor is running during the switch-over process. The drive controller must be dimensioned to the occurring starting currents.

The ‚speed search‘ function must be activated if the motor is still running during a restart of the drive controller (mains on) (e.g. due to large rotating masses).

### **Switching at the input**

For applications that require cyclic switching off and on of the drive controller, maintain an off-time of at least 5 min after the last switch on. If you require shorter cycle times please contact KEB Automation KG.

### **Short-circuit resistance**

The drive converters are conditional short-circuit proof. After resetting the internal protection devices, the function as directed is guaranteed.

Exceptions:

- If an earth-leakage fault or short-circuit often occurs at the output, this can lead to a defect in the unit.
- If a short-circuit occurs during regenerative operation (2nd or 4th quadrant, regeneration into the DC link), this can lead to a defect in the unit.

## **1.6 Maintenance**

The following maintenance work has to be carried out when required, but at least once per year by authorized and trained personnel. Check unit for loose screws and plugs and tighten if necessary.

- ▶ Check system for loose screws and plugs and tighten if necessary.
- ▶ Clean drive controller from dirt and dust deposits. Pay attention especially to cooling fins and protective grid of the fans.
- ▶ Examine and clean extracted air filter and cooling air filter of the control cabinet.
- ▶ Check the function of the fans of the drive controller. The fan must be replaced in case of audible vibrations or squeak.
- ▶ In the case of liquid-cooled drive controllers a visual test of the cooling circuit for leaks and corrosion must be carried out. The cooling circuit must be completely empty if a unit shall be switched off for a longer period. The cooling circuit must be blown out additionally with compressed air at temperatures below 0°C.

## 1.7 Repair

In case of malfunction, unusual noises or smells inform a person in charge!

### DANGER



#### **Unauthorized exchange, repair and modifications!**

##### **Unpredictable malfunctions!**

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

In case of failure, please contact the machine manufacturer. Only the machine manufacturer knows the parameterisation of the used drive controller and can provide an appropriate replacement or induce the maintenance.

## 1.8 Disposal

Electronic devices of the KEB Automation KG are exclusively professional devices for further industrial processing (so-called B2B devices).

Manufacturers of B2B devices are obliged to take back and recycle devices manufactured after 14.08.2018. These devices may not be disposed at the collection centres of public sector disposal organisations.



If no deviating agreement has been made between the customer and KEB or no deviating mandatory legal regulation exists, KEB products marked in this way can be returned. Company and keyword to the return point can be taken from the list below. Shipping costs are paid by the customer. Thereupon the devices will be professionally recycled and disposed.

The entry numbers are listed country-specific in the following table. The corresponding KEB return addresses can be found on our website.

| Withdrawal by           | WEEE-Reg.-No.            | Keyword                            |
|-------------------------|--------------------------|------------------------------------|
| <b>Austria</b>          |                          |                                    |
| KEB Automation GmbH     | ERA: 51976               | Stichwort „Rücknahme WEEE“         |
| <b>France</b>           |                          |                                    |
| RÉCYLUM - Recycle point | ADEME: FR021806          | Mots clés „KEB DEEE“               |
| <b>Germany</b>          |                          |                                    |
| KEB Automation KG       | EAR: DE12653519          | Stichwort „Rücknahme WEEE“         |
| <b>Italy</b>            |                          |                                    |
| COBAT                   | AEE: (IT) 19030000011216 | Parola chiave „Ritiro RAEE“        |
| <b>Spain</b>            |                          |                                    |
| KEB Automation KG       | RII-AEE 7427             | Palabra clave „Retirada RAEE“      |
| <b>Česko</b>            |                          |                                    |
| KEB Automation KG       | RETELA 09281/20 ECZ      | Klíčové slovo: Zpětný odběr OEEZ   |
| <b>Slowakei</b>         |                          |                                    |
| KEB Automation KG       | ASEKOL: RV22EEZ0000421   | Klíčové slovo: "Spätný odber OEEZ" |

The packaging must be feed to paper and cardboard recycling.

## 2 Product Description

The device series COMBIVERT F6 concerns to drive controllers, which are optimized for operation at synchronous and asynchronous motors.

The COMBIVERT can be extended with a safety module for the use in safety-oriented applications. The COMBIVERT F6 series are drive controllers with functional safety, optimized for operation at synchronous and asynchronous motors.

Various safety functions are available for different applications. It can be operated with a fieldbus module at different fieldbus systems. The control board has a system comprehensive operating concept.

The COMBIVERT complies with the requirements of the Machinery Directive. The possible functions are certified via a type test.

The COMBIVERT is a product of limited availability in accordance with [EN 61800-3](#). This product may cause radio interference in residential areas. In this case the operator may need to take corresponding measures.

The Machinery Directive, EMC Directive, Low Voltage Directive and other directives and regulations must be observed

### 2.1 Specified application

The COMBIVERT serves exclusively for the control and regulation of three-phase motors. It is intended for the installation into electrical systems or machines in the industrie.

Technical data and information for connection conditions shall be taken from the nameplate and from the instructions for use and must be strictly observed.

The used semiconductors and components of the KEB Automation KG are developed and dimensioned for the use in industrial products.

#### **Restriction**

If the product 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.

#### 2.1.1 Residual risks

Despite intended use, the drive controller can reach unexpected operating conditions in case of error, with wrong parameterization, by faulty connection or unprofessional interventions and repairs. This can be:

- wrong direction of rotation
- motor speed too high
- motor is running into limitation
- motor can be under voltage even in standstill
- automatic start

### 2.2 Unintended use

The operation of other electric consumers is prohibited and can lead to the destruction of the devices. The operation of our products outside the indicated limit values of the technical data leads to the loss of any liability claims.

## 2.3 Product features

These instructions for use describe the power units of the following devices:

|              |                      |
|--------------|----------------------|
| Device type: | Drive controller     |
| Series:      | COMBIVERT F6         |
| Power range: | 250...450 kW / 400 V |
| Housing:     | 9 High Speed Drive   |

The COMBIVERT F6 is characterized by the following features:

- Operation of three-phase asynchronous motors and three-phase synchronous motors, in operating modes open-loop or closed-loop with and without speed feedback
- Following fieldbus systems are supported:  
EtherCAT, VARAN, PROFINET, POWERLINK or CAN
- System-overlapping operating concept
- Wide operating temperature range
- Low switching losses by IGBT power unit
- Low noise development due to high switching frequencies
- Different heat sink concepts
- Temperature-controlled fan, easily replaceable
- Torque limits and s-curves are adjustable to protect gearboxes
- General protection functions of the COMBIVERT series against overcurrent, overvoltage, ground fault and overtemperature
- Analog inputs and outputs, digital inputs and outputs, relay output (potential-free), brake control and -supply, motor protection by I<sup>2</sup>t, KTY- or PTC input, two encoder interfaces, diagnostic interface, fieldbus interface (depending on the control board)
- Integrated safety function according to [EN 61800-5-2](#)

2.4 Part code

x x F 6 x x x - x x x x

Heat sink version

|  |
|--|
| 1: Air-cooler, mounted version   |
| 2: Liquid cooler (water), mounted version  |
| 3: Air-cooler, through-mount version IP54-ready  |
| 4: Liquid cooler (water), through-mount version IP54-ready   |
| 5: Air-cooler, through-mount version IP20  |
| 6: Liquid cooler (water), trough-mount version IP54-ready, sub-mounted braking resistors                     |
| 7: Liquid cooler (oil), through-mount version IP54-ready   |
| 8: Liquid cooler (oil), through-mount version IP54-ready, sub-mounted braking resistors                      |
| 9: Liquid cooler (water), mounted version, sub-mounted braking resistors                                     |
| A: Liquid cooler (water), mounted version, High Performance, sub-mounted braking resistors                   |
| B: Liquid cooler (water), through-mount version, IP54-ready, High Performance, sub-mounted braking resistors |
| C: Air-cooler, mounted version, Version 2  |
| D: Air-cooler, mounted version, High-Performance   |
| E: Liquid cooler (water), mounted version, High-Performance  |
| F: Air-cooler, through-mount version IP54-ready, High-Performance  |
| G: Liquid cooler (water), trough-mount version IP54-ready, High-Performance                                  |
| H: Air-cooler,, Convektion, trough-mount version IP54-ready  |

Control board variant



|  |
|--|
| <b>APPLIKATION</b>   |
| 1: Multi Encoder Interface, CAN <sup>® 2)</sup> , Real-Time Ethernet-busmodule <sup>3)</sup>                         |
| B Multi Encoder Interface, CAN <sup>® 2)</sup> , Real-Time Ethernet-busmodule <sup>3)</sup> , Alternative connector  |
| <b>KOMPAKT</b>   |
| 1: Multi Encoder Interface, CAN <sup>® 2)</sup> , STO, EtherCAT <sup>® 1)</sup>                                      |
| 2: Multi Encoder Interface, CAN <sup>® 2)</sup> , STO, VARAN   |
| <b>PRO</b>   |
| 0: No Encoder, CAN <sup>® 2)</sup> , Real-Time Ethernetinterface <sup>3)</sup>                                       |
| 1: Multi Encoder Interface, CAN <sup>® 2)</sup> , Real-Time Ethernet interface <sup>3)</sup>                         |
| 3: Multi Encoder Interface, CAN <sup>® 2)</sup> , Real-Time Ethernet interface <sup>3)</sup> , RS485-potential free  |
| 4: No Encoder, CAN <sup>® 2)</sup> , Real-Time Ethernetinterface <sup>3)</sup> , safe relay                          |
| 5: Multi Encoder Interface, CAN <sup>® 2)</sup> , Real-Time Ethernet interface <sup>3)</sup> , safety relay          |
| B: Multi Encoder Interface, CAN <sup>® 2)</sup> , Real-Time Ethernet interface <sup>3)</sup> , alternative connector |

*continued on the next page*

**PRODUCT DESCRIPTION**

|     |     |   |   |   |                        |   |  |   |
|-----|-----|---|---|---|------------------------|---|--|---|
| x x | F 6 | x   | x | x   | -x                     | x | x                                      | x |
|     |     | Switching frequency,<br>Software current limit,<br>Turn-off current |   | 0: 2 kHz / 125% / 150%  | 8: 2 kHz / 180% / 216% |   |  |   |
|     |     |   |   | 1: 4 kHz / 125% / 150%  | 9: 4 kHz / 180% / 216% |   |  |   |
|     |     |   |   | 2: 8 kHz / 125% / 150%  | A: 8 kHz / 180% / 216% |   |  |   |
|     |     |   |   | 3: 16 kHz / 125% / 150%   | B: 8 kHz / HSD         |   |  |   |
|     |     |   |   | 4: 2 kHz / 150% / 180%  | C: 6 kHz / HSD         |   |  |   |
|     |     |   |   | 5: 4 kHz / 150% / 180%  | Non standard switching |   | D: frequency / Overload characteristic |   |
|     |     |   |   | 6: 8 kHz / 150% / 180%  | E: Special Device      |   |  |   |
|     |     |   |   | 7: 16 kHz / 150% / 180%   |                        |   |  |   |
|     |     | Voltage/<br>Connection type   |   | 1: 3ph 230V AC/DC with braking transistor                             |                        |   |  |   |
|     |     |   |   | 2: 3ph 230V AC/DC without braking transistor                          |                        |   |  |   |
|     |     |   |   | 3: 3ph 400V AC/DC with braking transistor                             |                        |   |  |   |
|     |     |   |   | 4: 3ph 400V AC/DC without braking transistor                          |                        |   |  |   |
|     |     |   |   | A: 3ph 400V AC/DC incl. GTR7 / max. rectifier / max. pre-charging     |                        |   |  |   |
|     |     |   |   | B: 3ph 400V AC/DC without GTR7 / max. rectifier / max. pre-charging   |                        |   |  |   |
|     |     |   |   | C: 3ph 400V AC/DC. GTR7-variant 2                                     |                        |   |  |   |
|     |     |   |   | D: 3ph 400V AC/DC GTR7-variant 2 / max. rectifier / max. pre-charging |                        |   |  |   |
|     |     | Housing   |   | 2...9   |                        |   |  |   |
|     |     | Equipment   |   | 1: Safety module type 1 / STO at control type K                       |                        |   |  |   |
|     |     |   |   | 3: Safety module type 3   |                        |   |  |   |
|     |     |   |   | 4: Safety module type 4   |                        |   |  |   |
|     |     |   |   | 5: Safety module type 5   |                        |   |  |   |
|     |     | Control type  |   | A: APPLICATION  |                        |   |  |   |
|     |     |   |   | K: COMPACT  |                        |   |  |   |
|     |     |   |   | P: PRO  |                        |   |  |   |
|     |     | Series  |   | COMBIVERT F6  |                        |   |  |   |
|     |     | Inverter size   |   | 10...33   |                        |   |  |   |

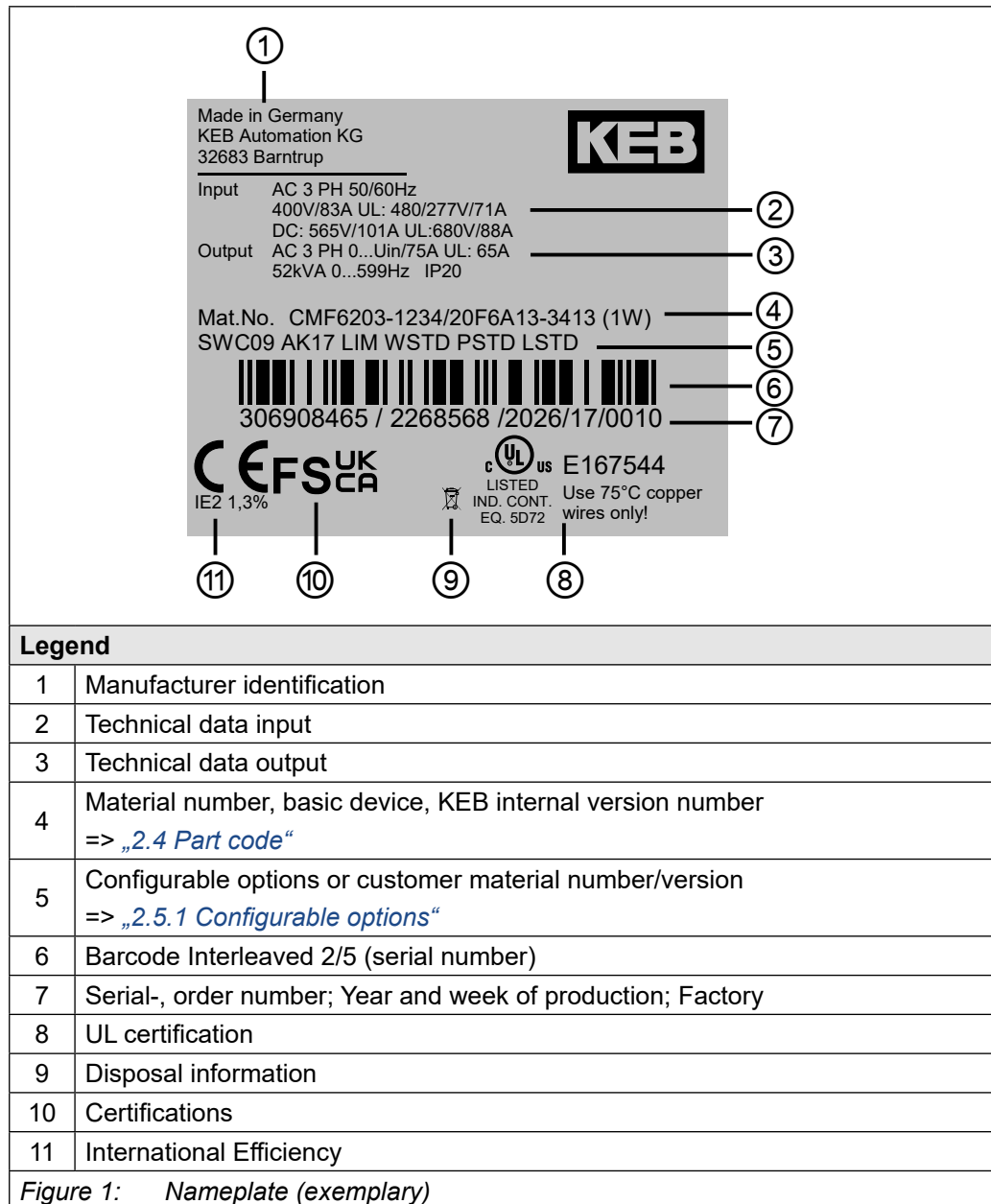
Table 1: Part code

- 1)  EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany
- 2)  CANopen® is registered trademark of CAN in AUTOMATION - International Users and Manufacturers Group e.V.
- 3) The Real-Time Ethernetbusmodul / Real-Time Ethernet interface contains various fieldbus control types which can be adjusted by software (parameter fb68)



The part code may not be used as order code, but only for identification!

## 2.5 Nameplate



2.5.1 Configurable options

| Features                              | Feature values      | Description                             |
|---------------------------------------|---------------------|---|
| Software                              | SWxxx <sup>1)</sup> | Software status of the drive controller |
| Accessories                           | Axxx <sup>1)</sup>  | Selected accessories                    |
|                                       | NAK                 | No accessories                          |
| Output frequency activation           | LIM                 | Limitation to 599 Hz                    |
|                                       | ULO                 | > 599Hz activated                       |
| Warranty                              | WSTD                | Warranty - Standard                     |
|                                       | Wxxx <sup>1)</sup>  | Warranty extension                      |
| Parameterization                      | PSTD                | Parameterization - Standard             |
|                                       | Pxxx <sup>1)</sup>  | Parameterization - Customer-specific    |
| Nameplate logo                        | LSTD                | Logo - Standard                         |
|                                       | Lxxx <sup>1)</sup>  | Logo - Customer-specific                |
| <i>Figure 2: Configurable options</i> |                     |   |

<sup>1)</sup> „x“ indicates a variable value

## 3 Technical data

Unless otherwise indicated, all electrical data in the following chapter refer to a 3-phase AC mains.

### 3.1 Operating conditions

#### 3.1.1 Climatic environmental conditions

| Storage                          |                     | Standard     | Class | Descriptions   |
|----------------------------------|---------------------|--------------|-------|--|
| Ambient temperature              |                     | EN 60721-3-1 | 1K4   | -25...55 °C  |
| Relative humidity                |                     | EN 60721-3-1 | 1K3   | 5...95 % (without condensation)  |
| Storage height                   |                     | –            | –     | Max. 3000 m above sea level  |
| Transport                        |                     | Standard     | Class | Descriptions   |
| Ambient temperature              |                     | EN 60721-3-2 | 2K3   | -25...70 °C  |
| Relative humidity                |                     | EN 60721-3-2 | 2K3   | 95 % at 40 °C (without condensation)   |
| Operation                        |                     | Standard     | Class | Descriptions   |
| Ambient temperature              |                     | EN 60721-3-3 | 3K3   | 5...40 °C (extended to -10...45 °C)  |
| Coolant inlet temperature        | Air                 | –            | –     | 5...40 °C (extended to -10...45 °C)  |
|                                  | Water <sup>1)</sup> | –            | –     | 5...55 °C  |
| Relative humidity                |                     | EN 60721-3-3 | 3K3   | 5...85 % (without condensation)  |
| Version and degree of protection |                     | EN 60529     | IP20  | Protection against foreign material > ø12.5 mm<br>No protection against water<br>Non-conductive pollution, occasional condensation when PDS is out of service.<br>Drive controller generally, except power connections and fan unit (IPxxA)  |
| Site altitude                    |                     | –            | –     | Max. 2000 m above sea level<br>• With site altitudes over 1000 m a derating of 1 % per 100 m must be taken into consideration.<br>• With site altitudes over 2000 m, the control board to the mains has only basic isolation. Additional measures must be taken when wiring the control. |

Table 2: Climatic environmental conditions

<sup>1)</sup> Observe the notes on the coolant => „6.1.3 Requirements for the coolant“

**3.1.2 Mechanical environmental conditions**

| <b>Storage</b>               | <b>Standard</b>     | <b>Class</b> | <b>Descriptions</b>  |
|------------------------------|---------------------|--------------|--|
| Vibration limits             | <i>EN 60721-3-1</i> | 1M2          | Vibration amplitude 1.5 mm (2...9Hz)<br>Acceleration amplitude 5 m/s <sup>2</sup> (9...200Hz)        |
| Shock limit values           | <i>EN 60721-3-1</i> | 1M2          | 40 m/s <sup>2</sup> ; 22 ms  |
| <b>Transport</b>             | <b>Standard</b>     | <b>Class</b> | <b>Descriptions</b>  |
| Vibration limits             | <i>EN 60721-3-2</i> | 2M1          | Vibration amplitude 3.5 mm (2...9Hz)<br>Acceleration amplitude 10 m/s <sup>2</sup> (9...200Hz)       |
| Shock limit values           | <i>EN 60721-3-2</i> | 2M1          | 100 m/s <sup>2</sup> ; 11 ms   |
| <b>Operation</b>             | <b>Standard</b>     | <b>Class</b> | <b>Descriptions</b>  |
| Vibration limits             | <i>EN 60721-3-3</i> | 3M4          | Vibration amplitude 3.0 mm (2...9Hz)<br>Acceleration amplitude 10 m/s <sup>2</sup> (9...200Hz)       |
|                              | <i>EN 61800-5-1</i> | –            | Vibration amplitude 0.075 mm (10...58 Hz)<br>Acceleration amplitude 10 m/s <sup>2</sup> (58...150Hz) |
| Shock limit values           | <i>EN 60721-3-3</i> | 3M4          | 100 m/s <sup>2</sup> ; 11 ms   |
| Pressure in the water cooler | –                   | –            | Rated operating pressure: 10 bar<br>Max. operating pressure: 10 bar                                  |

*Table 3: Mechanical environmental conditions*

**3.1.3 Further environmental operating conditions**

| <b>Operation</b>               | <b>Standard</b>     | <b>Class</b> | <b>Descriptions</b> |
|--------------------------------|---------------------|--------------|---------------------|
| Chemically active substances   | <i>EN 60721-3-3</i> | 3C2          | No salt spray       |
| Mechanically active substances |                     | 3S2          | –                   |
| Organic                        |                     | 3B1          | –                   |
| UV resistance                  |                     | –            | No requirement      |

*Table 4: Further environmental operating conditions*

**3.1.4 Electrical operating conditions**

3.1.4.1 Device classification

| <b>Requirement</b>   | <b>Standard</b>     | <b>Class</b> | <b>Descriptions</b>  |
|----------------------|---------------------|--------------|--|
| Overtoltage category | <i>EN 61800-5-1</i> | III          | –  |
| Pollution degree     | <i>EN 61800-5-1</i> | 2            | Non-conductive pollution, occasional condensation when PDS is out of service |

*Table 5: Device classification*

3.1.4.2 Electromagnetic compatibility

For devices without an internal filter, an external filter is required to comply with the following limits.

| EMC emitted interference  | Standard                       | Class        | Descriptions  |
|---|--------------------------------|--------------|---|
| Conducted interference emission   | EN 61800-3                     | C3           | From KEB internal version number: 2E<br>The specified class is only maintained in addition with a mains choke (without HF filter).  |
|   |                                | C2 / C3      | The specified class is only maintained in addition with a network choke and an HF filter.<br>Information on interference suppression (rated switching frequency, max. motor cable) can be found in the corresponding filter instructions. |
| Radiated emitted interference   | EN 61800-3                     | C2           | –   |
| EMF   | EN 61800-5-1                   | –            | Table P.2   |
| Immunity  | Standard                       | Level        | Descriptions  |
| Static discharges   | EN 61000-4-2                   | 8 kV<br>4 kV | AD (air discharge)<br>CD (contact discharge)  |
| Burst - Ports for process measurement control lines and signal interfaces | EN 61000-4-4                   | 2 kV         | –   |
| Burst - AC - Power ports  | EN 61000-4-4                   | 4 kV         | –   |
| Surge - Power ports   | EN 61000-4-5                   | 1 kV<br>2 kV | Phase-phase<br>Phase-ground   |
| Conducted immunity, induced by high-frequency fields                      | EN 61000-4-6                   | 10 V         | 0.15...80 MHz   |
| Electromagnetic fields  | EN 61000-4-3                   | 10 V/m       | 80 MHz...1 GHz  |
|   |                                | 3 V/m        | 1.4...2 GHz   |
|   |                                | 1 V/m        | 2...2.7 GHz   |
| voltage dips  | EN 61000-4-11<br>EN 61000-4-34 | Class 3      | –   |
| frequency fluctuations  | EN 61000-4-28                  | ± 2 %        | –   |
| Voltage unbalances  | EN 61000-2-4                   | ≤ 3 %        | –   |

Table 6: Electromagnetic compatibility

### 3.2 Device data of the High Speed Drive devices

#### 3.2.1 Overview of the High Speed Drive device data

The technical data are for 2/4-pole standard motors. With other pole numbers the drive controller must be dimensioned onto the rated motor current. Contact KEB for special or medium frequency motors.

| Device size                                |                                   | 29                                     | 30           | 31           | 30 <sup>9)</sup> | 31 <sup>9)</sup> | 32 <sup>9)</sup> | 33 <sup>9)</sup> |
|--|-----------------------------------|--|--------------|--------------|------------------|------------------|------------------|------------------|
| Housing                                    |                                   | 9                                      |              |              |                  |                  |                  |                  |
| Device type                                |                                   | High Speed Drive                       |              |              |                  |                  |                  |                  |
| Rated apparent output power                | $S_{out}$ / kVA                   | 319                                    | 395          | 436          | 395              | 436              | 492              | 554              |
| Max. rated motor power                     | <sup>1)</sup> $P_{mot}$ / kW      | 250                                    | 315          | 355          | 315              | 355              | 400              | 450              |
| Rated input voltage                        | $U_N$ / V                         | 400 (UL: 480)                          |              |              |                  |                  |                  |                  |
| Input voltage range                        | $U_{in}$ / V                      | 280...550                              |              |              |                  |                  |                  |                  |
| Mains phases                               |                                   | 3                                      |              |              |                  |                  |                  |                  |
| Mains frequency                            | $f_N$ / Hz                        | 50 / 60 ±2                             |              |              |                  |                  |                  |                  |
| Rated input current<br>@ $U_N = 400V$      | $I_{in}$ / A                      | 485                                    | 600          | 660          | 600              | 660              | 746              | 840              |
| Rated input current<br>@ $U_N = 480V$      | $I_{in\_UL}$ / A                  | 414                                    | 513          | 575          | 513              | 575              | 646              | 726              |
| Insulation resistance<br>@ $U_{dc} = 500V$ | $R_{iso}$ / MΩ                    | > 15                                   |              |              |                  |                  |                  |                  |
| Output voltage                             | $U_{out}$ / V                     | 0... $U_{in}$                          |              |              |                  |                  |                  |                  |
| Output frequency                           | <sup>2)</sup> $f_{out}$ / Hz      | 0...599 (0...2000)                     |              |              |                  |                  |                  |                  |
| Output phases                              |                                   | 3                                      |              |              |                  |                  |                  |                  |
| Rated output current<br>@ $U_N = 400V$     | $I_N$ / A                         | 460                                    | 570          | 630          | 570              | 630              | 710              | 800              |
| Rated output current<br>@ $U_N = 480V$     | $I_{N\_UL}$ / A                   | 400                                    | 495          | 545          | 495              | 545              | 615              | 692              |
| Rated output overload (60s)                | <sup>3)4)</sup> $I_{60s}$ / %     | 125                                    | 115          | 106          | 125              | 125              | 125              | 125              |
| Software current limit                     | <sup>3)</sup> $I_{lim}$ / %       | 125                                    | 112          | 112          | 125              | 125              | 125              | 125              |
| Overcurrent                                | <sup>3)</sup> $I_{OC}$ / %        | 150                                    | 135          | 135          | 150              | 150              | 150              | 150              |
| Rated switching frequency                  | $f_{SN}$ / kHz                    | 6                                      | 6            | 6            | 8                | 8                | 8                | 8                |
| Max. switching frequency                   | <sup>5)</sup> $f_{S\_max}$ / kHz  | 8                                      | 8            | 8            | 8                | 8                | 8                | 8                |
| Power dissipation at rated operation       | <sup>1)</sup> $P_D$ / kW          | 5,9                                    | 7,4          | 8,2          | 8,05             | 9                | 10,5             | 12               |
| Overload current over time                 | <sup>3)</sup> $I_{OL}$ / %        | „3.2.3.3 Overload characteristic (OL)“ |              |              |                  |                  |                  |                  |
| Maximum current<br>$f_s = 2$ kHz           | 0Hz/50Hz at<br>$I_{out\_max}$ / % | 137 /<br>150                           | 110 /<br>135 | 100 /<br>125 | –                | –                | –                | –                |
| Maximum current<br>$f_s = 4$ kHz           | 0Hz/50Hz at<br>$I_{out\_max}$ / % | 88 /<br>150                            | 71 /<br>135  | 64 /<br>125  | –                | –                | –                | –                |
| Maximum current<br>$f_s = 6$ kHz           | 0Hz/50Hz at<br>$I_{out\_max}$ / % | 73 /<br>150                            | 59 /<br>135  | 53 /<br>125  | –                | –                | –                | –                |

continued on the next page

| Device size   | 29   | 30      | 31      | 30 <sup>9)</sup> | 31 <sup>9)</sup> | 32 <sup>9)</sup> | 33 <sup>9)</sup> |
|---|--|---------|---------|------------------|------------------|------------------|------------------|
| <b>Housing</b>  | <b>9</b>   |         |         |                  |                  |                  |                  |
| <b>Device type</b>  | <b>High Speed Drive</b>  |         |         |                  |                  |                  |                  |
| Maximum current 0Hz/50Hz at $f_s=8\text{ kHz}$ $I_{out\_max}/\%$          | 58 / 103   | 47 / 83 | 42 / 75 | –                | –                | –                | –                |
| Maximum current 0Hz/100Hz at $f_s=2\text{ kHz}$ $I_{out\_max}/\%$         | –  | –       | –       | 110 / 150        | 110 / 150        | 105 / 150        | 100 / 150        |
| Maximum current 0Hz/100Hz at $f_s=4\text{ kHz}$ $I_{out\_max}/\%$         | –  | –       | –       | 101 / 150        | 95 / 150         | 85 / 150         | 75 / 150         |
| Maximum current 0Hz/100Hz at $f_s=8\text{ kHz}$ $I_{out\_max}/\%$         | –  | –       | –       | 53 / 150         | 48 / 150         | 42 / 142         | 34 / 126         |
| Max. braking current $I_{B\_max} / \text{A}$                              | 600  |         |         |                  |                  |                  |                  |
| Min. braking resistor value $R_{B\_min} / \Omega$                         | 1,3  |         |         |                  |                  |                  |                  |
| Braking transistor <sup>6)</sup>  | Max. cycle time: 120 s; Max c.d.f.: 25 %   |         |         |                  |                  |                  |                  |
| Protective function for braking transistor                                | Short-circuit monitoring   |         |         |                  |                  |                  |                  |
| Protective function braking resistor (Error GTR7 always on) <sup>7)</sup> | Feedback signal evaluation and current switch-off (only for AC mains connection) |         |         |                  |                  |                  |                  |
| Max. motor cable length shielded <sup>8)</sup> $l / \text{m}$             | 100  |         |         |                  |                  |                  |                  |

**Table 7: Overview of the HSD device data**

- <sup>1)</sup> Rated operation corresponds to  $U_N = 400\text{V}$ , rated switching frequency, output frequency = 50Hz (4-pole standard asynchronous motor).
- <sup>2)</sup> The output frequency is to be limited in such a way that it does not exceed 1/10 of the switching frequency. Notice! Devices with a maximum output frequency higher than 599Hz are subject to export restrictions.
- <sup>3)</sup> The values refer in % to the rated output current  $I_N$ .
- <sup>4)</sup> Observe limitations => „3.2.3.3 Overload characteristic (OL)“.
- <sup>5)</sup> A detailed description of the Derating => „3.3.1 Switching frequency and temperature“.
- <sup>6)</sup> The cyclic duration factor is additionally limited by the used braking resistor.
- <sup>7)</sup> The feedback signal evaluation monitors the functionality of the braking transistor. The power is switched off via the internal mains input bridge of the AC supply. There is no current switch-off with DC voltage supply.
- <sup>8)</sup> The maximum cable length depends on various factors. Further information can be found in the corresponding filter instructions.
- <sup>9)</sup> Only available as a fluid cooler (water).

### 3.2.2 Voltage and frequencies for 400V devices

| Input voltages and frequencies |                               |
|--------------------------------|-------------------------------|
| Rated input voltage            | $U_N / \text{V}$ 400          |
| Rated mains voltage (USA)      | $U_{N\_UL} / \text{V}$ 480    |
| Input voltage range            | $U_{IN} / \text{V}$ 280...550 |
| Input phases                   | 3                             |
| Mains frequency                | $f_N / \text{Hz}$ 50/60       |
| Mains frequency tolerance      | $f_N / \text{Hz}$ $\pm 2$     |

**Table 8: Input voltages and frequencies of the 400V devices**

| DC link voltage                            |                     |           |
|--|---------------------|-----------|
| DC link rated voltage @ $U_N = 400V$       | $U_{N\_dc} / V$     | 565       |
| DC link rated voltage @ $U_{N\_UL} = 480V$ | $U_{N\_UL\_dc} / V$ | 680       |
| DC link voltage working voltage range      | $U_{IN\_dc} / V$    | 390...780 |

Table 9: DC link voltage for 400V devices

| Output voltages and frequencies |                              |                              |
|---------------------------------|------------------------------|------------------------------|
| Output voltage at AC supply     | <sup>1)</sup> $U_{out} / V$  | $0 \dots U_{N\_ac}$          |
| Output frequency                | <sup>2)</sup> $f_{out} / Hz$ | $0 \dots 599 (0 \dots 2000)$ |
| Output phase                    |                              | 3                            |

Table 10: Output voltages and frequencies of the 400V devices

- <sup>1)</sup> The voltage to the motor is dependent on the actual input voltage and the control method („3.2.2.1 Example of the calculation of the possible motor voltage:“).
- <sup>2)</sup> The output frequency is to be limited in such a way that it does not exceed 1/10 of the switching frequency. Devices with a maximum output frequency higher than 599Hz are restricted for export.

3.2.2.1 Example of the calculation of the possible motor voltage:

The motor voltage for dimensioning of the drive is depending on the used components. The motor voltage reduces according to the following table:

| Component                    | Reduction / % | Example  |
|------------------------------|---------------|--|
| Mains choke $U_k$            | 4             | Open-loop drive controller with mains- and motor choke at non-rigid supply system:<br>400 V mains voltage (100%) - 36 V reduced voltage (11%)<br>= 356 V motor voltage |
| Drive controller open-loop   | 4             |  |
| Drive controller closed-loop | 8             |  |
| Motor choke $U_k$            | 1             |  |
| Non-rigid supply system      | 2             |  |

Table 11: Example of the calculation of the possible motor voltage:

### 3.2.3 Input and output currents / overload

#### 3.2.3.1 Input and output currents / overload air cooler

| Device size                                  |                                 | 29  | 30  | 31  |
|--|---------------------------------|---|-----|-----|
| Rated input current @ $U_N = 400V$           | <sup>1)</sup> $I_{in} / A$      | 485                                       | 600 | 660 |
| Rated input current @ $U_{N\_UL} = 480V$     | <sup>1)</sup> $I_{in\_UL} / A$  | 414                                       | 513 | 575 |
| Rated input current DC @ $U_N = 565 V$       | $I_{in\_dc} / A$                | 583                                       | 723 | 799 |
| Rated input current DC @ $U_{N\_UL} = 680 V$ | $I_{in\_UL\_dc} / A$            | 507                                       | 628 | 691 |
| Rated output current @ $U_N = 400V$          | $I_N / A$                       | 460                                       | 570 | 630 |
| Rated output current @ $U_{N\_UL} = 480V$    | $I_{N\_UL} / A$                 | 400                                       | 495 | 545 |
| Rated output overload (60 s)                 | <sup>2)</sup> $I_{60s} / \%$    | 125                                       | 115 | 106 |
| Overload current                             | <sup>2)</sup> $I_{OL} / \%$     | => „3.2.3.3 Overload characteristic (OL)“ |     |     |
| Software current limit                       | <sup>2) 3)</sup> $I_{lim} / \%$ | 125                                       | 112 | 112 |
| Overcurrent                                  | <sup>2)</sup> $I_{oc} / \%$     | 150                                       | 135 | 135 |

**Table 12:** Input and output currents / overload of the HSD units Air cooler

- <sup>1)</sup> The values resulting from rated operation with B6 rectifier circuit and mains choke 4%  $U_k$ .
- <sup>2)</sup> The values refer in % to the rated output current  $I_N$ .
- <sup>3)</sup> Limitation of the current setpoint in closed-loop operation. This setpoint limit is not active in v/f operation.

#### 3.2.3.2 Input and output currents / overload Fluid cooler (water)

| Device size                                  |                                 | 30  | 31  | 32  | 33   |
|--|---------------------------------|---|-----|-----|------|
| Rated input current @ $U_N = 400V$           | <sup>1)</sup> $I_{in} / A$      | 600                                       | 660 | 746 | 840  |
| Rated input current @ $U_{N\_UL} = 480V$     | <sup>1)</sup> $I_{in\_UL} / A$  | 513                                       | 575 | 646 | 726  |
| Rated input current DC @ $U_N = 565 V$       | $I_{in\_dc} / A$                | 723                                       | 799 | 900 | 1015 |
| Rated input current DC @ $U_{N\_UL} = 680 V$ | $I_{in\_UL\_dc} / A$            | 628                                       | 691 | 780 | 878  |
| Rated output current @ $U_N = 400V$          | $I_N / A$                       | 570                                       | 630 | 710 | 800  |
| Rated output current @ $U_{N\_UL} = 480V$    | $I_{N\_UL} / A$                 | 495                                       | 545 | 615 | 692  |
| Rated output overload (60 s)                 | <sup>2)</sup> $I_{60s} / \%$    | 125                                       | 125 | 125 | 125  |
| Overload current                             | <sup>2)</sup> $I_{OL} / \%$     | => „3.2.3.3 Overload characteristic (OL)“ |     |     |      |
| Software current limit                       | <sup>2) 3)</sup> $I_{lim} / \%$ | 125                                       | 125 | 125 | 125  |
| Overcurrent                                  | <sup>2)</sup> $I_{oc} / \%$     | 150                                       | 150 | 150 | 150  |

**Table 13:** Input and output currents / overload of the HSD devices Fluid cooler (water)

- <sup>1)</sup> The values resulting from rated operation with B6 rectifier circuit and mains choke 4%  $U_k$ .
- <sup>2)</sup> The values refer in % to the rated output current  $I_N$ .
- <sup>3)</sup> Limitation of the current setpoint in closed-loop operation. This setpoint limit is not active in v/f operation.

### 3.2.3.3 Overload characteristic (OL)

All drive converters can be operated at a rated switching frequency with a utilisation of 106% or 125% for 60 seconds.

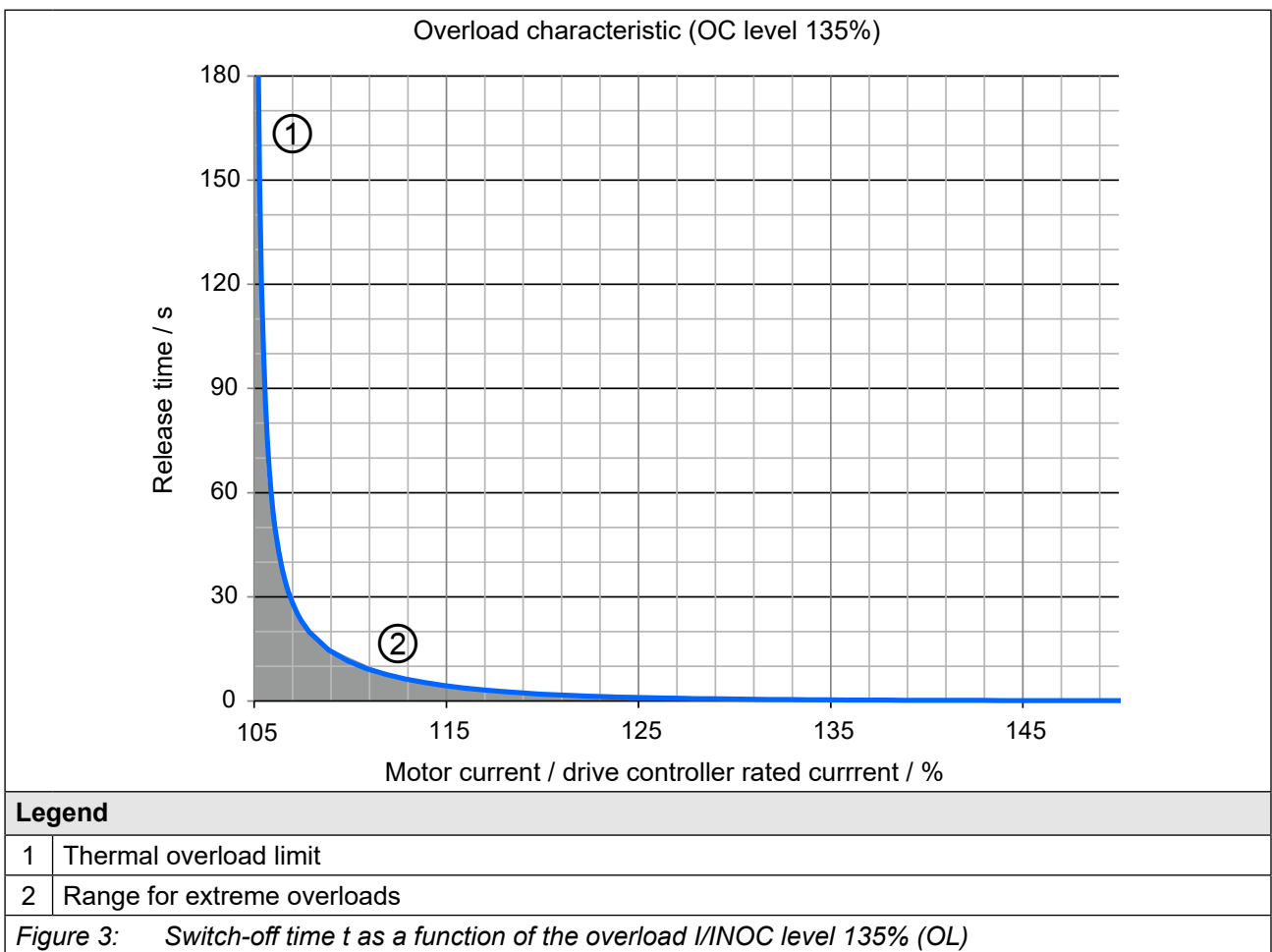
The OL overload function is a root mean square (RMS) function.

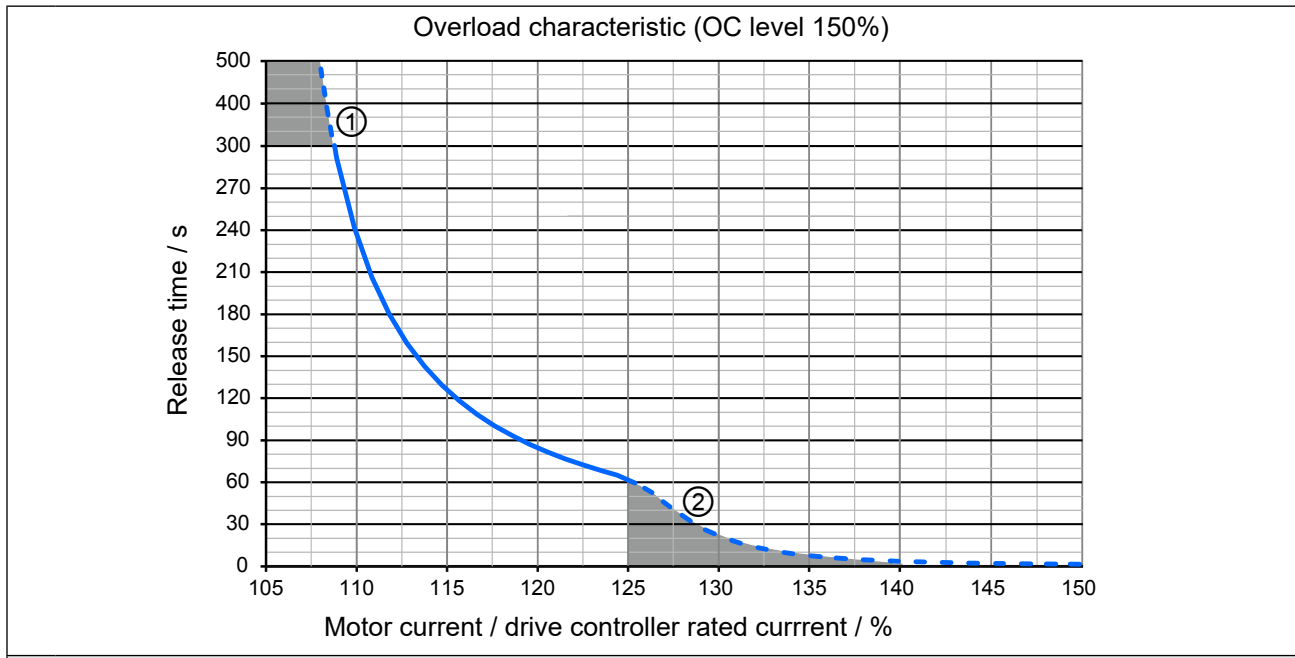
The greater the difference between the overload and underload phases, the greater the deviation of the RMS from the arithmetic mean value.

For extreme overloads ( $\Rightarrow$  „*Figure 3: Switch-off time  $t$  as a function of the overload  $I/INOC$  level 135% (OL)*“ / „*Figure 4: Switch-off time  $t$  as a function of the overload  $I/INOC$  level 150% (OL)*“) the capacity utilisation is weighted more heavily. This means the load is provided with a factor for the calculation of the RMS value, by way that the overload protection function triggers, even if the RMS value does not reach 100%.

**Restrictions:**

- The thermal design of the heat sink is based on the rated operation. The following values are taken into account: Rated output current, ambient temperature, rated switching frequency, rated voltage.
- At high ambient temperatures and/or high heat sink temperatures (for example, by preceding utilisation nearby 100%) the drive controller can change to overtemperature error before triggering the protective function OL.
- At low output frequencies or switching frequencies higher than the rated switching frequency, the frequency-dependent maximum current can be exceeded before triggering the overload error OL and error OL2 can be triggered  
=> „3.2.3.4 Frequency-dependent maximum current (OL2)“.





**Legend**

|   |                             |
|---|-----------------------------|
| 1 | Thermal overload limit      |
| 2 | Range for extreme overloads |

Figure 4: Switch-off time  $t$  as a function of the overload  $I/I_{NOC}$  level 150% (OL)

- On exceeding a load of 105 % the overload integrator starts.
- When falling below the integrator counts backwards.
- If the integrator reaches the overload characteristic "Error! Overload (OL)" is triggered.

After a cooling down period, the integrator can be reset now. The drive controller must remain switched on during the cooling down phase.

**Operation in the range of the thermal overload limit**

Due to the high steepness of the overload characteristic, the duration of a permissible overload in this range ① cannot be determined exactly. Therefore, the design of the drive controller should be assumed to have a maximum overload time of 300s.

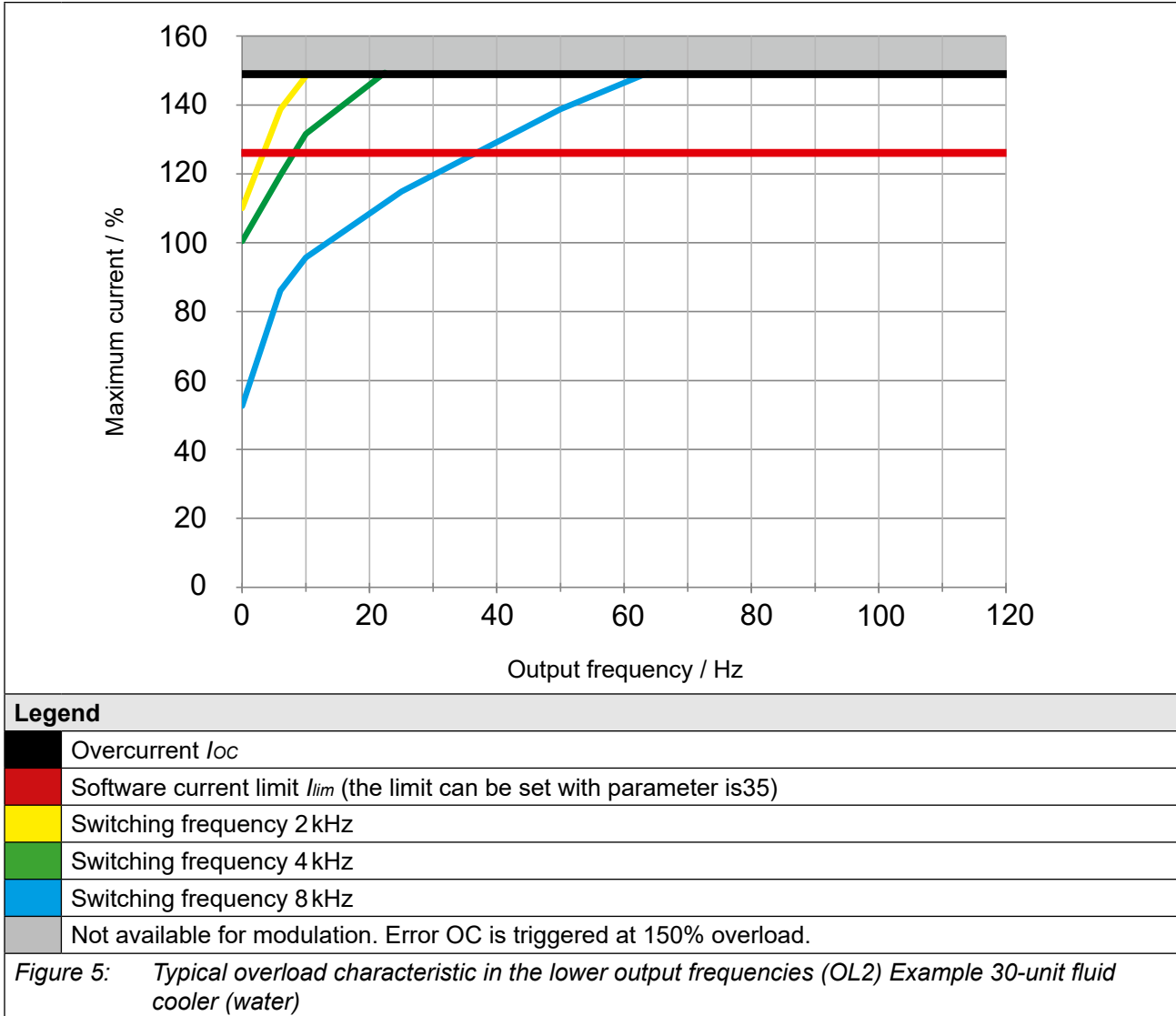
**3.2.3.4 Frequency-dependent maximum current (OL2)**

The characteristics of the maximum currents for a switching frequency which are depending on the output frequency are different for each drive controller, but in general the following rule applies to housing 9:

- Lower maximum currents apply for switching frequencies > rated switching frequency.

If error (OL2) shall be triggered on exceeding the maximum currents or if the switching frequency is automatically reduced (derating) can be adjusted in the drive controller parameters.

The following characteristic curve indicates the permissible maximum current for the output frequency values 0 Hz, 6 Hz, 10 Hz, 25 Hz, 50 Hz and 100 Hz. Device size 30 HSD (fluid cooler) is represented exemplary.



The frequency-dependent maximum current  $I_{out\_max}$  refers in % to the rated output current  $I_N$ .  
 The current remains constant from the last specified output frequency value.



The values for the respective device size are listed in the following tables.

**Frequency-dependent maximum current (air cooler)**

| Device size   |                  | 29    |     |     |     |     |     |
|---|------------------|-------|-----|-----|-----|-----|-----|
| Rated switching frequency   |                  | 6 kHz |     |     |     |     |     |
| Output frequency  | $f_{out}$ / Hz   | 0     | 1,5 | 6   | 10  | 25  | 50  |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 62.5 <math>\mu</math>s (Parameter is22=0)</i> | $I_{out\_max}$ % |       |     |     |     |     |     |
|   | 2 kHz            | 137   | 148 | 150 | 150 | 150 | 150 |
|   | 4 kHz            | 88    | 97  | 118 | 130 | 150 | 150 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 71.4 <math>\mu</math>s (Parameter is22=1)</i> | $I_{out\_max}$ % |       |     |     |     |     |     |
|   | 1.75 kHz         | 137   | 148 | 150 | 150 | 150 | 150 |
|   | 3.5 kHz          | 100   | 110 | 130 | 141 | 150 | 150 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 83.3 <math>\mu</math>s (Parameter is22=2)</i> | $I_{out\_max}$ % |       |     |     |     |     |     |
|   | 7 kHz            | 66    | 71  | 83  | 90  | 111 | 138 |
|   | 1.5 kHz          | 137   | 148 | 150 | 150 | 150 | 150 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 83.3 <math>\mu</math>s (Parameter is22=2)</i> | $I_{out\_max}$ % |       |     |     |     |     |     |
|   | 3 kHz            | 112   | 123 | 142 | 150 | 150 | 150 |
|   | 6 kHz            | 73    | 80  | 94  | 103 | 130 | 150 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 100 <math>\mu</math>s (Parameter is22=3)</i>  | $I_{out\_max}$ % |       |     |     |     |     |     |
|   | 1.25 kHz         | 137   | 148 | 150 | 150 | 150 | 150 |
|   | 2.5 kHz          | 125   | 135 | 150 | 150 | 150 | 150 |
|   | 5 kHz            | 81    | 88  | 106 | 117 | 149 | 150 |

Table 14: Frequency-dependent maximum current for appliance size 29 HSD air cooler

| Device size   |                  | 30    |     |     |     |     |     |
|---|------------------|-------|-----|-----|-----|-----|-----|
| Rated switching frequency   |                  | 6 kHz |     |     |     |     |     |
| Output frequency  | $f_{out}$ / Hz   | 0     | 1,5 | 6   | 10  | 25  | 50  |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 62.5 <math>\mu</math>s (Parameter is22=0)</i> | $I_{out\_max}$ % |       |     |     |     |     |     |
|   | 2 kHz            | 110   | 119 | 134 | 135 | 135 | 135 |
|   | 4 kHz            | 71    | 78  | 95  | 105 | 135 | 135 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 71.4 <math>\mu</math>s (Parameter is22=1)</i> | $I_{out\_max}$ % |       |     |     |     |     |     |
|   | 8 kHz            | 47    | 50  | 57  | 62  | 74  | 83  |
|   | 1.75 kHz         | 110   | 119 | 134 | 135 | 135 | 135 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 71.4 <math>\mu</math>s (Parameter is22=1)</i> | $I_{out\_max}$ % |       |     |     |     |     |     |
|   | 3.5 kHz          | 81    | 89  | 105 | 114 | 135 | 135 |
|   | 7 kHz            | 53    | 57  | 67  | 73  | 89  | 111 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 83.3 <math>\mu</math>s (Parameter is22=2)</i> | $I_{out\_max}$ % |       |     |     |     |     |     |
|   | 1.5 kHz          | 110   | 119 | 134 | 135 | 135 | 135 |
|   | 3 kHz            | 91    | 99  | 114 | 123 | 135 | 135 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 83.3 <math>\mu</math>s (Parameter is22=2)</i> | $I_{out\_max}$ % |       |     |     |     |     |     |
|   | 6 kHz            | 59    | 64  | 76  | 83  | 105 | 135 |
|   | 1.25 kHz         | 110   | 119 | 134 | 135 | 135 | 135 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 100 <math>\mu</math>s (Parameter is22=3)</i>  | $I_{out\_max}$ % |       |     |     |     |     |     |
|   | 2.5 kHz          | 100   | 109 | 124 | 132 | 135 | 135 |
|   | 5 kHz            | 65    | 71  | 86  | 94  | 120 | 135 |

Table 15: Frequency-dependent maximum current for appliance size 30 HSD air cooler

| Device size   |                  | 31    |     |     |     |     |     |
|---|------------------|-------|-----|-----|-----|-----|-----|
| Rated switching frequency   |                  | 6 kHz |     |     |     |     |     |
| Output frequency  | $f_{out}$ / Hz   | 0     | 1,5 | 6   | 10  | 25  | 50  |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 62.5 <math>\mu</math>s (Parameter is22=0)</i> | $i_{out\_max}$ % |       |     |     |     |     |     |
|   | 2 kHz            | 100   | 108 | 121 | 125 | 125 | 125 |
|   | 4 kHz            | 64    | 71  | 86  | 95  | 123 | 125 |
|   | 8 kHz            | 42    | 45  | 51  | 56  | 67  | 75  |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 71.4 <math>\mu</math>s (Parameter is22=1)</i> | $i_{out\_max}$ % |       |     |     |     |     |     |
|   | 1.75 kHz         | 100   | 108 | 121 | 125 | 125 | 125 |
|   | 3.5 kHz          | 73    | 80  | 95  | 103 | 125 | 125 |
|   | 7 kHz            | 48    | 51  | 60  | 66  | 81  | 101 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 83.3 <math>\mu</math>s (Parameter is22=2)</i> | $i_{out\_max}$ % |       |     |     |     |     |     |
|   | 1.5 kHz          | 100   | 108 | 121 | 125 | 125 | 125 |
|   | 3 kHz            | 82    | 89  | 103 | 111 | 125 | 125 |
|   | 6 kHz            | 53    | 58  | 69  | 75  | 95  | 125 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 100 <math>\mu</math>s (Parameter is22=3)</i>  | $i_{out\_max}$ % |       |     |     |     |     |     |
|   | 1.25 kHz         | 100   | 108 | 121 | 125 | 125 | 125 |
|   | 2.5 kHz          | 91    | 99  | 112 | 119 | 125 | 125 |
|   | 5 kHz            | 59    | 64  | 77  | 85  | 109 | 125 |

Table 16: Frequency-dependent maximum current for appliance size 31 HSD air cooler

**Frequency-dependent maximum current (fluid cooler water)**

| Device size  |                  | 30    |     |     |     |     |     |
|--|------------------|-------|-----|-----|-----|-----|-----|
| Rated switching frequency  |                  | 8 kHz |     |     |     |     |     |
| Output frequency   | $f_{out}$ / Hz   | 0     | 6   | 10  | 25  | 50  | 100 |
| Frequency-dependent maximum current @ $f_s$<br>Basic Time Period = 62.5 $\mu$ s (Parameter is22=0) | $i_{out\_max}$ % |       |     |     |     |     |     |
|  | 2 kHz            | 110   | 139 | 148 | 150 | 150 | 150 |
|  | 4 kHz            | 101   | 120 | 132 | 150 | 150 | 150 |
|  | 8 kHz            | 53    | 86  | 96  | 115 | 139 | 150 |
| Frequency-dependent maximum current @ $f_s$<br>Basic Time Period = 71.4 $\mu$ s (Parameter is22=1) | $i_{out\_max}$ % |       |     |     |     |     |     |
|  | 1.75 kHz         | 110   | 139 | 148 | 150 | 150 | 150 |
|  | 3.5 kHz          | 103   | 124 | 136 | 150 | 150 | 150 |
|  | 7 kHz            | 65    | 95  | 105 | 124 | 150 | 150 |
| Frequency-dependent maximum current @ $f_s$<br>Basic Time Period = 83.3 $\mu$ s (Parameter is22=2) | $i_{out\_max}$ % |       |     |     |     |     |     |
|  | 1.5 kHz          | 110   | 139 | 148 | 150 | 150 | 150 |
|  | 3 kHz            | 105   | 129 | 140 | 150 | 150 | 150 |
|  | 6 kHz            | 77    | 103 | 114 | 134 | 150 | 150 |
| Frequency-dependent maximum current @ $f_s$<br>Basic Time Period = 100 $\mu$ s (Parameter is22=3)  | $i_{out\_max}$ % |       |     |     |     |     |     |
|  | 1.25 kHz         | 110   | 139 | 148 | 150 | 150 | 150 |
|  | 2.5 kHz          | 108   | 134 | 144 | 150 | 150 | 150 |
|  | 5 kHz            | 89    | 111 | 123 | 144 | 150 | 150 |

Table 17: Frequency-dependent maximum current for device size 30 HSD (fluid cooler water)

| Device size  |                  | 31    |     |     |     |     |     |
|--|------------------|-------|-----|-----|-----|-----|-----|
| Rated switching frequency  |                  | 8 kHz |     |     |     |     |     |
| Output frequency   | $f_{out}$ / Hz   | 0     | 6   | 10  | 25  | 50  | 100 |
| Frequency-dependent maximum current @ $f_s$<br>Basic Time Period = 62.5 $\mu$ s (Parameter is22=0) | $i_{out\_max}$ % |       |     |     |     |     |     |
|  | 2 kHz            | 110   | 130 | 139 | 150 | 150 | 150 |
|  | 4 kHz            | 95    | 110 | 120 | 139 | 150 | 150 |
|  | 8 kHz            | 48    | 78  | 87  | 104 | 126 | 150 |
| Frequency-dependent maximum current @ $f_s$<br>Basic Time Period = 71.4 $\mu$ s (Parameter is22=1) | $i_{out\_max}$ % |       |     |     |     |     |     |
|  | 1.75 kHz         | 110   | 130 | 139 | 150 | 150 | 150 |
|  | 3.5 kHz          | 99    | 115 | 124 | 144 | 150 | 150 |
|  | 7 kHz            | 60    | 86  | 95  | 113 | 135 | 150 |
| Frequency-dependent maximum current @ $f_s$<br>Basic Time Period = 83.3 $\mu$ s (Parameter is22=2) | $i_{out\_max}$ % |       |     |     |     |     |     |
|  | 1.5 kHz          | 110   | 130 | 139 | 150 | 150 | 150 |
|  | 3 kHz            | 103   | 120 | 129 | 149 | 150 | 150 |
|  | 6 kHz            | 71    | 94  | 103 | 121 | 145 | 150 |
| Frequency-dependent maximum current @ $f_s$<br>Basic Time Period = 100 $\mu$ s (Parameter is22=3)  | $i_{out\_max}$ % |       |     |     |     |     |     |
|  | 1.25 kHz         | 110   | 130 | 139 | 150 | 150 | 150 |
|  | 2.5 kHz          | 107   | 125 | 134 | 150 | 150 | 150 |
|  | 5 kHz            | 83    | 102 | 111 | 130 | 150 | 150 |

Table 18: Frequency-dependent maximum current for device size 31 HSD (fluid cooler water)

DEVICE DATA OF THE HIGH SPEED DRIVE DEVICES

| Device size   |                    | 32    |     |     |     |     |     |
|---|--------------------|-------|-----|-----|-----|-----|-----|
| Rated switching frequency   |                    | 8 kHz |     |     |     |     |     |
| Output frequency  | $f_{out}$ / Hz     | 0     | 6   | 10  | 25  | 50  | 100 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 62.5 <math>\mu</math>s (Parameter is22=0)</i> | $i_{out\_max}$ / % |       |     |     |     |     |     |
|   | 2 kHz              | 105   | 117 | 125 | 142 | 150 | 150 |
|   | 4 kHz              | 85    | 98  | 106 | 123 | 146 | 150 |
|   | 8 kHz              | 42    | 69  | 77  | 92  | 111 | 142 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 71.4 <math>\mu</math>s (Parameter is22=1)</i> | $i_{out\_max}$ / % |       |     |     |     |     |     |
|   | 1.75 kHz           | 105   | 117 | 125 | 142 | 150 | 150 |
|   | 3.5 kHz            | 90    | 103 | 110 | 128 | 148 | 150 |
|   | 7 kHz              | 53    | 76  | 84  | 100 | 120 | 145 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 83.3 <math>\mu</math>s (Parameter is22=2)</i> | $i_{out\_max}$ / % |       |     |     |     |     |     |
|   | 1.5 kHz            | 105   | 117 | 125 | 142 | 150 | 150 |
|   | 3 kHz              | 95    | 108 | 115 | 133 | 150 | 150 |
|   | 6 kHz              | 63    | 84  | 91  | 108 | 129 | 148 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 100 <math>\mu</math>s (Parameter is22=3)</i>  | $i_{out\_max}$ / % |       |     |     |     |     |     |
|   | 1.25 kHz           | 105   | 117 | 125 | 142 | 150 | 150 |
|   | 2.5 kHz            | 100   | 112 | 120 | 137 | 150 | 150 |
|   | 5 kHz              | 74    | 91  | 98  | 115 | 137 | 150 |

Table 19: Frequency-dependent maximum current for device size 32 HSD (fluid cooler water)

| Device size   |                    | 33    |     |     |     |     |     |
|---|--------------------|-------|-----|-----|-----|-----|-----|
| Rated switching frequency   |                    | 8 kHz |     |     |     |     |     |
| Output frequency  | $f_{out}$ / Hz     | 0     | 6   | 10  | 25  | 50  | 100 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 62.5 <math>\mu</math>s (Parameter is22=0)</i> | $i_{out\_max}$ / % |       |     |     |     |     |     |
|   | 2 kHz              | 100   | 109 | 114 | 130 | 147 | 150 |
|   | 4 kHz              | 75    | 87  | 94  | 109 | 130 | 150 |
|   | 8 kHz              | 34    | 61  | 68  | 82  | 99  | 126 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 71.4 <math>\mu</math>s (Parameter is22=1)</i> | $i_{out\_max}$ / % |       |     |     |     |     |     |
|   | 1.75 kHz           | 100   | 109 | 114 | 130 | 147 | 150 |
|   | 3.5 kHz            | 81    | 93  | 99  | 114 | 134 | 150 |
|   | 7 kHz              | 47    | 68  | 75  | 89  | 107 | 133 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 83.3 <math>\mu</math>s (Parameter is22=2)</i> | $i_{out\_max}$ / % |       |     |     |     |     |     |
|   | 1.5 kHz            | 100   | 109 | 114 | 130 | 147 | 150 |
|   | 3 kHz              | 88    | 98  | 104 | 119 | 138 | 150 |
|   | 6 kHz              | 56    | 74  | 81  | 96  | 114 | 140 |
| <b>Frequency-dependent maximum current @ <math>f_s</math></b><br><i>Basic Time Period = 100 <math>\mu</math>s (Parameter is22=3)</i>  | $i_{out\_max}$ / % |       |     |     |     |     |     |
|   | 1.25 kHz           | 100   | 109 | 114 | 130 | 147 | 150 |
|   | 2.5 kHz            | 94    | 104 | 109 | 124 | 142 | 150 |
|   | 5 kHz              | 66    | 81  | 87  | 102 | 122 | 147 |

Table 20: Frequency-dependent maximum current for device size 33 HSD (fluid cooler water)

3.2.4 Overview of rectifier data for HSD devices

| Device size   |   | 29   | 30   | 31   | 32   | 33   |
|---|---|------|------|------|------|------|
| Rated rectifier power                                 | $P_{rect}$ / kW                           | 271  | 342  | 385  | 434  | 488  |
| Continuous rectifier power                            | <sup>1)</sup> $P_{rect\_cont}$ / kW       | 488  | 488  | 488  | 488  | 488  |
| Continuous input current @ $U_N = 400V$               | <sup>1)</sup> $i_{in\_cont}$ / A          | 840  | 840  | 840  | 840  | 840  |
| Continuous input current @ $U_{N\_UL} = 480V$         | <sup>1)</sup> $i_{in\_UL\_cont}$ / A      | 726  | 726  | 726  | 726  | 726  |
| Rated output current DC @ $U_{N\_dc} = 565V$          | $i_{out\_dc}$ / A                         | 583  | 723  | 799  | 900  | 1015 |
| Continuous output current DC @ $U_{N\_dc} = 565V$     | <sup>1)</sup> $i_{out\_dc\_cont}$ / A     | 1015 | 1015 | 1015 | 1015 | 1015 |
| Rated output current DC @ $U_{N\_UL\_dc} = 680V$      | $i_{out\_UL\_dc}$ / A                     | 507  | 628  | 691  | 780  | 878  |
| Continuous output current DC @ $U_{N\_UL\_dc} = 680V$ | <sup>1)</sup> $i_{out\_UL\_dc\_cont}$ / A | 878  | 878  | 878  | 878  | 878  |

Table 21: Overview of rectifier data for 400 V devices

<sup>1)</sup> Continuous operation is a load that exceeds the rated operation. Continuous operation only occurs if the internal rectifier is used to supply additional drive controllers via the DC terminals => „5.3.6 DC-bus connection“. In continuous operation, the OH error can be triggered depending on the operating conditions of the internal inverter.

### 3.2.5 Power dissipation at rated operation

#### 3.2.5.1 Power loss in rated operation Air cooler

| Device size   |                                | 29  | 30   | 31  |
|---|--------------------------------|-----|------|-----|
| Rated switching frequency                               | $f_{SN}$ / kHz                 | 6   | 6    | 6   |
| Power dissipation at rated operation                    | <sup>1)</sup> $P_D$ / kW       | 5,9 | 7,4  | 8,2 |
| Power dissipation at rated operation DC                 | <sup>2)</sup> $P_{D\_dc}$ / kW | 5,2 | 6,55 | 7,2 |
| <i>Table 22: Power loss of the HSD units Air cooler</i> |                                |     |      |     |

<sup>1)</sup> Rated operation corresponds to  $U_N = 400$  V;  $f_{SN}$ ;  $I_N$ ;  $f_N = 50$  Hz (typically value)

<sup>2)</sup> Rated operation corresponds to  $U_{N\_dc} = 565$  V;  $I_N$

#### 3.2.5.2 Power loss in rated operation Fluid cooler (water)

| Device size   |                                | 30   | 31  | 32   | 33   |
|---|--------------------------------|------|-----|------|------|
| Rated switching frequency   | $f_{SN}$ / kHz                 | 8    | 8   | 8    | 8    |
| Power dissipation at rated operation                              | <sup>1)</sup> $P_D$ / kW       | 8,05 | 9   | 10,5 | 12   |
| Power dissipation at rated operation DC                           | <sup>2)</sup> $P_{D\_dc}$ / kW | 7    | 7,9 | 9,2  | 10,5 |
| <i>Table 23: Power loss of the HSD units Fluid cooler (water)</i> |                                |      |     |      |      |

<sup>1)</sup> Rated operation corresponds to  $U_N = 400$  V;  $f_{SN}$ ;  $I_N$ ;  $f_N = 50$  Hz (typically value)

<sup>2)</sup> Rated operation corresponds to  $U_{N\_dc} = 565$  V;  $I_N$

3.2.6 Fusing of the HSD devices

3.2.6.1 Fuse protection for AC supply

| Device size | Max. size of the fuse / A |                           |               |               |                |                          |
|-------------|---------------------------|---------------------------|---------------|---------------|----------------|--------------------------|
|             | $U_N = 400V$<br>gG (IEC)  | $U_N = 480V$<br>class "L" |               |               | $U_N = 480V$   |                          |
|             | SCCR<br>100 kA            | SCCR<br>18 kA             | SCCR<br>30 kA | SCCR<br>42 kA | SCCR<br>100 kA | Type <sup>1)</sup>       |
| 29          | 630                       | 600                       | ---           | ---           | 550            | COOPER BUSSMANN 170M3022 |
|             |                           |                           |               |               |                | COOPER BUSSMANN 170M3122 |
|             |                           |                           |               |               |                | COOPER BUSSMANN 170M3172 |
|             |                           |                           |               |               |                | COOPER BUSSMANN 170M3272 |
|             |                           |                           |               |               | 600            | SIBA 206xy32.550         |
| 30          | 630                       | ---                       | 601           | ---           | 630            | SIBA GMBH 206xy32.630    |
|             |                           |                           |               |               |                | COOPER BUSSMANN 170M5xy2 |
|             |                           |                           |               |               |                | LITTELFUSE PSR032xy0630  |
| 31          | 700<br>(2x350)            | ---                       | 700           | ---           | 700            | SIBA GMBH 206xy32.700    |
|             |                           |                           |               |               |                | COOPER BUSSMANN 170M5xy3 |
|             |                           |                           |               |               |                | LITTELFUSE PSR032xy0700  |
| 32          | 800<br>(2x400)            | ---                       | 800           | ---           | 800            | SIBA GMBH 206xy32.800    |
|             |                           |                           |               |               |                | COOPER BUSSMANN 170M5xy4 |
|             |                           |                           |               |               |                | LITTELFUSE PSR032xy0800  |
| 33          | 900<br>(2x450)            | ---                       | ---           | 900           | 900            | SIBA GMBH 206xy32.900    |
|             |                           |                           |               |               |                | COOPER BUSSMANN 170M5xy5 |
|             |                           |                           |               |               |                | LITTELFUSE PSR032xy0900  |

Table 24: Fusing of the HSD devices

<sup>1)</sup> "x" stands for various indicators. "y" stands for different connection variants.



**Short-circuit capacity**

According to requirements from *EN 61439-1* and *EN 61800-5-1*, the following applies to connection to a mains supply: The devices are suitable for use in a circuit capable of delivering not more than 100kA eff. unaffected symmetrical short-circuit current.

3.2.6.2 Fuse protection for DC supply

| Device size | Recommended size of the fuse / A |                        | Permissible fuses <sup>1)</sup>   |
|-------------|----------------------------------|------------------------|---|
|             | $U_{N\_dc} = 565V$               | $U_{N\_UL\_dc} = 680V$ |   |
|             | SCCR 85 kA                       | SCCR 85 kA             |   |
| 29          | 700                              | 630                    | Bussmann 170M6150<br>Littelfuse PSR073DL0700<br>Littelfuse PSX3XLDB1400 |
| 30          | 900                              | 800                    |   |
| 31          | 1000                             | 900                    |   |
| 32          | 1100                             | 1000                   |   |
| 33          | 1250                             | 1100                   |   |

Table 25: DC Fusing of the 400 V / 480 V devices

<sup>1)</sup> Fuses of the same type with lower rated currents can be used if they are suitable for the application.

**NOTICE**

**Observe the rated voltage of the fuse!**

- ▶ The rated voltage of the fuse must be at least equal to the maximum DC supply voltage of the drive controller.

### 3.3 General electrical data

#### 3.3.1 Switching frequency and temperature

The drive controller cooling is designed by way that the heat sink overtemperature threshold is not exceeded at rated conditions. A switching frequency higher than the rated switching frequency also produces higher losses and thus a higher heat sink heating. If the heat sink temperature reaches a critical threshold ( $T_{DR}$ ), the switching frequency can be reduced automatically step by step. This prevents that the drive controller switches off due to overheating of the heat sink. If the heat sink temperature falls below the threshold  $T_{UR}$ , the switching frequency is increased back to the setpoint. At temperature  $T_{EM}$  the switching frequency is immediately reduced to rated switching frequency. „Derating“ must be activated, for this function to work.

##### 3.3.1.1 Switching frequencies and temperatures for air coolers

| Device size  |                                  | 29 | 30 | 31  |
|--|----------------------------------|----|----|-----|
| Rated switching frequency                              | <sup>1)</sup> $f_{SN}$ / kHz     | 6  | 6  | 6   |
| Max. switching frequency                               | <sup>1)</sup> $f_{S\_max}$ / kHz | 8  | 8  | 8   |
| Min. switching frequency                               | <sup>1)</sup> $f_{S\_min}$ / kHz | 2  | 2  | 2   |
| Max. heat sink temperature 1                           | $T_{HS1}$ / °C                   | 90 | 95 | 100 |
| Max. heat sink temperature 2                           | $T_{HS2}$ / °C                   | 75 | 75 | 75  |
| Max. heat sink temperature 3                           | $T_{HS3}$ / °C                   | 85 | 93 | 97  |
| Max. interior temperature power unit 1                 | $T_{ID\_PU1}$ / °C               | 65 | 65 | 65  |
| Max. interior temperature power unit 2                 | $T_{ID\_PU2}$ / °C               | 75 | 75 | 75  |
| Max. interior temperature power unit 3                 | $T_{ID\_PU3}$ / °C               | 90 | 90 | 90  |
| Temperature for derating the switching frequency       | <sup>2)</sup> $T_{DR}$ / °C      | 80 | 85 | 90  |
| Temperature for uprating the switching frequency       | <sup>2)</sup> $T_{UR}$ / °C      | 75 | 80 | 85  |
| Temperature for switching to rated switching frequency | <sup>2)</sup> $T_{EM}$ / °C      | 85 | 90 | 95  |

Table 26: Switching frequencies and temperatures for air coolers

<sup>1)</sup> The output frequency is to be limited in such a way that it does not exceed 1/10 of the switching frequency.

<sup>2)</sup> The switching point refers to the temperature of  $T_{HS1}$ .

## GENERAL ELECTRICAL DATA

### 3.3.1.2 Switching frequencies and temperatures for fluid coolers (water)

| Device size  |                                  | 30 | 31 | 32 | 33 |
|--|----------------------------------|----|----|----|----|
| Rated switching frequency                              | <sup>1)</sup> $f_{SN}$ / kHz     | 8  | 8  | 8  | 8  |
| Max. switching frequency                               | <sup>1)</sup> $f_{S\_max}$ / kHz | 8  | 8  | 8  | 8  |
| Min. switching frequency                               | <sup>1)</sup> $f_{S\_min}$ / kHz | 2  | 2  | 2  | 2  |
| Max. heat sink temperature 1                           | $T_{HS1}$ / °C                   | 85 | 85 | 85 | 85 |
| Max. heat sink temperature 2                           | $T_{HS2}$ / °C                   | 65 | 65 | 65 | 65 |
| Max. heat sink temperature 3                           | $T_{HS3}$ / °C                   | 75 | 75 | 75 | 75 |
| Max. interior temperature power unit 1                 | $T_{ID\_PU1}$ / °C               | 65 | 65 | 65 | 65 |
| Max. interior temperature power unit 2                 | $T_{ID\_PU2}$ / °C               | 75 | 75 | 75 | 75 |
| Max. interior temperature power unit 3                 | $T_{ID\_PU3}$ / °C               | 90 | 90 | 90 | 90 |
| Temperature for derating the switching frequency       | <sup>2)</sup> $T_{DR}$ / °C      | 75 | 75 | 75 | 75 |
| Temperature for uprating the switching frequency       | <sup>2)</sup> $T_{UR}$ / °C      | 70 | 70 | 70 | 70 |
| Temperature for switching to rated switching frequency | <sup>2)</sup> $T_{EM}$ / °C      | 80 | 80 | 80 | 80 |

*Table 27: Switching frequencies and temperatures for fluid coolers (water)*

<sup>1)</sup> The output frequency is to be limited in such a way that it does not exceed 1/10 of the switching frequency.

<sup>2)</sup> The switching point refers to the temperature of  $T_{HS1}$ .

### 3.3.2 DC link / braking transistor function



#### Activation of the braking transistor function

To be able to use the braking transistor, the function must be activated with parameter "is30 braking transistor function".

For more information => [F6 Programming manual](#).

#### NOTICE

#### Falling below the minimum braking resistor value!

#### Destruction of the drive controller

- ▶ The minimum brake resistance value must not fall below!

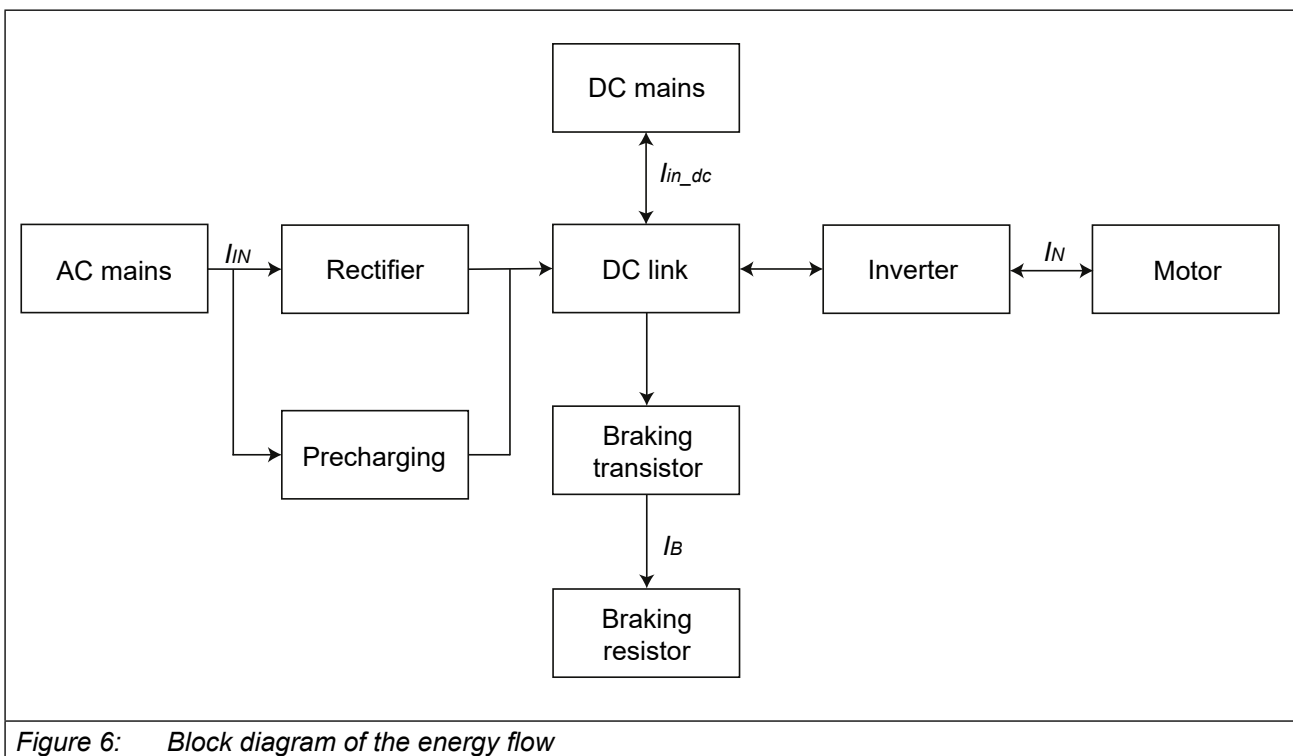


Figure 6: Block diagram of the energy flow

#### NOTICE

#### Destruction of the drive controller!

If the error "ERROR GTR7 always ON" occurs, the current consumption is switched off internally via the mains input bridge of the AC supply.

- ▶ If the error "ERROR GTR7 always ON" occurs, the drive controller is defective and must be disconnected from the power supply no later than 16 hours!
- ▶ With DC mains connection and the use of non-intrinsically safe braking resistors or sub-mounted braking resistors, the drive controller must be de-energised after 1 second at the latest.

## 3.3.2.1 DC link / braking transistor function

| Device size   |                           | 29  | 30    | 31    | 32    | 33    |
|---|---------------------------|---|-------|-------|-------|-------|
| DC link rated voltage @ $U_N = 400V$                                      | $U_{N\_dc} / V$           | 565   |       |       |       |       |
| DC link rated voltage @ $U_{N\_UL} = 480V$                                | $U_{N\_dc\_UL} / V$       | 680   |       |       |       |       |
| DC link voltage working voltage range                                     | $U_{in\_dc} / V$          | 390...780   |       |       |       |       |
| DC switch-off level "ERROR Under-potential"                               | $U_{UP} / V$              | 240   |       |       |       |       |
| DC switch-off level "ERROR Over-potential"                                | $U_{OP} / V$              | 840   |       |       |       |       |
| DC switch-off level braking resistor <sup>1)</sup>                        | $U_B / V$                 | 780   |       |       |       |       |
| Max. braking current  | $I_{B\_max} / A$          | 600   |       |       |       |       |
| Min. braking resistor value   | $R_{B\_min} / \Omega$     | 1,3   |       |       |       |       |
| Braking transistor <sup>2)</sup>  |                           | Max. cycle time: 120 s;<br>Max c.d.f.: 25 %                                   |       |       |       |       |
| Protective function for braking transistor                                |                           | Short-circuit monitoring  |       |       |       |       |
| Protective function braking resistor (Error GTR7 always on) <sup>3)</sup> |                           | Feedback signal evaluation and current switch-off<br>(only for AC connection) |       |       |       |       |
| DC link capacity  | $C_{int} / \mu F$         | 23400   | 23400 | 23400 | 27900 | 27900 |
| Max. prechargeable total capacity @ $U_N = 400V$                          | $C_{pc\_max} / \mu F$     | 68400   | 68400 | 68400 | 68400 | 68400 |
| Max. prechargeable total capacity @ $U_{N\_UL} = 480V$                    | $C_{pc\_max\_UL} / \mu F$ | 47500   | 47500 | 47500 | 47500 | 47500 |

**Table 28: DC link / braking transistor function of the HSD devices**

- <sup>1)</sup> The DC switching level for the braking transistor is adjustable. The default value is the value specified in the table.
- <sup>2)</sup> The cyclic duration factor is additionally limited by the used braking resistor.
- <sup>3)</sup> The feedback signal evaluation monitors the functionality of the braking transistor. The current is switched off via the internal mains input bridge of the AC supply. There is no current switch-off with DC voltage supply.

3.3.3 Continuous thermal current

| Device size                                     |                         | 29  |     |     |     |
|---|-------------------------|-----|-----|-----|-----|
| Rated switching frequency                       | $f_{SN}$ / kHz          | 6   |     |     |     |
| Switching frequency                             | $f_s$ / kHz             | 2   | 4   | 6   | 8   |
| Continuous thermal current @ $U_N = 400V$       | $I_{Tout\_max}$ / A     | 460 | 460 | 460 | 460 |
| Continuous thermal current @ $U_{N\_UL} = 480V$ | $I_{Tout\_max\_UL}$ / A | 400 | 400 | 400 | 400 |

Table 29: Continuous thermal current for appliance size 29 Air cooler

| Device size                                     |                         | 30  |     |     |     |
|---|-------------------------|-----|-----|-----|-----|
| Rated switching frequency                       | $f_{SN}$ / kHz          | 6   |     |     |     |
| Switching frequency                             | $f_s$ / kHz             | 2   | 4   | 6   | 8   |
| Continuous thermal current @ $U_N = 400V$       | $I_{Tout\_max}$ / A     | 570 | 570 | 570 | 460 |
| Continuous thermal current @ $U_{N\_UL} = 480V$ | $I_{Tout\_max\_UL}$ / A | 495 | 495 | 495 | 400 |

Table 30: Continuous thermal current for appliance size 30 Air cooler

| Device size                                     |                         | 31  |     |     |     |
|---|-------------------------|-----|-----|-----|-----|
| Rated switching frequency                       | $f_{SN}$ / kHz          | 6   |     |     |     |
| Switching frequency                             | $f_s$ / kHz             | 2   | 4   | 6   | 8   |
| Continuous thermal current @ $U_N = 400V$       | $I_{Tout\_max}$ / A     | 630 | 630 | 630 | 460 |
| Continuous thermal current @ $U_{N\_UL} = 480V$ | $I_{Tout\_max\_UL}$ / A | 545 | 545 | 545 | 400 |

Table 31: Continuous thermal current for appliance size 31 Air cooler

| Device size                                     |                         | 30  |     |     |     |
|---|-------------------------|-----|-----|-----|-----|
| Rated switching frequency                       | $f_{SN}$ / kHz          | 8   |     |     |     |
| Switching frequency                             | $f_s$ / kHz             | 2   | 4   | 6   | 8   |
| Continuous thermal current @ $U_N = 400V$       | $I_{Tout\_max}$ / A     | 570 | 570 | 570 | 570 |
| Continuous thermal current @ $U_{N\_UL} = 480V$ | $I_{Tout\_max\_UL}$ / A | 495 | 495 | 495 | 495 |

Table 32: Continuous thermal current for appliance size 30 Fluid cooler (water)

| Device size                                     |                         | 31  |     |     |     |
|---|-------------------------|-----|-----|-----|-----|
| Rated switching frequency                       | $f_{SN}$ / kHz          | 8   |     |     |     |
| Switching frequency                             | $f_s$ / kHz             | 2   | 4   | 6   | 8   |
| Continuous thermal current @ $U_N = 400V$       | $I_{Tout\_max}$ / A     | 630 | 630 | 630 | 630 |
| Continuous thermal current @ $U_{N\_UL} = 480V$ | $I_{Tout\_max\_UL}$ / A | 545 | 545 | 545 | 545 |

Table 33: Continuous thermal current for appliance size 31 Fluid cooler (water)

| Device size                                     |                         | 32  |     |     |     |
|---|-------------------------|-----|-----|-----|-----|
| Rated switching frequency                       | $f_{SN}$ / kHz          | 8   |     |     |     |
| Switching frequency                             | $f_s$ / kHz             | 2   | 4   | 6   | 8   |
| Continuous thermal current @ $U_N = 400V$       | $I_{Tout\_max}$ / A     | 710 | 710 | 710 | 710 |
| Continuous thermal current @ $U_{N\_UL} = 480V$ | $I_{Tout\_max\_UL}$ / A | 615 | 615 | 615 | 615 |

Table 34: Continuous thermal current for appliance size 32 Fluid cooler (water)

| Device size                                     |                         | 33  |     |     |     |
|---|-------------------------|-----|-----|-----|-----|
| Rated switching frequency                       | $f_{SN}$ / kHz          | 8   |     |     |     |
| Switching frequency                             | $f_s$ / kHz             | 2   | 4   | 6   | 8   |
| Continuous thermal current @ $U_N = 400V$       | $I_{Tout\_max}$ / A     | 800 | 800 | 800 | 800 |
| Continuous thermal current @ $U_{N\_UL} = 480V$ | $I_{Tout\_max\_UL}$ / A | 692 | 692 | 692 | 692 |

Table 35: Continuous thermal current for appliance size 33 Fluid cooler (water)

3.3.4 Sub-mounted braking resistors

| Technical data of the sub-mounted braking resistors |                |      |
|---|----------------|------|
| Braking resistor value                              | $R$ / $\Omega$ | 1,5  |
| Rated power   | $P_D$ / W      | 2200 |
| Duty cycle referring to 120s @ $U_{N\_dc} = 780V$   | duty cycle / s | 0,6  |

Table 36: Sub-mounted braking resistors

**NOTICE**

Observe the power dissipation of the sub-mounted braking resistors!

In braking mode (with sub-mounted braking resistors), the power to be dissipated by the heat sink increases.

- Observe the power dissipation of the braking resistors when designing the cooling system.

## 3.3.5 Fan

| Device size                 |                | 29  | 30  | 31  | 32 <sup>2)</sup> | 33 <sup>2)</sup> |
|-----------------------------|----------------|-----|-----|-----|------------------|------------------|
| Interior fan                | Number         | 3   | 3   | 3   | 3                | 3                |
|                             | Speed-variable | yes | yes | yes | yes              | yes              |
| Heat sink fan <sup>1)</sup> | Number         | 3   | 3   | 3   | –                | –                |
|                             | Speed-variable | yes | yes | yes | –                | –                |

*Table 37: Fan*

<sup>1)</sup> Observe external heat sink fan supply => „5.3.7 External heat sink fan supply (FAN)“.

<sup>2)</sup> Only available as water-cooled device.



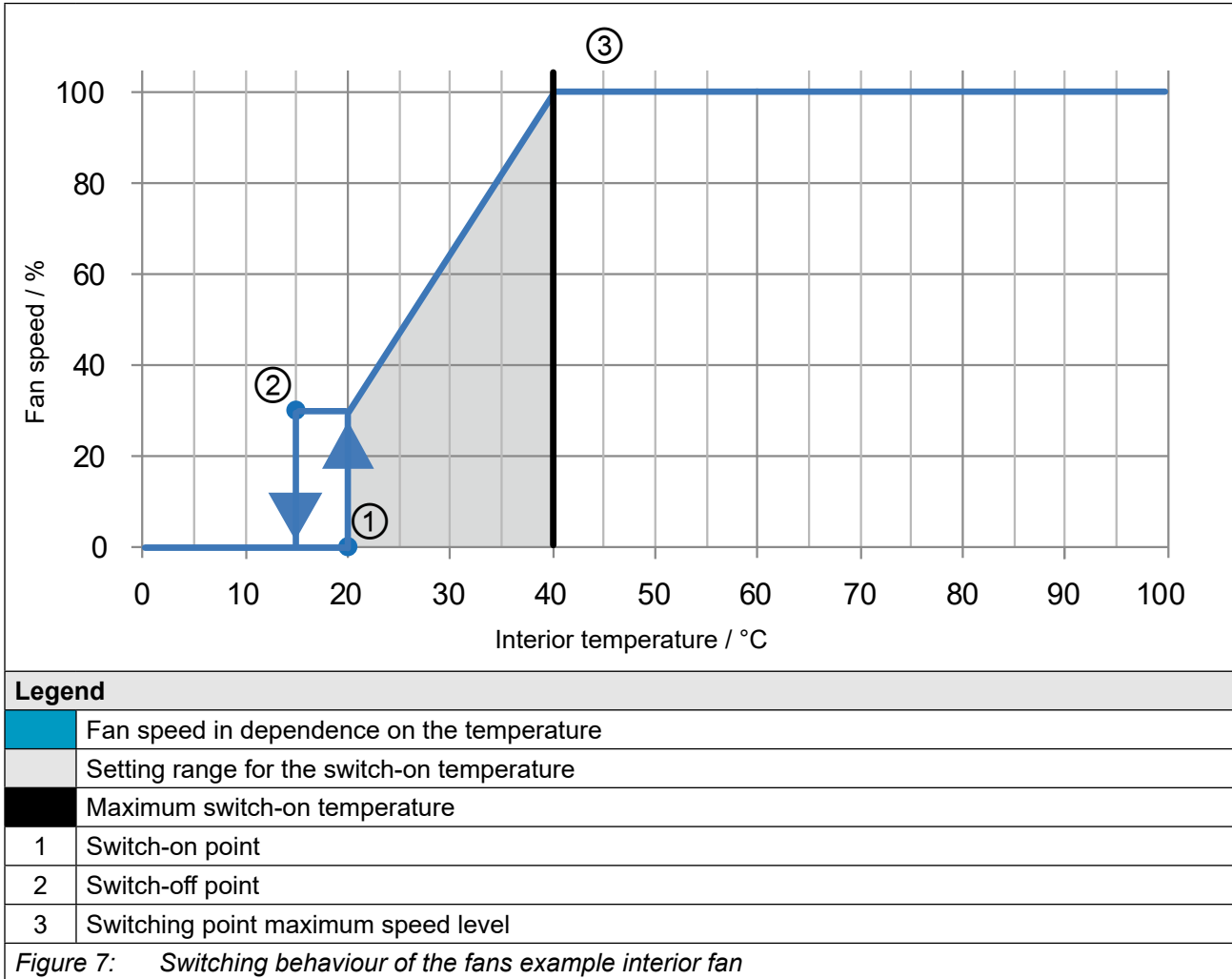
The fans are speed-variable. They are automatically controlled to high or low speed depending on the setting of the temperature limits in the software.

**NOTICE****Destruction of the fan!**

- ▶ Take care that no foreign substances drop into the fan!

3.3.5.1 Switching behaviour of the fans

The temperature monitoring controls the fans with different switch-on and switch-off points.



3.3.5.2 Switching points of the fans

The switching point for the switch-on temperature and the maximum speed level of the fans are adjustable. The following table shows the default values.

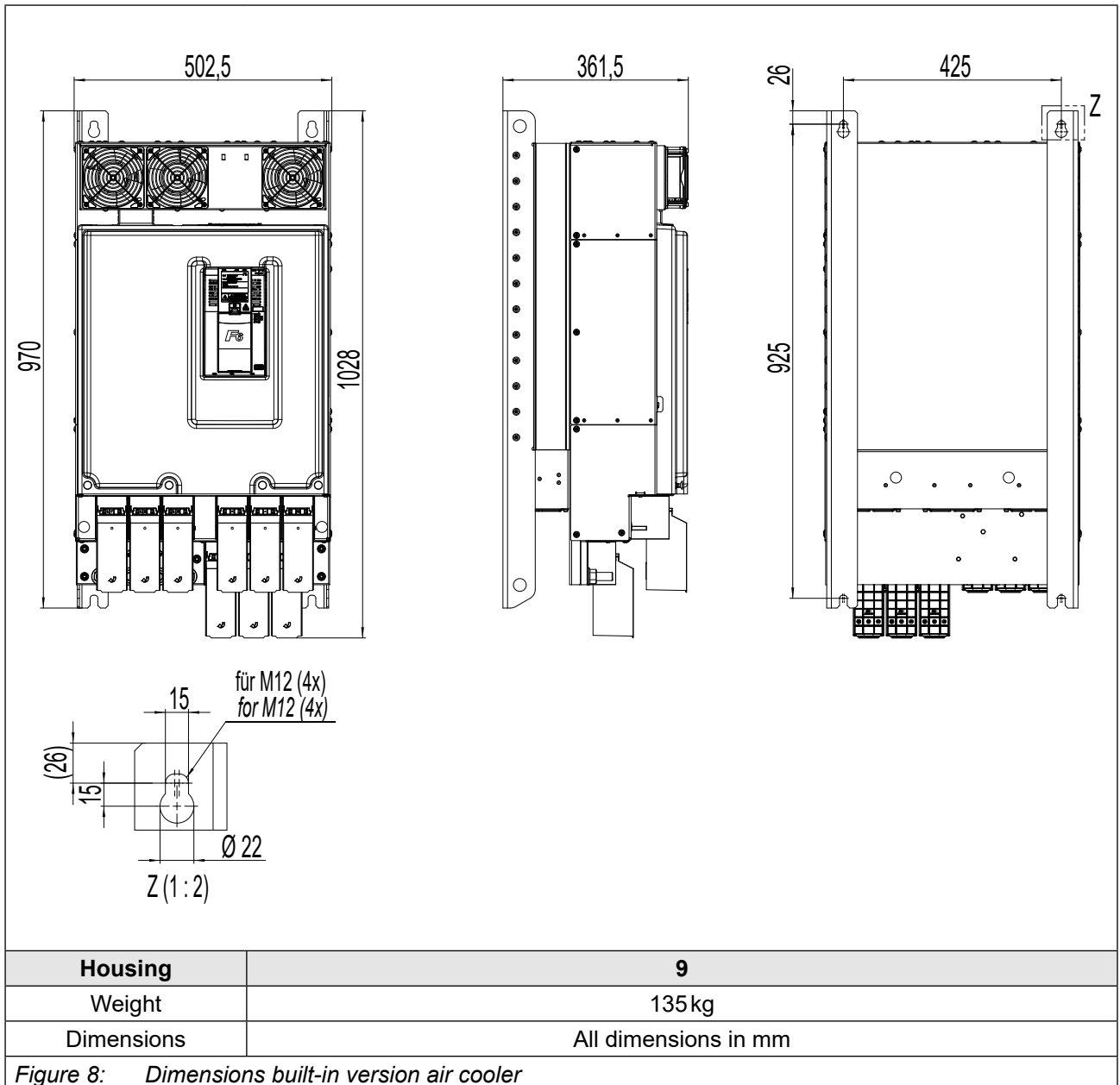
| Fan                   |                      | Heat sink | Interior |
|-----------------------|----------------------|-----------|----------|
| Switch-on temperature | $T / ^\circ\text{C}$ | 35        | 20       |
| Maximum speed level   | $T / ^\circ\text{C}$ | 65        | 45       |

Table 38: Switching points of the fans

## 4 Installation

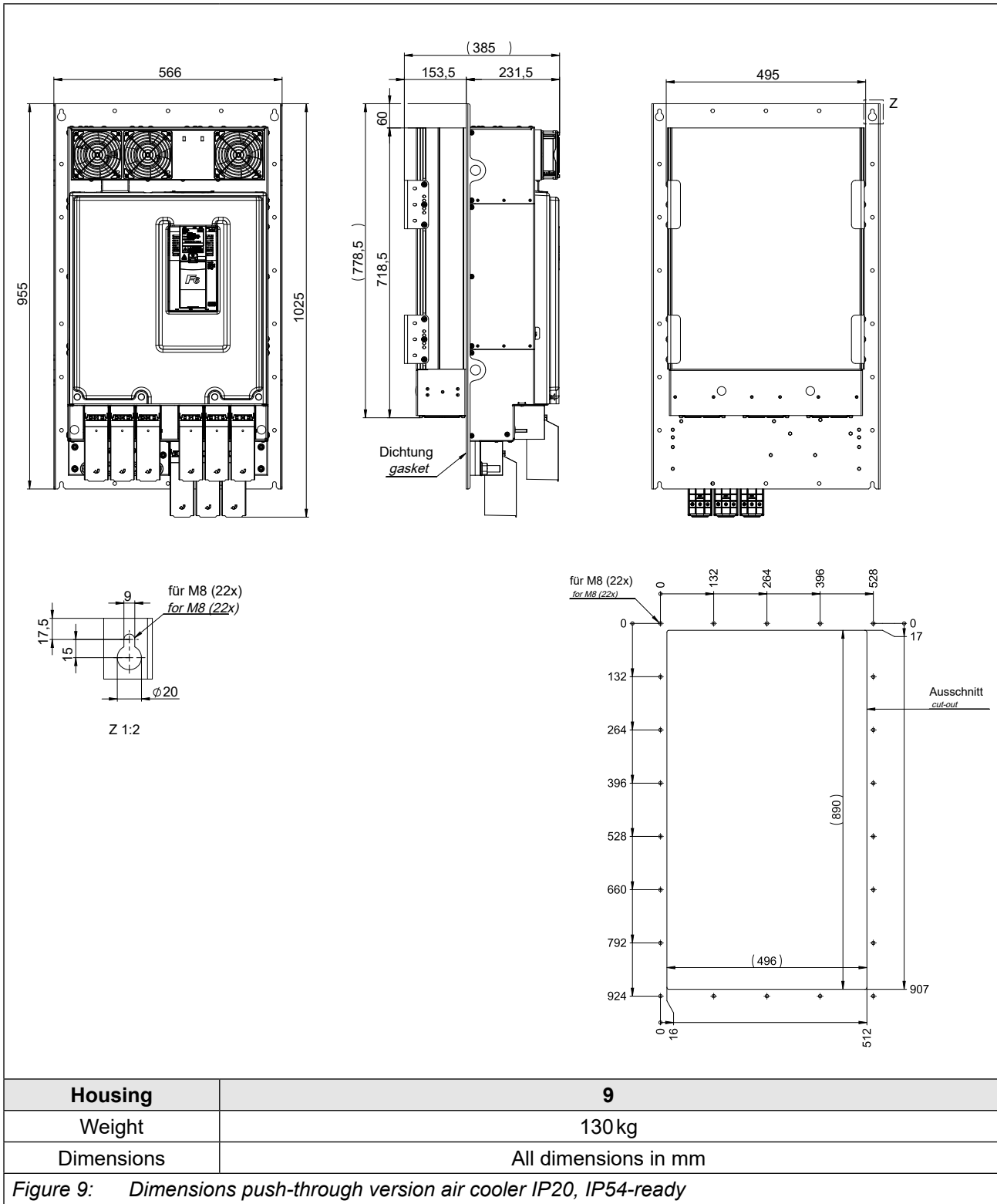
### 4.1 Dimensions and weights

#### 4.1.1 Built-in version air cooler

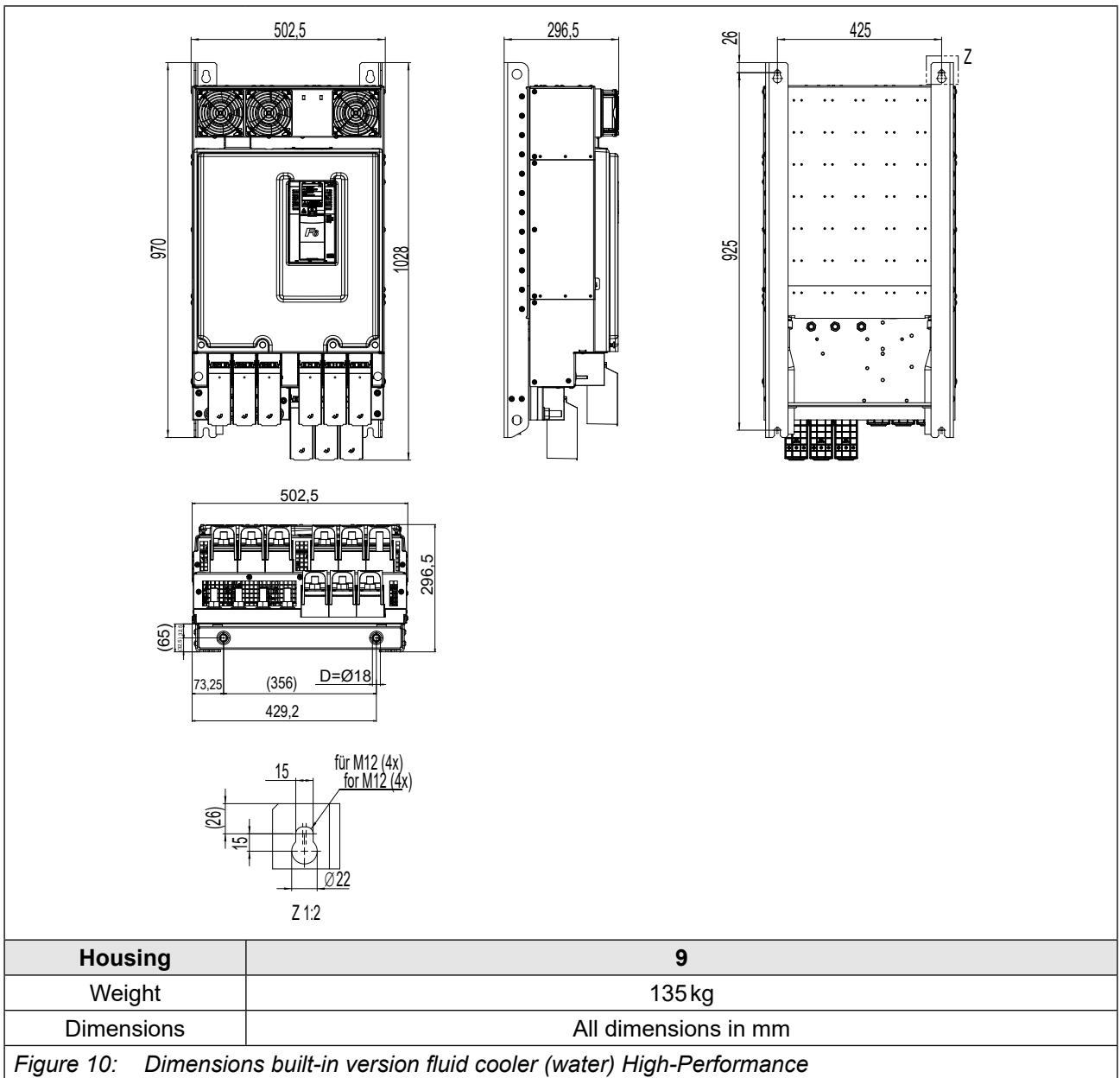


**DIMENSIONS AND WEIGHTS**

**4.1.2 Push-through version air cooler IP20, IP54-ready**

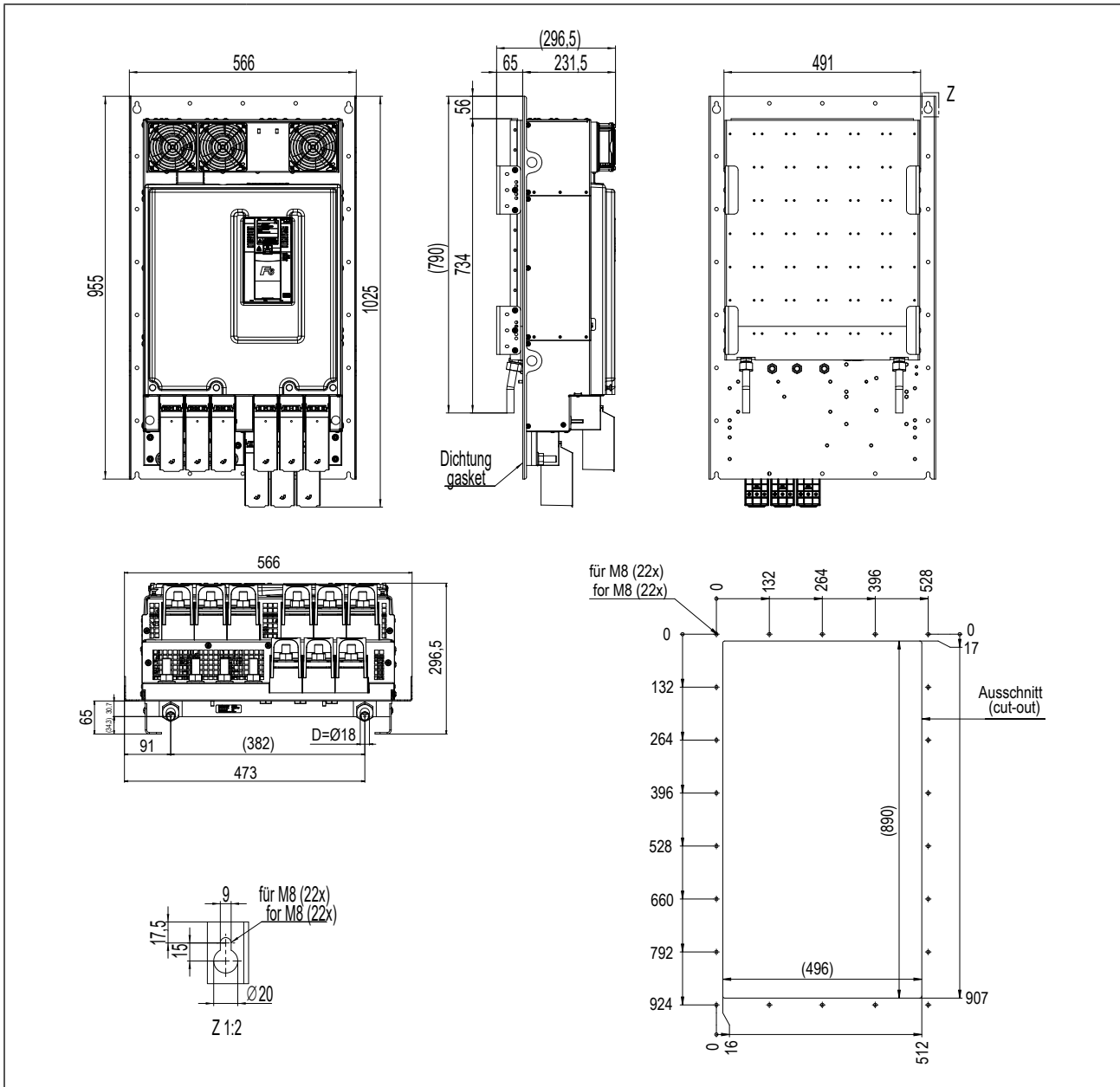


4.1.3 Built-in version fluid cooler (water) High-Performance with aluminium heat sink



**DIMENSIONS AND WEIGHTS**

**4.1.4 Push-through version fluid cooler (water) High-Performance with aluminium heat sink IP20, IP54-ready**



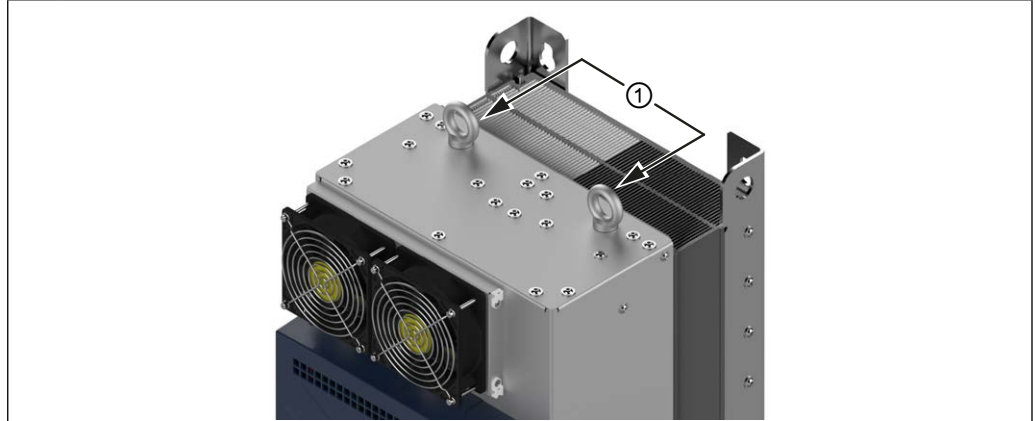
|                   |                             |
|-------------------|-----------------------------|
| <b>Housing</b>    | <b>9</b>                    |
| <b>Weight</b>     | <b>135 kg</b>               |
| <b>Dimensions</b> | <b>All dimensions in mm</b> |

Figure 11: Dimensions push-through version fluid cooler (water) High-Performance IP20, IP54-ready

## 4.2 Control cabinet installation

### 4.2.1 Control cabinet installation

Drive controllers in housings 7, 8 and 9 have 2 threaded bushes for M10 ring bolts according to *DIN 580* on the top. These are used to accommodate appropriate lifting devices for transport.



#### Legend

|   |                |
|---|----------------|
| 1 | M10 ring bolts |
|---|----------------|

Figure 12: Example of an F6 in housing 8 with M10 ring bolts

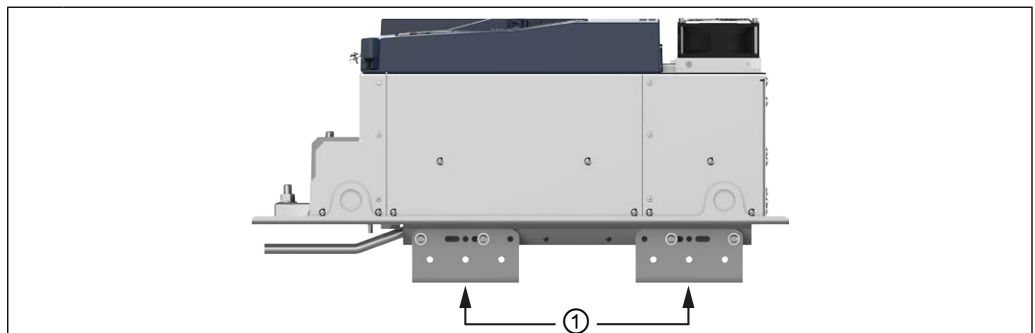
### 4.2.2 Devices with transport bracket

The transport bracket can be removed after mounting the drive controller. The transport brackets must be stored to make the drive controller transportable again in case of service.

#### NOTICE

#### Damage caused by improper mounting

- The transport brackets must not be used to fasten the drive controller!



#### Legend

|   |                   |
|---|-------------------|
| 1 | Transport bracket |
|---|-------------------|

Figure 13: Example of an F6 housing 7 with transport brackets

#### NOTICE

#### Damage to the water connections

#### Bending of the tubes!

- Never set the device down or transport it without the transport brackets!

**4.2.3 Mounting instructions**

For the mounting of the drive controllers the following mounting materials with the appropriate quality were tested by KEB.

| <b>Required material</b>                                    | <b>Tightening torque</b> |
|---|--------------------------|
| Hexagon-head screw ISO 4017 - M12 - 8.8                     | 80 Nm<br>705 lb inch     |
| Flat washer ISO 7090 - 12 - 200 HV                          | –                        |
| <i>Table 39: Mounting instructions for built-in version</i> |                          |

| <b>Required material</b>  | <b>Tightening torque</b> |
|---|--------------------------|
| Hexagon-head screw ISO 4017 - M8 - 8.8                          | 25 Nm<br>220 lb inch     |
| Flat washer ISO 7090 - 8 - 200 HV                               | –                        |
| <i>Table 40: Mounting instructions for push-through version</i> |                          |

**NOTICE**

**Use of other mounting material**

- ▶ The alternatively selected fixing material must meet the above material characteristics (quality) and tightening torques!

The use of other fixing materials is beyond the control of KEB and is therefore the sole responsibility of the customer.

#### 4.2.4 Mounting distances

Power dissipation for the control cabinet dimension => „3.2.5 Power dissipation at rated operation“. A lower value can be used here depending on the operating mode/load.



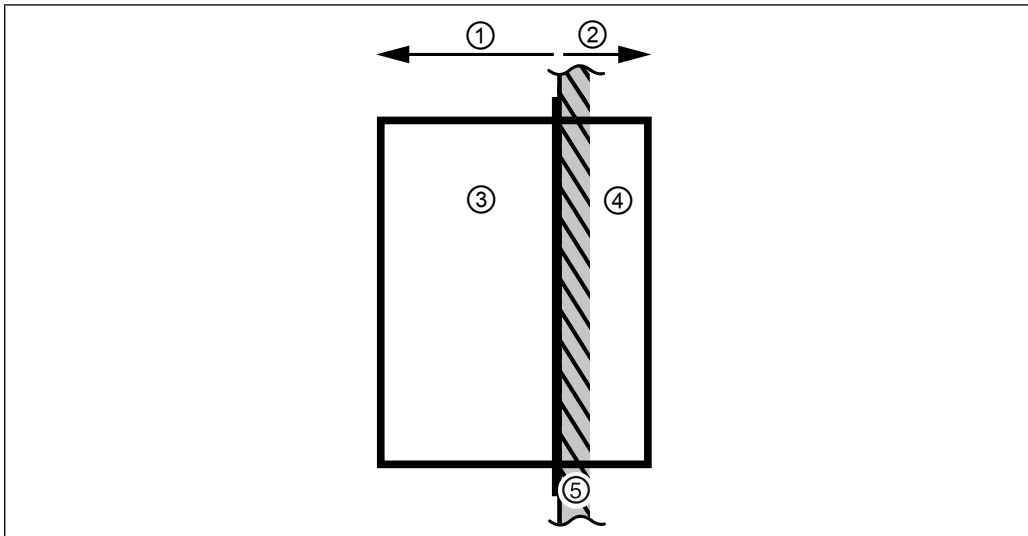
#### Mounting of the drive controller

For reliable operation, the drive controller must be mounted without any distance on a smooth, closed, metallicly bright mounting plate.

| Mounting distances | Dimension   | Distance in mm | Distance in inch |
|--------------------|---|----------------|------------------|
|                    | A   | 150            | 6                |
|                    | B   | 100            | 4                |
|                    | C   | 30             | 1,2              |
|                    | D   | 0              | 0                |
|                    | E   | 0              | 0                |
|                    | F <sup>1)</sup>   | 50             | 2                |
|                    | <sup>1)</sup> Distance to preceding elements in the control cabinet door. |                |                  |

Figure 14: Mounting distances

4.2.5 Installation of IP54-ready devices



| Legend |  |
|--------|--|
| 1      | IP20 zone inside the housing                   |
| 2      | IP54 zone outside the housing                  |
| 3      | Drive controller (power unit and control unit) |
| 4      | Drive controller (heat sink)                   |
| 5      | Housing (e.g. Control cabinet wall)            |

Figure 15: Installation of IP54-ready devices



**IP54 zone: Heat sink outside the housing**

The protection class IP54 can only be achieved when the device is properly installed.

For proper installation, a suitable IP54 seal (=> „5.4.2 Seal for IP54-ready devices“) must be installed between heat sink and housing (e.g. control cabinet wall).

The tightness must be checked after the installation. If properly installed, the separation to the housing corresponds to degree of protection IP54.

In the case of fan-cooled units, the fans must be protected from negative environmental influences.

These include combustible, oily or dangerous fumes or gases, corrosive chemicals, coarse foreign bodies and excessive dust. This applies especially to the access of the heatsink from the top (air outlet).Icing is inadmissible.

UL: Device heat sink is classified as NEMA type 1

**IP20 zone: Device inside the housing**

This part is intended for the installation in a suitable housing for the required degree of protection (e.g. control cabinet).

The power connections are excluded => „3.1.1 Climatic environmental conditions“.

**NOTICE**

**Defect due to continuous splash water !**

- ▶ Never expose the device to continuous splashing water (e.g. direct exposure to rain)!

**4.2.6 Control cabinet ventilation**

If construction-conditioned the control cabinet cannot be without indoor ventilation, appropriate filters must avoid suction of foreign objects.

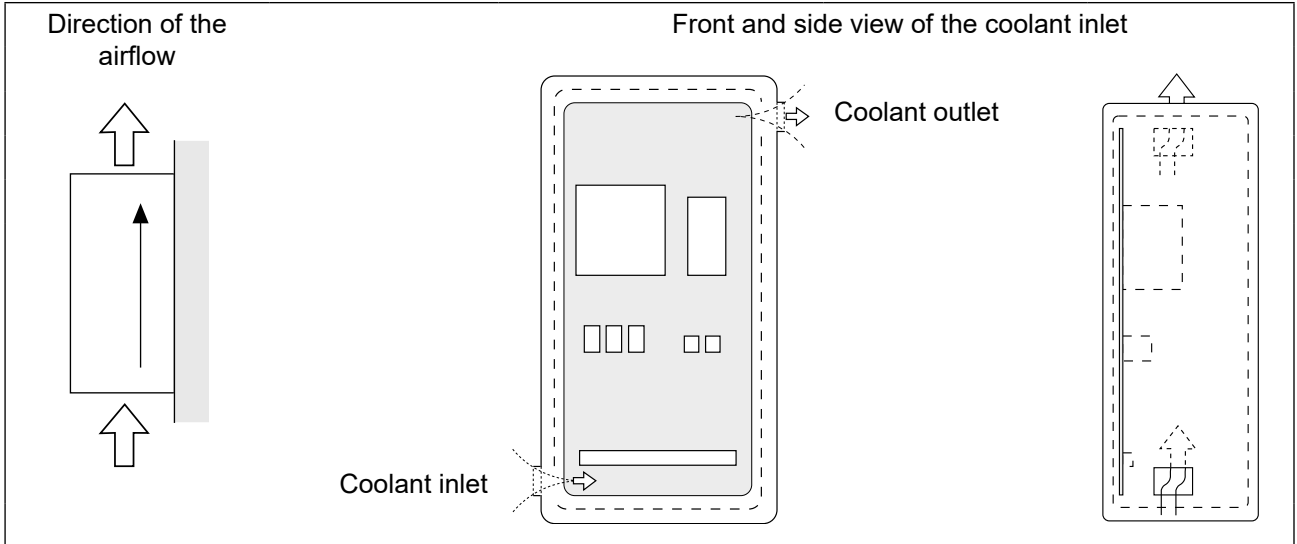
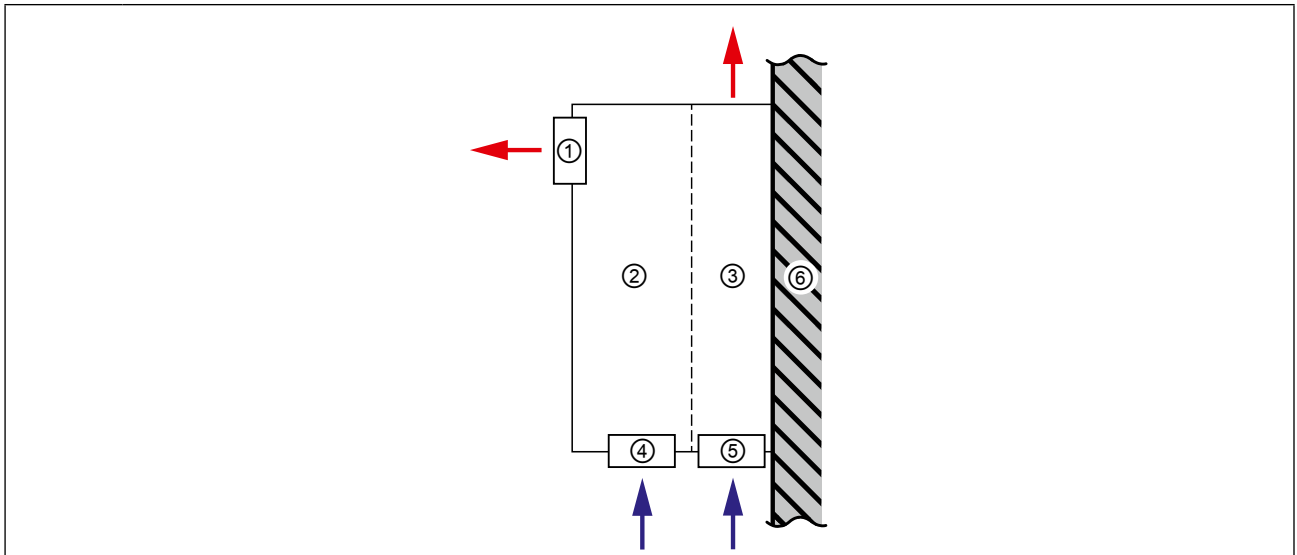


Figure 16: Control cabinet ventilation

**4.2.7 Airflow of the drive controller**



| Legend |   |
|--------|---|
|        | Airflow direction                         |
| 1      | Interior fan (from housing 4)             |
| 2      | Drive controller (power unit and control) |
| 3      | Drive controller (heat sink)              |
| 4      | Interior fan for (housing 2 and 3)        |
| 5      | Heatsink fan                              |
| 6      | Housing (e.g. Control cabinet rear)       |

Figure 17: Airflow of the drive controller

## 5 Installation and connection

### 5.1 Overview of the COMBIVERT F6

| Housing 9 |  | No.   | Name | Description   |
|-----------|--|-------|------|---|
|           |  | 1     | ---  | Interior fan  |
|           |  | 2 / 6 | ---  | Shield clamps for shielded control cables   |
|           |  | 3     | FAN  | External heat sink fan supply <sup>1)</sup>   |
|           |  | 4     | ---  | Nameplate   |
|           |  | 5     | ---  | LEDs (see manual for control section chapter => "Overview") <ul style="list-style-type: none"> <li>• For control board COMPACT: FS without function.</li> <li>• For control card APPLICATION and PRO: Status indication of the safety module</li> </ul> |
|           |  | 7     | X1A  | Power circuit terminals for: <ul style="list-style-type: none"> <li>• Mains input</li> <li>• Braking resistor</li> <li>• DC voltage interface</li> <li>• Motor connection</li> </ul>  |
|           |  | 8     | PE   | Protective earth; at connection to protective earth each terminal may be assigned only once   |
|           |  |       |      |   |

Figure 18: F6 housing 9 top view

<sup>1)</sup> Observe external heat sink fan supply => „5.3.7 External heat sink fan supply (FAN)“

| Housing 9 |  | No. | Name | Description  |  |
|-----------|--|-----|------|--|--|
|           |  | 1   | ---  | Interior fan   |  |
|           |  | 7   | X1A  | Power circuit terminals for: <ul style="list-style-type: none"> <li>• Mains input</li> <li>• Braking resistor</li> <li>• DC voltage interface</li> <li>• Motor connection</li> </ul> |  |
|           |  | 8   | PE   | Protective earth;<br>at connection to protective earth<br>each terminal may be assigned<br>only once   |  |
|           |  | 9   | X1C  | Terminal for: <ul style="list-style-type: none"> <li>• Motor temperature monitoring</li> <li>• Brake control</li> </ul>  |  |
|           |  | 10  | X3A  | Encoder interface channel A  |  |
|           |  | 11  | X3B  | Encoder interface channel B  |  |
|           |  | 12  | ---  | Heat sink fan  |  |
|           |  |     |      |  |  |
|           |  |     |      |  |  |
|           |  |     |      |  |  |
|           |  |     |      |  |  |

Figure 19: F6 housing 9 front view

| Housing 9 |       | No. | Name   | Description |
|-----------|-------|-----|--|-------------|
|           | 1     | --- | Interior fan   |             |
|           | 2 / 6 | --- | Shield clamps for shielded control cables  |             |
|           | 3     | FAN | External heat sink fan supply  |             |
|           | 13    | S1  | Rotary coding switch A   |             |
|           | 14    | S2  | Rotary coding switch B   |             |
|           | 15    | X4C | Fieldbus interface (out)   |             |
|           | 16    | X4B | Fieldbus interface (in)  |             |
|           | 17    | X2B | Safety module  |             |
|           | 18    | X2A | Control terminal block for <ul style="list-style-type: none"> <li>CAN bus</li> <li>Analog inputs and analog output</li> <li>Digital inputs and outputs</li> <li>24V DC voltage supply</li> </ul> |             |
|           | 19    | --- | Thread for screw eyes  |             |

Figure 20: F6 housing 9 rear view with control board APPLICATION



Further information can be found in the respective control board manual.



Instructions for use COMBIVERT F6 control board APPLICATION  
[www.keb.de/fileadmin/media/Manuals/dr/ma\\_dr\\_f6-cu-a-inst-20118593\\_en.pdf](http://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_f6-cu-a-inst-20118593_en.pdf)



Instructions for use COMBIVERT F6 control board COMPACT  
[www.keb.de/fileadmin/media/Manuals/dr/ma\\_dr\\_f6-cu-k-inst-20144795\\_en.pdf](http://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_f6-cu-k-inst-20144795_en.pdf)



Instructions for use COMBIVERT F6 control board PRO  
[www.keb.de/fileadmin/media/Manuals/dr/ma\\_dr\\_f6-cu-p-inst-20182705\\_en.pdf](http://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_f6-cu-p-inst-20182705_en.pdf)



## 5.2 Connection of the power unit

**NOTICE**

**Destruction of the drive controller!**

- ▶ Never exchange mains input and motor output!

### 5.2.1 Connection of the voltage supply

The COMBIVERT F6 can be supplied via terminals L1, L2 and L3 (AC power supply) or via terminals + and - (DC power supply with inrush current limitation)

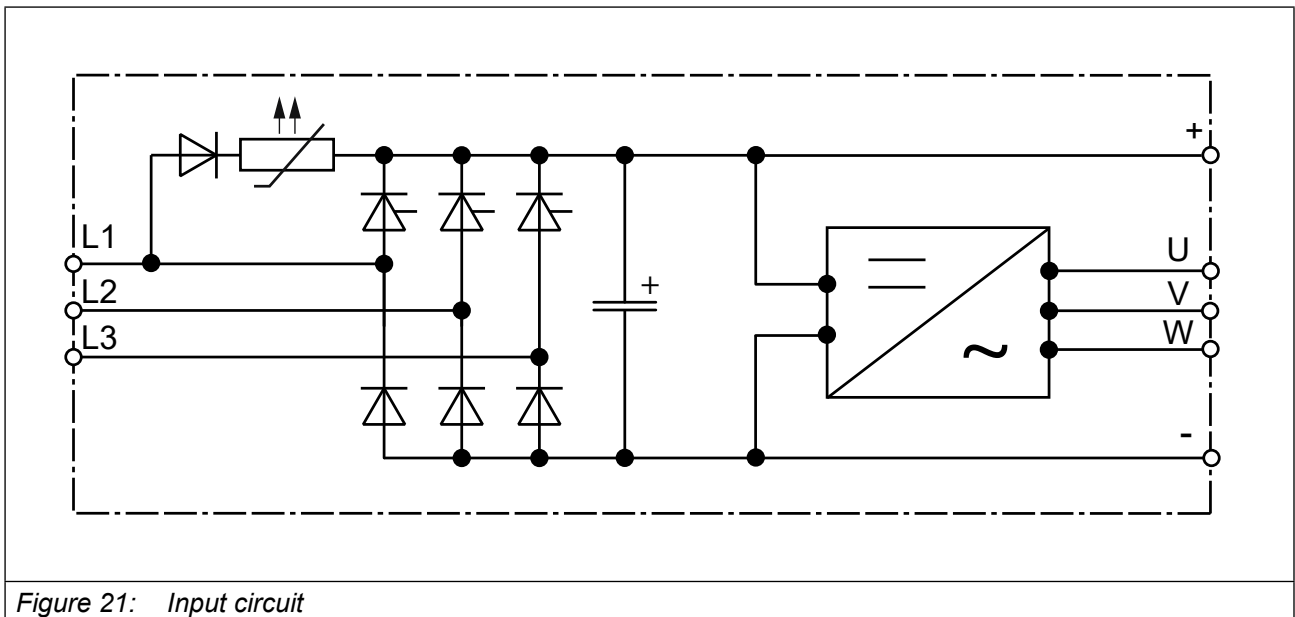


Figure 21: Input circuit

**NOTICE**

**With AC power supply, observe the minimum waiting time between two switch-on procedures!**

Cyclical switching off and on of the drive controller leads to temporary high impedance of the PTC precharging resistor. After the PTC precharging resistor has cooled down, it can be restarted without restrictions. The waiting time between two switch-on processes depends on the external capacitance, the AC mains voltage and the ambient temperature.

- ▶ Without external capacity: 5 min
- ▶ With external capacity (additional drive controllers): 20 min

**NOTICE**

**No inrush current limitation with DC power supply!**

- ▶ An external inrush current limiter must be provided for DC power supplies.

## CONNECTION OF THE POWER UNIT

### 5.2.1.1 Terminal block X1A for 400V devices



| Name | Function   | Terminal connection                   | Tightening torque    | Max. number of conductors |
|------|--|---------------------------------------|----------------------|---------------------------|
| L1   | Mains connection<br>3-phase                          | 16 mm stud for M16 crimp<br>connector | 35 Nm<br>310 lb inch | 2                         |
| L2   |  |                                       |                      |                           |
| L3   |  |                                       |                      |                           |
| +    | DC terminals   |                                       |                      |                           |
| -    |  |                                       |                      |                           |
| R    | Connection for braking<br>resistor (between + and R) |                                       |                      |                           |
| U    | Motor connection                                     |                                       |                      |                           |
| V    |  |                                       |                      |                           |
| W    |  |                                       |                      |                           |

Figure 22: Terminal block X1A for 400 V devices

5.2.2 Protective earth and functional earth



Protective and functional earth must not be connected to the same terminal.

5.2.2.1 Protective earth

The protective earth (PE) serves for electrical safety particularly personal protection in error case.



**Electric shock due to incorrect dimensioning!**

► The earthing cross-section is in accordance with *VDE 0100* !

| Name | Function                        | Terminal connection                | Tightening torque   | Max. number of conductors |
|------|---------------------------------|------------------------------------|---------------------|---------------------------|
| PE,  | Connection for protective earth | 16 mm stud for M16 crimp connector | 35Nm<br>310 lb inch | 1                         |

Figure 23: Connection for protective earth



**Incorrect installation of the PE connection**

Only the M16 studs with nuts may be used to connect the protective earth!

5.2.2.2 Functional earthing

A functional earthing may also be necessary, if for EMC requirements additional potential equalization between devices or parts of the system must be available.



The use of the functional earth (FE) is not required if the frequency inverter is EMC-technically wired.

The functional earth may not be wired green /yellow!



Notes on EMC-compatible installation can be found here.  
[www.keb.de/fileadmin/media/Manuals/emv/0000neb0000.pdf](http://www.keb.de/fileadmin/media/Manuals/emv/0000neb0000.pdf)



### 5.3 Mains connection

#### 5.3.1 Supply cable

The conductor cross-section of the supply cable is determined by the following factors:

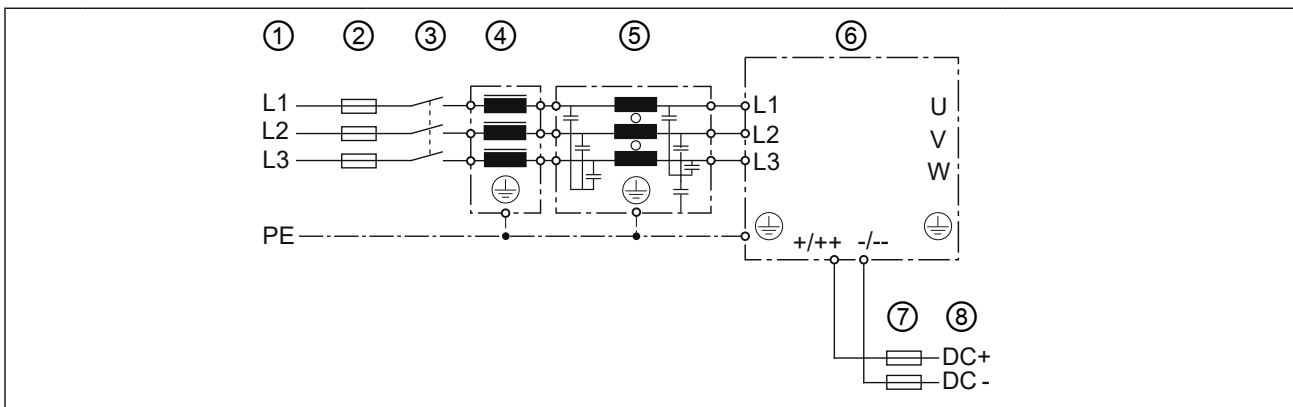
- Input current of the drive controller
- Used line type
- Installation and ambient temperatures
- The locally valid electrical regulations



The application engineer is responsible for the design!

#### 5.3.2 AC mains connection

##### 5.3.2.1 AC supply 3-phase



| No.                 | Type                              | Description  |    |
|---------------------|-----------------------------------|--|----|
| 1                   | Mains phase                       | 3-phase  |    |
|                     | Mains form                        | TN, TT   | IT |
|                     |                                   | The rated voltage between one phase conductor and earth potential (or the neutral point in the IT system) must not exceed 300V, USA UL: 480 / 277 V.<br>(For the IT system, a short-term disconnection must be ensured). |    |
| Personal protection | RCMA with separator or RCD type B | Insulation monitors  |    |
| 2                   | Mains fuses                       | see chapter "Protection of the drive controllers"  |    |
| 3                   | Mains contactor                   | -  |    |
| 4                   | Mains choke                       | see notes in chapter "Filters and chokes"  |    |
| 5                   | HF filter for TN-, TT systems     | Required for compliance with the limit values in accordance with <i>EN 61800-3</i> .   |    |
|                     | HF filter for IT systems          |  |    |
| 6                   | Drive controller                  | COMBIVERT F6   |    |
| 7                   | DC-fuses                          | See note in chapter „Fusing of the devices“.   |    |
| 8                   | DC-supply                         | DC supply generated by the drive controller for connecting further drive controllers => „5.3.6 DC-bus connection“  |    |

Figure 24: Connection of the mains supply 3-phase

### 5.3.3 DC mains connection

#### 5.3.3.1 Terminal block X1A DC connection



| Name | Function     | Terminal connection                | Tightening torque    | Max. number of conductors |
|------|--------------|------------------------------------|----------------------|---------------------------|
| +    | DC terminals | 16 mm stud for M16 crimp connector | 35 Nm<br>310 lb inch | 2                         |
| -    |              |                                    |                      |                           |

Figure 25: Terminal block X1A DC connection

5.3.3.2 Connection at DC voltage supply

**NOTICE**

**Destruction of the drive controller!**

▶ Never exchange “+ / ++” and “- / --”!

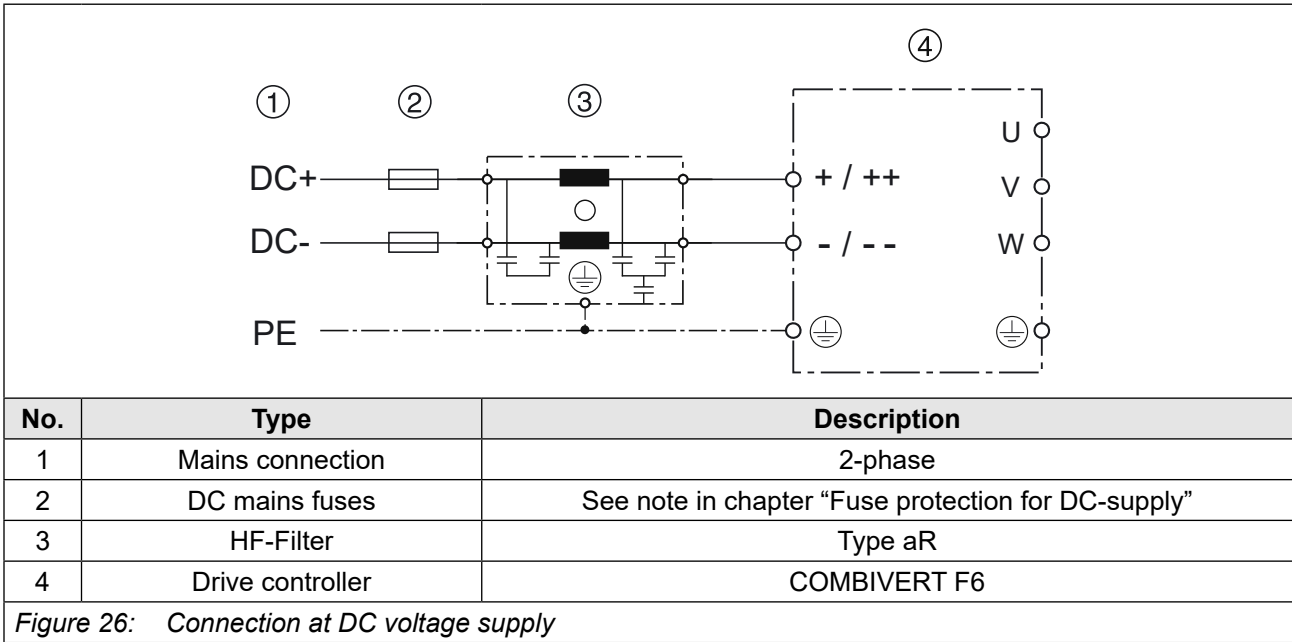
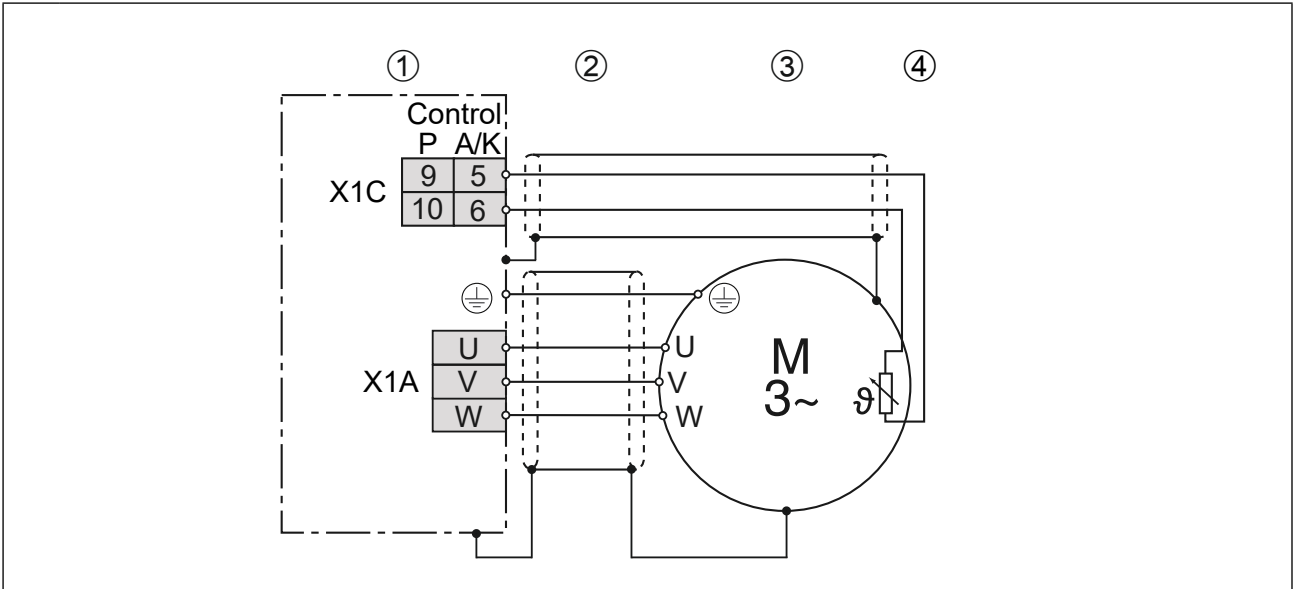


Figure 26: Connection at DC voltage supply

5.3.4 Connection of the motor

5.3.4.1 Wiring of the motor



**Legend**

|   |  |
|---|--|
| 1 | KEB COMBIVERT  |
| 2 | Apply motor cable, shielding on both sides over a large surface on the bare metallic frame or mounting plate (remove paint if necessary) |
| 3 | Three-phase motor  |
| 4 | Temperature monitoring (optional) => <i>Instructions for use "Control circuit"</i>   |

Figure 27: Wiring of the motor

5.3.4.2 Terminal block X1A motor connection



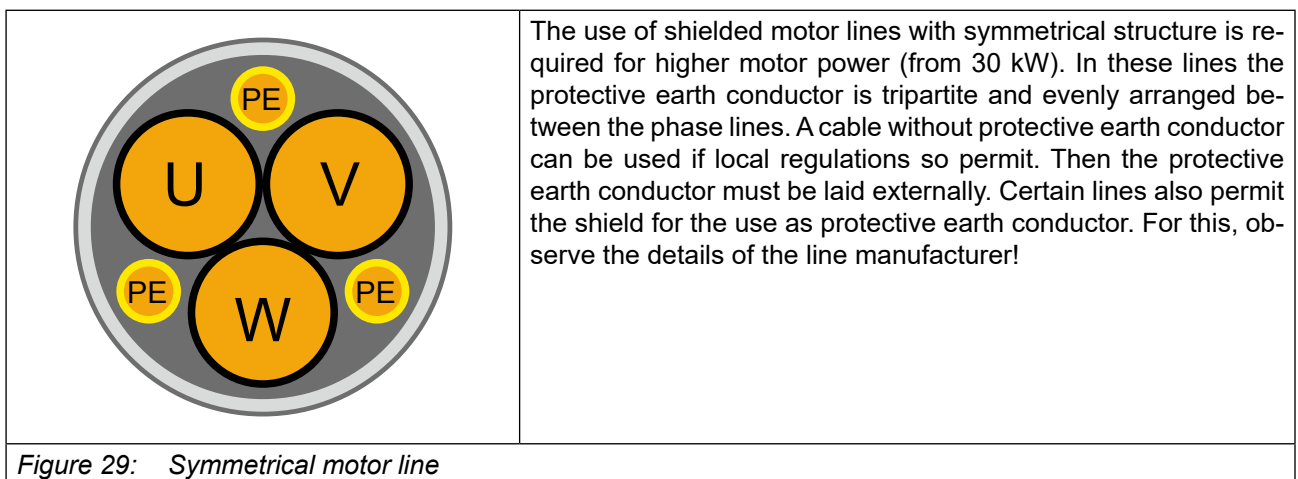
| Name | Function         | Terminal connection                | Tightening torque   | Max. number of conductors |
|------|------------------|------------------------------------|---------------------|---------------------------|
| U    | Motor connection | 16 mm stud for M16 crimp connector | 35 Nm<br>310lb inch | 2                         |
| V    |                  |                                    |                     |                           |
| W    |                  |                                    |                     |                           |

Figure 28: Terminal block X1A motor connection

### 5.3.4.3 Selection of the motor line

The correct cabling as well as the motor line itself play an important part in case of low power in connection with long motor line lengths. Low-capacitance line (phase/phase < 65 pF/m, phase/screen < 120 pF/m) at the inverter output have the following effects:

- allow major motor line lengths („5.3.4.4 Motor cable length and conducted interferences at AC supply“)
- better EMC properties (reduction of the common-mode output currents to earth)



### 5.3.4.4 Motor cable length and conducted interferences at AC supply

The maximum motor cable length is depending on the capacity of the motor cable as well as on the EMC emitted interference. External measures must be taken here (e.g. the use of a line filter).



The cable length can be increased significantly by using motor chokes or motor filters. KEB recommends the use of motor chokes or filters for a cable length upto 25m.



Further information on the motor cable length can be found in the corresponding filter instructions.

5.3.4.5 Motor cable length for parallel operation of motors

The resulting motor cable length for parallel operation of motors, or parallel installation with multiple cables arises from the following formula:

$$\text{Resulting motor cable length} = \sum \text{single cable length} \times \sqrt{\text{Number of motor cables}}$$

5.3.4.6 Motor cable cross-section

The motor cable cross-section is dependent

- on the characteristic of the output current (e.g. harmonic content)
- on the real effective value of the motor current
- on the cable length
- on the type of the used cable
- on the ambient conditions such as bundling and temperature

5.3.4.7 Interconnection of the motor

**NOTICE**

**Incorrect behavior of the motor!**

- ▶ The connecting-up instructions of the motor manufacturer are always generally valid!

**NOTICE**

**Protect motor against voltage peaks!**

- ▶ Drive controllers switch at the output with high dv/dt. Voltage peaks that endanger the insulation system at the motor can occur especially in case of long motor cables (>15 m). A motor choke, a dv/dt-filter or sine-wave filter can be used to protect the motor with regard to the operating mode.

5.3.4.8 Connection of the temperature monitoring and brake control (X1C)

A switchable temperature evaluation is implemented in the COMBIVERT.

There are different types for the evaluation available. These are depending on the control board => *Instruction manual „control board“*.

The desired operating mode can be adjusted via software (dr33). If the evaluation is not required, it must be deactivated via software (parameter pn12 = 7) => *Programming manual*.

| X1C | PIN | Name     | Description                      |
|-----|-----|----------|----------------------------------|
|     | 1   | BR+      | Brake control / output +         |
|     | 2   | BR-      | Brake control / output -         |
|     | 3   | reserved | –                                |
|     | 4   | reserved | –                                |
|     | 5   | TA1      | Temperature detection / output + |
|     | 6   | TA2      | Temperature detection / output - |

Figure 30: Terminal block X1C for control board APPLICATION and COMPACT

| X1C | PIN | Name     | Description                           |
|-----|-----|----------|---------------------------------------|
|     | 1   | BR+      | Brake control / output +              |
|     | 2   | BR-      | Brake control / output -              |
|     | 3   | 0V       | For supply of the checkback inputs    |
|     | 4   | 24Vout   |                                       |
|     | 5   | DIBR1    | Checkback input 1 for brake and relay |
|     | 6   | DIBR2    | Checkback input 2 for brake and relay |
|     | 7   | reserved | –                                     |
|     | 8   | reserved | –                                     |
|     | 9   | TA1      | Temperature detection / output +      |
|     | 10  | TA2      | Temperature detection / output -      |

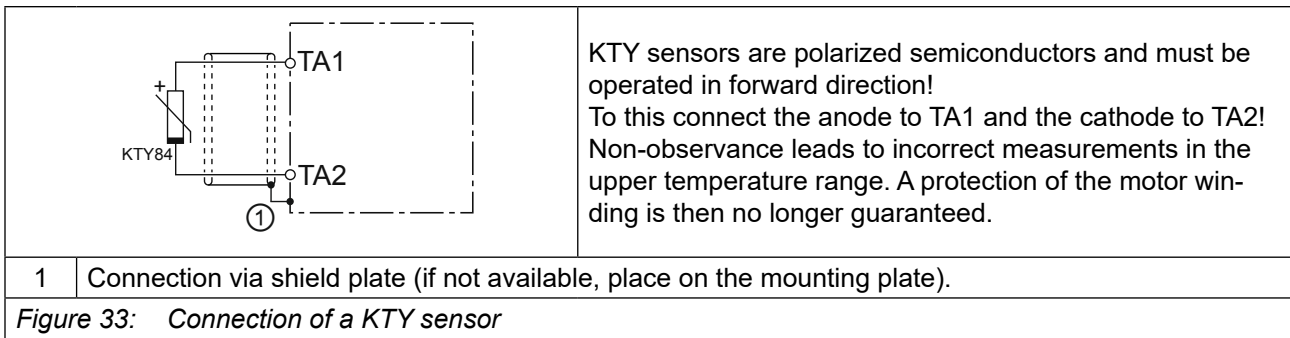
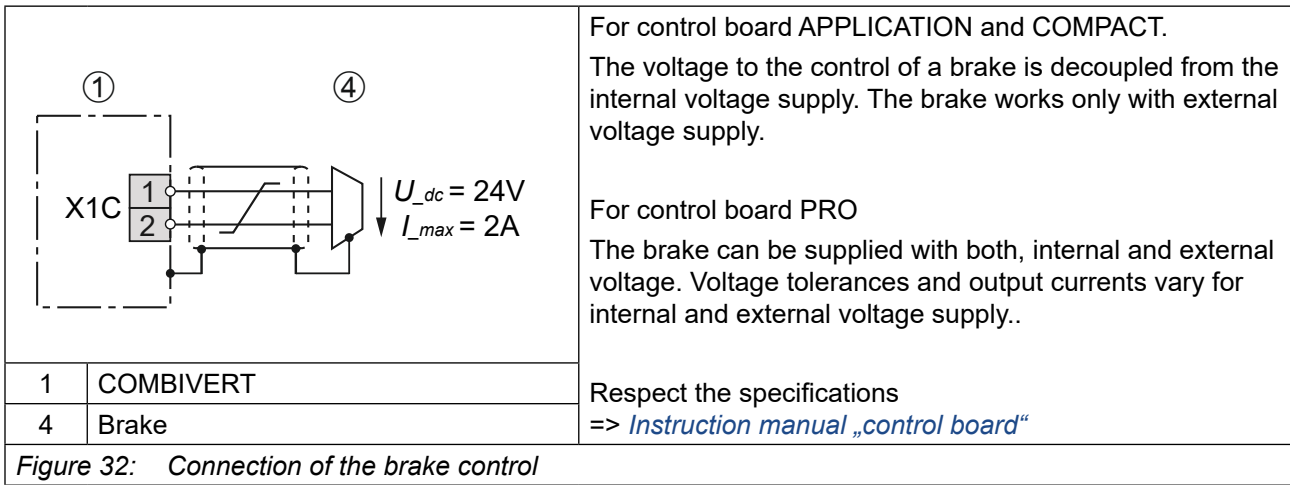
Figure 31: Terminal block X1C for control board PRO

**NOTICE**

**Malfunctions due to incorrect line or laying!**

**Malfunctions of the control due to capacitive or inductive coupling.**

- ▶ Do not route cables from the motor temperature sensor (also shielded) together with control cables.
- ▶ Cables from the motor temperature sensor within the motor cables may only be used with double shielding!
- ▶ The input of the temperature detection has basic isolation.



**NOTICE**

**No protection of the motor winding in case of wrong connection.**

- ▶ Operate KTY sensors in forward direction.
- ▶ KTY sensors may not be combined with other detections.



Further information about the wiring of the temperature monitoring and the brake control have to be observed in the respective control unit manual.

### 5.3.5 Connection and use of a braking resistor

**⚠ CAUTION****Fire risk by using brake resistors !**

- ▶ The risk of fire can be significantly reduced by using „intrinsically safe braking resistors“ or by using suitable monitoring functions / circuits.

**NOTICE****Destruction of the frequency inverter if the value has fallen below the minimum brake resistance value!**

- ▶ The minimum brake resistance value must not fall below!  
*„3.2 Device data of the High Speed Drive devices“*

**⚠ CAUTION****Hot surfaces caused by load of the braking resistor!****Burning of the skin!**

- ▶ Cover hot surfaces safe-to-touch.
- ▶ Before touching, check the surface.
- ▶ If necessary, attach warning signs on the system.

5.3.5.1 Terminal block X1A connection braking resistor



| Name | Function  | Terminal connection                | Tightening torque   | Max. number of conductors |
|------|---|------------------------------------|---------------------|---------------------------|
| +    | Connection for braking resistor (between + and R) | 16 mm stud for M16 crimp connector | 35 Nm<br>310lb inch | 2                         |
| R    |   |                                    |                     |                           |

Figure 34: Terminal block X1A connection braking resistor



At devices with sub-mounted braking resistors, there is no electrical connection to the braking transistor at terminal R!

## 5.3.5.2 Use of non-intrinsically safe braking resistors

**⚠ WARNING****Use of non-intrinsically safe braking resistors****Fire or smoke emission in case of overload or error!**

- ▶ Only use braking resistors with temperature sensor.
- ▶ Evaluate temperature sensor.
- ▶ Trigger an error at the drive controller (e.g. external input).
- ▶ Switch off input voltage (e.g. input contactor).
- ▶ Connection examples for non-intrinsically safe braking resistors
- ▶ => *Instructions for use "Installation braking resistors"*



Instructions for use "Installation braking resistors"

[www.keb.de/fileadmin/media/Manuals/dr/ma\\_dr\\_braking-resistors-20116737\\_en.pdf](http://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_braking-resistors-20116737_en.pdf)

Chapter „Connection of a braking resistor with extended temperature monitoring“.



### 5.3.6 DC-bus connection

The DC link of several drive controllers are coupled in a DC-bus connection. This enables energy to be exchanged between the devices and increases the energy efficiency of the application.

As part of a DC-bus connection, this drive controller can either be supplied via the DC terminals => „5.3.3 DC mains connection“ or supply other drive controllers via the DC terminals => „5.3.2 AC mains connection“.



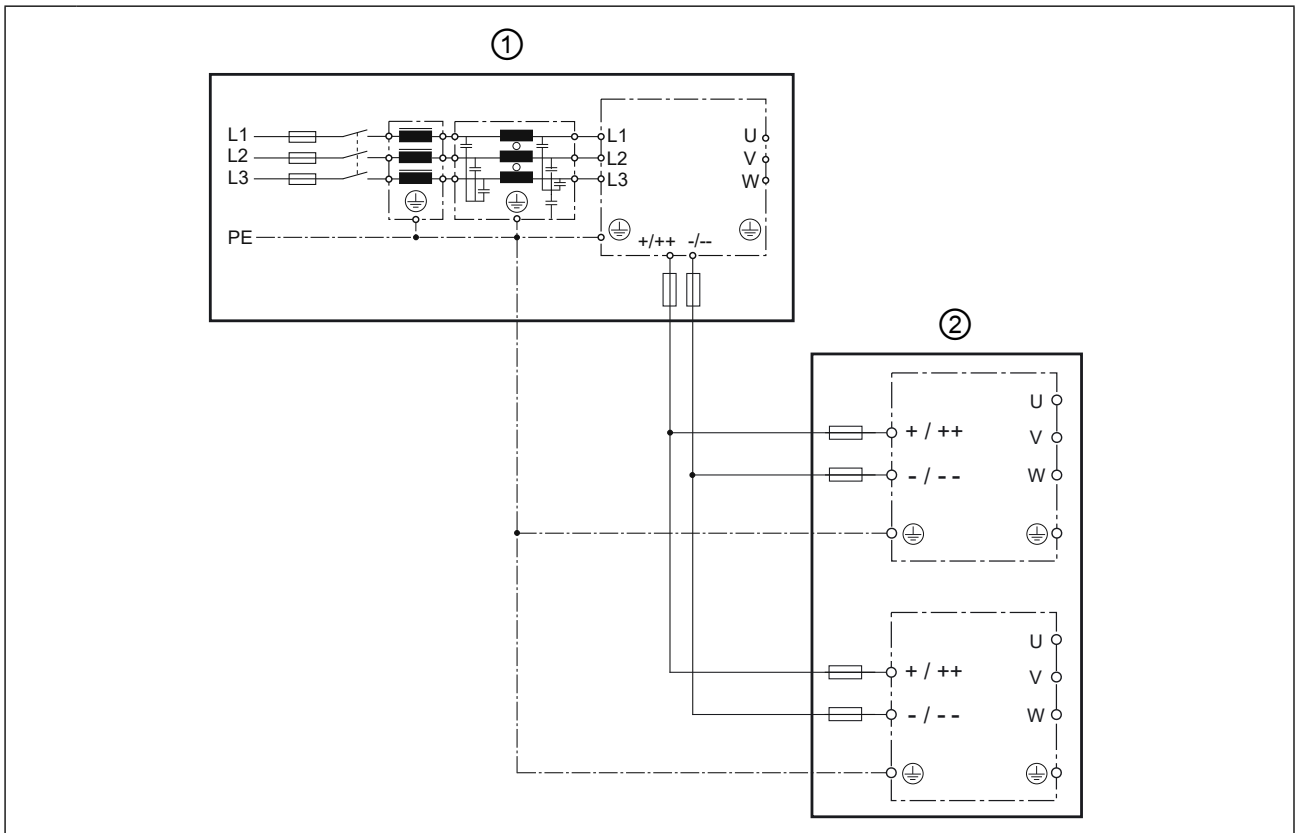

---

KEB drive controllers meet the requirements of the EMC product standard *EN IEC 61800-3* for DC power supplies. Due to the large number of possible interconnection options in the DC network, the user is responsible for ensuring the conformity of the overall system.

---

**The following additional safety instructions must be observed when using this drive controller in a DC-bus connection:**

- This drive controller may only be operated together with other F6 and S6 drive controllers of the 400V class in a DC-bus connection.
- This drive controller must be installed in an enclosure.
- This drive controller must be protected with fuses at the DC terminals => „3.2.6.2 Fuse protection for DC supply“.
- If one fuse in the DC-bus connection blows as a result of a short circuit, all fuses in the DC-bus connection should be replaced due to the risk of prior damage.
- The parameterisation of the input phase failure detection must be adapted => F6 Programming manual.



| Legend |  |
|--------|--|
| 1      | Drive controller for supplying further drive controllers   |
| 2      | Other drive controllers connected to the DC-bus connection |

Figure 35: DC-bus connection

**① When using this drive controller to supply other drive controllers via the DC terminals, the following must also be observed:**

- The maximum prechargeable total capacity (internal capacity + external capacity) must not be exceeded => „Table 28: DC link / braking transistor function of the HSD devices“.
- The minimum waiting time between two precharging procedures must be observed => „5.2.1 Connection of the voltage supply“.
- Drive controllers supplied via the DC terminals must not be loaded during precharging.
- Overloading of the rectifier must be prevented by the user => „3.2.4 Overview of rectifier data for HSD devices“.

**② When supplying this drive controller via the DC terminals, the following must also be observed:**

- The drive controller must be pre-charged by the supplying drive controller or an external pre-charging module.

### 5.3.7 External heat sink fan supply (FAN)



The external heat sink fan supply is only available for air-cooled appliances.



The control card and the heat sink fans should be supplied via separate external voltage sources.

In the event of a fault in the heat sink fans, this provides an uninterrupted supply of power to the control system.



#### **Avoid overtemperature errors by adjusting the fan voltage**

The voltage drop across the supply cable must be taken into account when supplying the fans with power.

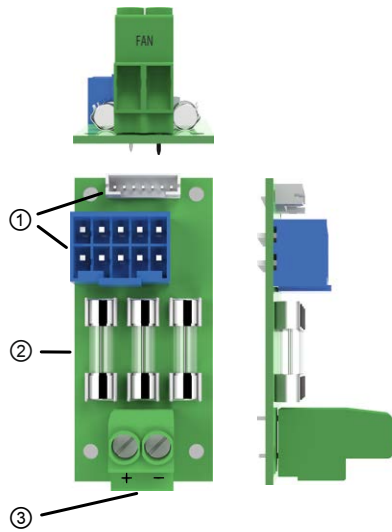
The voltage at the FAN terminal must be 24V at full fan speed. KEB recommends a voltage source with adjustable output voltage

## **NOTICE**

### **Use of unsuitable voltage sources!**

#### **Electric shock!**

- ▶ Only voltage sources (PELV) according to VDE 0100 permitted.
- ▶ Ensure that the overvoltage category of the voltage supply is sufficient.
- ▶ Observe the triggering characteristics of the fuses when selecting the voltage source of the heat sink fan supply.



**Legend**

|                           |                     |   |
|---------------------------|---------------------|---|
| 1                         |                     | Only internal use   |
| 2                         |                     | Fuse: F200, F201, F202<br>SIBA GmbH No. 179021.10                                   |
| 3                         |                     | FAN: Connection + / - for external 24 V power supply                                |
| Fuse(s)                   | $I / A$             | 10 (Type gG)  |
| Max. number of conductors |                     | 2   |
| Supply voltage            | $U_{FAN\_dc} / V$   | 24 -5/+15%  |
| Rated input current       | $I_{FAN\_dc} / A$   | 24  |
| Peak current              | $I_{FAN\_Peak} / A$ | 30  |
| Tightening torque         | $F_N / Nm$          | 0,5...0,6   |
|                           | $F_N / lb\ inch$    | 4,5...5,3   |
| Connection cross section  | for IEC $A / mm^2$  | 0.2...4 (flexible cable with wire end ferrule)<br>1.5 max. (for 2 conductors)       |
|                           | for UL $A / AWG$    | 24...10 (UL: flexible cable without wire end ferrule)<br>14 max. (for 2 conductors) |

Figure 36: External heat sink fan supply

## 5.4 Accessories

### 5.4.1 Filters and chokes

| Voltage class | Drive controller size | HF filter    | Mains choke<br>50 Hz / 4 % $U_k$ |
|---------------|-----------------------|--------------|----------------------------------|
| 400V          | 29                    | 33E6T60-3150 | 30Z1B04-1000                     |
|               | 30                    | 33E6T60-3150 | 30Z1B04-1000                     |
|               | 31                    | 33E6T60-3150 | 31Z1B04-1000                     |
|               | 32                    | 33E6T60-3150 | 32Z1B04-1000                     |
|               | 33                    | 33E6T60-3150 | 33Z1B04-1000                     |

Table 41: Filters and chokes



The specified filters and chokes are designed for rated operation.

### 5.4.2 Seal for IP54-ready devices

| Name           | Material number |
|----------------|-----------------|
| Flat seal IP54 | 00F6T45-0001    |

Table 42: Seal for IP54-ready devices

### 5.4.3 Side-mounted braking resistors



Technical data and design about non-intrinsically safe braking resistors

[www.keb.de/fileadmin/media/Manuals/dr/ma\\_dr\\_braking-resistors-20116737\\_en.pdf](http://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_braking-resistors-20116737_en.pdf)



## 6 Operation of Liquid-Cooled Devices

### 6.1 Water-cooled devices

The use of water-cooled KEB COMBIVERT drive converters is offered, because there are process-caused coolants available with some applications. However, the following instructions must be observed.

#### 6.1.1 Heat sink and operating pressure

| Design system       | Material          | max. operating pressure | Connection                                  |
|---------------------|-------------------|-------------------------|---|
| Aluminium heat sink | Aluminium -1,67 V | 10 bar                  | => „6.1.4 Connection of the cooling system“ |

#### NOTICE

#### Deformation of the heat sink!

- ▶ In order to avoid a deformation of the heat sink and the damages thereby, the indicated maximum operating pressure may not be exceeded briefly also by pressure peaks.
- ▶ Observe the Pressure Equipment Directive 2014/68/EU!

#### 6.1.2 Materials in the cooling circuit

For the screw connections and also for the metallic articles in the cooling circuit which are in contact with the coolant (electrolyte) a material is to be selected, which forms a small voltage difference to the heat sink in order to avoid contact corrosion and/or pitting corrosion (electro-chemical voltage series, see the following table). The specific case of application must be checked by the customer in tuning of the complete cooling circuit and must be classified according to the used materials. With hoses and seals take care that halogen-free materials are used.

A liability for occurring damages by wrongly used materials and from this resulting corrosion cannot be taken over!

| Material     | formed ion             | Standard potential | Material                        | formed ion       | Standard potential |
|--------------|------------------------|--------------------|---------------------------------|------------------|--------------------|
| Lithium      | Li+                    | -3.04 V            | Nickel                          | Ni <sup>2+</sup> | -0.25 V            |
| Potassium    | K+                     | -2.93 V            | Tin                             | Sn <sup>2+</sup> | -0.14 V            |
| Calcium      | Ca <sup>2+</sup>       | -2.87 V            | Lead                            | Pb <sup>3+</sup> | -0.13 V            |
| Sodium       | Na+                    | -2.71 V            | Iron                            | Fe <sup>3+</sup> | -0.037 V           |
| Magnesium    | Mg <sup>2+</sup>       | -2.38 V            | Hydrogen                        | 2H+              | 0.00 V             |
| <b>Titan</b> | <b>Ti<sup>2+</sup></b> | <b>-1.75 V</b>     | <b>Stainless steel (1.4404)</b> | <b>various</b>   | <b>0.2...0.4 V</b> |
| Aluminium    | Al <sup>3+</sup>       | -1.67 V            | Copper                          | Cu <sup>2+</sup> | 0.34 V             |
| Manganese    | Mn <sup>2+</sup>       | -1.05 V            | Carbon                          | C <sup>2+</sup>  | 0.74 V             |
| Zinc         | Zn <sup>2+</sup>       | -0.76 V            | Silver                          | Ag+              | 0.80 V             |

*continued on the next page*

| Material | formed ion       | Standard potential | Material | formed ion       | Standard potential |
|----------|------------------|--------------------|----------|------------------|--------------------|
| Chrome   | Cr <sup>3+</sup> | -0.71 V            | Platinum | Pt <sup>2+</sup> | 1.20 V             |
| Iron     | Fe <sup>2+</sup> | -0.44 V            | Gold     | Au <sup>3+</sup> | 1.42 V             |
| Cadmium  | Cd <sup>2+</sup> | -0.40 V            | Gold     | Au <sup>+</sup>  | 1.69 V             |
| Cobald   | Co <sup>2+</sup> | -0.28 V            |          |                  |                    |

Table 43: Electrochemical series / standard potentials against hydrogen

### 6.1.3 Requirements for the coolant

The requirements for the coolant depend on the ambient conditions as well as the used cooling system.

General requirements for the coolant:

| Requirement                 | Description  |
|-----------------------------|--|
| Standards                   | Corrosion protection according to <i>EN 12502-1...5</i> , water treatment and use of materials in cooling systems according to <i>VGB S 455 P</i> .  |
| VGB Cooling water directive | The VGB cooling water directive ( <i>VGB S 455 P</i> ) contains instructions about common process technology of the cooling. Particularly the interactions between cooling water and components of the cooling system are described.   |
| Abrasive substances         | Abrasive substances as used in abrasive (quartz sand), clogging the cooling circuit.   |
| Hard water                  | Cooling water may not cause scale deposits or loose excretions. The total hardness should be between 7...20 °dH, the carbon hardness at 3...10 °dH.  |
| Soft water                  | Soft water (<7°dH) corrodes the material.  |
| Frost protection            | An appropriate antifreeze must be used for applications when the heat sink or the coolant is exposed temperatures below zero. Use only products of one manufacturer for a better compatibility with other additives.<br>KEB recommends the antifreeze Antifrogen N from Clariant with a maximum volume content of 52 %.  |
| Corrosion protection        | Additives can be used as corrosion protection. In connection with frost protection the antifreeze must have a concentration of 20...25 Vol %, in order to avoid a change of the additives.<br>Alternatively, an antifreeze / glycol with a concentration of 20% ... max. vol 52% can be used. If antifreeze is used, the water does not need to be provided with additional additives. |

Table 44: Requirements for the coolant

Special requirements for open and half-open cooling systems:

| Requirement            | Description  |
|------------------------|--|
| Impurities             | Mechanical impurities in half-open cooling systems can be counteracted when appropriate water filters are used.  |
| Salt concentration     | The salt content can increase through evaporation at half-open systems. Thus the water is more corrosive. Adding of fresh water and removing of process water works against.   |
| Algae and myxobacteria | Algae and myxobacteria can arise caused by increased water temperature and contact with atmospheric oxygen. The algae and myxobacteria clog the filters and obstruct the water-flow. Biocide containing additives can avoid this. Especially at longer OFF periods of the cooling circuit preventive maintenance is necessary. |
| Organic materials      | The contamination with organic materials must be kept as small as possible, because separate slime can be caused by this.  |

Table 45: Special requirements for open and half-open cooling systems



Damages at the device which are caused by clogged, corroded heat sinks or other obvious operating errors, leads to the loss of the warranty claims.

6.1.4 Connection of the cooling system

The connection to the cooling system can occur as closed or open cooling circuit. The connection to a closed cycle cooling circuit is recommended, because the danger of contamination of coolant is very small. Preferably also a monitoring of the pH value of the coolant should be installed.

Pay attention to a corresponding conductor cross-section at required equipotential bonding in order to avoid electro-chemical procedures.

=> „6.1.2 Materials in the cooling circuit“

Other elements in the cooling circuit such as pumps, shut-off valves, ventilation etc. must be attached according to the cooling system and the local conditions.

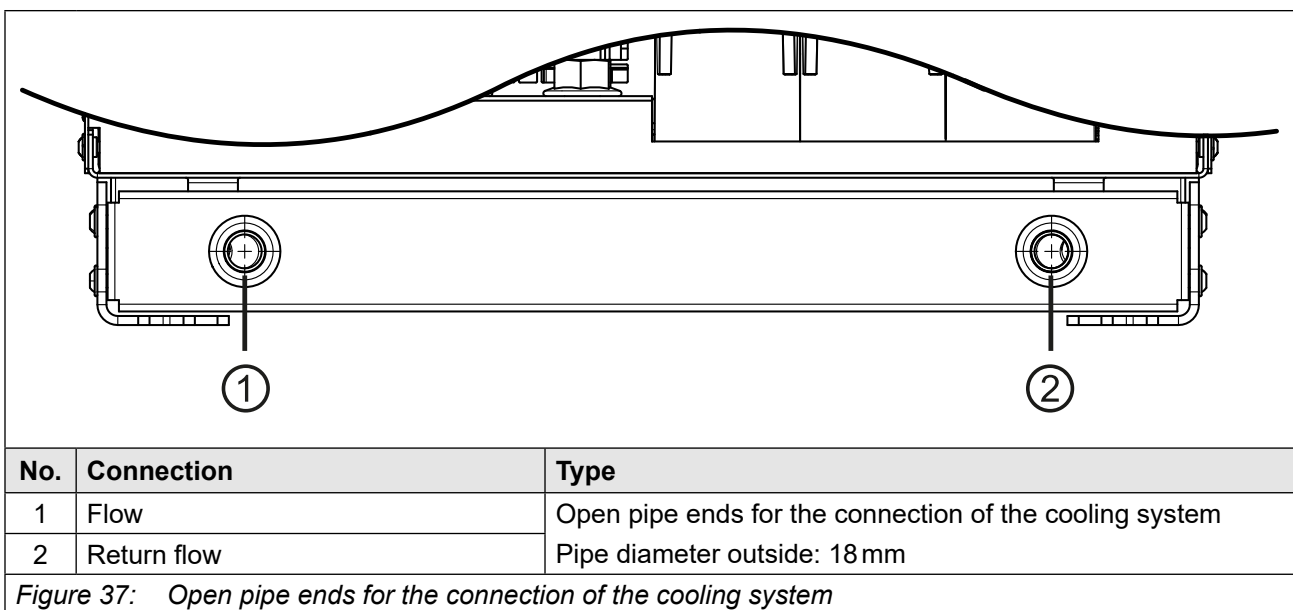


Figure 37: Open pipe ends for the connection of the cooling system



For the connection of the cooling system KEB recommends the use of functional nuts, e.g. from the manufacturer "Parker", type FMxxL71 (xx = pipe diameter).

The recommended tightening torque is 80 Nm.



To monitor the volume flow in the cooling system KEB recommends the use of a volume flow monitor.

### 6.1.5 Coolant temperature and moisture condensation

The flow temperature should be selected depending on the volume flow so that the heat sink temperature is always 10 K below the overtemperature level (OH) during rated operation. This avoids sporadic shutdown.

The maximum heat sink temperature can be found in chapter => „3.3.1 Switching frequency and temperature“.

#### 6.1.5.1 Condensation

A temperature difference between drive converter and ambient temperature can lead to condensation at high humidity.

Moisture condensation is dangerous for the drive converter. The drive converter can be destroyed through occurring short-circuits.

**NOTICE**

**Destruction of the drive converter due to short circuit!**

► Avoid any condensation.

#### 6.1.5.2 Supply of temper coolant

- The supply of optimally tempered coolant is possible by using heaters in the cooling circuit to control the coolant temperature.
- The following dew point table shows the coolant inlet temperature depending on the ambient temperature and air humidity.

| Air humidity / %                      | 10  | 20  | 30  | 40  | 50  | 60  | 70  | 80  | 90  |
|---------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ambient temperature / °C              |     |     |     |     |     |     |     |     |     |
| -10                                   | -34 | -26 | -22 | -19 | -17 | -15 | -13 | -11 | -11 |
| -5                                    | -29 | -22 | -18 | -15 | -13 | -11 | -8  | -7  | -6  |
| 0                                     | -26 | -19 | -14 | -11 | -8  | -6  | -4  | -3  | -2  |
| 5                                     | -23 | -15 | -11 | -7  | -5  | -2  | 0   | 2   | 3   |
| 10                                    | -19 | -11 | -7  | -3  | 0   | 1   | 4   | 6   | 8   |
| 15                                    | -18 | -7  | -3  | 1   | 4   | 7   | 9   | 11  | 13  |
| 20                                    | -12 | -4  | 1   | 5   | 9   | 12  | 14  | 16  | 18  |
| 25                                    | -8  | 0   | 5   | 10  | 13  | 16  | 19  | 21  | 23  |
| 30                                    | -6  | 3   | 10  | 14  | 18  | 21  | 24  | 26  | 28  |
| 35                                    | -2  | 8   | 14  | 18  | 22  | 25  | 28  | 31  | 33  |
| 40                                    | 1   | 11  | 18  | 22  | 27  | 31  | 33  | 36  | 38  |
| 45                                    | 4   | 15  | 22  | 27  | 32  | 36  | 38  | 41  | 43  |
| <b>Coolant inlet temperature / °C</b> |     |     |     |     |     |     |     |     |     |

Table 46: Dew point table



Information on coolant management is given in the following document

[www.keb.de/fileadmin/media/Techinfo/dr/an/ti\\_dr\\_an-liquid-cooling-00004\\_en.pdf](http://www.keb.de/fileadmin/media/Techinfo/dr/an/ti_dr_an-liquid-cooling-00004_en.pdf)



**NOTICE**

**Destruction of the heat sink at storage / transport of water-cooled devices!**

Observe the following points when storing water-cooled devices:

- ▶ Completely empty the cooling circuit
- ▶ Blow out the cooling circuit with compressed air

**NOTICE**

**Destruction of the drive converter due to condensation!**

- ▶ Use only NC valves!

**6.1.6 Permissible volume flow with water cooling**

The volume flow of the following table must be observed.

| Device size      |                   | 30 | 31 | 32 | 33 |
|------------------|-------------------|----|----|----|----|
| Min. volume flow | $Q_{min}$ / l/min | 25 | 25 | 30 | 35 |
| Max. volume flow | $Q_{max}$ / l/min | 35 | 40 | 40 | 40 |

Table 47: Permissible volume flow with water cooling



The volume flow depends on the total power dissipation.  
=> „6.1.7 Coolant heating“

**NOTICE**

**Destruction of the heat sink due to erosion!**

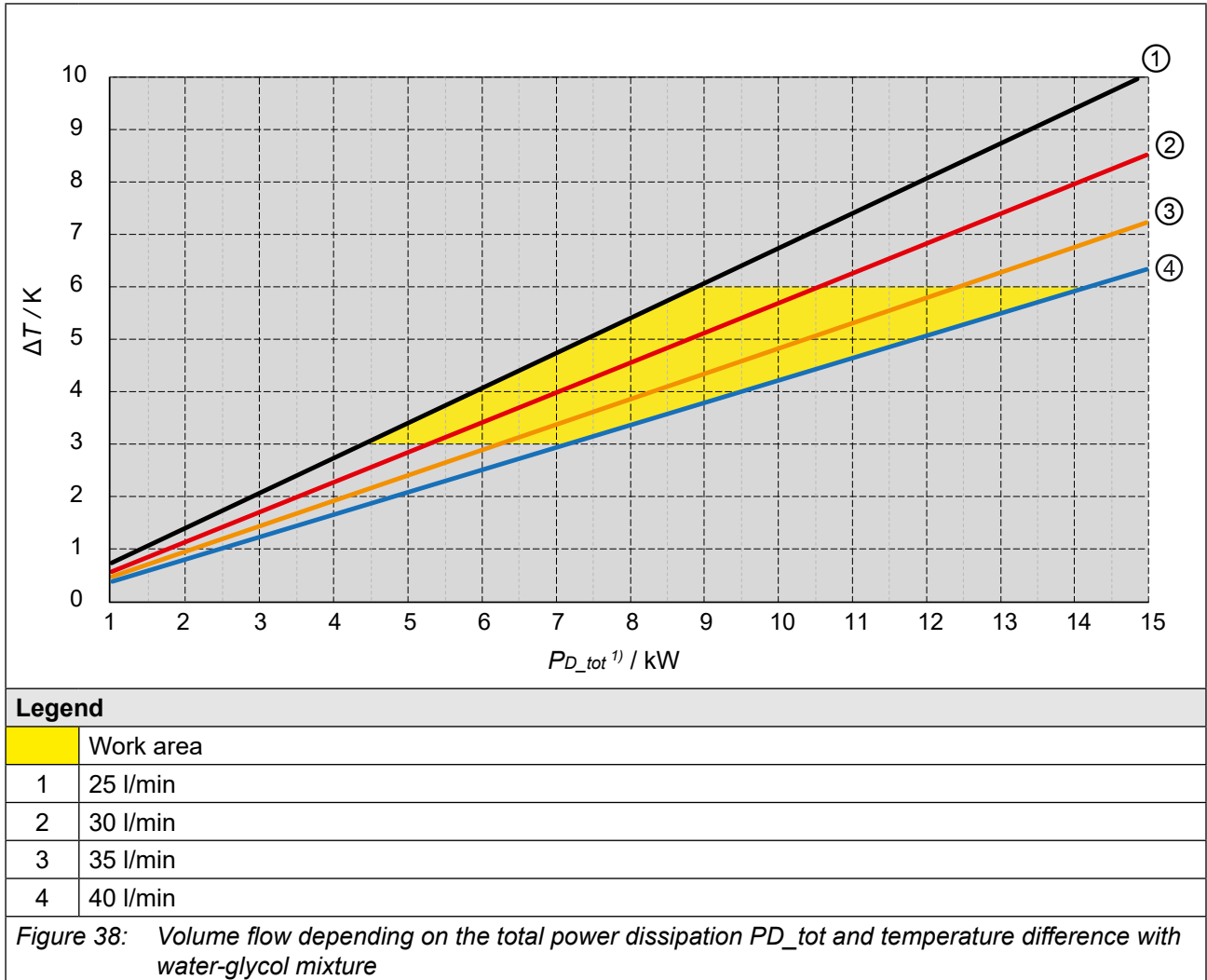
- ▶ The maximum permissible volume flow must not be exceeded.

### 6.1.7 Coolant heating

The following curve characteristics apply to a flow temperature of 55 °C and a glycol content of 52 %.

#### 6.1.7.1 Coolant heating

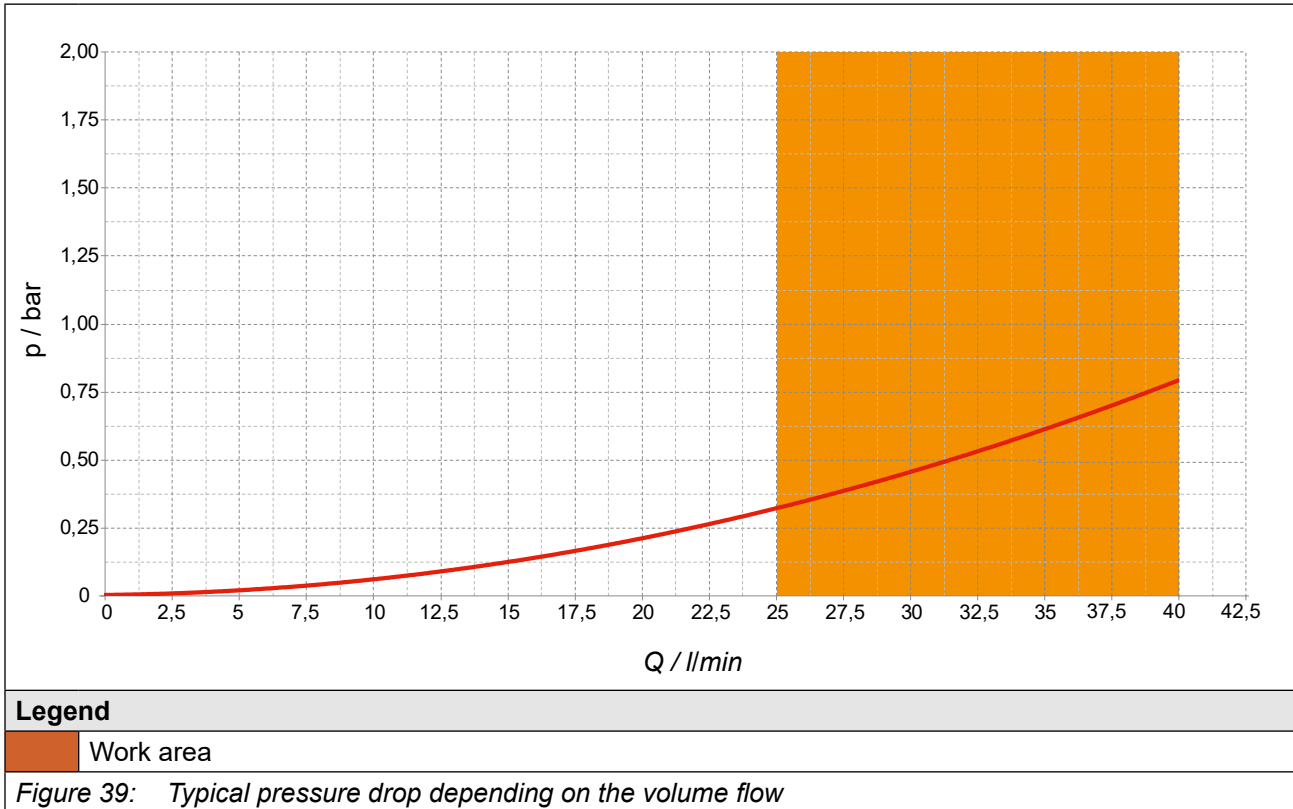
Volume flow depending on the total power dissipation and temperature difference between flow and return flow.



<sup>1)</sup>  $P_{D\_tot}$  can be higher than the power dissipation  $P_D$  during rated operation due to overload, higher switching frequency or sub-mounted braking resistors.

6.1.8 Typical pressure drop of the heat sink

- The curve characteristic shown below is valid for 25 °C flow temperature and a glycol content of 52 %.
- If higher flow temperatures are used, the pressure drop in the system decreases.
- This also applies to cooling media such as water or another glycol mixture.
- A glycol mixture from Clariant in a ratio of 52 % or 33 % is recommended.



## 7 Approvals and certifications

### 7.1 CE marking

The drive controller marked with a CE logo comply with the requirements specified by European Union directives. The CE Declaration of Conformity is available on the Internet at <https://www.keb-automation.com/search>




For further information regarding the CE declarations of conformity

=> „7.3 Further informations and documentation“

---

7.2 UL certification

|   |  |                           |
|---|--|---------------------------|
|  | Acceptance according to UL is marked at KEB drive controllers with the adjacent logo on the nameplate. | UL file number<br>E167544 |
|---|--|---------------------------|

To be conform according to UL for use on the North American and Canadian Market the following additionally instructions must be observed (original text of the UL-File):

- All models:  
Maximum Surrounding Air Temperature: 45°C
- Use 75°C Copper Conductors Only
- Control Circuit Overcurrent Protection Required
- Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the Manufacturer Instructions, National Electrical Code and any additional local codes.

CSA: For Canada: Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the Canadian Electrical Code, Part I.

LA PROTECTION INTÉGRÉE CONTRE LES COURTSCIRCUITS N'ASSURE PAS LA PROTECTION DE LA DÉRIVATION. LA PROTECTION DE LA DÉRIVATION DOIT ÊTRE EXÉCUTÉE CONFORMÉMENT AU CODE CANADIEN DE L'ÉLECTRICITÉ, PREMIÈRE PARTIE.

- Only for use in non-corner grounded type WYE source not exceeding 277V phase to ground.
- For installations according to Canadian National Standard C22.2 No. 274-13:  
For use in Pollution Degree 2 and Overvoltage Category III environments only.
- Models 29F6: Suitable For Use On A Circuit Capable Of Delivering Not More Than 18000 rms Symmetrical Amperes, 480 Volts Maximum when protected by Class L Fuses, see instruction manual for Branch Circuit Protection details.

Models 30F6, 31F6, 32F6: Suitable For Use On A Circuit Capable Of Delivering Not More Than 30000 rms Symmetrical Amperes, 480 Volts Maximum when protected by Class L Fuses, see instruction manual for Branch Circuit Protection details.

Models 33F6: Suitable For Use On A Circuit Capable Of Delivering Not More Than 42000 rms Symmetrical Amperes, 480 Volts Maximum when protected by Class L Fuses, see instruction manual for Branch Circuit Protection details.

All Models: Suitable For Use On A Circuit Capable Of Delivering Not More Than 100,000 rms Symmetrical Amperes, 480 Volts Maximum when protected by Semiconductor Fuses by SIBA, Type 206xy32.xxx, or by Bussmann, Type 170M5xxx or by Littelfuse, Type PSR032xyxxxx, see instruction manual for Branch Circuit Protection details.

- **WARNING** – The opening of the branch circuit protective device may be an indication that a fault current has been interrupted. To reduce the risk of fire or electrical shock, current-carrying parts and other components of the controller should be examined and replaced if damaged. If burnout of the current element of an overload relay occurs, the complete overload relay must be replaced.

CSA: For Canada:

“ATTENTION - LE DÉCLENCHEMENT DU DISPOSITIF DE PROTECTION DU CIRCUIT DE DÉRIVATION PEUT ÊTRE DÛ À UNE COUPURE QUI RÉSULTE D'UN COURANT DE DÉFAUT. POUR LIMITER LE RISQUE D'INCENDIE OU DE CHOC ÉLECTRIQUE, EXAMINER LES PIÈCES PORTEUSES DE COURANT ET LES AUTRES ÉLÉMENTS DU CONTRÔLEUR ET LES REMPLACER S'ILS SONT ENDOMMAGÉS. EN CAS DE GRILLAGE DE L'ÉLÉMENT TRAVERSÉ PAR LE COURANT DANS UN RELAIS DE SURCHARGE, LE RELAIS TOUT ENTIER DOIT ÊTRE REMPLACÉ.”

- External Brake resistor ratings and duty cycle:
  - Duty cycle 25%
  - Max. 30 sec on-time / 90 sec off-time

Sub-mounted brake resistor ratings and duty cycle:

- Duty cycle 0.5%
- Max. 0.6 sec on-time / 119.4 sec off-time
- For liquid cooled devices:
  - Maximum working pressure: 10 bar (145 psi)
  - Liquid inlet temperature range: +5...+40°C (standard) and +5...+55°C (high performance)
  - Min water flow rate: 10 l/min

### 7.3 Further informations and documentation

You find supplementary manuals and instructions for the download under [www.keb-automation.com/search](http://www.keb-automation.com/search)

#### General instructions

- EMC and safety instructions
- Manuals for additional control boards, safety modules, fieldbus modules, etc.

#### Instruction and information for construction and development

- Input fuses in accordance with UL
- Programming manual for control and power unit
- Motor configurator to select the appropriate drive controller and to create downloads for parameterizing the drive controller

#### Approvals and approbations

- Declaration of conformity CE
- TÜV certificate
- FS certification

Other markings and approvals not listed here are identified by a corresponding logo on the rating plate or device, if applicable. The corresponding certificates are available on our website.

#### Others

- COMBIVIS, the software for comfortable parameterization of drive controllers via PC (available per download)
- EPLAN drawings

## 8 Revision history

| Version | Date    | Description   |
|---------|---------|---|
| 00      | 2022-12 | Completion pre-series version   |
| 01      | 2023-06 | Product description, technical data, coolant heating adapted.   |
| 02      | 2023-08 | Device size 30 and UL certification included.   |
| 03      | 2023-11 | Corrections of the currents   |
| 04      | 2024-01 | Series version of the manual created, OL2 currents adapted.   |
| 05      | 2025-03 | Glossary, standards, type code updated. Editorial changes, changes to the temperature switching thresholds. |
| 06      | 2025-05 | Inclusion of appliance sizes 29, 30, 31 as air coolers. Description for DC-Ready devices added.             |
| 07      | 2026-01 | Editorial changes, description of conducted interference updated.   |

## Glossary

|                         |  |                   |   |
|-------------------------|--|-------------------|---|
| 0V                      | Earth-potential-free common point  | Encoder emulation | Software-generated encoder output   |
| 1ph                     | 1-phase mains  | End customer      | The end customer is the user of the customer product  |
| 3ph                     | 3-phase mains  | Endat             | Bidirectional encoder interface of the company Heidenhain   |
| AC                      | AC current or voltage  | EtherCAT          | Real-time Ethernet bus system of the company Beckhoff   |
| AFE                     | From 07/2019 AIC replaces the previous name AFE  | Ethernet          | Real-time bus system - defines protocols, plugs, types of cables  |
| AFE filter              | From 07/2019 AIC filter replaces the previous name AFE filter  | FE                | Functional earth  |
| AIC                     | Active Infeed Converter  | FSoE              | Functional Safety over Ethernet   |
| AIC filter              | Filter for Active Infeed Converter   | FU                | Drive controller  |
| Application             | The application is the intended use of the KEB product   | GND               | Reference potential, ground   |
| ASCL                    | Asynchronous sensorless closed loop  | GTR7              | Braking transistor  |
| Auto motor ident.       | Automatically motor identification; calibration of resistance and inductance   | HF filter         | KEB specific term for an EMC filter (for description see EMC filter).   |
| AWG                     | American wire gauge  | Hiperface         | Bidirectional encoder interface of the company Sick-Stegmann  |
| B2B                     | Business-to-business   | HMI               | Human machine interface (touch screen)  |
| BiSS                    | Open source real-time interface for sensors and actuators (DIN 5008)   | HSP5              | Fast, serial protocol   |
| CAN                     | Fieldbus system  | HTL               | Incremental signal with an output voltage (up to 30V) -> TTL  |
| c.d.f.                  | Cyclic duration factor   | IEC               | IEC xxxxx stands for an international standard of the International Electrotechnical Commission   |
| CDM                     | Complete drive module including auxiliary equipment (control cabinet)  | IPxx              | Protection class (xx for class)   |
| COMBIVERT               | KEB drive controller   | KEB product       | The KEB product is subject of this manual   |
| COMBIVIS                | KEB start-up and parameterizing software   | KTY               | Silicium temperature sensor (polarized)   |
| Customer                | The customer has purchased a KEB product from KEB and integrates the KEB product into his product (customer product) or resells the KEB product (dealer) | Manufacturer      | The manufacturer is KEB, unless otherwise specified (e.g. as manufacturer of machines, engines, vehicles or adhesives)  |
| DC                      | DC current or voltage  | MCM               | American unit for large wire cross sections   |
| DI                      | Demineralized water, also referred to as deionized (DI) water  | Modulation        | Means in drive technology that the power semiconductors are controlled  |
| DIN                     | German Institut for standardization  | MTTF              | Mean service life to failure  |
| DS 402                  | CiA DS 402 - CAN device profile for drives   | NHN               | Standard elevation zero; based on the specified height definition in Germany (DHHN2016). The international data generally deviate from this by only a few cm to dm, so that the specified value can be applied to the regionally applicable definition. |
| ELV                     | Extra-low voltage  | OC                | Overcurrent   |
| EMC filter              | EMC filters are used to suppress conducted interferences in both directions between the drive controller and the mains                                   | OH                | Overheat  |
| Emergency stop          | Shutdown of a drive in emergency case (not de-energized)   | OL                | Overload  |
| Emergency switching off | Switching off the voltage supply in emergency case   |                   |   |
| EMS                     | Energy Management System   |                   |   |
| EN                      | European standard  |                   |   |

|        |  |
|--------|--|
| OSSD   | Output signal switching device; - an output signal that is checked in regular intervals on its shutdown. (safety technology)     |
| PDS    | Power drive system incl. motor and measuring probe   |
| PE     | Protective earth   |
| PELV   | Protective Extra Low Voltage   |
| PF     | Term used in the safety technology (EN 61508-1...7) for the size of error probability  |
| PFH    | Term used in the safety technology (EN 61508-1...7) for the size of error probability per hour                                   |
| PLC    | Programmable logic controller  |
| Pt100  | Temperature sensor with $R_0=100\Omega$  |
| Pt1000 | Temperature sensor with $R_0=1000\Omega$   |
| PTC    | PTC-resistor for temperature detection   |
| PWM    | Pulse width modulation   |
| RJ45   | Modular connector with 8 lines   |
| SCL    | Synchronous sensorless closed loop   |
| SELV   | Safe extra-low voltage, unearthed  |
| SIL    | The safety integrity level is a measure for quantifying the risk reduction. Term used in the safety technology (EN 61508 -1...7) |
| SS1    | Safety function „Safe stop 1“ in accordance with IEC 61800-5-2   |
| SSI    | Synchronous serial interface for encoder   |
| STO    | Safety function „Safe Torque Off“ in accordance with IEC 61800-5-2   |
| TTL    | Logic with 5 V operating voltage   |
| USB    | Universal serial bus   |
| VARAN  | Real-time Ethernet bus system  |

## List of Figures

|            |  |    |
|------------|--|----|
| Figure 1:  | Nameplate (exemplary).....   | 21 |
| Figure 2:  | Configurable options.....  | 22 |
| Figure 3:  | Switch-off time $t$ as a function of the overload I/INOC level 135% (OL) .....   | 31 |
| Figure 4:  | Switch-off time $t$ as a function of the overload I/INOC level 150% (OL) .....   | 32 |
| Figure 5:  | Typical overload characteristic in the lower output frequencies (OL2) Example<br>30-unit fluid cooler (water) .....            | 34 |
| Figure 6:  | Block diagram of the energy flow.....  | 45 |
| Figure 7:  | Switching behaviour of the fans example interior fan .....   | 50 |
| Figure 8:  | Dimensions built-in version air cooler .....   | 51 |
| Figure 9:  | Dimensions push-through version air cooler IP20, IP54-ready .....  | 52 |
| Figure 10: | Dimensions built-in version fluid cooler (water) High-Performance .....  | 53 |
| Figure 11: | Dimensions push-through version fluid cooler (water) High-Performance IP20,<br>IP54-ready .....                                | 54 |
| Figure 12: | Example of an F6 in housing 8 with M10 ring bolts .....  | 55 |
| Figure 13: | Example of an F6 housing 7 with transport brackets.....  | 55 |
| Figure 14: | Mounting distances.....  | 57 |
| Figure 15: | Installation of IP54-ready devices .....   | 58 |
| Figure 16: | Control cabinet ventilation.....   | 59 |
| Figure 17: | Airflow of the drive controller.....   | 59 |
| Figure 18: | F6 housing 9 top view.....   | 60 |
| Figure 19: | F6 housing 9 front view.....   | 61 |
| Figure 20: | F6 housing 9 rear view with control board APPLICATION.....   | 62 |
| Figure 21: | Input circuit.....   | 63 |
| Figure 22: | Terminal block X1A for 400V devices .....  | 64 |
| Figure 23: | Connection for protective earth.....   | 65 |
| Figure 24: | Connection of the mains supply 3-phase.....  | 66 |
| Figure 25: | Terminal block X1A DC connection.....  | 67 |
| Figure 26: | Connection at DC voltage supply.....   | 68 |
| Figure 27: | Wiring of the motor.....   | 69 |
| Figure 28: | Terminal block X1A motor connection.....   | 70 |
| Figure 29: | Symmetrical motor line .....   | 71 |
| Figure 30: | Terminal block X1C for control board APPLICATION and COMPACT.....  | 73 |
| Figure 31: | Terminal block X1C for control board PRO.....  | 73 |
| Figure 32: | Connection of the brake control.....   | 74 |
| Figure 33: | Connection of a KTY sensor .....   | 74 |
| Figure 34: | Terminal block X1A connection braking resistor .....   | 76 |
| Figure 35: | DC-bus connection .....  | 79 |
| Figure 36: | External heat sink fan supply .....  | 81 |
| Figure 37: | Open pipe ends for the connection of the cooling system .....  | 86 |
| Figure 38: | Volume flow depending on the total power dissipation $PD_{tot}$ and temperature diffe-<br>rence with water-glycol mixture..... | 89 |
| Figure 39: | Typical pressure drop depending on the volume flow.....  | 90 |

## List of Tables

|           |  |    |
|-----------|--|----|
| Table 1:  | Part code.....   | 20 |
| Table 2:  | Climatic environmental conditions .....  | 23 |
| Table 3:  | Mechanical environmental conditions .....  | 24 |
| Table 4:  | Further environmental operating conditions.....                                      | 24 |
| Table 5:  | Device classification.....   | 24 |
| Table 6:  | Electromagnetic compatibility .....  | 25 |
| Table 7:  | Overview of the HSD device data .....  | 27 |
| Table 8:  | Input voltages and frequencies of the 400V devices .....                             | 27 |
| Table 9:  | DC link voltage for 400V devices .....   | 28 |
| Table 10: | Output voltages and frequencies of the 400V devices .....                            | 28 |
| Table 11: | Example of the calculation of the possible motor voltage:.....                       | 28 |
| Table 12: | Input and output currents / overload of the HSD units Air cooler.....                | 29 |
| Table 13: | Input and output currents / overload of the HSD devices Fluid cooler (water) .....   | 29 |
| Table 14: | Frequency-dependent maximum current for appliance size 29 HSD air cooler .....       | 35 |
| Table 15: | Frequency-dependent maximum current for appliance size 30 HSD air cooler .....       | 35 |
| Table 16: | Frequency-dependent maximum current for appliance size 31 HSD air cooler .....       | 36 |
| Table 17: | Frequency-dependent maximum current for device size 30 HSD (fluid cooler water)..... | 37 |
| Table 18: | Frequency-dependent maximum current for device size 31 HSD (fluid cooler water)..... | 37 |
| Table 19: | Frequency-dependent maximum current for device size 32 HSD (fluid cooler water)..... | 38 |
| Table 20: | Frequency-dependent maximum current for device size 33 HSD (fluid cooler water)..... | 38 |
| Table 21: | Overview of rectifier data for 400 V devices .....                                   | 39 |
| Table 22: | Power loss of the HSD units Air cooler .....   | 40 |
| Table 23: | Power loss of the HSD units Fluid cooler (water) .....                               | 40 |
| Table 24: | Fusing of the HSD devices .....  | 41 |
| Table 25: | DC Fusing of the 400 V / 480 V devices .....   | 42 |
| Table 26: | Switching frequencies and temperatures for air coolers.....                          | 43 |
| Table 27: | Switching frequencies and temperatures for fluid coolers (water) .....               | 44 |
| Table 28: | DC link / braking transistor function of the HSD devices .....                       | 46 |
| Table 29: | Continuous thermal current for appliance size 29 Air cooler .....                    | 47 |
| Table 30: | Continuous thermal current for appliance size 30 Air cooler .....                    | 47 |
| Table 31: | Continuous thermal current for appliance size 31 Air cooler .....                    | 47 |
| Table 32: | Continuous thermal current for appliance size 30 Fluid cooler (water).....           | 47 |
| Table 33: | Continuous thermal current for appliance size 31 Fluid cooler (water).....           | 47 |
| Table 34: | Continuous thermal current for appliance size 32 Fluid cooler (water).....           | 48 |
| Table 35: | Continuous thermal current for appliance size 33 Fluid cooler (water).....           | 48 |
| Table 36: | Sub-mounted braking resistors.....   | 48 |
| Table 37: | Fan.....   | 49 |
| Table 38: | Switching points of the fans .....   | 50 |
| Table 39: | Mounting instructions for built-in version.....                                      | 56 |
| Table 40: | Mounting instructions for push-through version.....                                  | 56 |
| Table 41: | Filters and chokes.....  | 82 |
| Table 42: | Seal for IP54-ready devices.....   | 82 |

## GLOSSARY

|           |   |    |
|-----------|---|----|
| Table 43: | Electrochemical series / standard potentials against hydrogen ..... | 84 |
| Table 44: | Requirements for the coolant.....                                   | 84 |
| Table 45: | Special requirements for open and half-open cooling systems .....   | 85 |
| Table 46: | Dew point table .....   | 87 |
| Table 47: | Permissible volume flow with water cooling.....                     | 88 |



**MORE KEB PARTNERS WORLDWIDE:**

[www.keb-automation.com/contact](http://www.keb-automation.com/contact)





**Automation with Drive**

**[www.keb-automation.com](http://www.keb-automation.com)**

KEB Automation KG Suedstrasse 38 D-32683 Barntrop Tel. +49 5263 401-0 E-Mail: [info@keb.de](mailto:info@keb.de)