
# COMBIVERT **F6**

## INSTRUCTIONS FOR USE | **INSTALLATION F6 HOUSING 2**

Translation of the original manual
Document 20099887 EN 07

# Preface

The described hard- and software are developments of the KEB Automation KG. The enclosed documents correspond to conditions valid at printing. Misprint, mistakes and technical changes reserved.

## Signal words and symbols

Certain operations can cause hazards during the installation, operation or thereafter. There are safety informations in the documentation in front of these operations. Security signs are located on the device or machine. A warning contains signal words which are explained in the following table:

| | |
|---|---|
| **⚠ DANGER** | Dangerous situation, which will cause death or serious injury in case of non-observance of this safety instruction. |
| **⚠ WARNING** | Dangerous situation, which may cause death or serious injury in case of non-observance of this safety instruction. |
| **⚠ CAUTION** | Dangerous situation, which may cause minor injury in case of non-observance of this safety instruction. |
| ***NOTICE*** | Situation, which can cause damage to property in case of non-observance. |

***RESTRICTION***

Is used when certain conditions must meet the validity of statements or the result is limited to a certain validity range.

Is used when the result will be better, more economic or trouble-free by following these 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.
*www.keb.de/service/downloads*

## 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. Further information is provided in chapter "Certification".

## 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.
*www.keb.de/terms-and-conditions*

Further agreements or specifications require a written confirmation.

## Support

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

**The use of our units in the target products is 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 Automation KG 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.

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# Glossary

| | |
|---|---|
| 0V | Earth-potential-free common point |
| 1ph | 1-phase mains |
| 3ph | 3-phase mains |
| AC | AC current or voltage |
| AFE | From 07/2019 AIC replaces the previous name AFE |
| AFE filter | From 07/2019 AIC filter replaces the previous name AFE filter |
| AIC | Active Infeed Converter |
| AIC filter | Filter for Active Infeed Converter |
| Application | The application is the intended use of the KEB product |
| ASCL | Asynchronous sensorless closed loop |
| Auto motor ident. | Automatically motor identification; calibration of resistance and inductance |
| AWG | American wire gauge |
| B2B | Business-to-business |
| BiSS | Open source real-time interface for sensors and actuators (DIN 5008) |
| CAN | Fieldbus system |
| CDM | Complete drive module including auxiliary equipment (control cabinet) |
| COMBIVERT | KEB drive converters |
| COMBIVIS | KEB start-up and parameterizing software |
| 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) |
| DC | DC current or voltage |
| DI | Demineralized water, also referred to as deionized (DI) water |
| DIN | German Institut for standardization |
| DS 402 | CiA DS 402 - CAN device profile for drives |
| EMC | Electromagnetic compatibility |
| Emergency stop | Shutdown of a drive in emergency case (not de-energized) |
| Emergency switching off | Switching off the voltage supply in emergency case |
| EN | European standard |
| Encoder emulation | Software-generated encoder output |
| End customer | The end customer is the user of the customer product |
| Endat | Bidirectional encoder interface of the company Heidenhain |
| EtherCAT | Real-time Ethernet bus system of the company Beckhoff |
| Ethernet | Real-time bus system - defines protocols, plugs, types of cables |
| FE | Functional earth |
| FSoE | Functional Safety over Ethernet |
| FU | Drive converter |
| GND | Reference potential, ground |
| GTR7 | Braking transistor |
| HF filter | High frequency filter to the mains |
| Hiperface | Bidirectional encoder interface of the company Sick-Stegmann |
| HMI | Human machine interface (touch screen) |
| HSP5 | Fast, serial protocol |
| HTL | Incremental signal with an output voltage (up to 30V) -> TTL |
| IEC | International standard |
| IP xx | Degree of protection (xx for level) |
| KEB product | The KEB product is subject of this manual |
| KTY | Silicium temperature sensor (polarized) |
| Manufacturer | The manufacturer is KEB, unless otherwise specified (e.g. as manufacturer of machines, engines, vehicles or adhesives) |
| MCM | American unit for large wire cross sections |
| Modulation | Means in drive technology that the power semiconductors are controlled |
| MTTF | Mean service life to failure |
| NN | Sea level |
| OC | Overcurrent |
| OH | Overheat |
| OL | Overload |
| OSSD | Output signal swithching 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 |
| PFD | Term used in the safety technology (EN 61508-1...7) for the size of error probability |
| PFH | Term used in the safety technology (EN 61508-1...7) for the size of error probability per hour |

| | |
|---|---|
| PLC | Programmable logic controller |
| PT100 | Temperature sensor with R0=100Ω |
| PT1000 | Temperature sensor with R0=1000Ω |
| PTC | PTC-resistor for temperature detection |
| PWM | Pulse width modulation |
| RJ45 | Modular connector with 8 lines |
| SCL | Synchronous sensorless closed loop |
| SELV | Safety Extra Low Voltage (< 60 V) |
| SIL | The security 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 | Incremental signal with an output voltage up to 5 V |
| USB | Universal serial bus |
| VARAN | Real-time Ethernet bus system |

# Standards for drive converters / control cabinets

## Product standards that apply directly to the drive converter

| | |
|---|---|
| EN 61800-2 | Adjustable speed electrical power drive systems - Part 2: General requirements - Rating specifications for low voltage adjustable frequency a.c. power drive systems (VDE 0160-102, IEC 61800-2) |
| EN 61800-3 | Speed-adjustable electrical drives. Part 3: EMC requirements and specific test methods (VDE 0160-103, IEC 61800-3) |
| EN 61800-5-1 | Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy (IEC 61800-5-1); German version EN 61800-5-1 |
| EN 61800-5-2 | Adjustable speed electrical power drive systems - Part 5-2: Safety Requirements - Functional (IEC 22G/264/CD) |
| UL 61800-5-1 | American version of the EN 61800-5-1 with „National Deviations“ |

## Basic standards to which drive converter standards refer directly

| | |
|---|---|
| EN 55011 | Industrial, scientific and medical equipment - Radio frequency disturbance characteristics - Limits and methods of measurement (CISPR 11); German version EN 55011 |
| EN 55021 | Interference to mobile radiocommunications in the presence of impulse noise - Methods of judging degradation and measures to improve performance (IEC/CISPR/D/230/FDIS); German version prEN 55021 |
| EN 60529 | Degrees of protection provided by enclosures (IP Code) (IEC 60529) |
| EN 60664-1 | Insulation coordination for equipment within low-voltage systems Part 1: Principles, requirements and tests (IEC 60664-1) |
| EN 60721-3-1 | Classification of environmental conditions - Part 3-1: Classification of groups of environmental parameters and their severities - Section 1: Storage (IEC 60721-3-1); German version EN 60721-3-1 |
| EN 60721-3-2 | Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 2: Transportation and handling (IEC 104/670/CD) |
| EN 60721-3-3 | Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities; section 3: Stationary use at weatherprotected locations; Amendment A2 (IEC 60721-3-3); German version EN 60721-3-3 |
| EN 61000-2-1 | Electromagnetic compatibility (EMC) - Part 2: Environment - Section 1: Description of the environment - Electromagnetic environment for low-frequency conducted disturbances and signalling in public power supply systems |
| EN 61000-2-4 | Electromagnetic compatibility (EMC) - Part 2-4: Environment; Compatibility levels in industrial plants for low-frequency conducted disturbances (IEC 61000-2-4); German version EN 61000-2-4 |
| EN 61000-4-2 | Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test (IEC 61000-4-2); German version EN 61000-4-2 |
| EN 61000-4-3 | Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test (IEC 61000-4-3); German version EN 61000-4-3 |
| EN 61000-4-4 | Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test (IEC 61000-4-4); German version EN 61000-4-4 |

| | |
|---|---|
| EN 61000-4-5 | Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test (IEC 61000-4-5); German version EN 61000-4-5 |
| EN 61000-4-6 | Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6); German version EN 61000-4-6 |
| EN 61000-4-34 | Electromagnetic compatibility (EMC) - Part 4-34: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests for equipment with mains current more than 16 A per phase (IEC 61000-4-34); German version EN 61000-4-34 |
| EN 61508-1...7 | Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1...7 (VDE 0803-1…7, IEC 61508-1…7) |
| EN 62061 | Safety of machinery - functional safety of electrical, electronic and programmable electronic safety-related systems (VDE 0113-50, IEC 62061) |
| EN ISO 13849-1 | Safety of machinery - safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1); German version EN ISO 13849-1 |

## Standards that are used in the environment of the drive converter

| | |
|---|---|
| DGUV regulation 3 | Electrical installations and equipment |
| DIN 46228-1 | Wire-end ferrules; Tube without plastic sleeve |
| DIN 46228-4 | Wire-end ferrules; Tube with plastic sleeve |
| DIN IEC 60364-5-54 | Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements, protective conductors and protective bonding conductors (IEC 64/1610/CD) |
| DIN VDE 0100-729 | Low-voltage electrical installations - Part 7-729: Requirements for special installations or locations - Operating or maintenance gangways (IEC 60364-7-729:2007, modified); German implementation HD 60364-7-729:2009 |
| DNVGL-CG-0339 | Environmental test specification for electrical, electronic and programmable equipment and systems |
| EN 1037 | Safety of machinery - Prevention of unexpected start-up; German version EN 1037 |
| EN 12502-1...5 | Protection of metallic materials against corrosion - Part 1...5 |
| EN 60204-1 | Safety of machinery - electrical equipment of machines Part 1: General requirements (VDE 0113-1, IEC 44/709/CDV) |
| EN 60439-1 | Low-voltage switchgear and controlgear assemblies - Part 1: Type-tested and partially type-tested assemblies (IEC 60439-1); German version EN 60439-1 |
| EN 60947-7-1 | Low-voltage switchgear and controlgear - Part 7-1: Ancillary equipment - Terminal blocks for copper conductors (IEC 60947-7-1:2009); German version EN 60947-7-1:2009 |
| EN 60947-8 | Low-voltage switchgear and controlgear - Part 8: Control units for built-in thermal protection (PTC) for rotating electrical machines (IEC 60947-8:2003 + A1:2006 + A2:2011) |
| EN 61373 | Railway applications - Rolling stock equipment - Shock and vibration tests (IEC 61373); German version EN 61373 |
| EN 61439-1 | Low-voltage switchgear and controlgear assemblies - Part 1: General rules (IEC 121B/40/CDV); German version FprEN 61439-1 |
| VGB R 455 P | Water treatment and use of materials in cooling systems |
| ISO 4017 | Fasteners - Hexagon head screws - Product grades A and B |
| ISO 4762 | Hexagon socket head cap screws |
| ISO 7090 | Plain washers, chamfered - Normal series - Product grade A |
| ISO 7092 | Plain washers - Small series - Product grade A |
| ISO 7045 | Pan head screws with type H or type Z cross recess - Product grade A |

# 1 Basic Safety Instructions

The COMBIVERT is designed and constructed in accordance with state-of-the-art technology and the recognised 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. Non-observance of the safety instructions by the customer, user or other third party leads to the loss of all resulting claims against the manufacturer.

**NOTICE**

**Hazards and risks through ignorance.**

► 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 *DIN IEC 60364-5-54*.
- Knowledge of national safety regulations (e.g. *DGUV regulation 3*).

## 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 converter shall be protected against excessive strains.

**Transport of drive converters 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 converters on suitable pallets.

► Do not stack drive converters or burden them with other heavy objects.


**Drive converters contain electrostatic sensitive components.**

► Avoid contact.

► Wear ESD-protective clothing.

Do not store drive converters

- 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 COMBIVERT is not intended for the use in potentially explosive environment.

**⚠ CAUTION**

**Maximum design edges and high weight!**

**Contusions and bruises!**

► Never stand under suspended loads.

► Wear safety shoes.

► Secure drive converter 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. Non-compliance with the applicable standards.
- 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 inverter according to the specified degree of protection.
- Make sure that no small parts fall into the COMBIVERT 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 converter.
- The safety instructions are to be kept!

## 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 measurement.
- ► Wait until all drives has been stopped in order that no regenerative energy can be generated.
- ► Await capacitor discharge time (5 minutes) if necessary, measure DC voltage at the terminals.
- ► If personal protection is required, install suitable protective devices for drive converters.
- ► Never bridge upstream protective devices (also not for test 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 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 *DIN IEC 60364-5-54* .

If personnel protection is required during installation of the system, suitable protective devices must be used for drive converters.
*www.keb.de/fileadmin/media/Manuals/knowledge/04_techinfo/00_general/ti_rcd_0400_0002_gbr.pdf*

Installations which include drive converter 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 converter 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.
- The wiring must be made with flexible copper cable for a temperature > 75°C.
- 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. 300 V. 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/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 inverter.

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 converters 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 500 V 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 drive converter must not be started 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 converter 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 converter.
- ► 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.

If a drive converter with electrolytic capacitors in a DC link (see technical data) has not been in operation for more than one year, observe the following instructions.

*www.keb.de/fileadmin/media/Manuals/knowledge/04_techinfo/00_general/ti_format_capacitors_0400_0001_gbr.pdf*

**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.

***Switching at the output***

Switching between motor and drive converter 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 converter 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 converter (mains on) (e.g. due to large rotating masses).

***Switching an the input***

For applications that require cyclic switching off and on of the drive converter, 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 converter 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 converter. The fan must be replaced in case of audible vibrations or squeak.

► In the case of liquid-cooled drive converters 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.

## 1.8 Repair

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

**⚠ DANGER**

**Unauthorized exchange, repair and modifications!**

**Unpredictable malfunctions!**

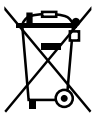
- ► The function of the drive converter is dependent on its parameterization. Never replace without knowledge of the application.
- ► Modification or repair is permitted only by KEB Automation KG authorized personnel.
- ► Only use original manufacturer parts.
- ► Infringement will annul the liability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

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

## 1.7 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 |
|---|---|---|
| Austria | | |
| KEB Automation GmbH | ERA: 51976 | Stichwort „Rücknahme WEEE“ |
| France | | |
| RÉCYLUM - Recycle point | ADEME: FR021806 | Mots clés „KEB DEEE“ |
| Germany | | |
| KEB Automation KG | EAR: DE12653519 | Stichwort „Rücknahme WEEE“ |
| Italy | | |
| COBAT | AEE: (IT) 19030000011216 | Parola chiave „Ritiro RAEE“ |

The packaging must be feed to paper and cardboard recycling.

# 2 Product Description

The device series COMBIVERT F6 concerns to drive converters, which are optimized for the operation at synchronous and asynchronous motors. The COMBIVERT can be extended with a safety module for the use in safety-oriented applications. It can be operated with a fieldbus module at different fieldbus systems. The control board has a system comprehensive operating concept.

The COMBIVERT meets the requirements of the Low-Voltage Directive. The harmonized standards of the series *EN 61800-5-1* for drive converter were used.

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 machine directive, EMC directive, Low Voltage Directive and other guidelines and regulations must be observed depending on the version.

## 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.

Technical data and information for connection conditions shall be taken from the type plate and from the instruction manual 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 converter 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 device. 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

This instruction manual describes the power circuits of the following devices:

| | |
|---|---|
| Device type: | Drive converter |
| Series: | COMBIVERT F6 |
| Power range: | 2.2...7.5 kW / 230 V<br>4...15 kW / 400 V |
| Housing: | 2 |

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 device
- Low noise development due to high switching frequencies
- Different heat sink concepts:
  - Air cooler as built-in version
  - Air cooler as push-through version with IP20 degree of protection
  - Air cooler as push-through version with IP54 degree of protection
- Temperature-controlled fan, easily replaceable
- Depending on the operating mode, the torque limits and the s-curves are adjustable (to protect the gearbox).
- 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 $I^2t$, 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 (water), mounted version |
| | 2: | Liquid cooler (water), mounted version |
| | 3: | Air-cooler, through-mount version IP54 |
| | 4: | Liquid cooler (water), through-mount version IP54 |
| | 5: | Air-cooler, through-mount version IP20 |
| | 6: | Liquid cooler (water), trough-mount version IP54, sub-mounted braking resistors |
| | 7: | Liquid cooler (oil), through-mount version IP54 |
| | 9: | Liquid cooler (water), mounted version, sub-mounted braking resistors |
| | A: | Liquid cooler (water), trough-mount version IP54, sub-mounted braking resistors version 2 |
| | B: | Liquid cooler (water), mounted version, sub-mounted braking resistors version 2 |
| Control board variant | | **APPLIKATION** |
| | 1: | Multi Encoder Interface, CAN® [2], Real-Time Ethernet-busmodule [3] |
| | | **KOMPAKT** |
| | 1: | Multi Encoder Interface, CAN® [2], STO, EtherCAT® [1] |
| | 2: | Multi Encoder Interface, CAN® [2], STO, VARAN |
| | | **PRO** |
| | 3: | Multi Encoder Interface, CAN® [2], Real-Time Ethernet interface [3], RD485-potential free |
| | 4: | No Encoder, CAN® [2], Real-Time Ethernetinterface [3], safe relay |
| | 5: | Multi Encoder Interface, CAN® [2], Real-Time Ethernet interface [3], Safety Relay |

| Switching frequency, Software current limit, Turn-off current | | | | |
|---|---|---|---|---|
| | 0: | 2 kHz / 125% / 150% | 6: | 8 kHz / 150% / 180% |
| | 1: | 4 kHz / 125% / 150% | 7: | 16 kHz / 150% / 180% |
| | 2: | 8 kHz / 125% / 150% | 8: | 2 kHz / 180% / 216% |
| | 3: | 16 kHz / 125% / 150% | 9: | 4 kHz / 180% / 216% |
| | 4: | 2 kHz / 150% / 180% | A: | 8 kHz / 180% / 216% |
| | 5: | 4 kHz / 150% / 180% | B: | 16 kHz / 180% / 216% |

| | | |
|---|---|---|
| Voltage / Connection type | 1: | 3ph 230 V AC/DC with braking transistor |
| | 2: | 3ph 230 V AC/DC without braking transistor |
| | 3: | 3ph 400 V AC/DC with braking transistor |
| | 4: | 3ph 400 V AC/DC without braking transistor |
| Housing | | 2…9 |
| Equipment | 0: | Without safety function |
| | 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 |

*continued on the next page*

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

| | |
|---|---|
| Series | COMBIVERT F6 |
| Inverter size | 10…33 |

*Table 1: Part code*

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

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)*

# 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** |
|---|---|---|---|---|
| Surrounding 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** |
| Surrounding 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** |
| Surrounding temperature | | *EN 60721-3-3* | 3K3 | 5…40 °C (extended to -10…45 °C) |
| Coolant inlet temperature | Air | – | – | 5…40 °C (-10…45 °C) |
| | Liquid | – | – | 5…40 °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 converter 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*

### 3.1.2 Mechanical ambient conditions

| **Storage** | **Standard** | **Class** | **Descriptions** |
|---|---|---|---|
| Vibration limits | *EN 60721-3-1* | 1M2 | Vibration amplitude 1.5 mm (2…9 Hz)<br>Acceleration amplitude 5 m/s² (9…200 Hz) |
| Shock limit values | *EN 60721-3-1* | 1M2 | 40 m/s²; 22 ms |
| **Transport** | **Standard** | **Class** | **Descriptions** |
| Vibration limits | *EN 60721-3-2* | 2M1 | Vibration amplitude 3.5 mm (2…9 Hz)<br>Acceleration amplitude 10 m/s² (9…200 Hz)<br>(Acceleration amplitude 15 m/s² (200…500 Hz))* |
| Shock limit values | *EN 60721-3-2* | 2M1 | 100 m/s²; 11 ms |
| **Operation** | **Standard** | **Class** | **Descriptions** |
| Vibration limits | *EN 60721-3-3* | 3M4 | Vibration amplitude 3.0 mm (2…9 Hz)<br>Acceleration amplitude 10 m/s² (9…200 Hz) |
| | *EN 61800-5-1* | – | Vibration amplitude 0.075 mm (10…57 Hz)<br>Acceleration amplitude 10 m/s² (57…150 Hz) |
| Shock limit values | *EN 60721-3-3* | 3M4 | 100 m/s²; 11 ms |

*Table 3: Mechanical ambient conditions*

**Not tested*

### 3.1.3 Chemical / mechanical active substances

| **Storage** | | **Standard** | **Class** | **Descriptions** |
|---|---|---|---|---|
| Contamination | Gases | *EN 60721-3-1* | 1C2 | – |
| | Solids | | 1S2 | – |
| **Transport** | | **Standard** | **Class** | **Descriptions** |
| Contamination | Gases | *EN 60721-3-2* | 2C2 | – |
| | Solids | | 2S2 | – |
| **Operation** | | **Standard** | **Class** | **Descriptions** |
| Contamination | Gases | *EN 60721-3-3* | 3C2 | – |
| | Solids | | 3S2 | – |

*Table 4: Chemical / mechanical active substances*

### 3.1.4 Electrical operating conditions

#### 3.1.4.1 Device classification

| Requirement | Standard | Class | Descriptions |
|---|---|---|---|
| Overvoltage category | *EN 61800-5-1* | III | – |
| | *EN 60664-1* | | – |
| Pollution degree | *EN 60664-1* | 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 emissions | *EN 61800-3* | C2 | – |
| Radiated emissions | *EN 61800-3* | C2 | – |
| **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 - 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 |
| Immunity to conducted disturbances, induced by radio-frequency fields | *EN 61000-4-6* | 10 V | 0.15...80 MHz |
| Electromagnetic fields | *EN 61000-4-3* | 10 V/m<br>3 V/m<br>1 V/m | 80 MHz...1 GHz<br>1.4...2 GHz<br>2...2.7 GHz |
| Voltage fluctuations/<br>voltage dips | *EN 61000-2-1*<br>*EN 61000-4-34* | – | -15 %...+10 %<br>90 % |
| Frequency changes | *EN 61000-2-4* | – | ≤ 2 % |
| Voltage deviations | *EN 61000-2-4* | – | ±10 % |
| Voltage unbalance | *EN 61000-2-4* | – | ≤ 3 % |

*Table 6: Electromagnetic compatibility*

## 3.2 Device data of the 230 V devices

### 3.2.1 Overview of the 230 V devices

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

| **Device size** | | | **10** | **12** | **13** | **14** |
|---|---|---|---|---|---|---|
| **Housing** | | | **2** | | | |
| Rated apparent output power | | $S_{out}$ / kVA | 4.4 | 7 | 9.6 | 13 |
| Max. rated motor power | | $P_{mot}$ / kW | 2.2 | 4 | 5.5 | 7.5 |
| | | | | | | |
| Rated input voltage | | $U_N$ / V | 230 (UL: 240) | | | |
| Input voltage range | | $U_{in}$ / V | 170...264 | | | |
| Mains phases | | | 3 | | | |
| Mains frequency | | $f_N$ / Hz | 50 / 60 ±2 | | | |
| Rated input current @ $U_N$ = 230V | | $I_{in}$ / A | 16.5 | 22 | 30 | 41.5 |
| Rated input current @ $U_N$ = 240V | | $I_{in\_UL}$ / A | 16.5 | 22 | 30 | 41.5 |
| | | | | | | |
| Output voltage | | $U_{out}$ / V | 0...$U_{in}$ | | | |
| Output frequency | 2) | $f_{out}$ / Hz | 0...599 | | | |
| Output phases | | | 3 | | | |
| Rated output current @ $U_N$ = 230 V | | $I_N$ / A | 11 | 17.5 | 24 | 33 |
| Rated output current @ $U_N$ = 240 V | | $I_{N\_UL}$ / A | 11 | 17.5 | 24 | 33 |
| Rated output overload (60 s) | 1) 5) | $I_{60s}$ / % | 150 | | | |
| Software current limit | | $I_{lim}$ / % | 180 | | 150 | |
| Overcurrent | 1) | $I_{OC}$ / % | 216 | | 180 | |
| Rated switching frequency | | $f_{SN}$ / kHz | 8 | 4 | 4 | 4 |
| Max. switching frequency | 4) | $f_{S\_max}$ / kHz | 16 | | | |
| Power dissipation at rated operation | 3) | $P_D$ / W | 102 | tbd | | |
| | | | | | | |
| Overload current over time | | $I_{OL}$ / % | => „Overload characteristic (OL) for 230 V devices“ | | | |
| Maximum current 0Hz / 50Hz at $f_S$ = 2 kHz | | $I_{Max\_Out}$ / % | 216 / 216 | tbd | | |
| Maximum current 0Hz / 50Hz at $f_S$ = 4 kHz | | $I_{Max\_Out}$ / % | 200 / 216 | | | |
| Maximum current 0Hz / 50Hz at $f_S$ = 8 kHz | | $I_{Max\_Out}$ / % | 173 / 216 | | | |
| Maximum current 0Hz / 50Hz at $f_S$ = 16 kHz | | $I_{Max\_Out}$ / % | 127 / 216 | | | |
| | | | | | | |
| Max. braking current | | $I_{B\_max}$ / A | 21.5 | | | |
| Min. braking resistor value | | $R_{B\_min}$ / Ω | 19 | | | 12 |

*continued on the next page*

| Device size | 10 | 12 | 13 | 14 |
|---|---|---|---|---|
| **Housing** | **2** | | | |
| Protection function for braking transistor (GTR7) | No protection function available | | | |
| Insulating resistance @ $U_{dc}$ = 500V $R_{iso}$ / MΩ | > 20 | | | |

*Table 7: Overview of the 230V device data*

1) *The values refer in % to the rated output current $I_N$.*

2) *The output frequency is to be limited in such a way that it does not exceed 1/10 of the switching frequency. Devices with higher max. output frequency are subject to export restrictions and are only available upon request.*

3) *Rated operation corresponds to $U_N$ = 230V, rated switching frequency, output frequency = 50 Hz (4-pole standard asynchronous motor).*

4) *A detailed description of the derating => „Switching frequency and temperature of the 230 V devices“.*

5) *Observe limitations => „Overload characteristic (OL) for 230 V devices“.*

### 3.2.2 Voltage and frequencies for 230V devices

| Input voltages and frequencies | | |
|---|---|---|
| Rated input voltage | $U_N$ / V | 230 |
| Rated mains voltage (USA) | $U_{N\_UL}$ / V | 240 |
| Input voltage range | $U_{IN}$ / V | 170...264 |
| Input phases | | 3 |
| Mains frequency | $f_N$ / Hz | 50/60 |
| Mains frequency tolerance | ± $f_N$ / Hz | 2 |

*Table 8: Input voltages and frequencies of the 230V devices*

| DC link voltage | | |
|---|---|---|
| DC link rated voltage @ $U_N$ = 400V | $U_{N\_dc}$ / V | 325 |
| DC link rated voltage @ $U_{N\_UL}$ = 480V | $U_{N\_UL\_dc}$ / V | 339 |
| DC link voltage working voltage range | $U_{IN\_dc}$ / V | 240...373 |

*Table 9: DC link voltage for 230V devices*

| Output voltages and frequencies | | | |
|---|---|---|---|
| Output voltage at AC supply | 1) | $U_{out}$ / V | 0...$U_{in}$ |
| Output frequency | 2) | $f_{out}$ / Hz | 0…599 |
| Output phase | | | 3 |

*Table 10: Output voltages and frequencies of the 230V devices*

1) *The voltage to the motor is dependent on the actual input voltage and the control method (=> „Example of the calculation of the possible motor voltage 230V:“).*

2) *The output frequency is to be limited in such a way that it does not exceed 1/10 of the switching frequency. Devices with higher max. output frequency are subject to export restrictions and are only available on request.*

3.2.2.1 Example of the calculation of the possible motor voltage 230V:

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 | *Example:* |
| *Drive converter open-loop* | 4 | *open-loop drive converter with mains- and motor choke at non-rigid supply system:* |
| *Drive converter closed-loop* | 8 | *230 V mains voltage - 11 % = 204,7 V motor voltage* |
| *Motor choke $U_k$* | 1 | |
| *Non-rigid supply system* | 2 | |

*Table 11: Example of the calculation of the possible motor voltage 230V:*

### 3.2.3 Input and output currents / overload for 230 V devices

| **Device size** | | **10** | **12** | **13** | **14** |
|---|---|---|---|---|---|
| Rated input current @ $U_N$ = 230V | $I_{in}$ / A | 16.5 | 22 | 30 | 41.5 |
| Rated input current @ $U_{N\_UL}$ = 240V | $I_{in\_UL}$ / A | 16.5 | 22 | 30 | 41.5 |

*Table 12: Input currents of the 230 V devices*

*1) The values resulting from rated operation with B6 rectifier circuit and mains choke 4% $U_k$.*

| **Device size** | | **10** | **12** | **13** | **14** |
|---|---|---|---|---|---|
| Rated output current @ $U_N$ = 230V | $I_N$ / A | 11 | 17.5 | 24 | 33 |
| Rated output current @ $U_{N\_UL}$ = 240V | $I_{N\_UL}$ / A | 11 | 17.5 | 24 | 33 |
| Rated output overload (60 s) | 1) $I_{60s}$ / % | 150 | | | |
| Overload current | 1) $I_{OL}$ / % | *=> „Overload characteristic (OL) for 230 V devices“* | | | |
| Software current limit | 2) $I_{lim}$ / % | 180 | | 150 | |
| Overcurrent | 1) $I_{OC}$ / % | 216 | | 180 | |

*Table 13: Output currents of the 230 V devices*

*1) The values refer in % to the rated output current $I_N$.*

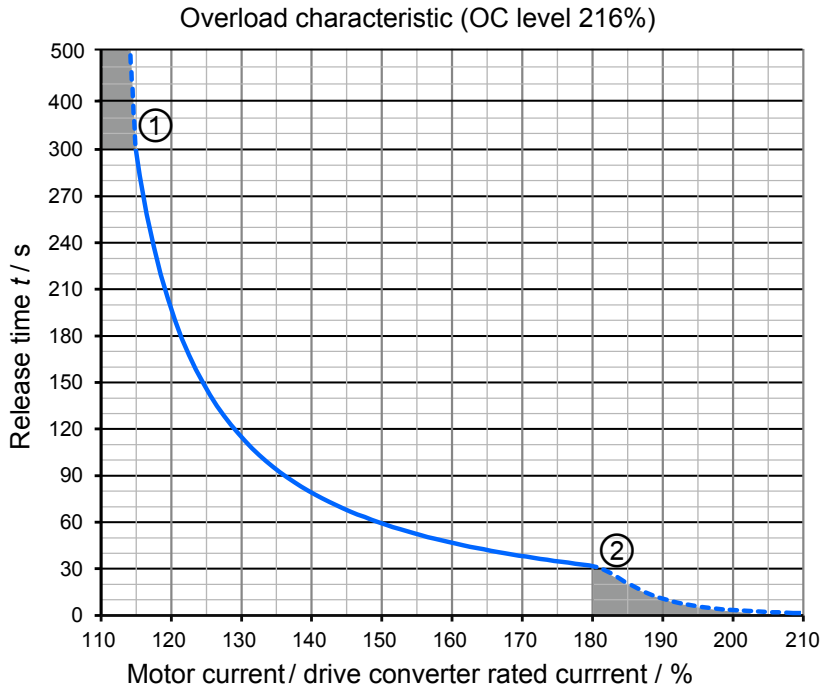
*2) Limitation of the current setpoint in closed-loop operation. This setpint limit is not active in v/f operation.*

### 3.2.3.1 Overload characteristic (OL) for 230 V devices

All drive converters with overload characteristic of 180 % or 216 % can be operated at rated switching frequency with an utilization of 150 % for 60 s.

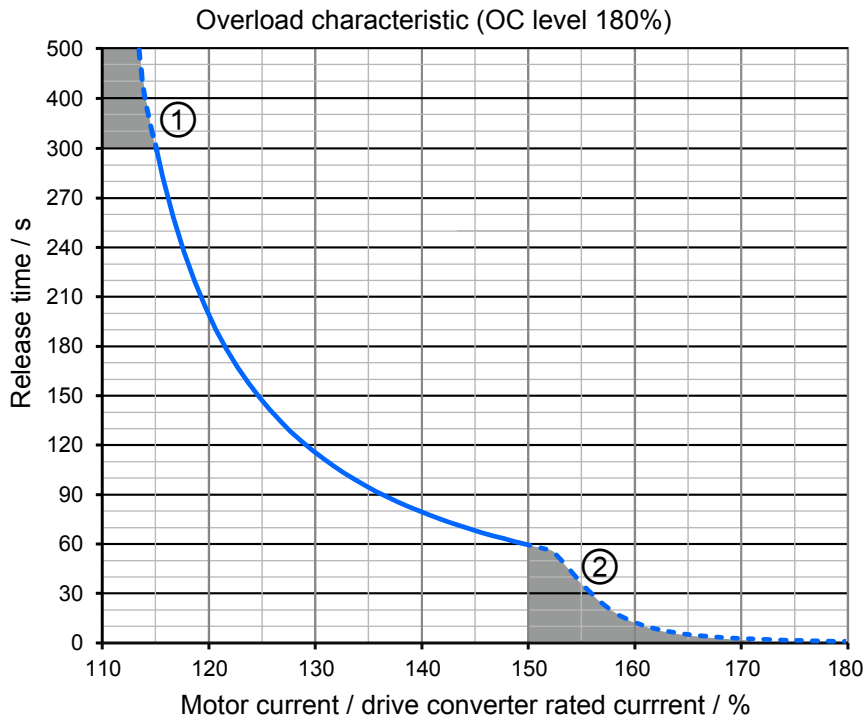
***Restrictions:***

- 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 surrounding temperatures and/or high heat sink temperatures (for example, by preceding utilization nearby 100%) the drive converter 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 and error OL2 can be triggered (=> „Frequency-dependent maximum current (OL2) for 230V devices“).




| Legend | |
|---|---|
| ① | Thermal overload limit |
| ② | Limitation by the software current limit (the limit can be set with parameter is35) |

*Figure 1: Turn-off time t depending on the overload I/IN at OC level 216 %*




| Legend | |
|---|---|
| ① | Thermal overload limit |
| ② | Limitation by the software current limit (the limit can be set with parameter is35) |

*Figure 2: Turn-off time t depending on the overload I/IN at OC level 180%*

- 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 converter 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 converter should be assumed to have a maximum overload time of 300s.

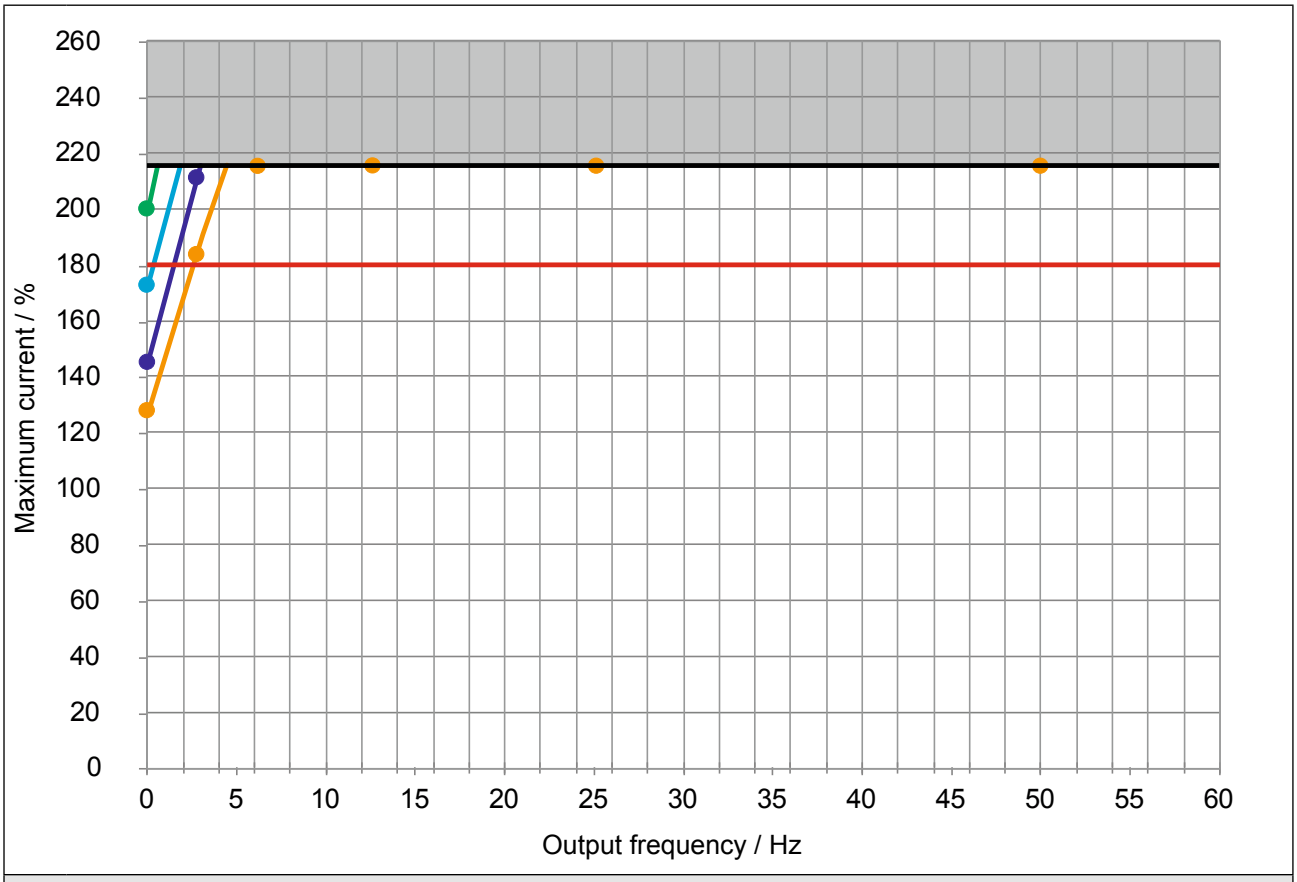
### 3.2.3.2 Frequency-dependent maximum current (OL2) for 230V devices

The characteristics of the maximum currents for a switching frequency which are depending on the output frequency are different for each drive converter, but the following rules are generally applicable:

- Applies for the rated switching frequency: at 0 Hz the drive converter can provide at least the rated output current and from 6 Hz the overcurrent *I*oc.
- 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 converter parameters.

The following characteristic curve indicates the permissible maximum current for the output frequency values 0 Hz, 3.1 Hz, 6.2 Hz, 12.5 Hz, 25 Hz and 50 Hz. Device size 10 is shown as an example.




| Legend | |
|---|---|
| | Overcurrent $I_{OC}$ |
| | Software current limit $I_{lim}$ (the limit can be set with parameter is35) |
| | Switching frequency 2 kHz |
| | Switching frequency 4 kHz |
| | Switching frequency 8 kHz |
| | Switching frequency 12 kHz |
| | Switching frequency 16 kHz |
| | Not available for modulation. Error OC is triggered at 216% overload. |

*Figure 3: Typical overload characteristics in the lower output frequencies (OL2) example device size 10*

The frequency-dependent maximum current $I_{lim}$ 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***

| **Device size** | | **10** | | | | | |
|---|---|---|---|---|---|---|---|
| **Rated switching frequency** | | **8 kHz** | | | | | |
| **Output frequency** | **$f_{out}$ / Hz** | **0** | **3.1** | **6.2** | **12.5** | **25** | **50** |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 62.5 µs (Parameter is22=0)* | 2 kHz | 216 | 216 | 216 | 216 | 216 | 216 |
| | 4 kHz | 200 | 216 | 216 | 216 | 216 | 216 |
| | 8 kHz | 173 | 216 | 216 | 216 | 216 | 216 |
| | 16 kHz | 127 | 191 | 216 | 216 | 216 | 216 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 71.4 µs (Parameter is22=1)* | 1.75 kHz | 216 | 216 | 216 | 216 | 216 | 216 |
| | 3.5 kHz | 205 | 216 | 216 | 216 | 216 | 216 |
| | 7 kHz | 180 | 216 | 216 | 216 | 216 | 216 |
| | 14 kHz | 136 | 205 | 216 | 216 | 216 | 216 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 83.3 µs (Parameter is22=2)* | 1.5 kHz | 216 | 216 | 216 | 216 | 216 | 216 |
| | 3 kHz | 209 | 216 | 216 | 216 | 216 | 216 |
| | 6 kHz | 186 | 216 | 216 | 216 | 216 | 216 |
| | 12 kHz | 146 | 216 | 216 | 216 | 216 | 216 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 100 µs (Parameter is22=3)* | 1.25 kHz | 216 | 216 | 216 | 216 | 216 | 216 |
| | 2.5 kHz | 214 | 216 | 216 | 216 | 216 | 216 |
| | 5 kHz | 193 | 216 | 216 | 216 | 216 | 216 |
| | 10 kHz | 159 | 216 | 216 | 216 | 216 | 216 |

*Table 14: Frequency-dependent maximum current for device size 10*

| **Device size** | | **12** | | | | | |
|---|---|---|---|---|---|---|---|
| **Rated switching frequency** | | **4 kHz** | | | | | |
| **Output frequency** | **$f_{out}$ / Hz** | **0** | **3** | **6** | **12.5** | **25** | **50** |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 62.5 µs (Parameter is22=0)* | 2 kHz | | | | | | |
| | 4 kHz | | | | | | |
| | 8 kHz | | | | | | |
| | 16 kHz | | | | | | |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 71.4 µs (Parameter is22=1)* | 1.75 kHz | | | | | | |
| | 3.5 kHz | | | TBD | | | |
| | 7 kHz | | | | | | |
| | 14 kHz | | | | | | |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 83.3 µs (Parameter is22=2)* | 1.5 kHz | | | | | | |
| | 3 kHz | | | | | | |
| | 6 kHz | | | | | | |
| | 12 kHz | | | | | | |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 100 µs (Parameter is22=3)* | 1.25 kHz | | | | | | |
| | 2.5 kHz | | | | | | |
| | 5 kHz | | | | | | |
| | 10 kHz | | | | | | |

*Table 15: Frequency-dependent maximum current for device size 12*

| **Device size** | | **13** | | | | | |
|---|---|---|---|---|---|---|---|
| **Rated switching frequency** | | **4 kHz** | | | | | |
| **Output frequency** | **$f_{out}$ / Hz** | **0** | **3.1** | **6.2** | **12.5** | **25** | **50** |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 62.5 µs (Parameter is22=0)* | 2 kHz | | | | | | |
| | 4 kHz | | | | | | |
| | 8 kHz | | | | | | |
| | 16 kHz | | | | | | |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 71.4 µs (Parameter is22=1)* | 1.75 kHz | | | | | | |
| | 3.5 kHz | | | TBD | | | |
| | 7 kHz | | | | | | |
| | 14 kHz | | | | | | |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 83.3 µs (Parameter is22=2)* | 1.5 kHz | | | | | | |
| | 3 kHz | | | | | | |
| | 6 kHz | | | | | | |
| | 12 kHz | | | | | | |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 100 µs (Parameter is22=3)* | 1.25 kHz | | | | | | |
| | 2.5 kHz | | | | | | |
| | 5 kHz | | | | | | |
| | 10 kHz | | | | | | |

*Table 16: Frequency-dependent maximum current for device size 13*

| Device size | | 14 | | | | | |
|---|---|---|---|---|---|---|---|
| Rated switching frequency | | 4 kHz | | | | | |
| Output frequency | $f_{out}$ / Hz | 0 | 3.1 | 6.2 | 12.5 | 25 | 50 |
| Frequency-dependent maximum current @ fs $I_{lim}$ / %<br>*Basic Time Period = 62.5 µs (Parameter is22=0)* | 2 kHz | | | | | | |
| | 4 kHz | | | | | | |
| | 8 kHz | | | | | | |
| | 16 kHz | | | | | | |
| Frequency-dependent maximum current @ fs $I_{lim}$ / %<br>*Basic Time Period = 71.4 µs (Parameter is22=1)* | 1.75 kHz | | | | | | |
| | 3.5 kHz | | | TBD | | | |
| | 7 kHz | | | | | | |
| | 14 kHz | | | | | | |
| Frequency-dependent maximum current @ fs $I_{lim}$ / %<br>*Basic Time Period = 83.3 µs (Parameter is22=2)* | 1.5 kHz | | | | | | |
| | 3 kHz | | | | | | |
| | 6 kHz | | | | | | |
| | 12 kHz | | | | | | |
| Frequency-dependent maximum current @ fs $I_{lim}$ / %<br>*Basic Time Period = 100 µs (Parameter is22=3)* | 1.25 kHz | | | | | | |
| | 2.5 kHz | | | | | | |
| | 5 kHz | | | | | | |
| | 10 kHz | | | | | | |

*Table 17: Frequency-dependent maximum current for device size 14*

### 3.2.4 Power dissipation at rated operation of the 230V devices

| Device size | | 10 | 12 | 13 | 14 |
|---|---|---|---|---|---|
| Power dissipation at rated operation | 1) $P_D$ / W | 102 | tbd | tbd | tbd |

*Table 18: Power dissipation of the 230 V devices*

1) *Rated operation corresponds to $U_N$ = 230 V; $f_{SN}$ ; $I_N$ ; $f_N$ = 50 Hz (typically value)*

### 3.2.5 Fuse protection of the drive converters of the 230V devices

| Device size | Max. size of the fuse / A | | | |
|---|---|---|---|---|
| | $U_N$ = 230 V gG (IEC) | $U_N$ = 240 V class „J“ | $U_N$ = 240 V gR | |
| | SCCR 30 kA | SCCR 5 kA | SCCR 30 kA | Type |
| 10 | | | | |
| 12 | TBD | | | |
| 13 | | | | |
| 14 | | | | |

*Table 19: Fusing of the 230 V / 240 V devices*

**Short-circuit capacity**
After requests from *EN 60439-1* and *EN 61800-5-1* the following is valid for the connection to a network: The devices are suitable for use in a circuit capable of delivering not more than 30 kA eff. unaffected symmetrical short-circuit current.

## 3.3 Device data of the 400 V devices

### 3.3.1 Overview of the 400 V devices

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

| **Device size** | | | **12** | **13** | **14** | **15** | **16** | |
|---|---|---|---|---|---|---|---|---|
| **Housing** | | | **2** | | | | | |
| Rated apparent output power | | $S_{out}$ / kVA | 6.6 | 8.3 | 11.4 | 16.6 | 22.9 | |
| Max. rated motor power | | $P_{mot}$ / kW | 4 | 5.5 | 7.5 | 11 | 15 | |
| | | | | | | | | |
| 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 @ $U_N$ = 400V | | $I_{in}$ / A | 13 | 17 | 21 | 31 | 43 | |
| Rated input current @ $U_N$ = 480V | | $I_{in\_UL}$ / A | 11 | 15 | 18 | 27 | 35 | |
| | | | | | | | | |
| Output voltage | | $U_{out}$ / V | 0...$U_{in}$ | | | | | |
| Output frequency | 2) | $f_{out}$ / Hz | 0...599 | | | | | |
| Output phases | | | 3 | | | | | |
| Rated output current @ $U_N$ = 400 V | | $I_N$ / A | 9.5 | 12 | 16.5 | 24 | 33 | |
| Rated output current @ $U_N$ = 480 V | | $I_{N\_UL}$ / A | 7.6 | 11 | 14 | 21 | 27 | |
| Rated output overload (60 s) | 1) 5) | $I_{60s}$ / % | 150 | | | | | |
| Software current limit | | $I_{lim}$ / % | 180 | | | 150 | | |
| Overcurrent | 1) | $I_{OC}$ / % | 216 | | | 180 | | |
| Rated switching frequency | | $f_{SN}$ / kHz | 8 | 8 | 4 | 4 | 2 | 4 |
| Max. switching frequency | 4) | $f_{S\_max}$ / kHz | 16 | | | | | |
| Power dissipation at rated operation | 3) | $P_D$ / W | 155 | 180 | 175 | 250 | 275 | 330 |
| | | | | | | | | |
| Overload current over time | | $I_{OL}$ / % | => „Overload characteristic (OL) for 400 V devices“ | | | | | |
| Maximum current 0Hz / 50Hz at $f_S$ = 2 kHz | | $I_{max\_out}$ / % | 211/216 | 216/216 | 157/216 | 108/180 | 100/180 | 127/180 |
| Maximum current 0Hz / 50Hz at $f_S$ = 4 kHz | | $I_{max\_out}$ / % | 168/216 | 200/216 | 145/216 | 100/180 | 75/166 | 100/180 |
| Maximum current 0Hz / 50Hz at $f_S$ = 8 kHz | | $I_{max\_out}$ / % | 116/216 | 100/216 | 72/187 | 50/129 | 48/118 | 91/180 |
| Maximum current 0Hz / 50Hz at $f_S$ = 16 kHz | | $I_{max\_out}$ / % | 63/168 | 58/150 | 42/109 | 29/75 | 24/69 | 58/124 |
| | | | | | | | | |
| Max. braking current | | $I_{B\_max}$ / A | 21.5 | | | | 33.6 | |
| Min. braking resistor value | | $R_{B\_min}$ / Ω | 39 | | | | 25 | |

*continued on the next page*

| Device size | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|
| **Housing** | **2** | | | | |
| Protection function for braking transistor (GTR7) | No protection function available | | | | |
| Insulation resistance @ $U_{dc}$ = 500 V $R_{iso}$ / MΩ | > 20 | | | | |

*Table 20: Overview of the 400V device data*

1) *The values refer in % to the rated output current $I_N$.*

2) *The output frequency is to be limited in such a way that it does not exceed 1/10 of the switching frequency. Devices with higher max. output frequency are subject to export restrictions and are only available upon request.*

3) *Rated operation corresponds to $U_N$ = 400V, rated switching frequency, output frequency = 50 Hz (4-pole standard asynchronous motor).*

4) *A detailed description of the derating => „Switching frequency and temperature of the 400 V devices“.*

5) *Observe limitations => „Overload characteristic (OL) for 400 V devices“.*

### 3.3.2 Voltage and frequencies for 400V devices

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

*Table 21: 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 22: DC link voltage for 400V devices*

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

*Table 23: Output voltages and frequencies of the 400V devices*

1) *The voltage to the motor is dependent on the actual input voltage and the control method (=> „Example of the calculation of the possible motor voltage:“).*

2) *The output frequency is to be limited in such a way that it does not exceed 1/10 of the switching frequency. Devices with higher max. output frequency are subject to export restrictions and are only available on request.*

3.3.2.1 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 | *Example:* |
| *Drive converter open-loop* | 4 | *open-loop drive converter with mains- and motor choke at non-rigid supply system:* |
| *Drive converter closed-loop* | 8 | *400 V mains voltage - 11 % = 356 V motor voltage* |
| *Motor choke $U_k$* | 1 | |
| *Non-rigid supply system* | 2 | |

*Table 24: Example of the calculation of the possible motor voltage:*

### 3.3.3 Input and output currents / overload for 400 V devices

| Device size | | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|
| Rated input current @ $U_N$ = 400V | $I_{in}$ / A | 13 | 17 | 21 | 31 | 43 |
| Rated input current @ $U_{N\_UL}$ = 480V | $I_{in\_UL}$ / A | 11 | 15 | 18 | 27 | 35 |

*Table 25: Input currents of the 400 V devices*

[1] *The values resulting from rated operation with B6 rectifier circuit and mains choke 4% $U_k$.*

| Device size | | 12 | 13 | 14 | 15 | 16 (2 kHz) | 16 (4 kHz) |
|---|---|---|---|---|---|---|---|
| Rated output current @ $U_N$ = 400V | $I_N$ / A | 9.5 | 12 | 16.5 | 24 | 33 | |
| Rated output current @ $U_{N\_UL}$ = 480V | $I_{N\_UL}$ / A | 7.6 | 11 | 14 | 21 | 27 | |
| Rated output overload (60 s) | [1] $I_{60s}$ / % | 150 | | | | | |
| Overload current | [1] $I_{OL}$ / % | => „Overload characteristic (OL) for 400 V devices“ | | | | | |
| Software current limit | [2] $I_{lim}$ / % | 180 | | | 150 | | |
| Overcurrent | [1] $I_{OC}$ / % | 216 | | | 180 | | |

*Table 26: Output currents of the 400 V devices*

[1] *The values refer in % to the rated output current $I_N$.*

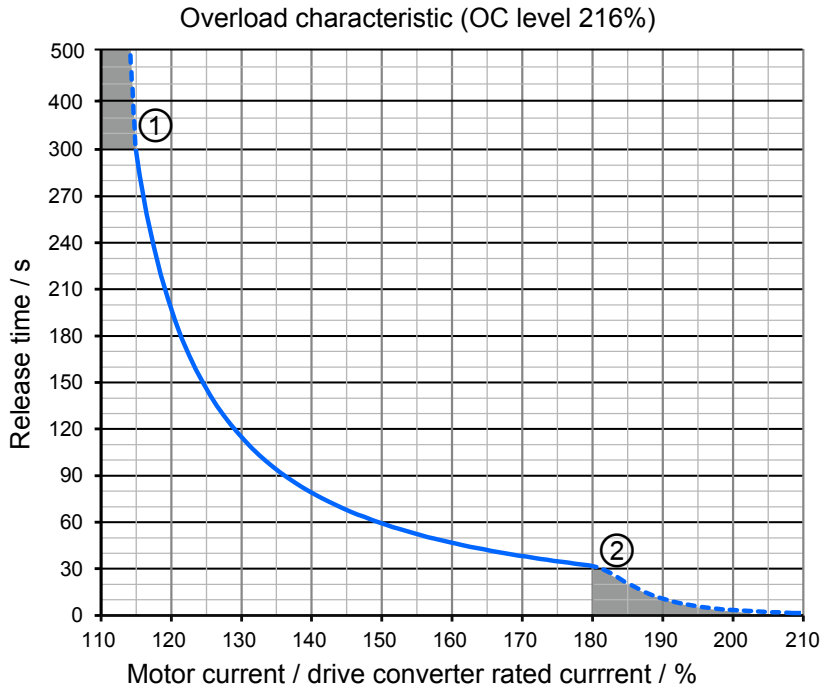
[2] *Limitation of the current setpoint in closed-loop operation. This setpint limit is not active in v/f operation.*

### 3.3.3.1 Overload characteristic (OL) for 400 V devices

All drive converters with overload characteristic of 180 % or 216 % can be operated at rated switching frequency with an utilization of 150 % for 60 s.

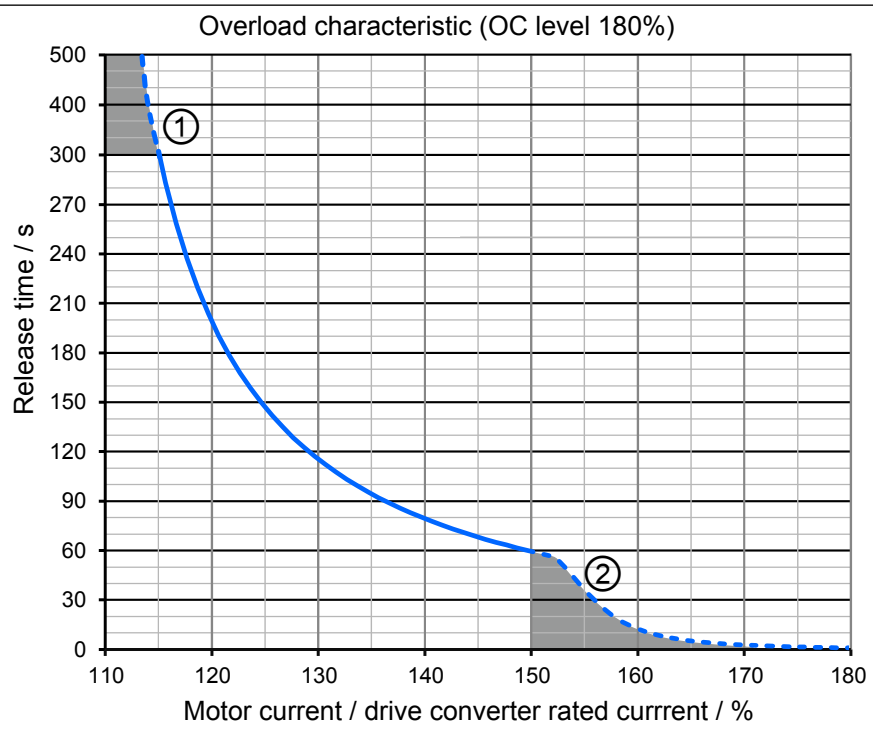
***Restrictions:***

- 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 surrounding temperatures and/or high heat sink temperatures (for example, by preceding utilization nearby 100%) the drive converter 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 and error OL2 can be triggered (=> „Frequency-dependent maximum current (OL2) for 400V devices“).




| Legend | |
|---|---|
| ① | Thermal overload limit |
| ② | Limitation by the software current limit (the limit can be set with parameter is35) |

*Figure 4: Turn-off time t depending on the overload I/IN at OC level 216 %*




| Legend | |
|---|---|
| ① | Thermal overload limit |
| ② | Limitation by the software current limit (the limit can be set with parameter is35) |

*Figure 5: Turn-off time t depending on the overload I/IN at OC level 180%*

- 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 converter 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 converter should be assumed to have a maximum overload time of 300s.

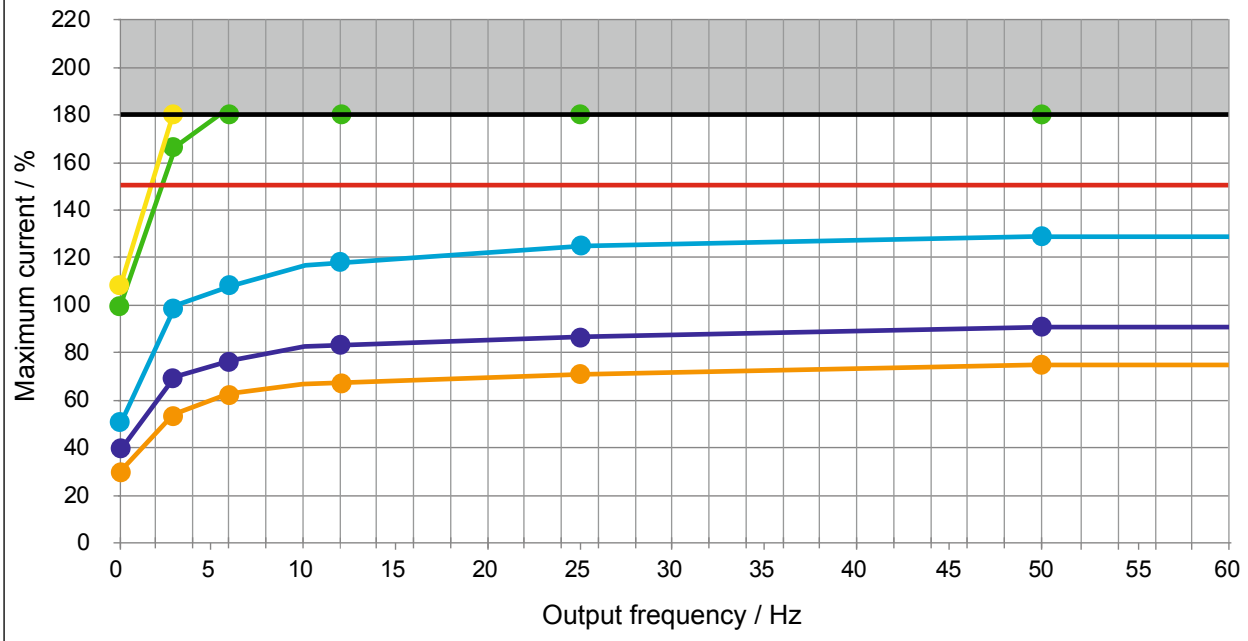
### 3.3.3.2 Frequency-dependent maximum current (OL2) for 400V devices

The characteristics of the maximum currents for a switching frequency which are depending on the output frequency are different for each drive converter, but the following rules are generally applicable:

- Applies for the rated switching frequency: at 0 Hz the drive converter can provide at least the rated output current and from 6 Hz the overcurrent *I*oc.
- 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 converter parameters.

The following characteristic curve indicates the permissible maximum current for the output frequency values 0 Hz, 3.1 Hz, 6.2 Hz, 12.5 Hz, 25 Hz and 50 Hz. Device size 15 is shown as an example.




| Legend | |
|---|---|
| | Overcurrent *Ioc* |
| | Software current limit *Ilim* (the limit can be set with parameter is35) |
| | Switching frequency 2 kHz |
| | Switching frequency 4 kHz |
| | Switching frequency 8 kHz |
| | Switching frequency 12 kHz |
| | Switching frequency 16 kHz |
| | Not available for modulation. Error OC is triggered at 180% overload. |

*Figure 6: Typical overload characteristics in the lower output frequencies (OL2) example device size 15.*

The frequency-dependent maximum current *Ilim* refers in % to the rated output current *IN*.

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***

| **Device size** | | **12** | | | | | |
|---|---|---|---|---|---|---|---|
| **Rated switching frequency** | | **8 kHz** | | | | | |
| **Output frequency** | **$f_{out}$ / Hz** | **0** | **3.1** | **6.2** | **12.5** | **25** | **50** |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 62.5 µs (Parameter is22=0)* | 2 kHz | 211 | 216 | 216 | 216 | 216 | 216 |
| | 4 kHz | 168 | 216 | 216 | 216 | 216 | 216 |
| | 8 kHz | 116 | 211 | 216 | 216 | 216 | 216 |
| | 16 kHz | 63 | 116 | 137 | 147 | 158 | 168 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 71.4 µs (Parameter is22=1)* | 1.75 kHz | 210 | 216 | 216 | 216 | 216 | 216 |
| | 3.5 kHz | 179 | 216 | 216 | 216 | 216 | 216 |
| | 7 kHz | 129 | 216 | 216 | 216 | 216 | 216 |
| | 14 kHz | 74 | 137 | 158 | 168 | 179 | 190 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 83.3 µs (Parameter is22=2)* | 1.5 kHz | 210 | 216 | 216 | 216 | 216 | 216 |
| | 3 kHz | 190 | 216 | 216 | 216 | 216 | 216 |
| | 6 kHz | 142 | 216 | 216 | 216 | 216 | 216 |
| | 12 kHz | 84 | 158 | 179 | 190 | 200 | 211 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 100 µs (Parameter is22=3)* | 1.25 kHz | 211 | 216 | 216 | 216 | 216 | 216 |
| | 2.5 kHz | 200 | 216 | 216 | 216 | 216 | 216 |
| | 5 kHz | 155 | 216 | 216 | 216 | 216 | 216 |
| | 10 kHz | 100 | 184 | 205 | 216 | 216 | 216 |

*Table 27: Frequency-dependent maximum current for device size 12*

| **Device size** | | **13** | | | | | |
|---|---|---|---|---|---|---|---|
| **Rated switching frequency** | | **8 kHz** | | | | | |
| **Output frequency** | **$f_{out}$ / Hz** | **0** | **3** | **6** | **12.5** | **25** | **50** |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 62.5 µs (Parameter is22=0)* | 2 kHz | 216 | 216 | 216 | 216 | 216 | 216 |
| | 4 kHz | 200 | 216 | 216 | 216 | 216 | 216 |
| | 8 kHz | 100 | 200 | 216 | 216 | 216 | 216 |
| | 16 kHz | 58 | 108 | 125 | 133 | 142 | 150 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 71.4 µs (Parameter is22=1)* | 1.75 kHz | 216 | 216 | 216 | 216 | 216 | 216 |
| | 3.5 kHz | 204 | 216 | 216 | 216 | 216 | 216 |
| | 7 kHz | 125 | 216 | 216 | 216 | 216 | 216 |
| | 14 kHz | 67 | 130 | 142 | 154 | 163 | 171 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 83.3 µs (Parameter is22=2)* | 1.5 kHz | 216 | 216 | 216 | 216 | 216 | 216 |
| | 3 kHz | 208 | 216 | 216 | 216 | 216 | 216 |
| | 6 kHz | 150 | 216 | 216 | 216 | 216 | 216 |
| | 12 kHz | 75 | 150 | 158 | 175 | 183 | 192 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 100 µs (Parameter is22=3)* | 1.25 kHz | 216 | 216 | 216 | 216 | 216 | 216 |
| | 2.5 kHz | 212 | 216 | 216 | 216 | 216 | 216 |
| | 5 kHz | 175 | 216 | 216 | 216 | 216 | 216 |
| | 10 kHz | 88 | 175 | 188 | 204 | 216 | 216 |

*Table 28: Frequency-dependent maximum current for device size 13*

| Device size | | 14 | | | | | |
|---|---|---|---|---|---|---|---|
| **Rated switching frequency** | | **4 kHz** | | | | | |
| **Output frequency** | **$f_{out}$ / Hz** | **0** | **3.1** | **6.2** | **12.5** | **25** | **50** |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 62.5 µs (Parameter is22=0)* | 2 kHz | 157 | 216 | 216 | 216 | 216 | 216 |
| | 4 kHz | 145 | 216 | 216 | 216 | 216 | 216 |
| | 8 kHz | 73 | 146 | 158 | 170 | 182 | 188 |
| | 16 kHz | 42 | 79 | 91 | 97 | 103 | 110 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 71.4 µs (Parameter is22=1)* | 1.75 kHz | 158 | 216 | 216 | 216 | 216 | 216 |
| | 3.5 kHz | 149 | 216 | 216 | 216 | 216 | 216 |
| | 7 kHz | 91 | 170 | 185 | 197 | 209 | 215 |
| | 14 kHz | 49 | 94 | 103 | 112 | 118 | 124 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 83.3 µs (Parameter is22=2)* | 1.5 kHz | 158 | 216 | 216 | 216 | 216 | 216 |
| | 3 kHz | 152 | 216 | 216 | 216 | 216 | 216 |
| | 6 kHz | 109 | 194 | 212 | 216 | 216 | 216 |
| | 12 kHz | 55 | 109 | 115 | 127 | 133 | 139 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 100 µs (Parameter is22=3)* | 1.25 kHz | 158 | 216 | 216 | 216 | 216 | 216 |
| | 2.5 kHz | 155 | 216 | 216 | 216 | 216 | 216 |
| | 5 kHz | 127 | 216 | 216 | 216 | 216 | 216 |
| | 10 kHz | 64 | 127 | 136 | 149 | 158 | 164 |

*Table 29: Frequency-dependent maximum current for device size 14*

| Device size | | 15 | | | | | |
|---|---|---|---|---|---|---|---|
| **Rated switching frequency** | | **4 kHz** | | | | | |
| **Output frequency** | **$f_{out}$ / Hz** | **0** | **3.1** | **6.2** | **12.5** | **25** | **50** |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 62.5 µs (Parameter is22=0)* | 2 kHz | 108 | 180 | 180 | 180 | 180 | 180 |
| | 4 kHz | 100 | 167 | 180 | 180 | 180 | 180 |
| | 8 kHz | 50 | 100 | 108 | 117 | 125 | 129 |
| | 16 kHz | 29 | 54 | 63 | 67 | 71 | 75 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 71.4 µs (Parameter is22=1)* | 1.75 kHz | 108 | 180 | 180 | 180 | 180 | 180 |
| | 3.5 kHz | 102 | 171 | 180 | 180 | 180 | 180 |
| | 7 kHz | 63 | 117 | 127 | 135 | 144 | 148 |
| | 14 kHz | 33 | 65 | 71 | 77 | 81 | 85 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 83.3 µs (Parameter is22=2)* | 1.5 kHz | 108 | 180 | 180 | 180 | 180 | 180 |
| | 3 kHz | 104 | 175 | 180 | 180 | 180 | 180 |
| | 6 kHz | 75 | 133 | 146 | 154 | 163 | 167 |
| | 12 kHz | 38 | 75 | 79 | 88 | 92 | 96 |
| **Frequency-dependent maximum current @ *fs*** $I_{lim}$ / % *Basic Time Period = 100 µs (Parameter is22=3)* | 1.25 kHz | 108 | 180 | 180 | 180 | 180 | 180 |
| | 2.5 kHz | 106 | 179 | 180 | 180 | 180 | 180 |
| | 5 kHz | 88 | 150 | 165 | 173 | 180 | 180 |
| | 10 kHz | 44 | 88 | 94 | 102 | 108 | 113 |

*Table 30: Frequency-dependent maximum current for device size 15*

| Device size | | 16 | | | | | |
|---|---|---|---|---|---|---|---|
| Rated switching frequency | | 2 kHz | | | | | |
| Output frequency | $f_{out}$ / Hz | 0 | 3.1 | 6.2 | 12.5 | 25 | 50 |
| Frequency-dependent maximum current @ $f_s$ $I_{lim}$ / %<br>*Basic Time Period = 62.5 µs (Parameter is22=0)* | 2 kHz | 100 | 166 | 180 | 180 | 180 | 180 |
| | 4 kHz | 75 | 136 | 149 | 158 | 164 | 167 |
| | 8 kHz | 49 | 94 | 103 | 109 | 115 | 118 |
| | 16 kHz | 24 | 52 | 58 | 64 | 67 | 70 |
| Frequency-dependent maximum current @ $f_s$ $I_{lim}$ / %<br>*Basic Time Period = 71.4 µs (Parameter is22=1)* | 1.75 kHz | 100 | 167 | 180 | 180 | 180 | 180 |
| | 3.5 kHz | 82 | 144 | 157 | 165 | 172 | 176 |
| | 7 kHz | 55 | 105 | 114 | 121 | 127 | 130 |
| | 14 kHz | 30 | 59 | 67 | 73 | 76 | 79 |
| Frequency-dependent maximum current @ $f_s$ $I_{lim}$ / %<br>*Basic Time Period = 83.3 µs (Parameter is22=2)* | 1.5 kHz | 100 | 167 | 180 | 180 | 180 | 180 |
| | 3 kHz | 88 | 152 | 165 | 173 | 180 | 180 |
| | 6 kHz | 62 | 115 | 126 | 133 | 139 | 142 |
| | 12 kHz | 36 | 67 | 76 | 82 | 85 | 88 |
| Frequency-dependent maximum current @ $f_s$ $I_{lim}$ / %<br>*Basic Time Period = 100 µs (Parameter is22=3)* | 1.25 kHz | 100 | 167 | 180 | 180 | 180 | 180 |
| | 2.5 kHz | 94 | 159 | 174 | 180 | 180 | 180 |
| | 5 kHz | 69 | 126 | 137 | 146 | 152 | 155 |
| | 10 kHz | 42 | 80 | 89 | 96 | 100 | 103 |

*Table 31: Frequency-dependent maximum current for device size 16 (2 kHz)*

| Device size | | 16 | | | | | |
|---|---|---|---|---|---|---|---|
| Rated switching frequency | | 4 kHz | | | | | |
| Output frequency | $f_{out}$ / Hz | 0 | 3.1 | 6.2 | 12.5 | 25 | 50 |
| Frequency-dependent maximum current @ $f_s$ $I_{lim}$ / %<br>*Basic Time Period = 62.5 µs (Parameter is22=0)* | 2 kHz | 127 | 179 | 180 | 180 | 180 | 180 |
| | 4 kHz | 100 | 164 | 180 | 180 | 180 | 180 |
| | 8 kHz | 91 | 136 | 167 | 180 | 180 | 180 |
| | 16 kHz | 58 | 88 | 109 | 118 | 121 | 124 |
| Frequency-dependent maximum current @ $f_s$ $I_{lim}$ / %<br>*Basic Time Period = 71.4 µs (Parameter is22=1)* | 1.75 kHz | 127 | 179 | 180 | 180 | 180 | 180 |
| | 3.5 kHz | 107 | 167 | 180 | 180 | 180 | 180 |
| | 7 kHz | 93 | 143 | 174 | 180 | 180 | 180 |
| | 14 kHz | 65 | 99 | 121 | 129 | 133 | 138 |
| Frequency-dependent maximum current @ $f_s$ $I_{lim}$ / %<br>*Basic Time Period = 83.3 µs (Parameter is22=2)* | 1.5 kHz | 127 | 179 | 180 | 180 | 180 | 180 |
| | 3 kHz | 114 | 171 | 180 | 180 | 180 | 180 |
| | 6 kHz | 96 | 150 | 180 | 180 | 180 | 180 |
| | 12 kHz | 73 | 109 | 133 | 139 | 146 | 152 |
| Frequency-dependent maximum current @ $f_s$ $I_{lim}$ / %<br>*Basic Time Period = 100 µs (Parameter is22=3)* | 1.25 kHz | 127 | 179 | 180 | 180 | 180 | 180 |
| | 2.5 kHz | 121 | 175 | 180 | 180 | 180 | 180 |
| | 5 kHz | 98 | 157 | 180 | 180 | 180 | 180 |
| | 10 kHz | 82 | 123 | 150 | 161 | 167 | 173 |

*Table 32: Frequency-dependent maximum current for device size 16 (4 kHz)*

### 3.3.4 Power dissipation at rated operation of the 400 V devices

| Device size | | | 12 | 13 | 14 | 15 | 16 | 16 |
|---|---|---|---|---|---|---|---|---|
| Rated switching frequency | | | 8 | 8 | 4 | 4 | 2 | 4 |
| Power dissipation at rated operation | 1) | $P_D$ / W | 155 | 180 | 175 | 250 | 275 | 330 |

*Table 33: Power dissipation of the 400 V devices*

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

### 3.3.5 Fuse protection of the drive converters of the 400V devices

| Device size | Max. size of the fuse / A | | | |
|---|---|---|---|---|
| | $U_N$ = 400 V gG (IEC) | $U_N$ = 480 V class „J“ | $U_N$ = 480 V gR | |
| | SCCR 30 kA | SCCR 5 kA | SCCR 30 kA | Type |
| 12 | 20 | 15 | 16 | SIBA 50 140 06.16 |
| 13 | 25 | 20 | 20 | SIBA 50 140 06.20 |
| 14 | 25 | 25 | 25 | SIBA 50 140 06.25 |
| 15 | 35 | 35 | 40 | SIBA 50 140 06.40 |
| 16 | 50 | 50 | 50 | SIBA 50 140 06.50 |

*Table 34: Fusing of the 400 V / 480 V devices*

**Short-circuit capacity**
After requests from *EN 60439-1* and *EN 61800-5-1* the following is valid for the connection to a network: The devices are suitable for use in a circuit capable of delivering not more than 30 kA eff. unaffected symmetrical short-circuit current.

## 3.4 General electrical data

### 3.4.1 Switching frequency and temperature of the 230 V devices

| Device size | | | 10 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|
| Rated switching frequency | 1) | $f_{SN}$ / kHz | 8 | 4 | 4 | 4 |
| Max. switching frequency | 1) | $f_{S\_max}$ / kHz | 16 | | | |
| Min. switching frequency | 1) | $f_{S\_min}$ / kHz | 2 | | | |
| Max. heat sink temperature | | $T_{HS}$ / °C | 90 | | | |
| Temperature for derating the switching frequency | | $T_{DR}$ / °C | 80 | | | |
| Temperature for uprating the switching frequency | | $T_{UR}$ / °C | 70 | | | |
| Temperature for switching to rated switching frequency | | $T_{EM}$ / °C | 85 | | | |

*Table 35: Switching frequency and temperature of the 230 V devices*

### 3.4.2 Switching frequency and temperature of the 400 V devices

| Device size | | | 12 | 13 | 14 | 15 | 16 | |
|---|---|---|---|---|---|---|---|---|
| Rated switching frequency | 1) | $f_{SN}$ / kHz | 8 | 8 | 4 | 4 | 2 | 4 |
| Max. switching frequency | 1) | $f_{S\_max}$ / kHz | 16 | | | | | |
| Min. switching frequency | 1) | $f_{S\_min}$ / kHz | 2 | | | | | |
| Max. heat sink temperature | | $T_{HS}$ / °C | 90 | | | | | |
| Temperature for derating the switching frequency | | $T_{DR}$ / °C | 80 | | | | | |
| Temperature for uprating the switching frequency | | $T_{UR}$ / °C | 70 | | | | | |
| Temperature for switching to rated switching frequency | | $T_{EM}$ / °C | 85 | | | | | |

*Table 36: Switching frequency and temperature of the 400 V devices*

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

The drive converter 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 converter switches off due to overheating of the heat sink. If the heat sink temperature falls below $T_{UR}$, 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.

### 3.4.3 DC link / braking transistor function (GTR7)

**NOTICE**

**Destruction of the drive converter if the value falls below the minimum brake resistance value**

► The minimum brake resistance value must not fall below!

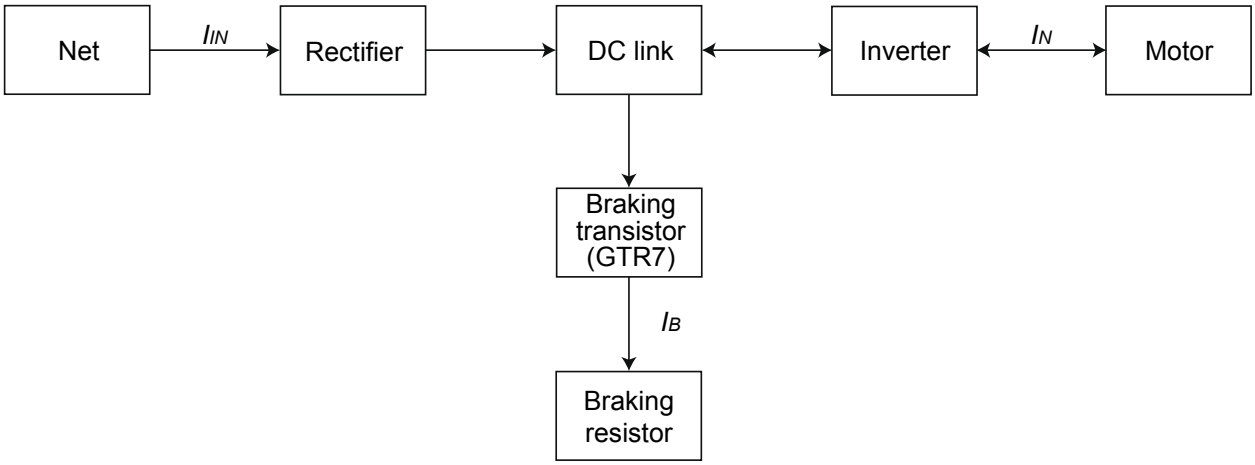



*Figure 7: Block diagram of the energy flow*

#### 3.4.3.1 DC link / braking transistor function of the 230 V devices

| **Device size** | | **10** | **12** | **13** | **14** |
|---|---|---|---|---|---|
| DC link rated voltage @ $U_N$ = 230 V | $U_{N\_dc}$ / V | 325 | | | |
| DC link rated voltage @ $U_{N\_UL}$ = 240 V | $U_{N\_dc\_UL}$ / V | 339 | | | |
| DC link voltage working voltage range | $U_{IN\_dc}$ / V | 240...373 | | | |
| DC switch-off level „Error! Underpotential“ | $U_{UP}$ / V | 216 | | | |
| DC switch-off level „Error! Overpotential“ | $U_{OP}$ / V | 400 | | | |
| DC switch-off level braking resistor [1)] | $U_B$ / V | 380 | | | |
| Max. braking current | $I_{B\_max}$ / A | 21.5 | | | 33.6 |
| Min. braking resistor value | $R_{B\_min}$ / Ω | 19 | | | 12 |
| Protection function for braking transistor (GTR7) | | No protection function available | | | |
| DC link capacity | $C$ / µF | 1410 | tbd | tbd | tbd |

*Table 37: DC link / braking transistor function of the 230 V devices*

[1)] *The DC switching level for the braking transistor is adjustable. The default value is the value specified in the table.*

3.4.3.2 DC link / braking transistor function of the 400 V devices

| Device size | | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|
| DC link rated voltage @ $U_N$ = 400 V | $U_{N\_dc}$ / V | 565 | | | | |
| DC link rated voltage @ $U_{N\_UL}$ = 480 V | $U_{N\_dc\_UL}$ / V | 680 | | | | |
| DC link voltage working voltage range | $U_{IN\_dc}$ / V | 390...780 | | | | |
| DC switch-off level „Error! Underpotential“ | $U_{UP}$ / V | 240 | | | | |
| DC switch-off level „Error! Overpotential“ | $U_{OP}$ / V | 840 | | | | |
| DC switch-off level braking resistor [1)] | $U_B$ / V | 780 | | | | |
| Max. braking current | $I_{B\_max}$ / A | 21.5 | | | | 33.6 |
| Min. braking resistor value | $R_{B\_min}$ / Ω | 39 | | | | 25 |
| Protection function for braking transistor (GTR7) | | No protection function available | | | | |
| DC link capacity | $C$ / µF | 470 | 705 | 820 | 1230 | 1230 |

*Table 38: DC link / braking transistor function of the 400 V devices*

[1)] *The DC switching level for the braking transistor is adjustable. The default value is the value specified in the table.*

### 3.4.4 Fan

| Device size | | 10 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|
| Interior fan | Number | 1 | | | | | |
| | Speed-variable | no | | | | | |
| Heat sink fan | Number | 2 | | | | | |
| | Speed-variable | no | | | | | |

*Table 39: Fan*

The fans are not speed adjustable.

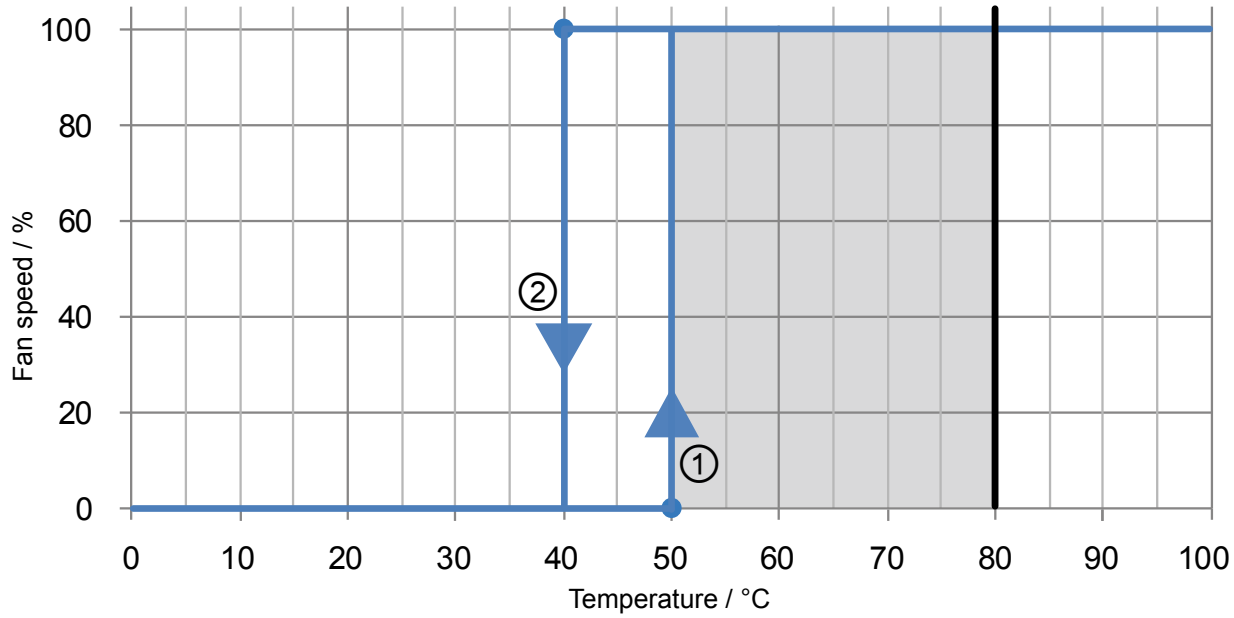
**NOTICE**

**Destruction of the fan!**

► Take care that no foreign substances drop into the fan!

### 3.4.4.1 Switching behaviour of the fans

The fans have different switch-on and switch-off points. The switching point for the switch-on temperature ① is adjustable. The hysteresis for the switch-off temperature ② cannot be changed. The switching behaviour of the fans depends on the heat sink and interior temperature.




| Legend | |
|---|---|
| | Fan speed in dependence on the temperature |
| | Setting range for the switch-on temperature |
| | Maximum switch-on temperature |
| ① | Switch-on point |
| ② | Switch-off point |

*Figure 8: Switching behaviour of the fan example heat sink fan*

### 3.4.4.2 Switching points of the fans

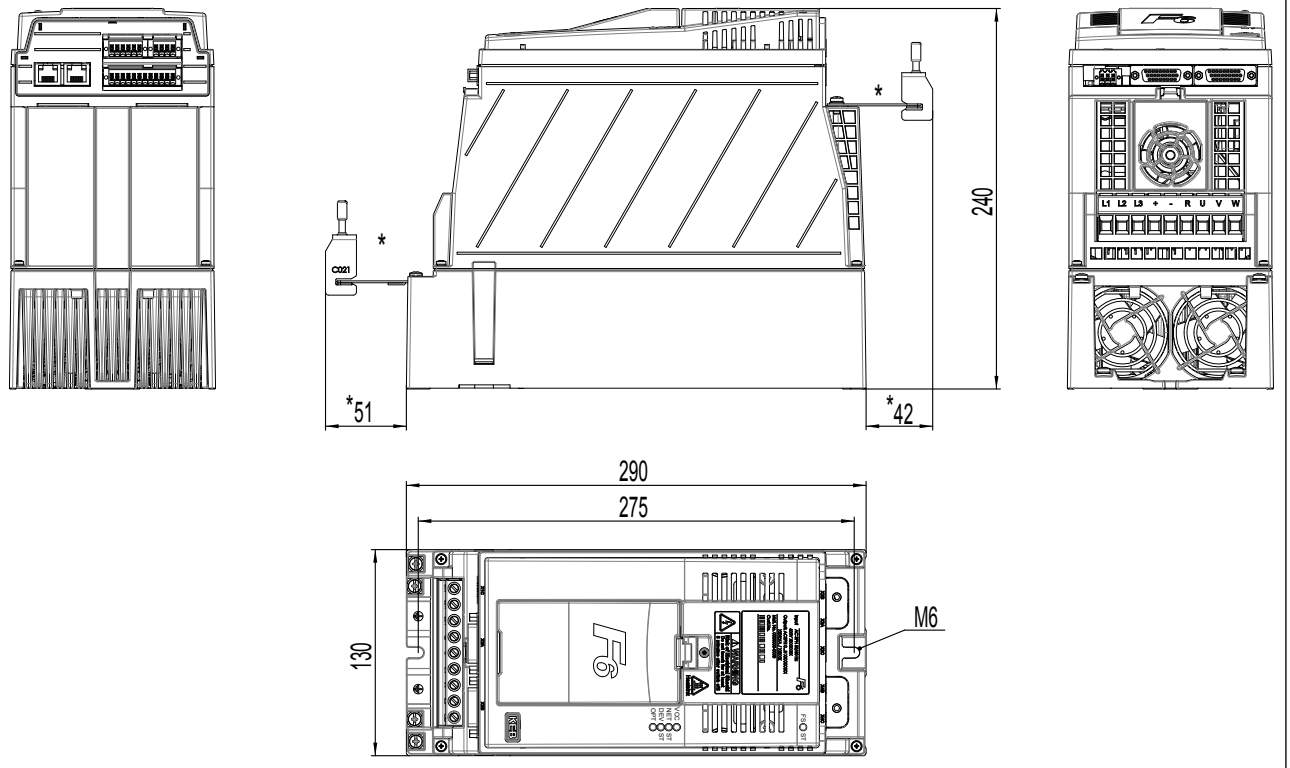
The switching point for the switch-on temperature and the maximum speed level of the fans are adjustable. The following table shows the default values.

| Fan | | Heat sink | Interior |
|---|---|---|---|
| Switch-on temperature | *T* / °C | 50 | 45 |
| Maximum switch-on temperature | *T* / °C | 80 | 55 |

*Table 40: Switching points of the fans*

## 3.5 Dimensions and weights

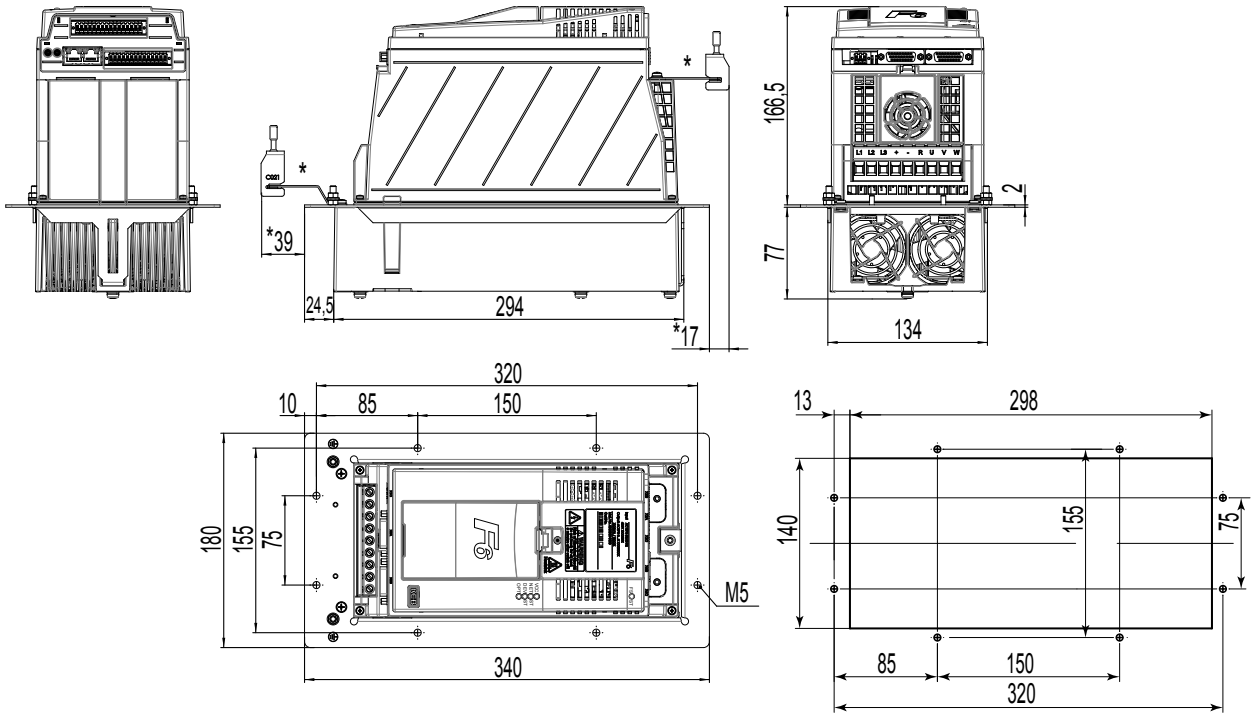
### 3.5.1 Built-in version air cooler




| Housing | 2 |
|---|---|
| Weight | 5 kg |
| Dimensions | All dimensions in mm |
| * | Optional shield connection braket |

*Figure 9: Dimensions built-in version air cooler*

### 3.5.2 Push-through version IP20

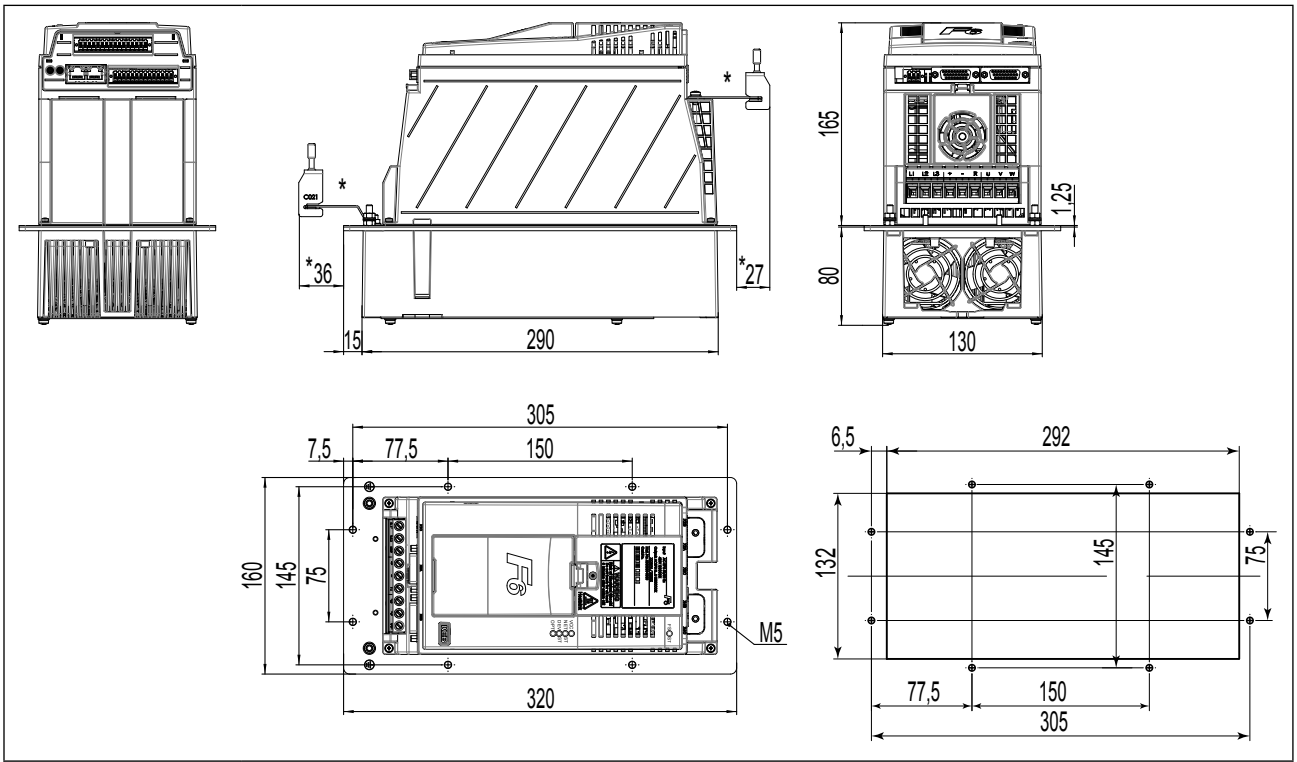



| Housing | 2 |
|---|---|
| Weight | 5.2 kg |
| Dimensions | All dimensions in mm |
| * | Optional shield connection braket |

*Figure 10: Dimensions push-through version IP20*

Optional push-through frame for the IP20 push-through version: 00F6V80-2004. Further information => *„Mounting kit push-through frame for IP20 devices“*.

### 3.5.3 Push-through version IP54




| Housing | 2 |
|---|---|
| Weight | 5.2 kg |
| Dimensions | All dimensions in mm |
| * | Optional shield connection braket |

*Figure 11: Dimensions push-through version IP54*

**IP54 zone: Heat sink underneath the mounting plate**

For proper installation, the enclosed seal (20F6T45-0001) must be installed between heat sink and housing (e.g. cabinet wall). The tightness must be checked after the installation. If properly installed, the separation to the housing corresponds to degree of protection IP54. However, the fans must be protected against unfavorable 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.

**IP20 zone: Device above the mounting plate**

Power connections excluded => *„Climatic environmental conditions“*. This part is intended for the installation in a suitable housing for the required degree of protection (e.g. control cabinet).

UL: Device heat sink is classified as NEMA type 1.

### 3.5.4 Control cabinet installation

#### 3.5.4.1 Mounting instructions

The following mounting materials with the appropriate quality must be used to mount the drive converter.

| Required material | Tightening torque |
|---|---|
| Socket screw *ISO 4762* - M6 - 8.8 | 6.5 Nm<br>58 lb inch |
| Flat washer *ISO 7092* - 6 - 200 HV | – |

*Table 41: Mounting instructions for built-in version*

| Required material | Tightening torque |
|---|---|
| Socket screw *ISO 4762* - M5 - 8.8 | 2.5 Nm<br>22 lb inch |
| Flat washer *ISO 7092* - 5 - 200 HV | – |

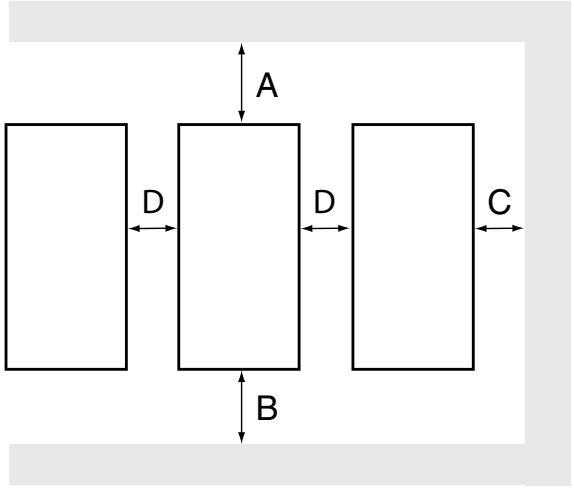
*Table 42: Mounting instructions for push-through version*

#### 3.5.4.2 Mounting distances

Power dissipation for the control cabinet dimension => *„Power dissipation at rated operation of the 400 V devices“*. A lower value can be used here depending on the operating mode/load.

**Reach maximum cooling capacity**

For maximum cooling capacity (volume flow), the drive converter must be mounted without any distance on a smooth, closed mounting plate.

| Mounting distances | Dimension | Distance in mm | Distance in inch |
|---|---|---|---|
|  | A | 150 | 6 |
| | B | 100 | 4 |
| | C | 30 | 1.2 |
| | D | 0 | 0 |
| | X [1] | 50 | 2 |

[1] Distance to preceding elements in the control cabinet door.

*Figure 12: Mounting distances*

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

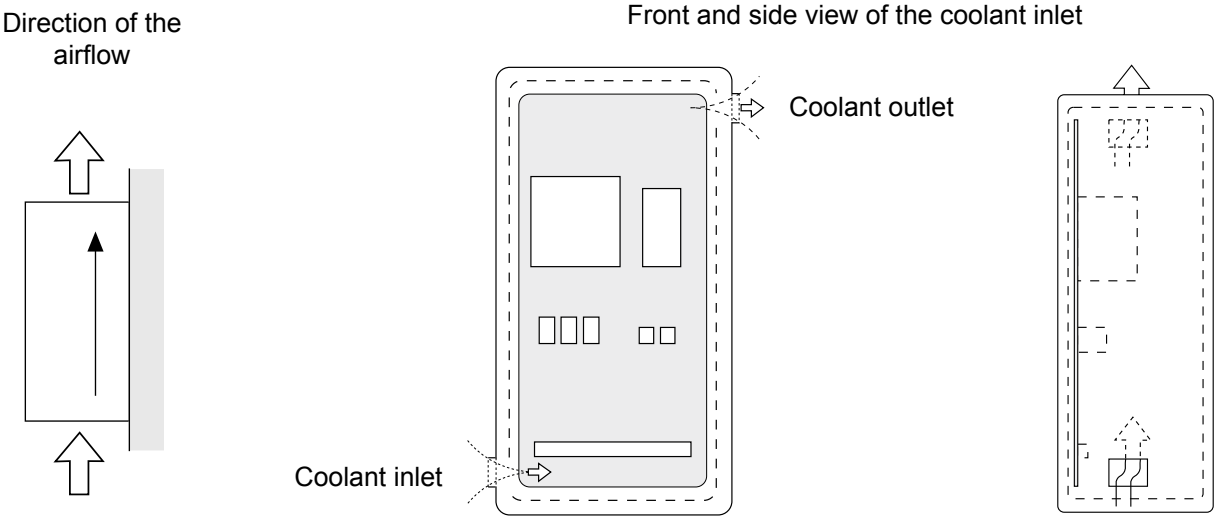



*Figure 13: Control cabinet ventilation*

# 4 Installation and Connection

## 4.1 Overview of the COMBIVERT F6

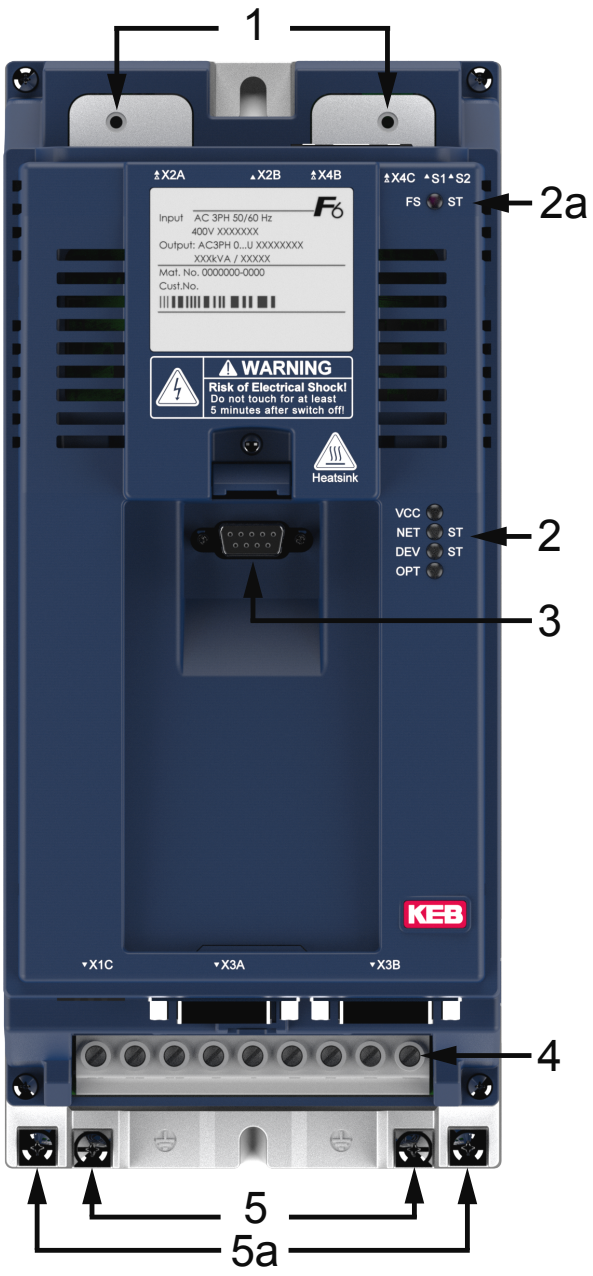
| Housing 2 | No. | Name | Description |
|---|---|---|---|
|  | 1 / 5a | --- | Fixing points for the optional shielding plates. The shielding e.g. from the motor cable is laid on the mounting plate in the control cabinet or on the shielding plates (optionally available).<br><br>Control unit:<br>• 00F6V80-2000<br><br>Power unit:<br>• Built-in version 00F6V80-2001<br>• Push-through version 00F6V80-2002) |
| | 2 | --- | LEDs (see the manual for control unit chapter „Overview“) |
| | 2a | --- | For control card COMPACT:<br>FS without function.<br>• For control card COMPACT FS without function<br>• For control card APPLICATION and PRO:<br>Status indication of the safety module |
| | 3 | X4A | Diagnostic interface with RS232/485 interface according to DIN 66019II protocol /<br>operator slot |
| | 4 | X1A | Power circuit terminals for:<br>• Mains input<br>• Braking resistor<br>• DC supply<br>• Motor connection |
| | 5 | PE | Protective earth;<br>at connection to protective earth each terminal may be assigned only once. |
| | | | |

*Figure 14: F6 housing 2 top view*

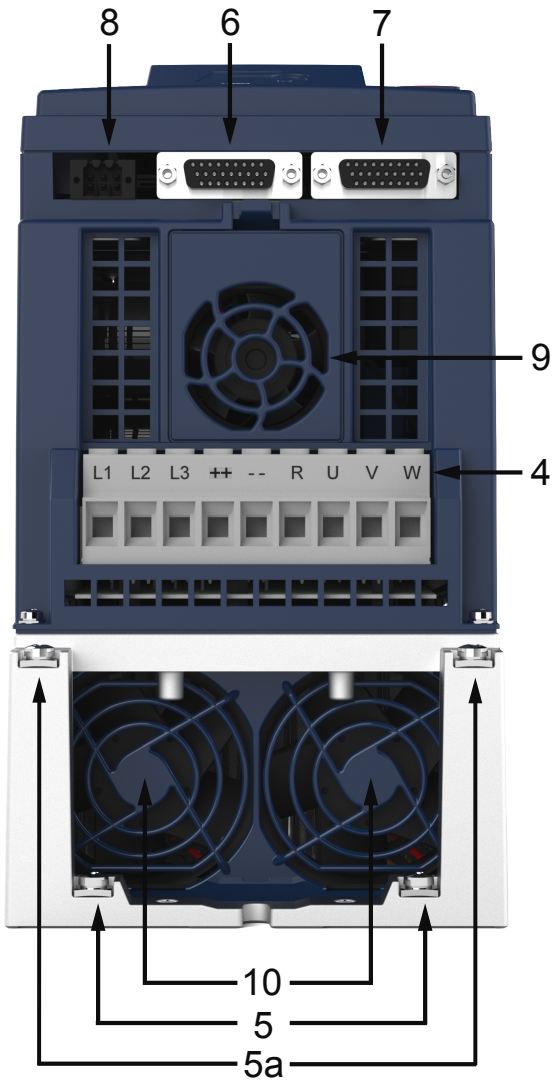
| Housing 2 | No. | Name | Description |
|---|---|---|---|
|  | 4 | X1A | Power circuit terminals for:<br>• Mains input<br>• Braking resistor<br>• DC supply<br>• Motor connection |
| | 5 | PE | Protective earth;<br>at connection to protective earth each terminal may be assigned only once. |
| | 5a | --- | Fixing points for the optional shielding plates. The shielding e.g. from the motor cable is laid on the mounting plate in the control cabinet or on the shielding plates (optionally available).<br>Power unit:<br>• Built-in version 00F6V80-2001<br>• Push-through version 00F6V80-2002) |
| | 6 | X3A | Encoder interface channel A |
| | 7 | X3B | Encoder interface channel B |
| | 8 | X1C | Motor temperature monitoring, brake control |
| | 9 | --- | Interior fan |
| | 10 | --- | Heat sink fan |

*Figure 15: F6 housing 2 front view*

Terminal R can alternatively be labeled with PB.

| Housing 2 | No. | Name | Description |
|---|---|---|---|
|  | 11 | S1 | Rotary coding switch A |
| | 12 | S2 | Rotary coding switch B |
| | 13 | X4C | Fieldbus interface (out) |
| | 14 | X4B | Fieldbus interface (in) |
| | 15 | X2B | Safety module |
| | 16 | X2A | Connection for:<br>• CAN bus<br>• Analog inputs and analog output<br>• Digital inputs and outputs<br>• 24V DC voltage supply |

*Figure 16: F6 housing 2 Rear view with control board APPLICATION*

Further views 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*

Instructions for use COMBIVERT F6 control board COMPACT
*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*

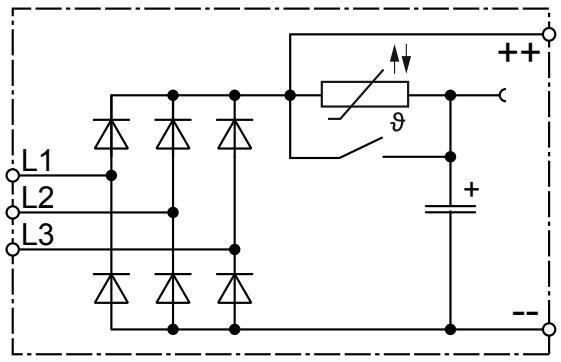
## 4.2 Connection of the power unit

**NOTICE**

**Destruction of the drive converter!**

► Never exchange mains input and motor output!

### 4.2.1 Connection of the voltage supply



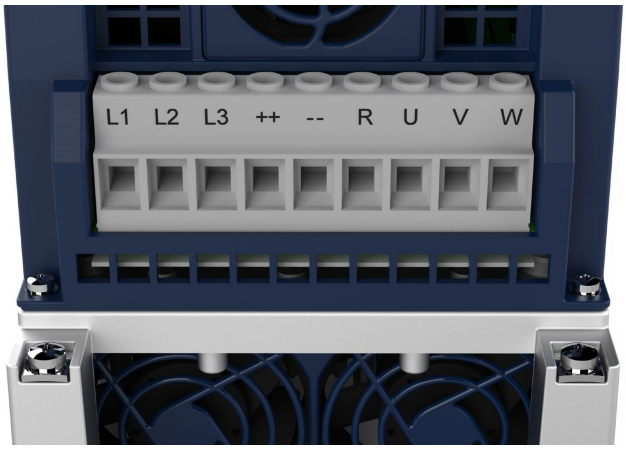

The COMBIVERT F6 housing 2 can be supplied from the mains. The starting current limiting is arranged before the DC link.

*Figure 17: Input circuit*

**Minimum waiting period between two switch-on procedures 5 minutes!**

Cyclic switching on and off of the device leads to temporary high resistance of the resistor (NTC) in the input. This causes a higher starting current, which causes stress to the components in the input range (e.g. the input rectifier) and can lead to triggering of the mains fuse.

#### 4.2.1.1 Terminal block X1A




| Name | Function | Cross-section for terminal connection | Tightening torque | Max. number of conductors |
|---|---|---|---|---|
| L1 | Mains connection 3-phase | Flexible line with wire-end ferrule with plastic collars 2.5...10 mm²<br>For 2 conductors 0.5mm...1.5mm²<br><br>For UL flexible line without wire-end ferrule AWG 26...6 | 1.5 Nm<br>13 lb inch | For IEC: 2<br><br>For UL: 1 |
| L2 | | | | |
| L3 | | | | |
| ++ | DC terminals | | | |
| -- | | | | |
| R | Connection for braking resistor (between R and ++) | | | |
| U | Motor connection | | | |
| V | | | | |
| W | | | | |

*Figure 18: Terminal block X1A*

Terminal R can alternatively be labeled with PB.

### 4.2.2 Protective earth and function earth

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

#### 4.2.2.1 Protective earth

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

**⚠ CAUTION**

**Electric shock due to incorrect dimensioning!**

► Cross-section wire to ground should be selected according to *DIN IEC 60364-5-54*!

| Name | Function | Terminal connection | Tightening torque |
|---|---|---|---|
| PE, ⏚ | Connection for protective earth | Screw M4 for crimp connector | 1.3 Nm<br>11 lb inch |

*Figure 19: Connection for protective earth*

**Incorrect installation of the PE connection**

Only the M4 screws may be used to connect the protective earth!

#### 4.2.2.2 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 as described in the manual => Before starting.

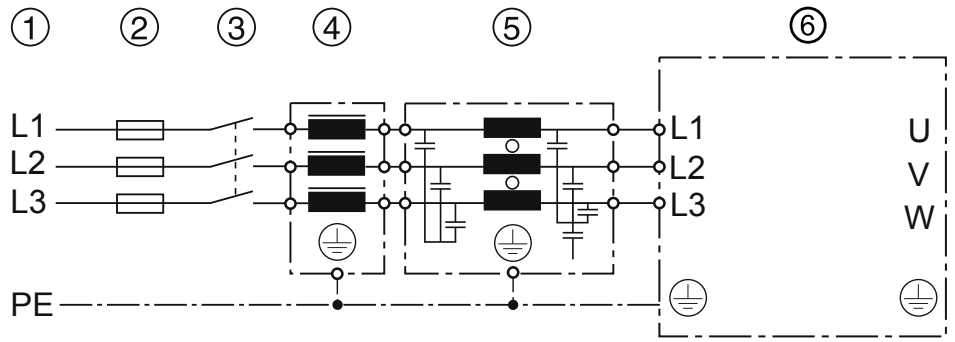
The functional earth may not be wired green / yellow!

Notes on EMC-compatible installation can be found here.

*www.keb.de/fileadmin/media/Manuals/emv/0000neb0000.pdf*

### 4.2.3 AC mains connection

#### 4.2.3.1 AC supply 3-phase




| No. | Typ | 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. (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 | Type gG or MCCB | |
| ③ | Mains contactor | | |
| ④ | Mains choke | see notes under the table | |
| ⑤ | HF filter for TN-, TT systems | Required for compliance with the limit values in accordance with *EN 61800-3.* | |
| | HF filter for IT systems | | |
| ⑥ | KEB COMBIVERT | F6 | |

*Figure 20: Connection of the mains supply 3-phase*

#### 4.2.3.2 Supply line

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

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

The application engineer is responsible for the design!

### 4.2.3.3 Note on hard power systems

The service life of drive converters with voltage DC link depends on the DC voltage, surrounding temperature and the current load of the electrolytic capacitors in the DC link. The use of mains chokes can increase the service life of the condensators to a considerable extent, especially when connecting to „hard“ power systems or when under permanent drive load (continuous duty).

The term "hard" power system means that the nodal point power ($S_{Net}$) of the mains is very high (>> 200) compared to the output rated power of the drive converter ($S_{out}$) (>>200).

$$k = \frac{S_{Net}}{S_{out}} >> 200$$

e.g.

$$k = \frac{2\,\text{MVA (supply transformer)}}{11.4\,\text{kVA (14F6)}} = 176 \longrightarrow \text{no choke required}$$

A listing of filters and chokes => „Filters and chokes“.

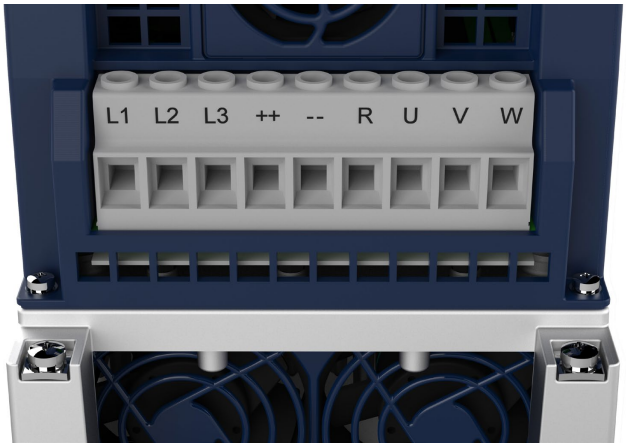
### 4.2.4 DC connection

**NOTICE**

**DC operation**

► DC operation is only permitted after consultation with KEB!

#### 4.2.4.1 Terminal block X1A DC connection

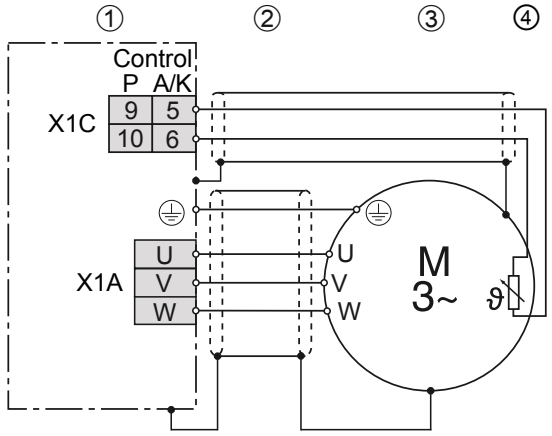



| Name | Function | Cross-section for terminal connection | Tightening torque | Max. number of conductors |
|---|---|---|---|---|
| ++ | DC terminals | Flexible line with wire-end ferrule with plastic collars 2.5...10 mm²<br>For 2 conductors 0.5mm...1.5mm²<br><br>For UL flexible line without wire-end ferrule AWG 26...6 | 1.5 Nm<br>13 lb inch | For IEC: 2<br><br>For UL: 1 |
| -- | | | | |

*Figure 21: Terminal block X1A DC connection*

### 4.2.5 Connection of the motor

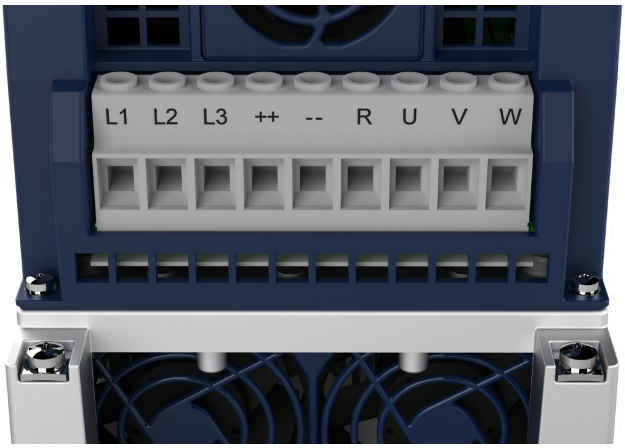
#### 4.2.5.1 Wiring of the motor




| 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) => *Instructions for use „Control circuit“* |

*Figure 22: Wiring of the motor*

#### 4.2.5.2 Terminal block X1A motor connection



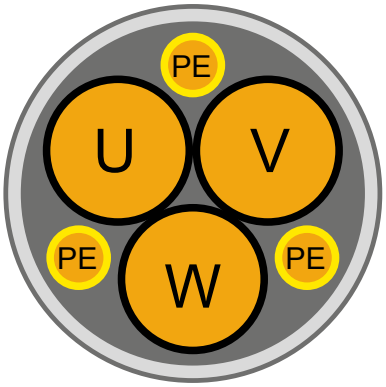

| Name | Function | Cross-section for terminal connection | Tightening torque | Max. number of conductors |
|---|---|---|---|---|
| U | Motor connection | Flexible line with wire-end ferrule with plastic collars 2.5...10 mm²<br>For 2 conductors 0.5mm...1.5mm²<br><br>For UL flexible line without wire-end ferrule AWG 26...6 | 1.5 Nm<br>13 lb inch | For IEC: 2<br><br>For UL: 1 |
| V | | | | |
| W | | | | |

*Figure 23: Terminal block X1A motor connection*

#### 4.2.5.3 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 (=> „Motor cable length and conducted interferences at AC supply“)
- better EMC properties (reduction of the common-mode output currents to earth)




The use of shielded motor lines with symmetrical structure is required for higher motor power (from 30 kW). In these lines the protective earth conductor is tripartite and evenly arranged between the phase lines. A cable without protective earth conductor can be used if local regulations so permit. Then the protective earth conductor must be laid externally. Certain lines also permit the shield for the use as protective earth conductor. For this, observe the details of the line manufacturer!

*Figure 24: Symmetrical motor line*

#### 4.2.5.4 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 following information is valid for the operation under rated conditions and the use of KEB listed filters under chapter => „Filters and chokes“ !

| **Inverter size** | **Max. motor cable length shielded**<br>**in accordance with** *EN 61800-3*<br>**Category C2**<br>**Motor cable (low capacitance)** | **max. leakage current (at $f_N$ ≤ 100 Hz)** |
|---|---|---|
| 10 | 100 m | < 5 mA |
| 12 | | |
| 13 | | |
| 14 | | |
| 15 | | |
| 16 | | |

*Table 43: Max. motor cable length*

The line length can be increased significant by using motor chokes or motor filters. KEB recommends the use of motor chokes or filters for a line length upto 50 m. Motor chokes or filters are absolutely necessary upto 100 m.

#### 4.2.5.5 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:

$$\text{resulting motor cable length} = \sum \text{single line length} \times \sqrt{\text{Number of motor lines}}$$

#### 4.2.5.6 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 line length
- on the type of the used line
- on the ambient conditions such as bundling and temperature

#### 4.2.5.7 Interconnection of the motor

***NOTICE***

**Incorrect behavior of the motor!**

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

**Protect motor against voltage peaks!**

► Drive converters 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.

### 4.2.5.8 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 dependending 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 pn33 = 7) => *Programming manual*

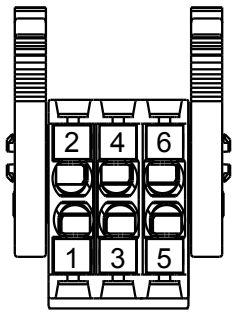
| X1C | PIN | Name | Description |
|---|---|---|---|
|  | 1 | BR+ | Brake control / output + |
| | 2 | BR- | Brake control / output - |
| | 3 | reserved | – |
| | 4 | reserved | – |
| | 5 | TA1 | Temperature detection / output + |
| | 6 | TA2 | Temperature detection / output - |

*Figure 25: Terminal block X1C for control board APPLICATION and COMPACT*

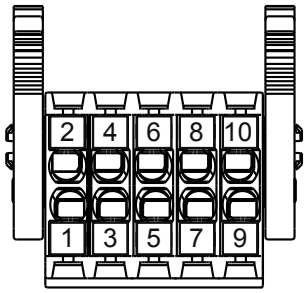
| X1C | PIN | Name | Description |
|---|---|---|---|
|  | 1 | BR+ | Brake control / output + |
| | 2 | BR- | Brake control / output - |
| | 3 | 0V | For supply of the checkback inputs |
| | 4 | 24Vout | |
| | 5 | DIBR1 | Checkback input 1 for brake and relay |
| | 6 | DIBR2 | Checkback input 2 for brake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

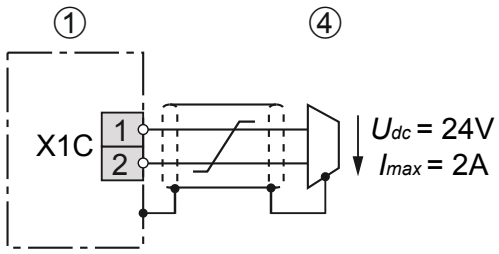
*Figure 26: Terminal block X1C for control board PRO*

**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.



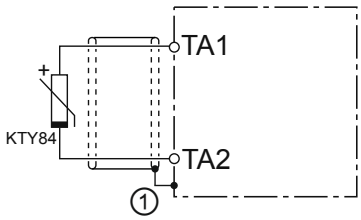

| | |
|---|---|
| ① | COMBIVERT |
| ④ | Brake |

For control board APPLICATION and COMPACT.
The voltage to the control of a brake is decoupled from the internal voltage supply. The brake works only with external voltage supply.

For control board PRO
The brake can be supplied with both, internal and external voltage. Voltage tolerances and output currents vary for internal and external voltage supply..

Respect the specifications
=> *instruction manual „control board“*

*Figure 27: Connection of the brake control*




KTY sensors are polarized semiconductors and must be operated in forward direction! To this connect the anode to TA1 and the cathode to TA2! Non-observance leads to incorrect measurements in the upper temperature range. A protection of the motor winding is then no longer guaranteed.

| | |
|---|---|
| ① | Connection via shield plate (if not available, place on the mounting plate). |

*Figure 28: Connection of a KTY sensor*

**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.

***NOTE***

„Basic insulation“ against SELV voltage of the control. A system voltage (Phase – PE) of 300 V is defined. Consequently, the connected sensors also must have a „basic insulation“ to the mains potential (e.g. motor winding)!

More information about the wiring of the temperature monitoring and the brake control are described in the respective control unit manual.

### 4.2.6 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 vale has fallen below the minimum brake resistance value!**

► The minimum brake resistance value must not fall below!
*=> „Overview of the 400 V devices“*

**⚠ CAUTION**

**Hot surfaces caused by load of the braking resistor!**

**Burning of the skin!**

► Cover hot surfaces safe-to-touch.

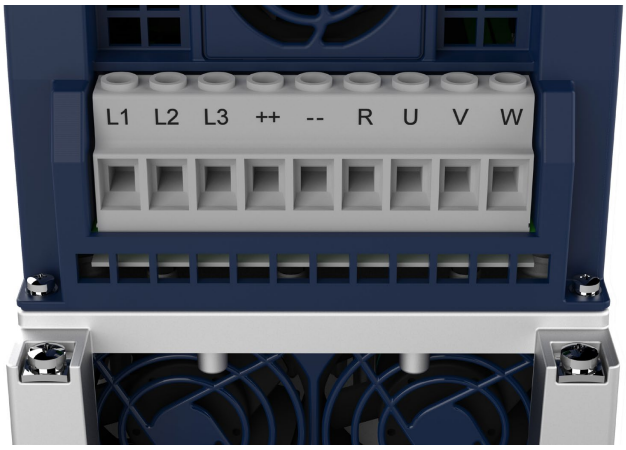
► Before touching, check the surface.

► If necessary, attach warning signs on the system.

#### 4.2.6.1 Installation instructions for side-mounted braking resistors

Instructions for the installation of intrinsically safe braking resistors *https://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_safe-braking-resistors-20106652_en.pdf* Chapter „Installation instructions“.

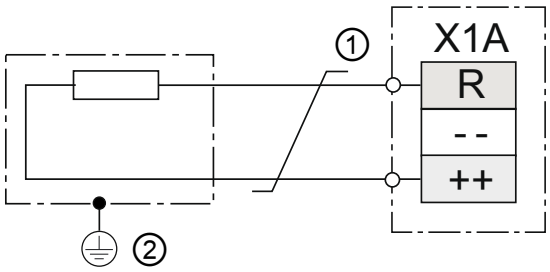
4.2.6.2 Terminal block X1A connection braking resistor




| Name | Function | Cross-section for terminal connection | Tightening torque | Max. number of conductors |
|---|---|---|---|---|
| ++ | Connection for braking resistor | Flexible line with wire-end ferrule with plastic collars 2.5...10 mm²<br>For 2 conductors 0.5mm...1.5mm²<br><br>For UL flexible line without wire-end ferrule AWG 26...6 | 1.5 Nm<br>13 lb inch | For IEC: 2<br><br>For UL: 1 |
| R | | | | |

*Figure 29: Terminal block X1A connection braking resistor*

### 4.2.6.3 Wiring of an intrinsically safe braking resistor




| Legend | |
|---|---|
| ① | Twist the connection cable. When extending the connection cables, the cables must be shielded additionally and connected on both sides. |
| ② | Protective earthing is provided via the housing. |

*Figure 30: Wiring of an intrinsically safe braking resistor*

Intrinsically safe braking resisitors behave in error case such as a safety fuse. They interrupt themselves without fire risk.

More information about intrinsically safe braking resistors
*www.keb.de/fileadmin/media/Manuals/dr/ma_dr_safe-braking-resistors-20106652_en.pdf*

### 4.2.6.4 Using a non-intrinsically safe braking resistor

Using a non-intrinsically safe braking resistor with extended temperature monitoring
*www.keb.de/fileadmin/media/Manuals/dr/ma_dr_braking-resistors-20116737_en.pdf*

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

## 4.3 Accessories

### 4.3.1 Filters and chokes

| Voltage class | Drive converter size | HF filter | Mains choke 50 Hz / 4 % $U_k$ |
|---|---|---|---|
| 230 V | 10 | 14E6T601050 | 10Z1B031000 |
| | 12 | 14E6T601050 | 12Z1B031000 |
| | 13 | 16E6T601050 | 13Z1B031000 |
| | 14 | 16E6T601050 | 14Z1B031000 |

*Table 44: Filters and chokes for 230V devices*

| Voltage class | Drive converter size | HF filter | Mains choke 50 Hz / 4 % $U_k$ |
|---|---|---|---|
| 400 V | 12 | 12E6T60-3000 | 12Z1B04-1000 |
| | 13 | 14E6T60-3000 | 13Z1B04-1000 |
| | 14 | 14E6T60-3000 | 14Z1B04-1000 |
| | 15 | 16E6T60-3000 | 15Z1B04-1000 |
| | 16 | 16E6T60-3000 | 16Z1B04-1000 |

*Table 45: Filters and chokes for 400V devices*

The specified filters and chokes are designed for rated operation.

### 4.3.2 Mounting kit shield connection brakets

| Name | Material number |
|---|---|
| Mounting kit shield connection braket control unit | 00F6V80-2000 |
| Mounting kit shield connection braket power unit for built-in version | 00F6V80-2001 |
| Mounting kit shield connection braket power unit for push-through version IP20 / IP54 | 00F6V80-2002 |

*Table 46: Mounting kit shield connection brakets*

### 4.3.3 Mounting kit push-through frame for IP20 devices

| Name | Material number |
|---|---|
| Push-through frame for push-through version IP20 (built-in version in push-through version) | 00F6V80-2004 |

*Table 47: Mounting kit for IP20 devices*

The built-in version can be converted with the mounting kit to an IP20 push-through version. The mounting kit for IP20 devices can be attached subsequently to the built-in version.

### 4.3.4 Side-mounted braking resistors

Technical data and design about intrinsically safe braking resistors => *https://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_safe-braking-resistors-20106652_en.pdf*

Technical data and design about non-intrinsically safe braking resistors => *https://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_braking-resistors-20116737_en.pdf*

# 5 Certification

## 5.1 CE-Marking

CE marked drive converters were developed and manufactured to comply with the regulations of the Low-Voltage Directive and EMC directive. The harmonized standards of the series *EN 61800-5-1* and *EN 61800-3* were used.

For further information regarding the CE declarations of conformity
=> „Further informations and documentation“.

## 5.2 UL certification

| | |
|---|---|
| c UL us | Acceptance according to UL is marked at KEB drive converters with the adjacent logo on the nameplate. |

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):

- Control Board Rating of relays (30Vdc/1A)
- Brake resistor ratings and duty cycle: see RATINGS
- Maximum Surrounding Air Temperature 45°C
- Use in a Pollution Degree 2 environment
- Power Terminals X1A
  Use 75°C Copper Conductors Only

  CSA:

- Power Terminals X1A: Maximum wire sizes and tightening torques:

  LU10.16 (Weidmueller):
  max. AWG 8 (maximum stripping length 10 mm),
  20.5 lb-inch (2.3 Nm)

- During the UL evaluation, only Risk of Electrical Shock and Risk of Fire aspects were investigated. Functional Safety aspects were not evaluated!
- 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.

## 5.3 Further informations and documentation

You find supplementary manuals and instructions for the download under
*www.keb.de/de/service/downloads*

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 converter and to create downloads for parameterizing the drive converter

Approvals and approbations
- Declaration of conformity CE
- TÜV certificate
- FS certification

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

# 6 Revision History

| Version | Date | Description |
|---|---|---|
| 00 | 2015-10 | Prototype |
| 01 | 2016-04 | Pre-series |
| 02 | 2016-08 | Pre-series (without UL certification) |
| 03 | 2016-11 | UL certified terminal X1A included |
| 04 | 2017-02 | Series version, 4kHz devices included (device size 16), new CI, UL certification included |
| 05 | 2018-05 | Corrections to the technical data figures of the overload characteristics adapted |
| 06 | 2019-11 | Switching performance of fans added, data of overload characteristics adapted. |
| 07 | 2020-01 | Inclusion of the 230V devices |

**Austria** | KEB Automation GmbH
Ritzstraße 8 4614 Marchtrenk Austria
Tel: +43 7243 53586-0 Fax: +43 7243 53586-21
E-Mail: info@keb.at Internet: www.keb.at

**Benelux** | KEB Automation KG
Dreef 4 - box 4 1703 Dilbeek Belgium
Tel: +32 2 447 8580
E-Mail: info.benelux@keb.de Internet: www.keb.de

**Brazil** | KEB South America - Regional Manager
Rua Dr. Omar Pacheco Souza Riberio, 70
CEP 13569-430 Portal do Sol, São Carlos Brazil
Tel: +55 16 31161294 E-Mail: roberto.arias@keb.de

**Czech Republic** | KEB Automation GmbH
Videnska 188/119d 61900 Brno Czech Republic
Tel: +420 544 212 008
E-Mail: info@keb.cz Internet: www.keb.cz

**France** | Société Française KEB SASU
Z.I. de la Croix St. Nicolas 14, rue Gustave Eiffel
94510 La Queue en Brie France
Tel: +33 149620101 Fax: +33 145767495
E-Mail: info@keb.fr Internet: www.keb.fr

**Germany** | **Geared Motors**
KEB Antriebstechnik GmbH
Wildbacher Straße 5 08289 Schneeberg Germany
Telefon +49 3772 67-0 Telefax +49 3772 67-281
Internet: www.keb-drive.de E-Mail: info@keb-drive.de

**Italy** | KEB Italia S.r.l. Unipersonale
Via Newton, 2 20019 Settimo Milanese (Milano) Italia
Tel: +39 02 3353531 Fax: +39 02 33500790
E-Mail: info@keb.it Internet: www.keb.it

**Japan** | KEB Japan Ltd.
15 - 16, 2 - Chome, Takanawa Minato-ku Tokyo 108 - 0074 Japan
Tel: +81 33 445-8515 Fax: +81 33 445-8215
E-Mail: info@keb.jp Internet: www.keb.jp

**P. R. China** | KEB Power Transmission Technology (Shanghai) Co. Ltd.
No. 435 QianPu Road Chedun Town Songjiang District
201611 Shanghai P.R. China
Tel: +86 21 37746688 Fax: +86 21 37746600
E-Mail: info@keb.cn Internet: www.keb.cn

**Poland** | KEB Automation KG
Tel: +48 60407727
E-Mail: roman.trinczek@keb.de Internet: www.keb.de

**Republic of Korea** | KEB Automation KG
Room 1709, 415 Missy 2000 725 Su Seo Dong
Gangnam Gu 135- 757 Seoul Republic of Korea
Tel: +82 2 6253 6771 Fax: +82 2 6253 6770 E-Mail: vb.korea@keb.de

**Russian Federation** | KEB RUS Ltd.
Lesnaya str, house 30 Dzerzhinsky MO
140091 Moscow region Russian Federation
Tel: +7 495 6320217 Fax: +7 495 6320217
E-Mail: info@keb.ru Internet: www.keb.ru

**Spain** | KEB Automation KG
c / Mitjer, Nave 8 - Pol. Ind. LA MASIA
08798 Sant Cugat Sesgarrigues (Barcelona) Spain
Tel: +34 93 8970268 Fax: +34 93 8992035 E-Mail: vb.espana@keb.de

**Switzerland** | KEB Automation AG
Witzbergstrasse 24 8330 Pfaeffikon/ZH Switzerland
Tel: +41 43 2886060 Fax: +41 43 2886088
E-Mail: info@keb.ch Internet: www.keb.ch

**United Kingdom** | KEB (UK) Ltd.
5 Morris Close Park Farm Indusrial Estate
Wellingborough, Northants, NN8 6 XF United Kingdom
Tel: +44 1933 402220 Fax: +44 1933 400724
E-Mail: info@keb.co.uk Internet: www.keb.co.uk

**United States** | KEB America, Inc
5100 Valley Industrial Blvd. South
Shakopee, MN 55379 United States
Tel: +1 952 2241400 Fax: +1 952 2241499
E-Mail: info@kebamerica.com Internet: www.kebamerica.com

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