COMBIVERT **F6**

INSTRUCTIONS FOR USE | **INSTALLATION F6 HOUSING 6**

Translation of the original manual
Document 20114694 EN 04

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.

Other wordmarks or/and logos are trademarks (™) or registered trademarks (®) of their respective owners.

Table of Contents

List of Figures

List of Tables

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 Front End module
AIC filter	Filter for Active Front End Module (AIC)
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 (<60V)
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 5V
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

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.

⚠ VORSICHT

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 %!

Premature ageing of the electrolytic capacitors!

- ► Insert mains choke with U_k = 4%.
- ► From a rated motor power of 55 kW, a mains choke with U_k = 4% must be used !

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!

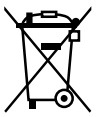
- ► The function of the drive converter is dependent on its parameterization. Never replace without knowledge of the application.
- ► Modification or repair is permitted only by KEB Automation KG authorized personnel.
- ► Only use original manufacturer parts.
- ► Infringement will annul the liability 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 unit series F6 concerns to drive converters, which are optimized for operation at synchronous and asynchronous motors. The COMBIVERT can be extended with a safety module for the use in safety-oriented applications. 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 unit. 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:

Unit type:	Drive converter
Series:	COMBIVERT F6
Power range:	45...90 kW / 400 V
Housing	6

The COMBIVERT F6 is characterized by the following features:

- Operation of three-phase asynchronous motors and three-phase synchronous motors, in operating modes open-loop or closed-loop with and without speed feedback
- following fieldbus systems are supported:
  EtherCAT, VARAN, PROFINET, POWERLINK or CAN
- System-overlapping operating concept
- wide operating temperature range
- low switching losses by IGBT power unit
- low noise development due to high switching frequencies
- Different heat sink concepts:
  - Air cooler 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
  - Oil cooler as push-through version with IP54 dregee of protection
  - Water cooler as built-in version
  - Water cooler as push-through version with IP20 degree of protection
  - Water cooler as push-through version with IP54 degree of protection
- Temperature-controlled fan, easily replaceable
- Torque limits and s-curves are adjustable to protect gearboxes
- General protection functions of the COMBIVERT series against overcurrent, overvoltage, ground fault and overtemperature
- Analog inputs and outputs, digital inputs and outputs, relay output (potential-free), brake control and -supply, motor protection by I^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)
	Water	–	–	5…40 °C
	Oil	–	–	40…55 °C
Relative humidity		*EN 60721-3-3*	3K3	5…85 % (without condensation)
Version and degree of protection		*EN 60529*	IP20	Protection against foreign material > ø12.5 mm No protection against water Non-conductive pollution, occasional condensation when PDS is out of service. Drive converter generally, except power connections and fan unit (IPxxA)
Site altitude		–	–	Max. 2000 m above sea level • With site altitudes over 1000 m a derating of 1 % per 100 m must be taken into consideration. • 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 0.3 mm (2…9 Hz) Acceleration amplitude 1 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) Acceleration amplitude 10 m/s² (9…200 Hz) (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) Acceleration amplitude 10 m/s² (9…200 Hz)
	EN 61800-5-1	–	Vibration amplitude 0.075 mm (10…57 Hz) Acceleration amplitude 10 m/s² (57…150 Hz)
Shock limit values	*EN 60721-3-3*	3M4	100 m/s²; 11 ms
Pressure in the water cooler	–	–	Max. operating pressure: 10 bar

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 4 kV	AD (air discharge) 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 2 kV	Phase-phase 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 3 V/m 1 V/m	80 MHz...1 GHz 1.4...2 GHz 2...2.7 GHz
Voltage fluctuations/ voltage dips	*EN 61000-2-1* *EN 61000-4-34*	–	-15 %...+10 % 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 Unit data of the 400V units

3.2.1 Overview

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.

Unit size			**21**	**22**	**23**			**24**	
Housing			**6**						
Rated apparent output power		S_{out} / kVA	62	80	104			125	
Max. rated motor power		P_{mot} / kW	45	55	75			90	
Rated input voltage		U_N / V	400 (UL: 480)						
Input voltage range		U_{in} / V	280...550						
Input phases			3						
Mains frequency		f_N / Hz	50 / 60 ±2						
Rated input current @ U_N = 400V		I_{IN} / A	99	126	158			189	
Rated input current @ U_N = 480V		I_{IN_UL} / A	85	106	128			162	
Output voltage		U_{out} / V	0...U_{in}						
Output frequency	2)	f_{out} / Hz	0...599						
Output phases			3						
Rated output current @ U_N = 400V		I_N / A	90	115	150			180	
Rated output current @ U_N = 480V		I_{N_UL} / A	77	96	124			156	
Rated output overload (60 s)	1) 5)	I_{60s} / %	150						
Software current limit		I_{lim} / %	150						
Overcurrent	1)	I_{OC} / %	180						
Rated switching frequency		f_{SN} / kHz	8	4	2	4	8 6)	2	4 7)
Max. switching frequency	4)	f_{Smax} / kHz	16						
Power dissipation at nominal operating	3)	P_D / W	1356	1194	1320	1650	2074	1580	1887
Overload current over time		I_{OL} / %	=> *„Overload characteristic (OL)“*						
Maximum current 0Hz / 50Hz at f_S = 2 kHz		I_{max_out} / %	180 / 180	180 / 180	154 / 180	154 / 180	180 / 180	129 / 180	141 / 180
Maximum current 0Hz / 50Hz at f_S = 4 kHz		I_{max_out} / %	180 / 180	157 / 180	121 / 180	121 / 180	173 / 180	101 / 180	112 / 180
Maximum current 0Hz / 50Hz at f_S = 8 kHz		I_{max_out} / %	133 / 180	104 / 180	80 / 157	79 / 180	120 / 180	66 / 151	74 / 174
Maximum current 0Hz / 50Hz at f_S = 16 kHz		I_{max_out} / %	55 / 133	43 / 104	33 / 80	35 / 81	58 / 138	28 / 67	35 / 83

continued on the next page

Unit size		21	22	23	24
Housing				**6**	
Max. braking current	I_{B_max} / A			168	
Min. braking resistor value	R_{B_min} / Ω			5	
Protection function for braking transistor (GTR7)				Short-circuit monitoring	
Insulating resistance @ U_{dc} = 500V	R_{iso} / MΩ			> 20	

Table 7: Overview of the 400V unit data

1) *The values refer in % to the output rated 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. Units with higher max. output frequency are subject to export restrictions and are only available on 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“.*

5) *Observe limitations „Overload characteristic (OL)“.*

6) *Only available as water-cooled device.*

7) *Only available as oil-cooled device.*

3.2.2 Voltage 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 8: Input voltages and frequencies of the 400V units

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

Table 9: DC link voltage for 400V units

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 10: Output voltages and frequencies of the 400V units

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. Units 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:

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 %*	

3.2.3 Input and output currents/ overload

Unit size		**21**	**22**	**23**	**24**
Rated input current @ U_N = 400V	I_{IN} / A	99	126	158	189
Rated input current @ U_{N_UL} = 480V	I_{IN_UL} / A	85	106	128	162

Table 11: Input currents of the 400 V units

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

Unit size			**21**	**22**	**23**	**24**
Rated output current @ U_N = 400V		I_N / A	90	115	150	180
Rated output current @ U_{N_UL} = 480V		I_{N_UL} / A	77	96	124	156
Rated output overload (60 s)	[1]	I_{60s} / %	150			
Overload current	[1]	I_{OL} / %	=> *„Overload characteristic (OL)“*			
Software current limit	[2]	I_{lim} / %	150			
Overcurrent	[1]	I_{OC} / %	180			

Table 12: Output currents

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

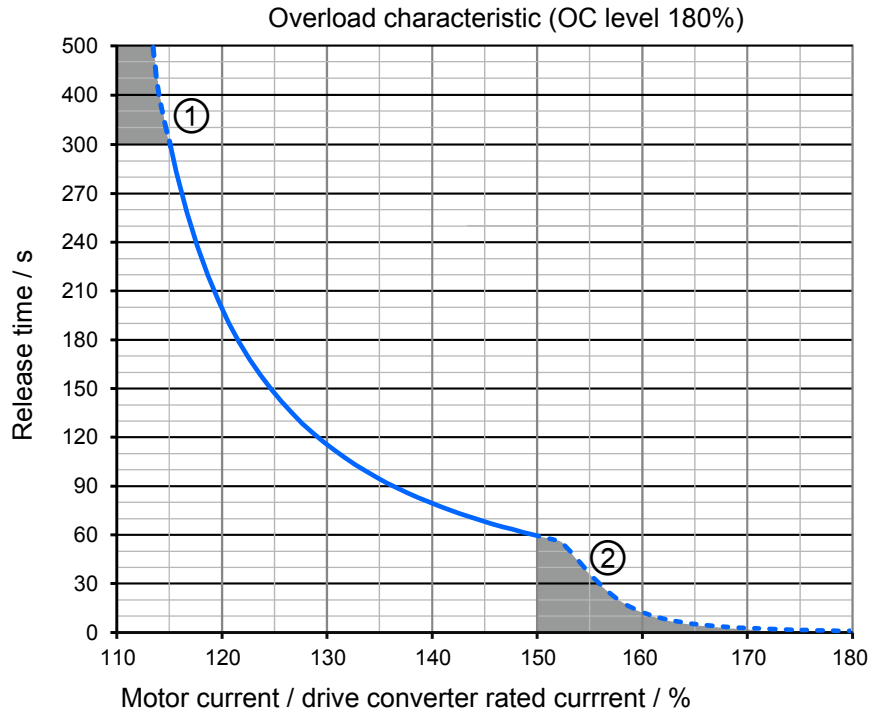
[2] *Limitation of the current setpoint in closed-loop operation. This setpint limit is not active in v/f operation.*

3.2.3.1 Overload characteristic (OL)

All drive converters 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 output current and the maximum surrounding temperature. 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)“*.



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

Figure 1: Switch-off time t depending on the overload I/IN at OC level 180% (OL overload characteristic)

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 cannot be determined exactly. Therefore, the design of the drive converter should be assumed to have a maximum overload time of 300s.

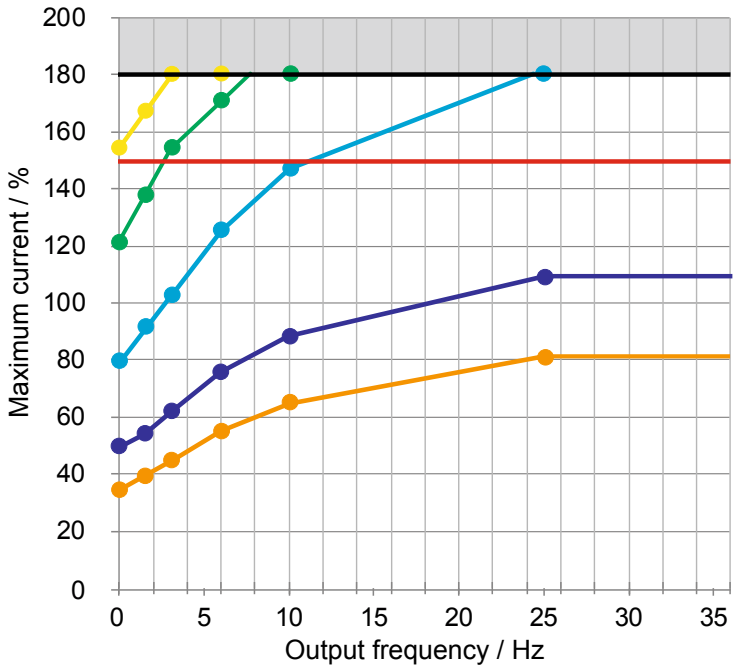
3.2.3.2 Frequency-dependent maximum current (OL2)

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 output frequency the drive converter can provide at least the rated output current.
- 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, 1,5 Hz, 3 Hz, 6 Hz, 10 Hz and 25 Hz. Unit size 23 is represented exemplary.



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 180% overload.

Figure 2: Typical overload characteristics in the lower output frequencies (OL2) Example. Unit size 23

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 unit size are listed in the following tables.

Frequency-dependent maximum current

Unit size		**21**					
Rated switching frequency		**8 kHz**					
Output frequency	**f_{out} / Hz**	**0**	**1.5**	**3**	**6**	**10**	**25**
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 62.5 µs (Parameter is22=0)*	2 kHz	180	180	180	180	180	180
	4 kHz	180	180	180	180	180	180
	8 kHz	133	158	175	180	180	180
	16 kHz	55	71	83	99	110	133
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 71.4 µs (Parameter is22=1)*	1.75 kHz	180	180	180	180	180	180
	3.5 kHz	180	180	180	180	180	180
	7 kHz	150	175	180	180	180	180
	14 kHz	71	89	101	118	132	159
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 83.3 µs (Parameter is22=2)*	1.5 kHz	180	180	180	180	180	180
	3 kHz	180	180	180	180	180	180
	6 kHz	167	180	180	180	180	180
	12 kHz	87	108	120	138	155	180
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 100 µs (Parameter is22=3)*	1.25 kHz	180	180	180	180	180	180
	2.5 kHz	180	180	180	180	180	180
	5 kHz	180	180	180	180	180	180
	10 kHz	110	133	147	168	180	180

Table 13: Frequency-dependent maximum current for unit size 21

Unit size		22					
Rated switching frequency		**4 kHz**					
Output frequency	f_{out} / Hz	**0**	**1.5**	**3**	**6**	**10**	**25**
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 62.5 µs (Parameter is22=0)*	2 kHz	180	180	180	180	180	180
	4 kHz	157	177	180	180	180	180
	8 kHz	104	124	137	155	173	180
	16 kHz	43	56	64	77	86	104
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 71.4 µs (Parameter is22=1)*	1.75 kHz	180	180	180	180	180	180
	3.5 kHz	168	180	180	180	180	180
	7 kHz	118	137	151	172	180	180
	14 kHz	56	70	79	93	104	124
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 83.3 µs (Parameter is22=2)*	1.5 kHz	180	180	180	180	180	180
	3 kHz	179	180	180	180	180	180
	6 kHz	131	150	166	180	180	180
	12 kHz	68	84	94	108	121	144
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 100 µs (Parameter is22=3)*	1.25 kHz	180	180	180	180	180	180
	2.5 kHz	180	180	180	180	180	180
	5 kHz	144	163	180	180	180	180
	10 kHz	86	104	115	132	147	175

Table 14: Frequency-dependent maximum current for unit size 22

Unit size		23					
Rated switching frequency		**2 kHz**					
Output frequency	f_{out} / Hz	**0**	**1.5**	**3**	**6**	**10**	**25**
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 62.5 µs (Parameter is22=0)*	2 kHz	154	169	180	180	180	180
	4 kHz	121	130	149	168	180	180
	8 kHz	80	95	105	119	133	157
	16 kHz	33	43	49	59	66	80
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 71.4 µs (Parameter is22=1)*	1.75 kHz	154	169	180	180	180	180
	3.5 kHz	129	144	158	177	180	180
	7 kHz	90	105	116	132	146	172
	14 kHz	43	54	61	71	79	95
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 83.3 µs (Parameter is22=2)*	1.5 kHz	154	169	180	180	180	180
	3 kHz	137	153	167	180	180	180
	6 kHz	100	115	127	144	159	180
	12 kHz	52	65	72	83	93	111
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 100 µs (Parameter is22=3)*	1.25 kHz	154	169	180	180	180	180
	2.5 kHz	146	161	176	180	180	180
	5 kHz	111	126	138	156	172	180
	10 kHz	66	80	88	101	113	134

Table 15: Frequency-dependent maximum current for unit size 23 (2 kHz)

Unit size		23					
Rated switching frequency		4 kHz					
Output frequency	f_{out} / Hz	0	1.5	3	6	10	25
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 62.5 µs (Parameter is22=0)*	2 kHz	154	171	180	180	180	180
	4 kHz	121	134	154	180	180	180
	8 kHz	79	88	102	125	147	180
	16 kHz	35	39	45	55	65	81
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 71.4 µs (Parameter is22=1)*	1.75 kHz	155	171	180	180	180	180
	3.5 kHz	130	143	164	180	180	180
	7 kHz	90	100	115	141	164	180
	14 kHz	43	48	55	68	80	100
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 83.3 µs (Parameter is22=2)*	1.5 kHz	155	171	180	180	180	180
	3 kHz	138	152	174	180	180	180
	6 kHz	100	111	128	156	180	180
	12 kHz	51	57	65	81	96	119
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 100 µs (Parameter is22=3)*	1.25 kHz	155	171	180	180	180	180
	2.5 kHz	146	162	180	180	180	180
	5 kHz	111	123	141	171	180	180
	10 kHz	65	72	84	103	122	151

Table 16: Frequency-dependent maximum current for unit size 23 (4 kHz)

Unit size		23					
Rated switching frequency		8 kHz					
Output frequency	f_{out} / Hz	0	1.5	3	6	10	25
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 62.5 µs (Parameter is22=0)*	2 kHz	180	180	180	180	180	180
	4 kHz	173	180	180	180	180	180
	8 kHz	120	133	153	180	180	180
	16 kHz	58	64	75	93	110	138
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 71.4 µs (Parameter is22=1)*	1.75 kHz	180	180	180	180	180	180
	3.5 kHz	180	180	180	180	180	180
	7 kHz	133	147	169	180	180	180
	14 kHz	70	77	90	111	132	164
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 83.3 µs (Parameter is22=2)*	1.5 kHz	180	180	180	180	180	180
	3 kHz	180	180	180	180	180	180
	6 kHz	147	162	180	180	180	180
	12 kHz	81	90	105	130	153	180
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 100 µs (Parameter is22=3)*	1.25 kHz	180	180	180	180	180	180
	2.5 kHz	180	180	180	180	180	180
	5 kHz	160	176	180	180	180	180
	10 kHz	101	111	129	159	180	180

Table 17: Frequency-dependent maximum current for unit size 23 (8 kHz)

Unit size		24					
Rated switching frequency		2 kHz					
Output frequency	f_{out} / Hz	0	1.5	3	6	10	25
Frequency-dependent maximum current @ f_s I_{lim} / % *Basic Time Period = 62.5 µs (Parameter is22=0)*	2 kHz	129	142	161	180	180	180
	4 kHz	101	112	128	156	179	180
	8 kHz	66	73	85	104	123	152
	16 kHz	29	32	37	46	54	68
Frequency-dependent maximum current @ f_s I_{lim} / % *Basic Time Period = 71.4 µs (Parameter is22=1)*	1.75 kHz	129	142	161	180	180	180
	3.5 kHz	108	119	137	165	180	180
	7 kHz	75	83	96	117	137	167
	14 kHz	36	40	46	57	67	84
Frequency-dependent maximum current @ f_s I_{lim} / % *Basic Time Period = 83.3 µs (Parameter is22=2)*	1.5 kHz	129	142	161	180	180	180
	3 kHz	115	127	145	174	180	180
	6 kHz	84	93	107	130	151	180
	12 kHz	43	47	54	68	80	99
Frequency-dependent maximum current @ f_s I_{lim} / % *Basic Time Period = 100 µs (Parameter is22=3)*	1.25 kHz	129	142	161	180	180	180
	2.5 kHz	122	135	153	180	180	180
	5 kHz	92	102	118	143	165	180
	10 kHz	54	60	70	86	101	126

Table 18: Frequency-dependent maximum current for unit size 24 (2 kHz)

Unit size		24					
Rated switching frequency		4 kHz					
Output frequency	f_{out} / Hz	0	1.5	3	6	10	25
Frequency-dependent maximum current @ f_s I_{lim} / % *Basic Time Period = 62.5 µs (Parameter is22=0)*	2 kHz	142	169	180	180	180	180
	4 kHz	112	136	156	180	180	180
	8 kHz	74	92	107	129	147	174
	16 kHz	35	43	49	61	70	84
Frequency-dependent maximum current @ f_s I_{lim} / % *Basic Time Period = 71.4 µs (Parameter is22=1)*	1.75 kHz	142	169	180	180	180	180
	3.5 kHz	120	144	165	180	180	180
	7 kHz	84	103	119	143	163	180
	14 kHz	42	52	60	74	85	102
Frequency-dependent maximum current @ f_s I_{lim} / % *Basic Time Period = 83.3 µs (Parameter is22=2)*	1.5 kHz	142	169	180	180	180	180
	3 kHz	127	153	174	180	180	180
	6 kHz	93	114	131	157	178	180
	12 kHz	49	61	71	87	99	119
Frequency-dependent maximum current @ f_s I_{lim} / % *Basic Time Period = 100 µs (Parameter is22=3)*	1.25 kHz	142	169	180	180	180	180
	2.5 kHz	134	161	180	180	180	180
	5 kHz	103	125	144	171	180	180
	10 kHz	62	76	89	108	123	147

Table 19: Frequency-dependent maximum current for unit size 24 (4 kHz)

3.2.4 Switching frequency and temperature

Unit size			21	22	23			24	
Rated switching frequency	1)	f_{SN} / kHz	8	4	2	4	8	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		90	95	67	95	87
Temperature for derating the switching frequency		T_{DR} / °C	84		84	85	57	85	77
Temperature for uprating the switching frequency		T_{UR} / °C	70		70	75	50	75	67
Temperature for switching to rated switching frequency		T_{EM} / °C	87		87	90	62	90	82

Table 20: Switching frequency and temperature of the 400 V units

1) *The output frequency should 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.

3.2.5 Power dissipation at nominal operating

Inverter size	21	22	23			24	
Rated switching frequency	8	4	2	4	8	2	4
Power dissipation at nominal operating [1] P_D / W	1356	1194	1320	1650	2074	1580	1887

Table 21: Power dissipation of the 400 V units

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

3.2.6 Protection of the drive converter

Unit size	Max. size of the fuse / A			
	U_N = 400V gG (IEC)	U_N = 480V class „J“	U_N = 480V gR	
	SCCR 30 kA	SCCR 10 kA	SCCR 30 kA	Type
21	125	110	125	SIBA 20 189 20.125
			125	COOPER BUSSMANN 170M1368
			125	LITTELFUSE L70QS125
22	160	150	160	SIBA 20 189 20.160
			160	COOPER BUSSMANN 170M1369
			175	LITTELFUSE L70QS175
23	200	175	180	SIBA 20 189 20.180
			200	COOPER BUSSMANN 170M1370
			200	LITTELFUSE L70QS200
24	250	200	200	SIBA 20 189 20.200
			200	COOPER BUSSMANN 170M1370
			200	LITTELFUSE L70QS200

Table 22: Fusing of the 400 V / 480 V units

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 units are suitable for use in a circuit capable of delivering not more than 30 kA eff. unaffected symmetrical short-circuit current.

3.2.7 DC link / braking transistor function (GTR7)

Activation of the braking transistor function
In order to use the braking transistor (GTR7), the function must be activated with parameter "is30 braking transistor function".
For more information => *F6 Programming manual*.

Unit size			21	22	23	24
Rated DC link voltage @ U_N = 400V		U_{N_dc} / V	565			
Rated DC link voltage @ U_{N_UL} = 480V		$U_{N\_dc\_UL}$ / V	680			
DC link voltage working voltage range		U_{IN_dc} / V	390...780			
DC switch-off level „Error! 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	168			
Min. brake resistance value		R_{B_min} / Ω	5			
Protection function for braking transistor (GTR7)			Short-circuit monitoring			
DC link capacity		C / µF	3300	3900	5200	6200

Table 23: DC link / braking transistor function of the 400 V units

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

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!

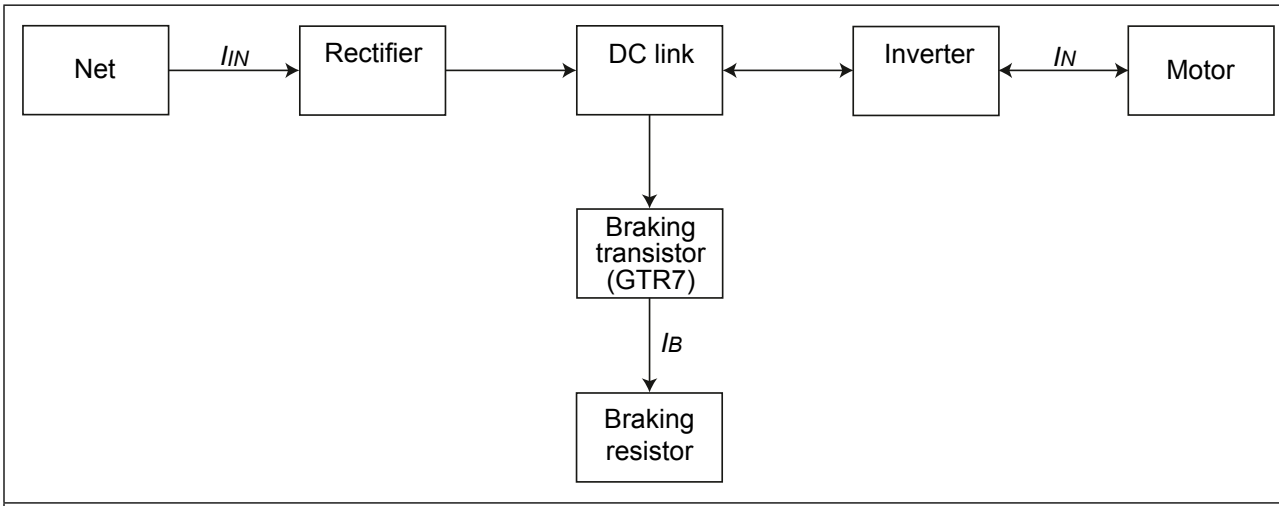


Figure 3: Block diagram of the energy flow

NOTICE

Destruction of the drive converter

► If the error "ERROR GTR7 always ON" occurs, the drive converter must be disconnected from the mains within 5 minutes!

3.2.8 Fan

Unit size		21	22	23	24
Interior fan	Number	1			
	Speed-variable	yes			
Heat sink fan	Number	2			
	Speed-variable	yes			

Table 24: Fan

The fans are speed adjustable! Depending on the setting of the software they are automatically controlled to high or low speed.

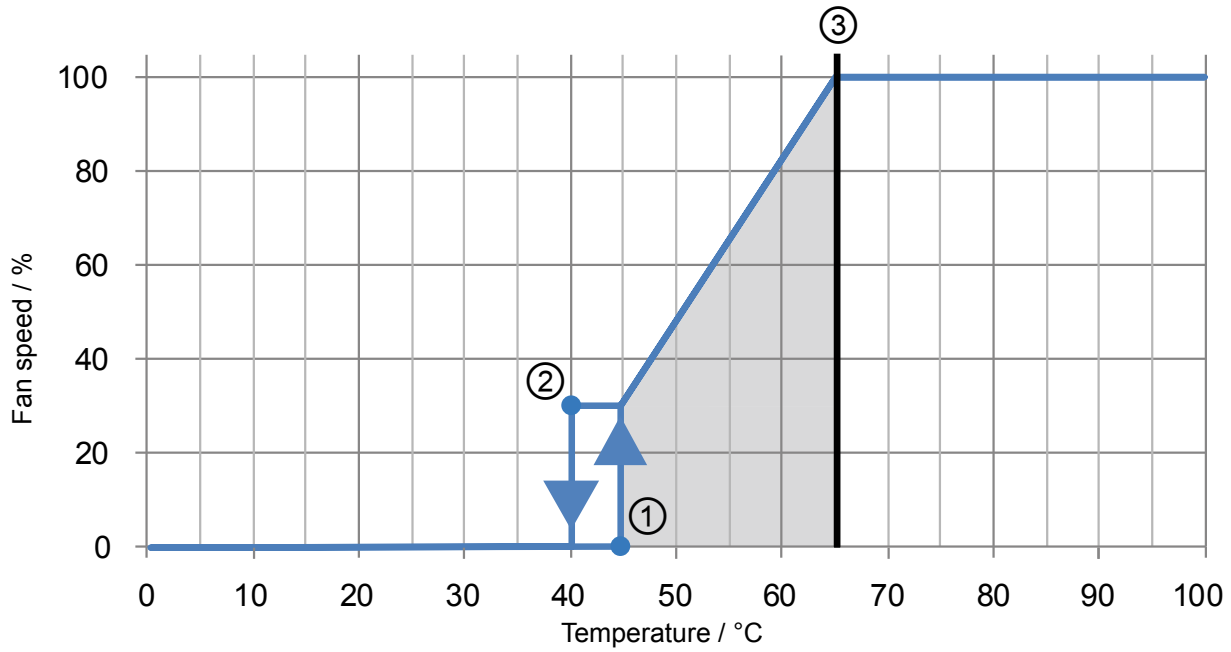
NOTICE

Destruction of the fan!

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

3.2.8.1 Switching behaviour of the fans

The fans have different switch-on and switch-off points. The switching point for the switch-on temperature ① and the maximum speed level ③ of the fans are adjustable. The switching point for the switch-off temperature ② cannot be changed.



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
③	Switching point maximum speed level

Figure 4: Switching behaviour of the fans example heat sink fan

3.2.8.2 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	45	45
Maximum speed level	*T* / °C	65	55

Table 25: Switching points of the fans

3.2.9 Sub-mounted braking resistors

Technical data of the sub-mounted braking resistors		
Braking resistor value	R / Ω	8
Rated power	P_D / W	730
Cyclic duration factor referring to 120s @ U_{N_dc} = 780V	ED / s	0,9

Table 26: Sub-mounted braking resistors

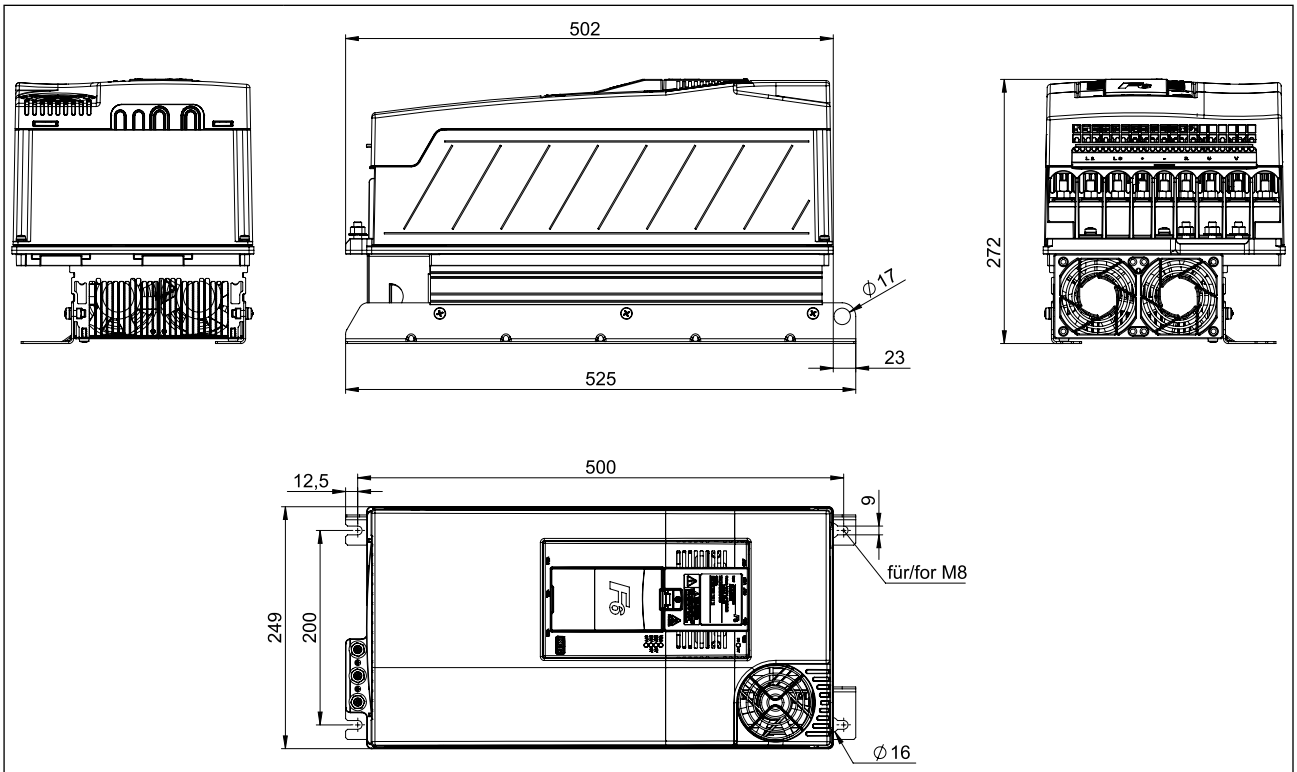
NOTICE

In braking mode (with sub-mounted braking resistors) the power to be dissipated of the heat sink will be increased.

This must be observed when designing the cooling system.

3.3 Dimensions and weights

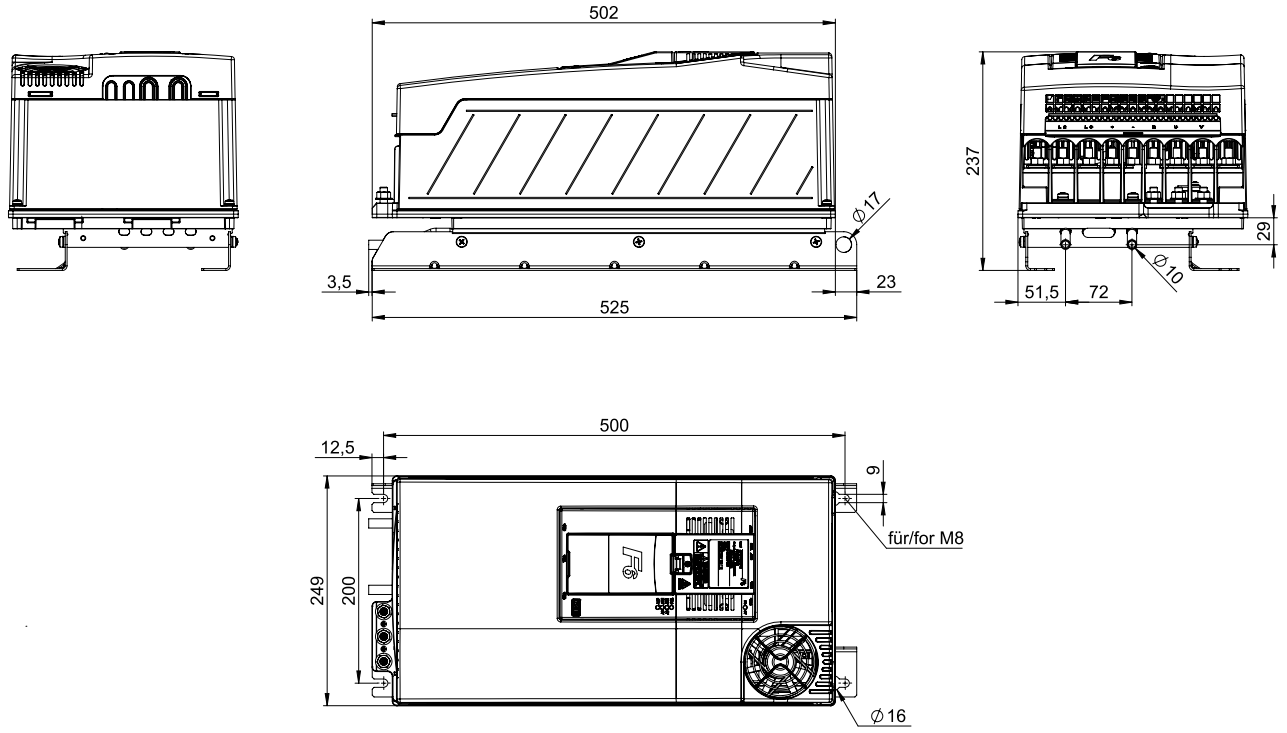
3.3.1 Built-in version air cooler



Housing	6
Weight	21.5 kg
Dimensions	All dimensions in mm

Figure 5: Dimensions built-in version air cooler

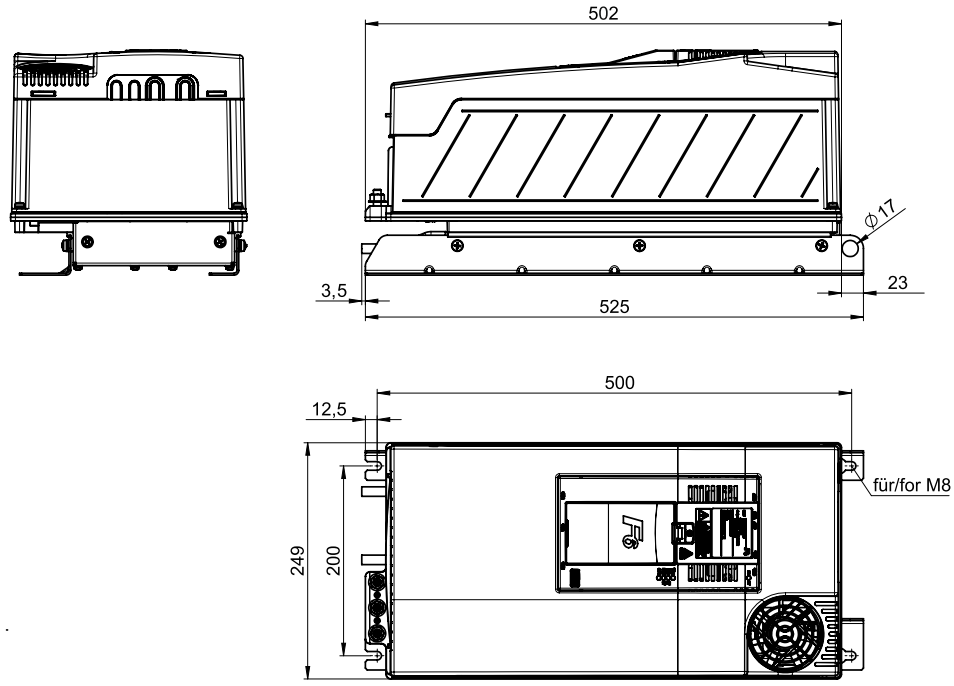
3.3.2 Built-in version water cooler



Housing	6
Weight	18.1 kg
Dimensions	All dimensions in mm

Figure 6: Dimensions built-in version water cooler

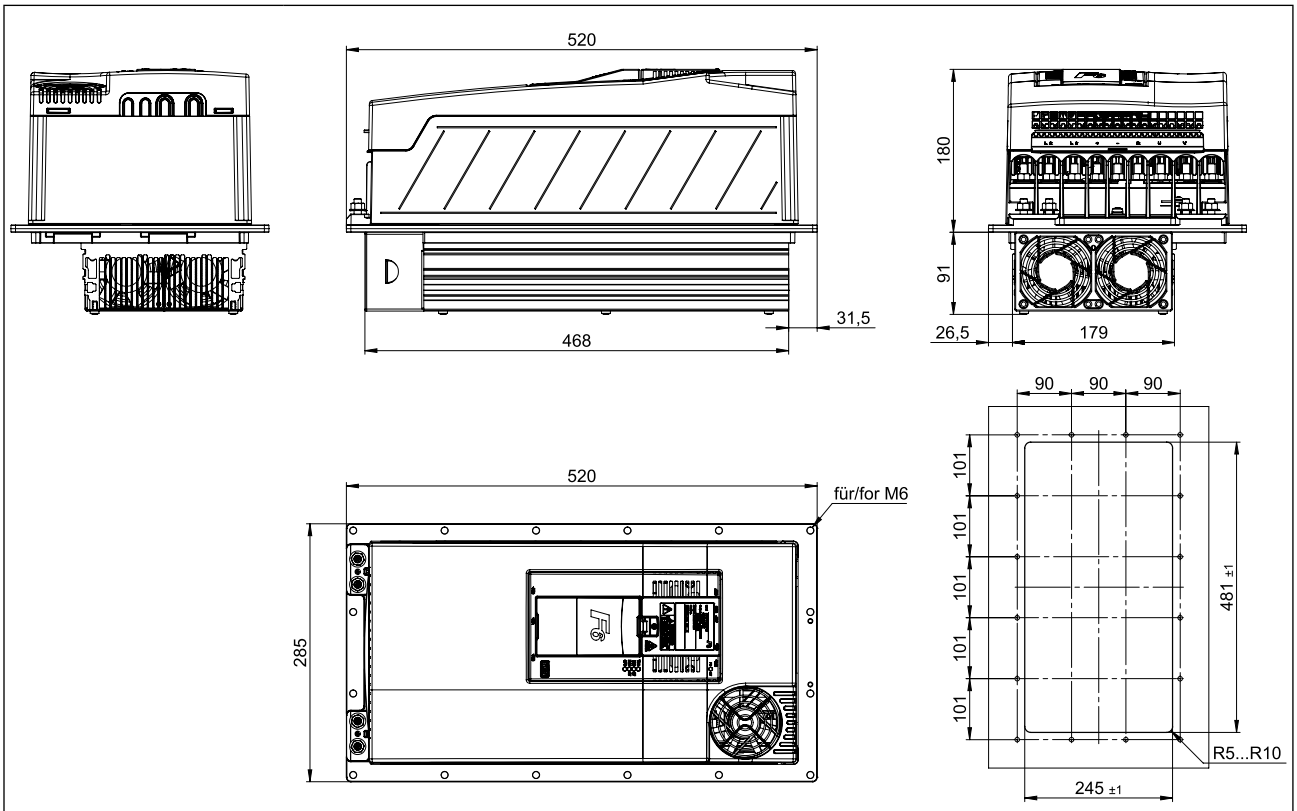
3.3.3 Built-in version water cooler with 2 sub-mounted braking resistors



Housing	6
Weight	20 kg
Dimensions	All dimensions in mm

Figure 7: Dimensions built-in version water cooler with 2 sub-mounted braking resistors

3.3.4 Push-through version air cooler IP54



Housing	6
Weight	20.6 kg
Dimensions	All dimensions in mm

Figure 8: Dimensions push-through version air cooler IP54

IP54 zone: Heat sink underneath the mounting plate

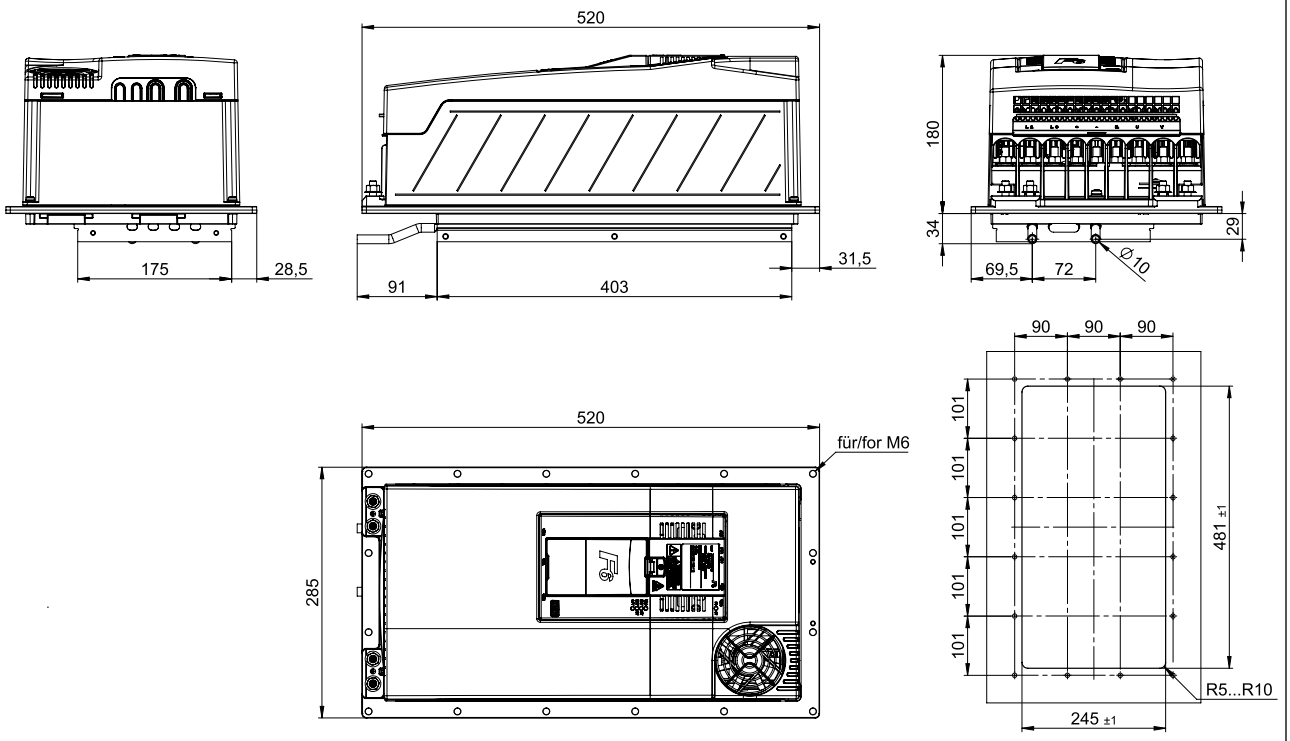
For proper installation, the enclosed seal (60F6T45-0002) must be installed between heat sink and housing (e.g. cabinet wall). The tightness must be checked after the installation. If properly installed, the separation to the housing corresponds to degree of protection IP54. However, the fans must be 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: Unit heat sink is classified as NEMA type 1.

3.3.5 Push-through version water cooler IP54



Housing	6
Weight	17.3 kg
Dimensions	All dimensions in mm

Figure 9: Dimensions push-through version water cooler IP54

IP54 zone: Heat sink underneath the mounting plate

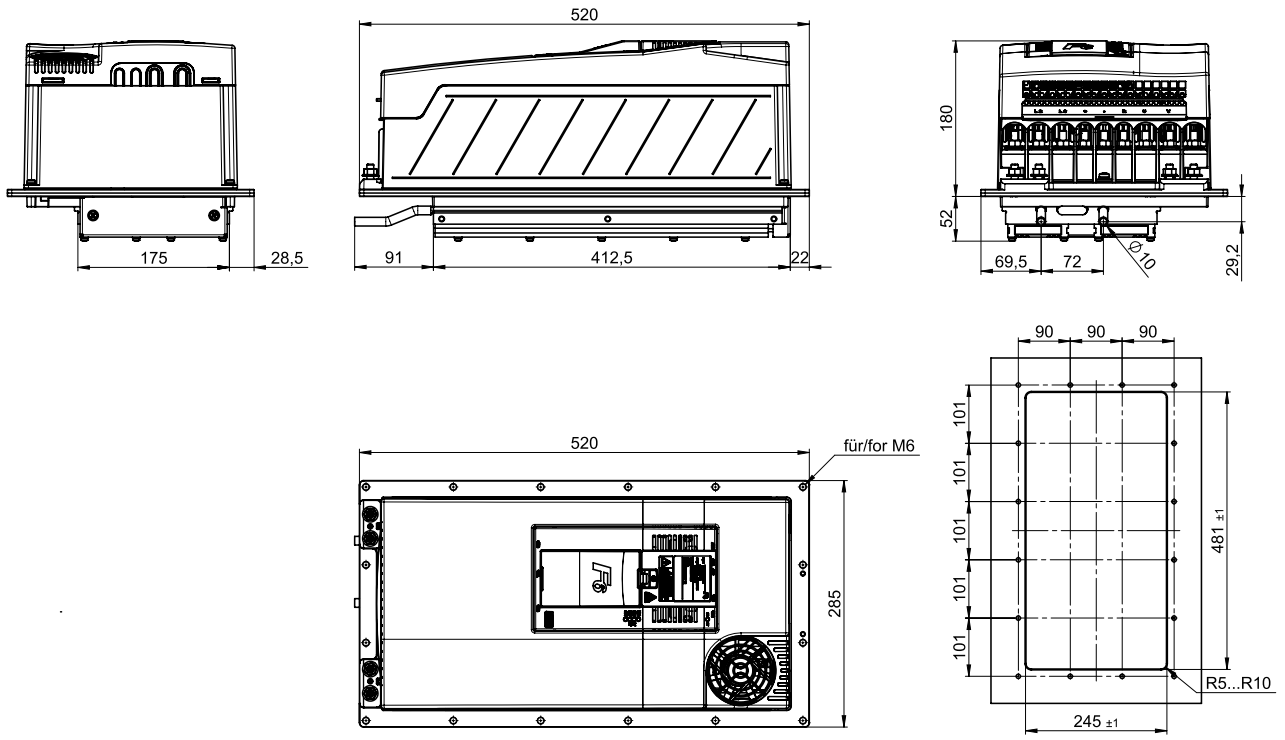
For proper installation, the enclosed seal (60F6T45-0002) must be installed between heat sink and housing (e.g. cabinet wall). The tightness must be checked after the installation. If properly installed, the separation to the housing corresponds to degree of protection IP54.

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: Unit heat sink is classified as NEMA type 1.

3.3.6 Push-through version water cooler IP54 with 2 sub-mounted braking resistors



Housing	6
Weight	19.2 kg
Dimensions	All dimensions in mm

Figure 10: Dimensions push-through version water cooler IP54 with 2 sub-mounted braking resistors

IP54 zone: Heat sink underneath the mounting plate

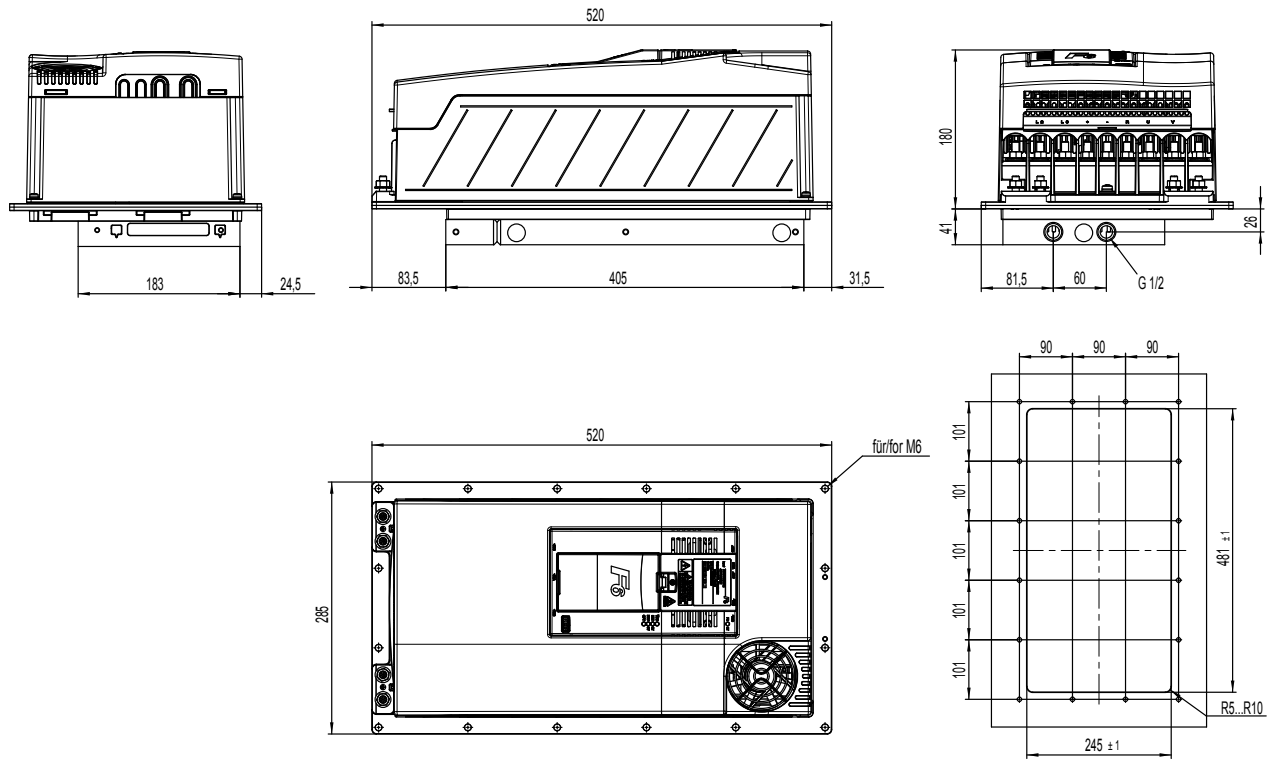
For proper installation, the enclosed seal (60F6T45-0002) must be installed between heat sink and housing (e.g. cabinet wall). The tightness must be checked after the installation. If properly installed, the separation to the housing corresponds to degree of protection IP54.

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: Unit heat sink is classified as NEMA type 1.

3.3.7 Push-through version oil cooler IP54



Housing	6
Weight	21 kg
Dimensions	All dimensions in mm

Figure 11: Dimensions push-through version oil cooler IP54

IP54 zone: Heat sink underneath the mounting plate

For proper installation, the enclosed seal (60F6T45-0002) 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.

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: Unit heat sink is classified as NEMA type 1.

3.3.8 Control cabinet installation

3.3.8.1 Mounting instructions

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

	Type	Tightening torque
Screw	Hexagon head screw *ISO 4017* - M8 - 8.8	22 Nm 194 lb inch
Washer	Flat washer *ISO 7090* - 8 - 200 HV	–

Table 27: Mounting instructions for built-in version

	Type	Tightening torque
Screw	Hexagon head screw *ISO 4017* - M6 - 8.8	9 Nm 80 lb inch
Washer	Flat washer *ISO 7090* - 6 - 200 HV	–

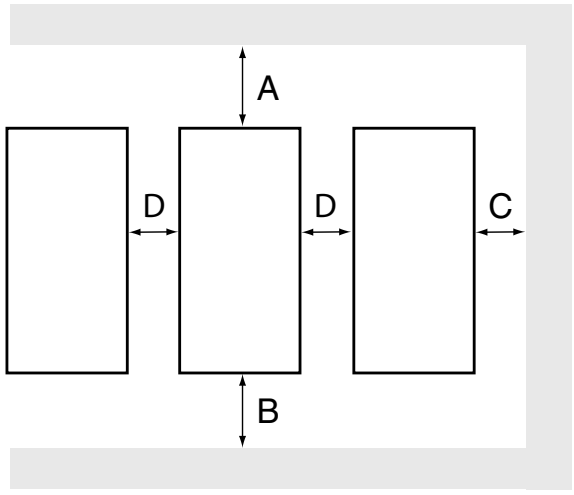
Table 28: Mounting instructions for push-through version

3.3.8.2 Mounting distances

Power dissipation for the control cabinet dimension *„Power dissipation at nominal operating“*. A lower value can be used here depending on the operating mode/load.

Mounting the drive converter

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

Mounting distances	Dimension	Distance in mm	Distance in inch
	A	150	6
	B	100	4
	C	30	1.2
	D	0	0
	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.

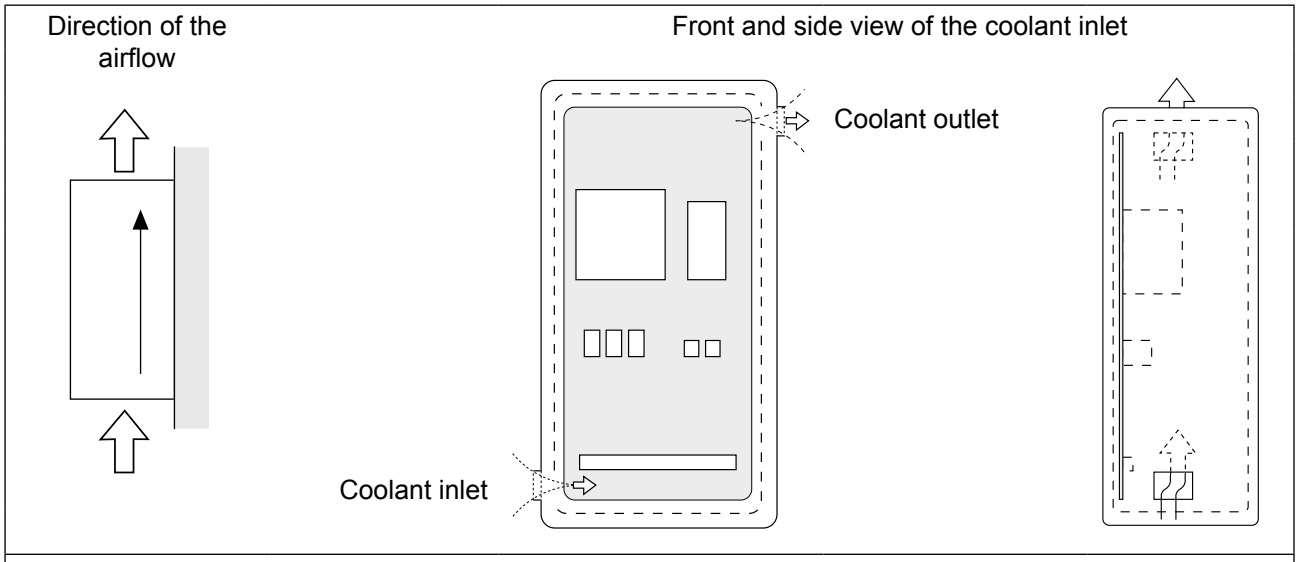


Figure 13: Control cabinet ventilation

4 Installation and Connection

4.1 Overview of the COMBIVERT F6

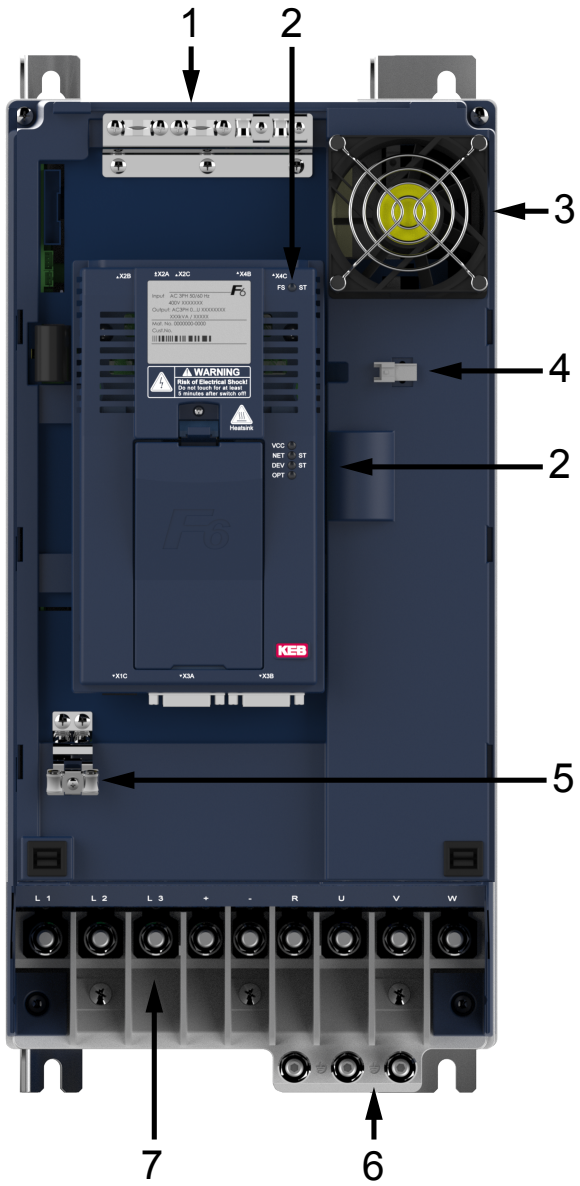
Housing 6	No.	Name	Description
	1 / 5	---	Shield clamps for shielded control lines
	2	---	LEDs (see the manual for control unit chapter „Overview“) • For control card COMPACT: FS without function. • For control card APPLICATION and PRO: Status indication of the safety module
	3	---	Interior fan
	4	---	Connector for the interior fan
	6	PE	Protective earth; at connection to protective earth each terminal may be assigned only once
	7	X1A	Power circuit terminals for: • Mains input • Braking resistor • DC supply • Motor connection

Figure 14: F6 housing 6 top view

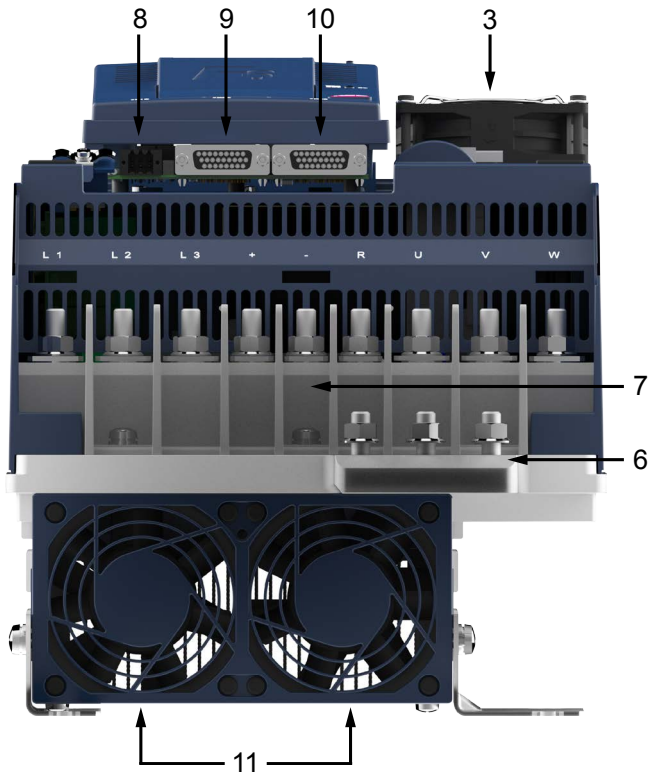
Housing 6	No.	Name	Description
	3	---	Interior fan
	6	PE	Protective earth; at connection to protective earth each terminal may be assigned only once
	7	X1A	Power circuit terminals for: • Mains input • Braking resistor • DC supply • Motor connection
	8	X1C	Motor temperature monitoring, brake control
	9	X3A	Encoder interface channel A
	10	X3B	Encoder interface channel B
	11	---	Heat sink fan

Figure 15: F6 housing 6 front view

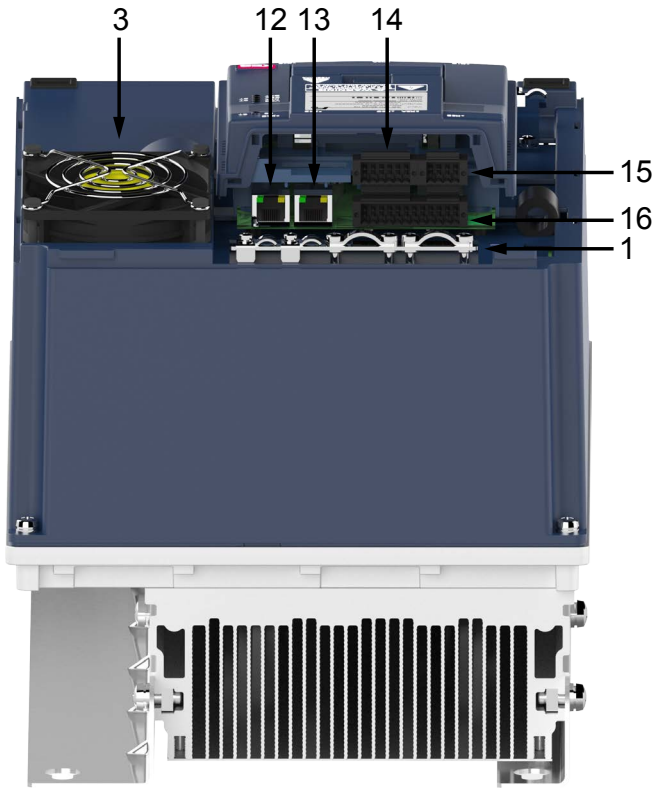
Housing 6	No.	Name	Description
	1	---	Shield clamps for shielded control lines
	3	---	Interior fan
	12	X4C	Fieldbus interface (out)
	13	X4B	Fieldbus interface (in)
	14	X2C	• CAN bus / • Analog inputs and analog output
	15	X2B	Safety functions / 24 V DC voltage supply / 2 digital outputs
	16	X2A	Control terminal block for digital inputs and outputs

Figure 16: F6 housing 6 rear view with control board COMPACT

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

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 APPLICATION
www.keb.de/fileadmin/media/Manuals/dr/ma_dr_f6-cu-a-inst-20118593_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

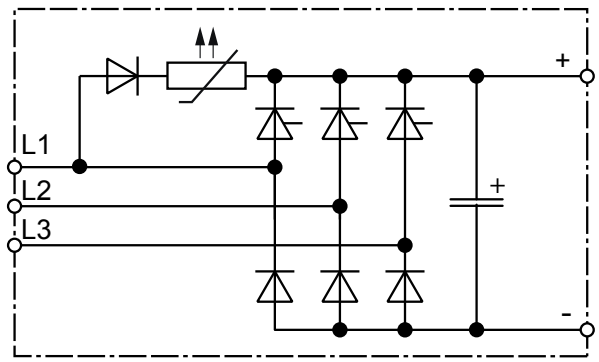
4.2 Connection of the power unit

NOTICE

Destruction of the drive converter!

► Never exchange mains input and motor output!

4.2.1 Connection of the voltage supply



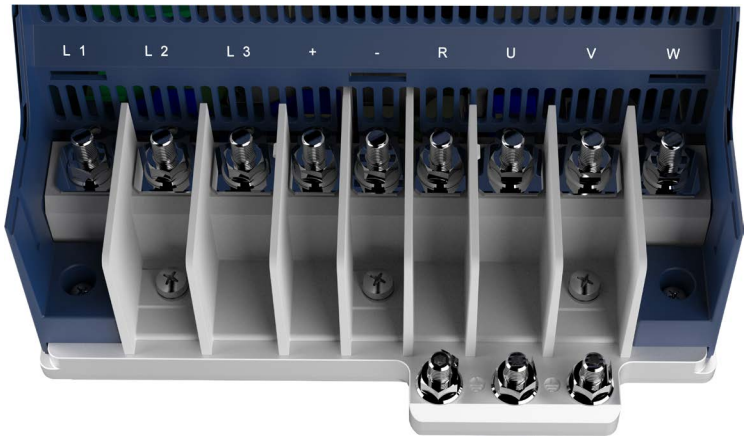
The COMBIVERT F6 housing 6 can be supplied by mains via terminals L1, L2 and L3.

Figure 17: Input circuit

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

Cyclic switching on and off of the unit leads to temporary high resistance of the resistor (PTC) in the input. After the PTC has cooled down, it can be restarted without restrictions.

4.2.1.1 Terminal block X1A for 400 V units



Name	Function	Terminal connection	Tightening torque	Cable lug dimension type	Max. number of conductors [1]
L1	Mains connection 3-phase	8 mm stud for M8 crimp connector	10...15 Nm 88...132 lb inch	1	For IEC: 2 For UL: 2
L2					
L3					
+	DC terminals			2	
-					
R	Connection for braking resistor (between + and R)				
U	Motor connection			1	
V					
W					

Figure 18: Terminal block X1A for 400 V units

[1] From 50mm² only one conductor allowed

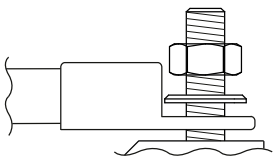
Cable lug dimension		Type 1	Type 2
Max. width	*l/mm*	24	19
Max. shaft length	*l/mm*	46	46
Max. diameter	*l/mm*	19	19

Table 29: Cable lug dimension X1A

Alternatively to a 95 mm² line, 2 parallel 35 mm² lines can also be laid.

NOTICE

Short circuit due too low air and creepage distances!



► The pressing of the cable lugs must point upwards when connecting 95 mm² lines!

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	Connection type	Tightening torque
⏚	Connection for protective earth	M8 threaded pin with nut for M8 crimp connector	10...15 Nm 88...132 lb inch

Figure 19: Connection for protective earth

Incorrect installation of the protective earth

Only M8 threaded pins with nut may be used as connection for 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.

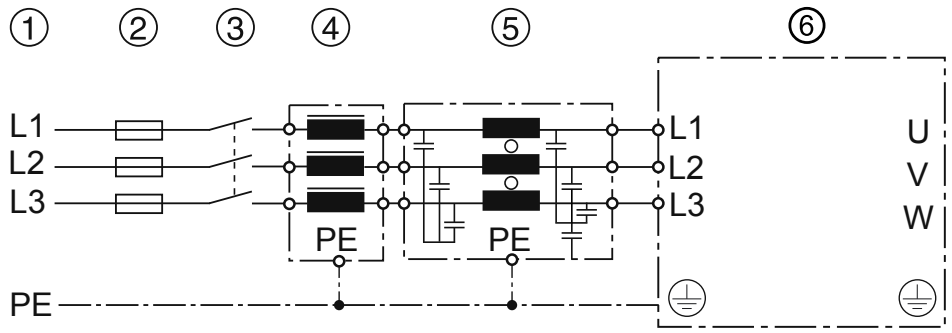
The functional earth may not be wired green / yellow!

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 artificial neutral point in the IT mains) must not exceed 300 V (effective value).	
	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 type and surrounding temperature
- 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 rated apparent output power of the drive converter (S_{out}).

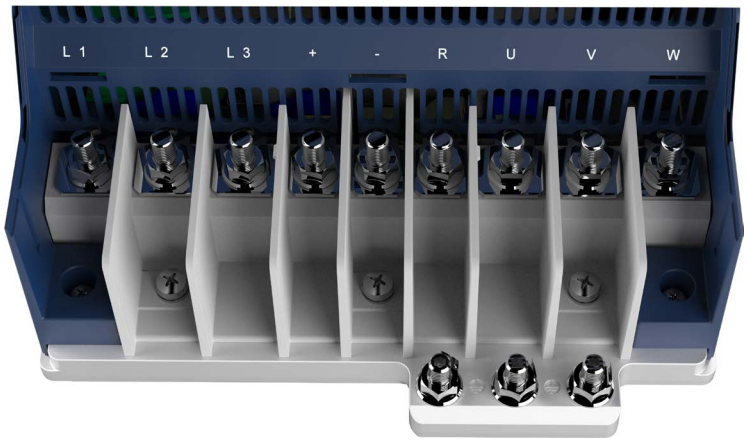
A listing of filters and chokes => *„Filters and chokes“*.

4.2.4 DC connection

NOTICE

DC operation is only permitted after consultation with KEB!

4.2.4.1 Terminal block X1A DC connection



Name	Function	Terminal connection	Tightening torque	Crimp connector dimension type	Max. number of conductors [1]
+	DC terminals	8 mm stud for M8 crimp connector	10...15 Nm 88...132 lb inch	2	For IEC: 2 For UL: 2
-					

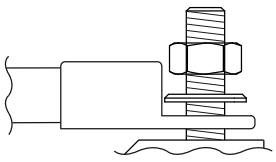
Figure 21: Terminal block X1A DC connection

[1] From 50mm² only one conductor allowed

Crimp connector dimension		Type 2
Max. width	*l/mm*	19
Max. shaft length	*l/mm*	46
Max. diameter	*l/mm*	19

Table 30: Crimp connector dimension DC connection

NOTICE

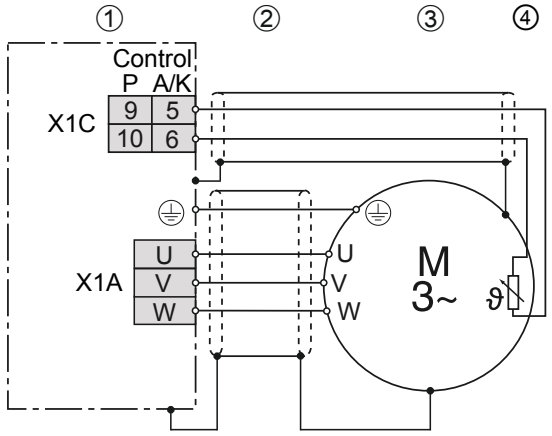


Short circuit due too low air and creepage distances!

► The pressing of the cable lugs must point upwards when connecting 95 mm² lines!

4.2.5 Connection of the motor

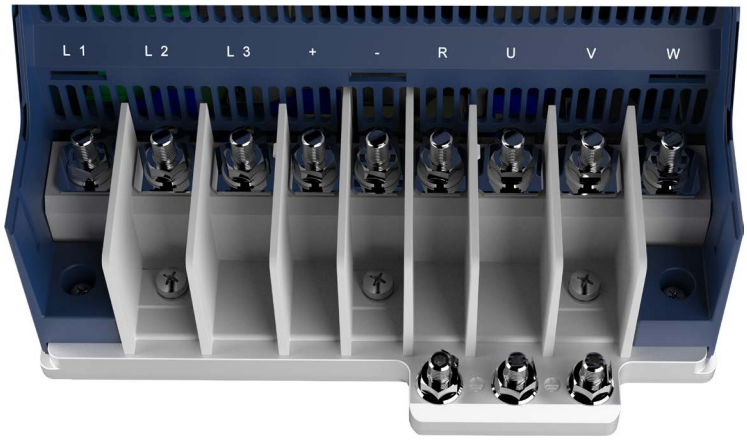
4.2.5.1 Wiring of the motor



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	Terminal connection	Tightening torque	Crimp connector dimension type	Max. number of conductors [1]
U V W	Motor connection	8 mm stud for M8 crimp connector	10...15 Nm 88...132 lb inch	1	For IEC: 2 For UL: 2

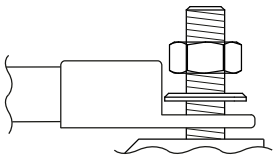
Figure 23: Terminal block X1A motor connection

[1] *From 50mm² only one conductor allowed*

Crimp connector dimension		Type 1
Max. width	*l/mm*	24
Max. shaft length	*l/mm*	46
Max. diameter	*l/mm*	19

Table 31: Crimp connector dimension motor connection

NOTICE



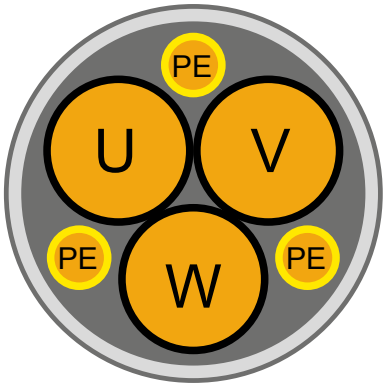
Short circuit due too low air and creepage distances!

► The pressing of the cable lugs must point upwards when connecting 95 mm² lines!

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“*.

Unit size	Max. motor cable length shielded in accordance with *EN 61800-3* Category C2 Motor cable (low capacitance)	max. leakage current (at $f_N \leq 100$ Hz)
21	100 m	< 5 mA
22		
23		
24		

Table 32: 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.

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 cable 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!

NOTICE

Protect motor against voltage peaks!

► Drive converters switch at the output with high du/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*

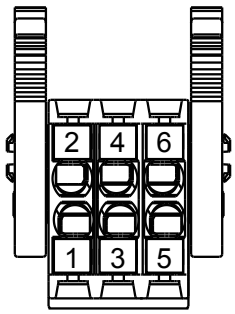
X1C	PIN	Name	Description
	1	BR+	Brake control / output +
	2	BR-	Brake control / output -
	3	reserved	–
	4	reserved	–
	5	TA1	Temperature detection / output +
	6	TA2	Temperature detection / output -

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

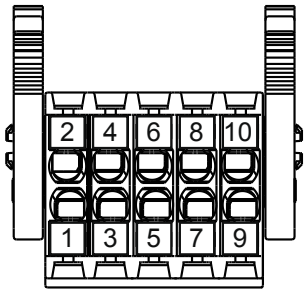
X1C	PIN	Name	Description
	1	BR+	Brake control / output +
	2	BR-	Brake control / output -
	3	0V	For supply of the checkback inputs
	4	24Vout	
	5	DIBR1	Checkback input 1 for brake and relay
	6	DIBR2	Checkback input 2 for brake and relay
	7	reserved	–
	8	reserved	–
	9	TA1	Temperature detection / output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

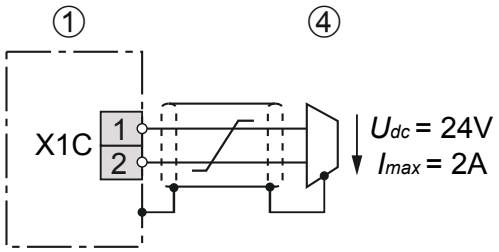
Figure 26: Terminal block X1C for control board PRO

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.



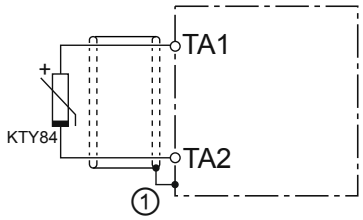
①	COMBIVERT
④	Brake

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“*

⚠ CAUTION

Hot surfaces caused by load of the braking resistor!

Burning of the skin!

► Cover hot surfaces safe-to-touch.

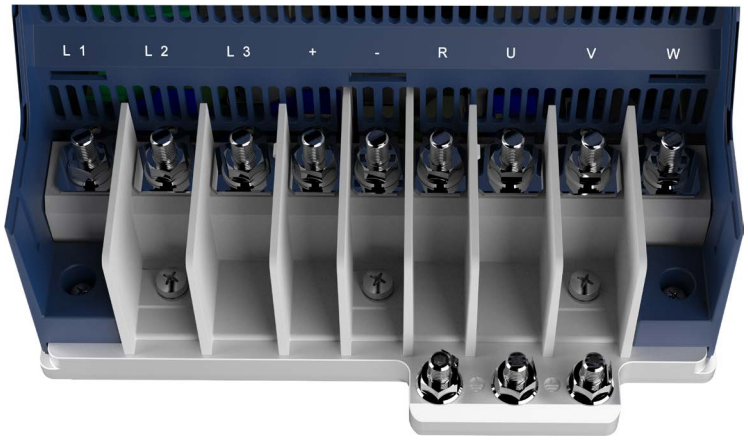
► Before touching, check the surface.

► 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	Terminal connection	Tightening torque	Crimp connector dimension type	Max. number of conductors [1]
+	Connection for braking resistor (between + and R)	8 mm stud for M8 crimp connector	10...15 Nm 88...132 lb inch	2	For IEC: 2
R					For UL: 2

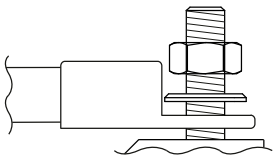
Figure 29: Terminal block X1A connection braking resistor

[1] From 50mm² only one conductor allowed

Crimp connector dimension		Type 2
Max. width	*l/mm*	19
Max. shaft length	*l/mm*	46
Max. diameter	*l/mm*	19

Table 33: Crimp connector dimension braking resistor

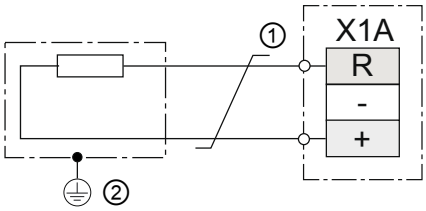
NOTICE



Short circuit due too low air and creepage distances!

► The pressing of the cable lugs must point upwards when connecting 95 mm² lines!

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
400 V	21	22E6T60-3000	21Z1B04-1000
	22	22E6T60-3000	22Z1B04-1000
	23	24E6T60-3000	23Z1B04-1000
	24	24E6T60-3000	24Z1B04-1000

Table 34: Filters and chokes

The specified filters and chokes are designed for rated operation.

4.3.2 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 Installation and operation of liquid-cooled devices

5.1 Water-cooled devices

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

5.1.1 Heat sink and operating pressure

Design system	Material	max. operating pressure	Connection
Aluminium heat sink with stainless steel tubes	Stainless steel 1.4404	10 bar	*=> „Connection of the cooling system“*

NOTICE

Deformation of the heat sink!

- ► In order to avoid a deformation of the heat sink and the damages thereby, the indicated maximum operating pressure may not be exceeded briefly also by pressure peaks.
- ► Observe the pressure equipment directive!

5.1.2 Materials in the cooling circuit

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

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

Material	formed ion	Standard potential	Material	formed ion	Standard potential
Lithium	Li+	-3.04 V	Nickel	Ni2+	-0.25 V
Potassium	K+	-2.93 V	Tin	Sn2+	-0.14 V
Calcium	Ca2+	-2.87 V	Lead	Pb3+	-0.13 V
Sodium	Na+	-2.71 V	Iron	Fe3+	-0.037 V
Magnesium	Mg2+	-2.38 V	Hydrogen	2H+	0.00 V
Titan	Ti2+	-1.75 V	**Stainless steel**	**various**	**0.2...0.4 V**
Aluminium	Al3+	-1.67 V	Copper	Cu2+	0.34 V
Manganese	Mn2+	-1.05 V	Carbon	C2+	0.74 V
Zinc	Zn2+	-0.76 V	Silver	Ag+	0.80 V
Chrome	Cr3+	-0.71 V	Platinum	Pt2+	1.20 V

continued on the next page

Material	formed ion	Standard potential	Material	formed ion	Standard potential
Iron	Fe2+	-0.44 V	Gold	Au3+	1.42 V
Cadmium	Cd2+	-0.40 V	Gold	Au+	1.69 V
Cobald	Co2+	-0.28 V			

Table 35: Electrochemical series / standard potentials against hydrogen

5.1.3 Requirements for the coolant

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

General requirements for the coolant:

Requirement	Description
Standards	Corrosion protection according to *EN 12502-1...5*, water treatment and use of materials in cooling systems according to *VGB R 455 P*.
VGB Cooling water directive	The VGB cooling water directive (*VGB R 455 P*) contains instructions about common process technology of the cooling. Particulary the interactions between cooling water and components of the cooling system are described.
Abrasive substances	Abrasive substances as used in abrasive (quartz sand), clogging the cooling circuit.
Hard water	Cooling water may not cause scale deposits or loose excretions. It shall have a low total hardness (<20°d) especially carbon hardness.
Soft water	Soft water (<7°dH) corrodes the material.
Frost protection	An appropriate antifreeze must be used for applications when the heat sink or the coolant is exposed temperatures below zero. Use only products of one manufacturer for a better compatibility with other additives.
Corrosion protection	Additives can be used as corrosion protection. In connection with frost protection the antifreeze must have a concentration of 20…25 Vol %, in order to avoid a change of the additives.

Table 36: Coolant requirements for water coolers

Special requirements for open and half-open cooling systems:

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

Table 37: Special requirements for open and half-open cooling systems for water coolers:

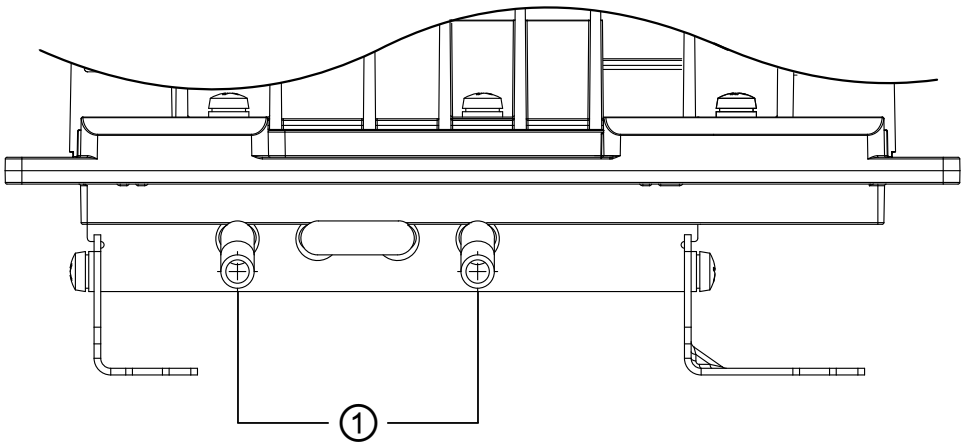
Damages at the unit which are caused by clogged, corroded heat sinks or other obvious operating errors, leads to the loss of the warranty claims.

5.1.4 Connection of the cooling system

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

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

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



Legend	
①	Open pipe ends for the connection of the cooling system Pipe diameter outside: 10 mm Pipe diameter inside: 7...8 mm

Figure 31: Open pipe ends for the connection of the cooling system for water coolers

Straight screw-in connections, cutting rings and union nuts (e.g. from Parker Ermeto) can be used for the connection of the cooling system.

KEB recommends the use of a flow switch in order to monitor the flow in the cooling system.

5.1.5 Coolant temperature and moisture condensation

The inlet temperature may not exceed 40°C. The maximum heat sink temperature can be found in chapter *„Switching frequency and temperature“*. To ensure a safe operation the coolant output temperature should be 10K below the heat sink temperature.

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

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

ATTENTION

Destruction of the drive converter due to short circuit!

► The user must guarantee that any moisture condensation is avoided!

5.1.5.1 Avoid moisture condensation

Supply of temper coolant

This is possible by using heatings in the cooling circuit for the control of the coolant temperature. The following dew point table is available for this:

The following table shows the coolant inlet temperature as a function of ambient temperature and air humidity.

Air humidity / % / Surrounding temperature / °C	10	20	30	40	50	60	70	80	90	100
-25	-45	-40	-36	-34	-32	-30	-29	-27	-26	-25
-20	-42	-36	-32	-29	-27	-25	-24	-22	-21	-20
-15	-37	-31	-27	-24	-22	-20	-18	-16	-15	-15
-10	-34	-26	-22	-19	-17	-15	-13	-11	-11	-10
-5	-29	-22	-18	-15	-13	-11	-8	-7	-6	-5
0	-26	-19	-14	-11	-8	-6	-4	-3	-2	0
5	-23	-15	-11	-7	-5	-2	0	2	3	5
10	-19	-11	-7	-3	0	1	4	6	8	9
15	-18	-7	-3	1	4	7	9	11	13	15
20	-12	-4	1	5	9	12	14	16	18	20
25	-8	0	5	10	13	16	19	21	23	25
30	-6	3	10	14	18	21	24	26	28	30
35	-2	8	14	18	22	25	28	31	33	35
40	1	11	18	22	27	31	33	36	38	40
45	4	15	22	27	32	36	38	41	43	45
50	8	19	28	32	36	40	43	45	48	50
	Coolant inlet temperature / C°									

Table 38: Dew point table

Temperature control

The cooling can be switched on by means of a pneumatic valve or a solenoid valve, which is connected uptream by a relay. The valves for temperature control must be used in the flow line of the cooling circuit in order to avoid pressure surges. All conventional valves can be used. Make sure that the valves are working properly and do not clamp.

NOTICE

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

Observe the following points when storing water-cooled devices:

► Completely empty the cooling circuit

► Blow out the cooling circuit with compressed air

Destruction of the drive converter due to condensation!

► Use only NC valves!

5.1.6 Coolant heating

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

The following graphic shows examples of measurements with different flow rates.

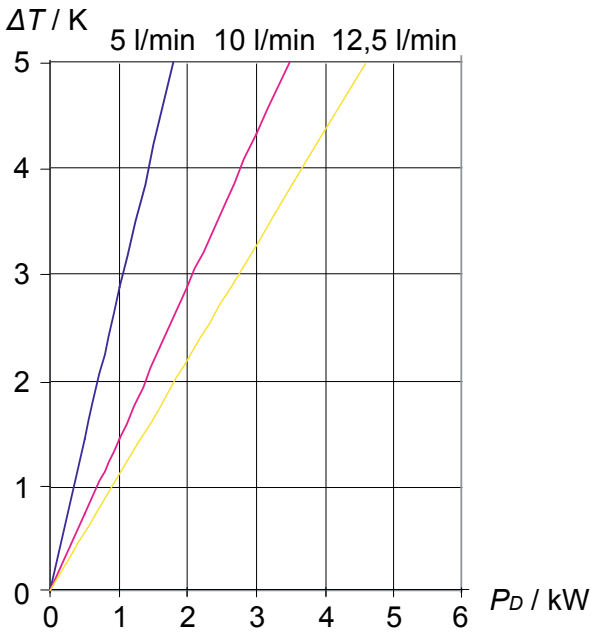


Figure 32: Coolant heating depending on power loss and flow rate with water

5.1.7 Typical pressure drop of the heat sink

The following graphic shows the typical pressure drop of the heat sink.

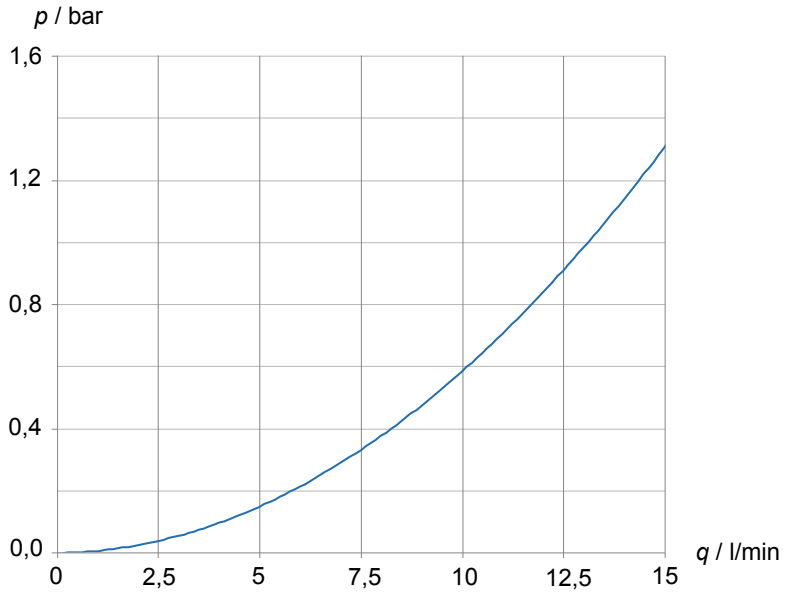


Figure 33: Typical pressure drop depending on the flow rate for water

5.2 Oil-cooled devices

The following instructions must be observed when using the device.

5.2.1 Heat sink and operating pressure for oil-cooled devices

Design system	Material	max. operating pressure	Connection
Aluminium heat sink	Aluminium 3.3206	10 bar	*=> „Connection of the oil cooling system“*

ATTENTION

Deformation of the heat sink!

- ► In order to avoid a deformation of the heat sink and the damages thereby, the indicated maximum operating pressure may not be exceeded briefly also by pressure peaks.
- ► Observe the pressure equipment directive!

5.2.2 Oil requirements

General requirements for the oil:

Requirement	Description
Characteristic of the oil	Hydraulic oil HLP 46 (ISO VG 46)
Oils with appropriate properties	• Mobil DTE 25 • Shell Tellus Oil 46 • Castrol Hyspin ZZ 46 Or similar oils

Table 39: Oil requirements

Special requirements for open and half-open cooling systems:

Impurities	Mechanical impurities in half-open cooling systems can be counteracted by using appropriate filters.
Organic materials	The contamination with organic materials must be kept as small as possible, because separate slime can be caused by this.

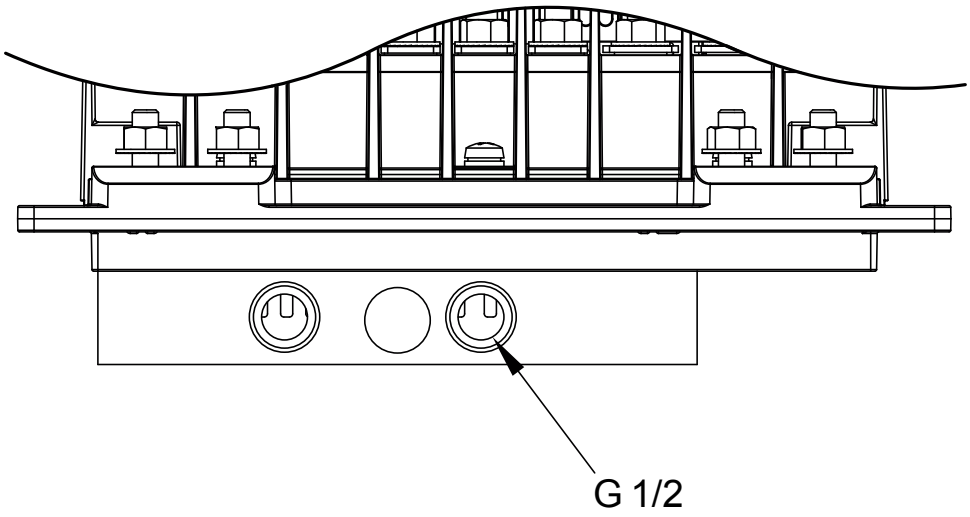
Table 40: Special requirements for open and semi-open cooling systems for oil coolers

Damage to the device resulting from clogged heat sinks or other obvious usage failures leads to the loss of warranty claims.

5.2.3 Connection of the oil cooling system

The connection to the oil cooling system can occur as closed or open cooling circuit. Connection to a closed cooling circuit is recommended, because the risk of oil contamination is very low.

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



Legend	
①	G 1/2 internal thread

Figure 34: Connection of the oil cooling system

KEB recommends the use of a flow switch in order to monitor the flow in the cooling system.

5.2.4 Permissible flow rate

The flow rates of the following table must be observed.

Permissible flow rate		
Min. flow rate	*l* / min	15
Max. flow rate	*l* / min	25

Table 41: Permissible flow rate for the oil cooler

5.2.5 Coolant temperature and moisture condensation

The inlet temperature may not exceed 55°C. The maximum heat sink temperature can be found in chapter *„Switching frequency and temperature“*. To ensure safe operation, the oil outlet temperature should be 10K below the heat sink temperature.

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

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

NOTICE

Destruction of the drive converter due to short circuit!

► The user must guarantee that any moisture condensation is avoided!

5.2.5.1 Avoid moisture condensation

Supply of temper oil

This is possible by using heatings in the cooling circuit for the control of the coolant temperature. The following dew point table is available for this:

The following table shows the coolant inlet temperature as a function of ambient temperature and air humidity.

Air humidity / % / Surrounding temperature / °C	10	20	30	40	50	60	70	80	90	100
-25	-45	-40	-36	-34	-32	-30	-29	-27	-26	-25
-20	-42	-36	-32	-29	-27	-25	-24	-22	-21	-20
-15	-37	-31	-27	-24	-22	-20	-18	-16	-15	-15
-10	-34	-26	-22	-19	-17	-15	-13	-11	-11	-10
-5	-29	-22	-18	-15	-13	-11	-8	-7	-6	-5
0	-26	-19	-14	-11	-8	-6	-4	-3	-2	0
5	-23	-15	-11	-7	-5	-2	0	2	3	5
10	-19	-11	-7	-3	0	1	4	6	8	9
15	-18	-7	-3	1	4	7	9	11	13	15
20	-12	-4	1	5	9	12	14	16	18	20
25	-8	0	5	10	13	16	19	21	23	25
30	-6	3	10	14	18	21	24	26	28	30
35	-2	8	14	18	22	25	28	31	33	35
40	1	11	18	22	27	31	33	36	38	40
45	4	15	22	27	32	36	38	41	43	45
50	8	19	28	32	36	40	43	45	48	50
	Coolant inlet temperature / C°									

Table 42: Dew point table

6 Certification

6.1 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 information and documentation“*.

6.2 UL certification

	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):

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

  CSA: For Canada: Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the Canadian Electrical Code, Part I.
- Only for use in non-corner grounded type WYE source not exceeding 277V phase to ground.
- For installations according to Canadian National Standard C22.2 No. 274-13:

  For use in Pollution Degree 2 and Overvoltage Category III environments only.
- Suitable For Use On A Circuit Capable Of Delivering Not More Than 10000 rms Symmetrical Amperes, 480 Volts Maximum when protected by Class J Fuses, see instruction manual for Branch Circuit Protection details.

  Suitable For Use On A Circuit Capable Of Delivering Not More Than 30000 rms Symmetrical Amperes, 480 Volts Maximum when protected by Semiconductor Fuses by SIBA (Type 20 189 20.), or by Bussmann (Type 170M13), or by Littelfuse (Type L70QS), see instruction manual for Branch Circuit Protection details.

  Details of the prescribed Branch Circuit Protection as specified in the below section ‘Branch Circuit Protection’ of this Report need to be marked in the instruction manual.
- 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.
- Brake resistor ratings and duty cycle:
  - Duty cycle 50%
  - Max. 60 sec on-time / 60 sec off-time

6.3 Further information and documentation

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

General instructions

- EMC and safety instructions
- Manuals for further control boards

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 certification
- FS certification

Others

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

7 Revision History

Version	Date	Description
00	2016-09	Pre-series
01	2017-11	Series, new CI, water cooling, UL certification included
02	2018-11	Corrections of technical drawings, Figures of the overload characteristics adapted
03	2019-10	Adding of devices with sub-mounted braking resistors
04	2020-03	Inclusion of the oil-cooled devices

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