COMBIVERT **F6**

INSTRUCTIONS FOR USE | **INSTALLATION F6 HOUSING 8**

Original manual - Pre-series -
Document 20120983 EN 01

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/nc/search

Laws and guidelines

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

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

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Glossary

0V	Earth-potential-free common point
1ph	1-phase mains
3ph	3-phase mains
AC	AC current or voltage
AFE	Active Front End module (AIC)
AFE filter	Filter for the AFE device
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
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
I²t-monitoring	Software function for thermal monitoring of the motor winding
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)
PA	Potential equalization
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

Port	Part of a network address to the assignment of TCP and UDP connections
PT100	Temperature sensor with R0=100Ω
PT1000	Temperature sensor with R0=1000Ω
PTC	PTC-resistor for temperature detection
PWM	Pulse width modulation
RJ45	Modular connector with 8 lines
SCL	Synchronous sensorless closed loop
SELV	Safety Extra Low Voltage (< 60 V)
SIL	The security integrity level is a measure for quantifying the risk reduction. Term used in the safety technology (EN 61508 -1...7)
SS1	Safety function „Safe stop 1“ in accordance with IEC 61800-5-2
SSI	Synchronous serial interface for encoder
STO	Safety function „Safe Torque Off“ in accordance with IEC 61800-5-2
TTL	Incremental signal with an output voltage up to 5 V
USB	Universal serial bus
VARAN	Real-time Ethernet bus system

Standards for drive converters / control cabinets

Product standards that apply directly to the drive converter

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

Basic standards to which drive converter standards refer directly

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

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

Standards that are used in the environment of the drive converter

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

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

1.2 Transport, storage and proper use

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

Transport of drive converters with an edge length >75 cm

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

► Transport of drive converters on suitable pallets.

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

Drive converters contain electrostatic sensitive components.

► Avoid contact.

► Wear ESD-protective clothing.

Do not store drive converters

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

1.3 Installation

⚠ DANGER

Do not operate in an explosive environment!

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

⚠ CAUTION

Maximum design edges and high weight!

Contusions and bruises!

► Never stand under suspended loads.

► Wear safety shoes.

► Secure drive converter accordingly when using lifting gear.

To prevent damages to the device:

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

1.4 Electrical connection

⚠ DANGER

Voltage at the terminals and in the device!

Danger to life due to electric shock !

- ► Never work on the open device or never touch exposed parts.
- ► For any work on the unit switch off the supply voltage, secure it against switching on and check absence of voltage by measurement.
- ► Wait until all drives has been stopped in order that no regenerative energy can be generated.
- ► Await capacitor discharge time (5 minutes) if necessary, measure DC voltage at the terminals.
- ► If personal protection is required, install suitable protective devices for drive converters.
- ► Never bridge upstream protective devices (also not for test purposes).
- ► Connect the protective earth conductor always to drive converter and motor.
- ► Install all required covers and protective devices for operation.
- ► The control cabinet shall be kept closed during operation.
- ► Residual current: This product may cause a dc current in the protective earth conductor. When a residual current protective device (RCD) or a residual current monitoring device (RCM) is used for the protection against direct or indirect contact, only a RCD or RCM type B is permitted on the power supply side of this product.
- ► Drive converters with a leakage current > 3.5 mA AC current (10 mA DC current) are intended for a stationary connection. Protective earth conductors must be designed in accordance with the local regulations for equipment with high leakage currents according to *EN 61800-5-1, EN 60204-1* or *DIN IEC 60364-5-54* .

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

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

For a trouble-free and safe operation, please pay attention to the following instructions:

- The electrical installation shall be carried out in accordance with the relevant requirements.
- Cable cross-sections and fuses must be dimensioned by the user according to the specified minimum/maximum values for the application.
- The wiring must be made with flexible copper cable for a temperature > 75°C.
- Connection of the drive converter is only permissible on symmetrical networks with a maximum line voltage (L1, L2, L3) with respect to earth (N/PE) of max. 300 V. An isolating transformer must be used for supply networks which exceed this value! In case of non-compliance the control is not longer considered to be a PELV circuit.
- With existing or newly wired circuits the person installing the units or machines must ensure that the PELV requirements are met.
- For drive converters that are not isolated from the supply circuit (in accordance with *EN 60721-3-2*) all control lines must be included in other protective measures (e.g. double insulation or shielded, earthed and insulated).
- When using components without isolated inputs/outputs, it is necessary that equipotential bonding exists between the components to be connected (e.g. by the equipotential line). Disregard can cause destruction of the components by equalizing currents.

1.4.1 EMC-compatible installation

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

Notes on EMC-compatible installation can be found here.
www.keb.de/fileadmin/media/Manuals/emv/0000neb0000.pdf

1.4.2 Voltage test

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

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

According to *EN 60204-1* it is permissible to disconnect already tested components. Drive converters of the KEB Automation KG are delivered ex works voltage tested to 100% according to product standard.

1.4.3 Insulation measurement

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

1.5 Start-up and operation

The drive converter must not be started until it is determined that the installation complies with the machine directive; Account is to be taken of *EN 60204-1*.

⚠ WARNING

Software protection and programming!

Hazards caused by unintentional behavior of the drive!

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

⚠ CAUTION

High temperatures at heat sink and coolant!

Burning of the skin!

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

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

If a drive converter with electrolytic capacitors in a DC link (see technical data) has not been in operation for more than one year, observe the following instructions.
www.keb.de/fileadmin/media/Manuals/knowledge/04_techinfo/00_general/ti_format_capacitors_0400_0001_gbr.pdf

NOTICE

Continuous operation (S1) with load > 60 %!

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

Die folgenden Wartungsarbeiten sind nach Bedarf, mindestens jedoch einmal pro Jahr, durch autorisiertes und eingewiesenes Personal durchzuführen.

► Check unit 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.

1.7 Repair

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

⚠ DANGER

Unauthorized exchange, repair and modifications!

Unpredictable malfunctions!

- ► The function of the drive 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.

1.8 Disposal

Drive converters with safety function are limited to a service life of 20 years. Then the devices must be replaced.

Drive converters of the KEB Automation KG are professional, electronic devices exclusively for further industrial processing (so-called B2B devices). Thus the marking does not occur with the symbol of the crossed-out wheeled bin, but by the word mark and the date of manufacture.

Unlike devices mainly used in private households, these devices may not be disposed at the collection centres of public sector disposal organisations. They must be disposed after the end of use in accordance with national applicable law to environmentally correct disposal of electrical and electronic equipment.

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 converters 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 nameplate 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:	160...315 kW / 400 V
Housing	8

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
- The 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
  - 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 the s-curves are adjustable to protect the gearbox
- General protection functions of the COMBIVERT series against overcurrent, overvoltage, ground fault and overtemperature
- Analog inputs and outputs, digital inputs and outputs, relay output (potential-free), brake control and -supply, motor protection by I^2t, KTY- or PTC input, two encoder interfaces, diagnostic interface, fieldbus interface (depending on the control board)
- Integrated safety function according to *EN 61800-5-2*

2.4 Type code

x x	F 6	x	x	x	- x	x	x	x		
								Heat sink version	1: Air cooler, built-in version	
									2: Liquid cooler, built-in version	
									3: Air cooler, push-through version IP54	
									4: Liquid cooler, push-through version IP54	
									5: Air cooler, push-through version IP20	
								Control board version	APPLICATION	
									1: Multi Encoder Interface, CAN® [2], Real-Time Ethernet bus module [3]	
									COMPACT	
									1: Multi Encoder Interface, CAN® [2], STO, EtherCAT® [1]	
									2: Multi Encoder Interface, CAN® [2], STO, VARAN	
									PRO	
									1: Multi Encoder Interface, CAN® [2], Real-Time Ethernet interface [3]	
									4: No Encoder, CAN® [2], Real-Time Ethernet interface [3], safe relay	
								Switching frequency, software current limit, overcurrent	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	1: Safety module type 1 / STO at control type K	
									3: Safety module type 3	
									4: Safety module type 4	
									5: Safety module type 5	
								Control type	A: APPLICATION	
									K: COMPACT	
									P: PRO	
								Series	COMBIVERT F6	
								Unit size	12…32	

Table 1: Type code

The type code is not used as order code, but only for identification!

[1] *EtherCAT® is a registered trademark and patented technology licensed by the Beckhoff Automation GmbH, Germany.*

[2] *CANopen® is a registered trademark of the CAN in AUTOMATION - International Users and Manufacturers Group e.V.*

[3] *The Real-Time Ethernet bus module / the Real-Time Ethernet interface contains various fieldbus controls which can be set 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 ambient 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
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 carried out when wiring the control system.

Table 2: Climatic ambient conditions

3.1.2 Mechanical ambient conditions

Storage	**Standard**	**Class**	**Descriptions**
Vibration limits	*EN 60721-3-1*	1M1	Vibration amplitude 0.3 mm (2…9 Hz) Acceleration amplitude 1 m/s² (9…200 Hz)
Shock limit values	*EN 60721-3-1*	1M1	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 3.5 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

The indicated values are only valid for units with external filter.

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 400 V 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			**27**	**28**	**29**	**30**	
Housing					**8**		
Rated apparent output power		S_{out} / kVA	208	256	319	395	
Max. rated motor power		P_{mot} / kW	160	200	250	315	
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	315	390	485	600	
Rated input current @ U_N = 480V		I_{IN_UL} / A	313	374	429	494	
Output voltage		U_{out} / V	0...Uin respectively (Uindc / √2)				
Output frequency	2)	f_{out} / Hz	0...599				
Output phases			3				
Rated output current @ U_N = 400V		I_N / A	300	370	460	570	
Rated output current @ U_N = 480V		I_{N_UL} / A	302	361	414	477	
Rated output overload (60 s)	1) 5)	I_{60s} / %	125				150
Software current limit		I_{lim} / %	125				150
Overcurrent	1)	I_{OC} / %	150				180
Rated switching frequency		f_{SN} / kHz	tbd	tbd	tbd	2	
Max. switching frequency	4)	f_{S_max} / kHz	tbd	tbd	tbd	12	
Power dissipation at nominal operating	3)	P_D / W	tbd	tbd	tbd	5000	
Overload current over time		I_{OL} / %	=> „Overload characteristic (OL)“				
Maximum current 0Hz / 50Hz bei f_S = 2 kHz		I_{Max_Out} / %	tbd	tbd	tbd	tbd	72 / 172
Maximum current 0Hz / 50Hz at f_S = 4 kHz		I_{Max_Out} / %	tbd	tbd	tbd	tbd	40 / 110
Maximum current 0Hz / 50Hz at f_S = 8 kHz		I_{Max_Out} / %	tbd	tbd	tbd	tbd	17 / 54
Maximum current 0Hz / 50Hz at f_S = 12 kHz		I_{Max_Out} / %	tbd	tbd	tbd	tbd	9 / 31
Max. braking current		I_{B_max} / A	380				
Min. brake resistance value		R_{B_min} / Ω	2.2				
Protection function for braking transistor (GTR7)			Short-circuit monitoring				
Insulating resistance @ U_{dc} = 500V		R_{iso} / MΩ	> 15				

Table 7: Overview of the 400V unit data

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

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

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	$\pm f_N$ / 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 DC operation of the 400V units

Output voltage at AC supply	1)	U_{out} / V	0…U_{N_ac}
Output voltage at DC supply	1)	U_{out} / V	0…$U_{N\_dc}/\sqrt{2}$
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		27	28	29	30
Rated input current @ U_N = 400V	I_{IN} / A	315	390	485	600
Rated input current @ U_{N_UL} = 480V	I_{IN_UL} / A	249	313	429	494

Table 11: Input currents of the 400 V units

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

Unit size			27	28	29	30
Rated output current @ U_N = 400V		I_N / A	300	370	460	570
Rated output current @ U_{N_UL} = 480V		I_{N_UL} / A	240	302	414	477
Rate output overload (60 s)	[1]	I_{60s} / %	125			150
Overload current	[1]	I_{OL} / %	=> „Overload characteristic (OL)“			
Software current limit	[2]	I_{lim} / %	125			150
Overcurrent	[1]	I_{OC} / %	150			180

Table 12: Output currents of the 400 V unit data

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

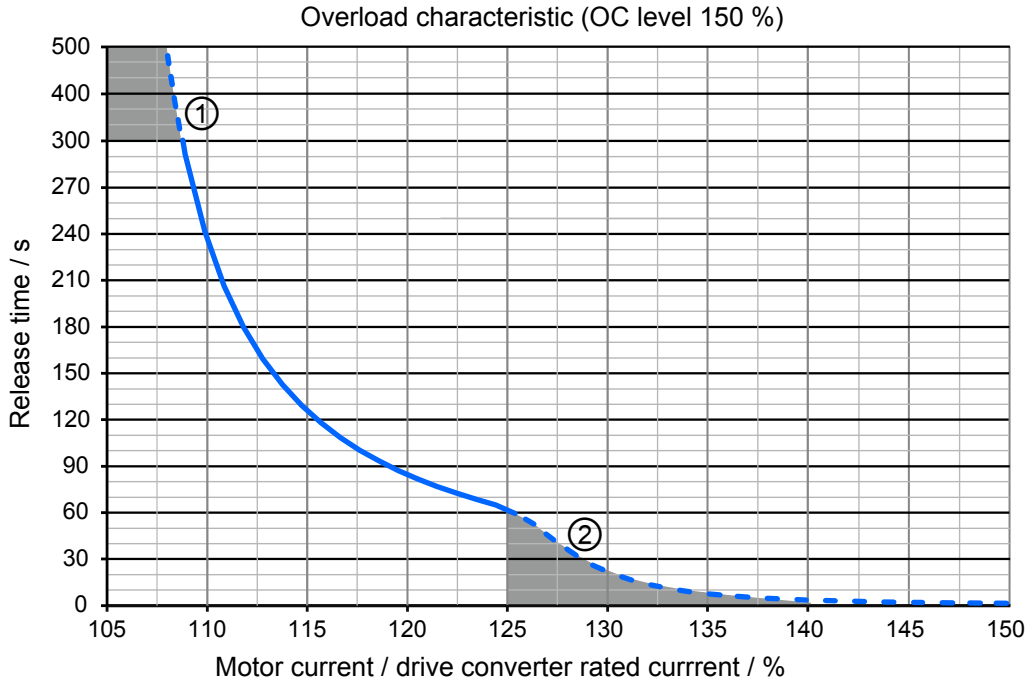
[2] *Limitation of the current setpoint in closed-loop operation. This setpint limit is not active in v/f operation.*

3.2.3.1 Overload characteristic (OL)

All drive converters can be operated at rated switching frequency with an utilization of 125 % for 60 s.

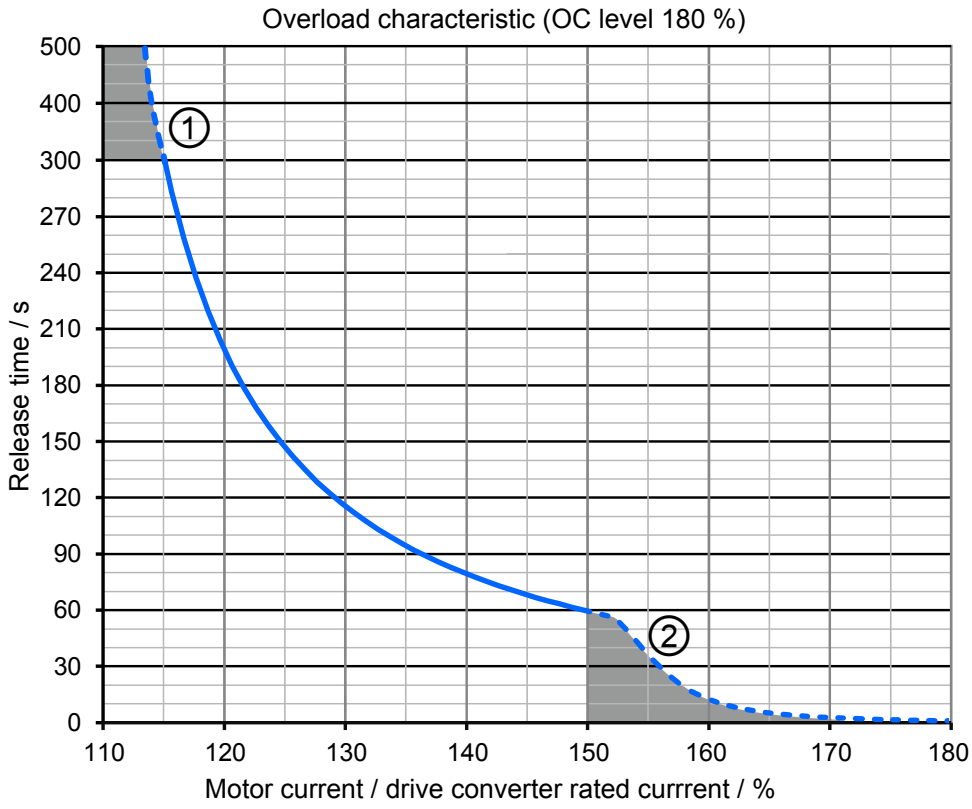
Restrictions:

- 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 150 % (OL overload characteristic)



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

Figure 2: 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 period.

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, a maximum overload time of 300 s should be assumed when designing the drive converter

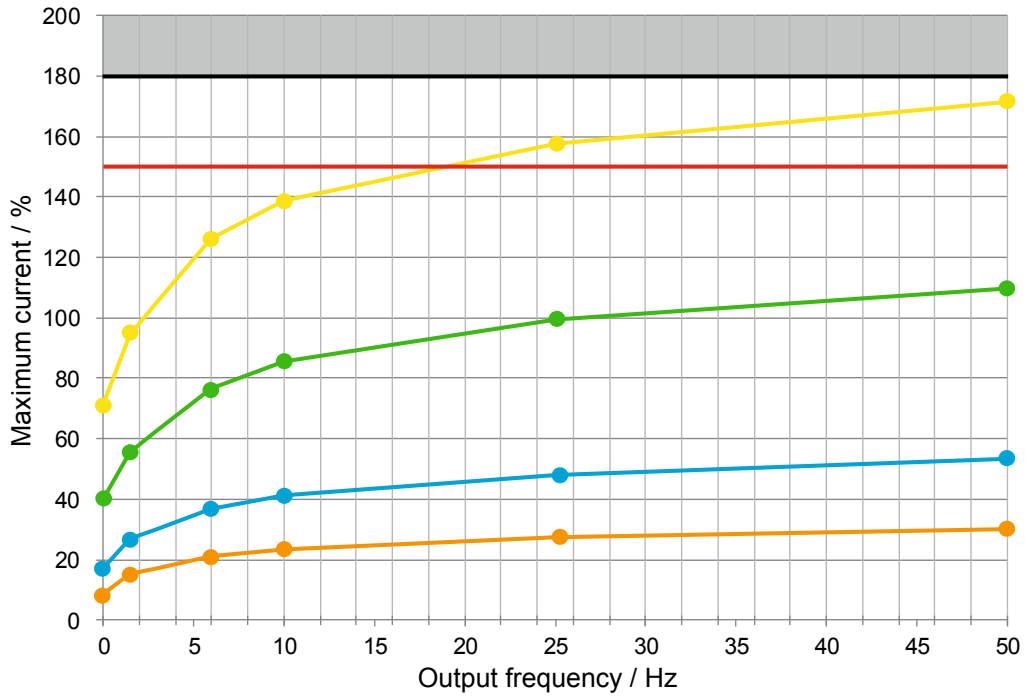
3.2.3.2 Frequency-dependent maximum current (OL2)

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 for housing size 8:

- 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 characteristics indicate the permissible maximum current for the output frequency values 0 Hz, 1,5 Hz, 6 Hz, 10 Hz, 25 Hz and 50 Hz. Unit size 30 (OC level: 180 %) 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
	Not available for modulation. Error OC is triggered at 180% overload.

Figure 3: Typical overload characteristics in the lower output frequencies (OL2) example unit size 30

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

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.

Unit size		**27**					
Rated switching frequency		**tbd kHz**					
Output frequency	**f_{out} / Hz**	**0**	**1.5**	**6**	**10**	**25**	**50**
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 62.5 µs (Parameter is22=0)*	2 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	4 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	8 kHz	tbd	tbd	tbd	tbd	tbd	tbd
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 71.4 µs (Parameter is22=1)*	1.75 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	3.5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	7 kHz	tbd	tbd	tbd	tbd	tbd	tbd
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 83.3 µs (Parameter is22=2)*	1.5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	3 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	6 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	12 kHz	tbd	tbd	tbd	tbd	tbd	tbd
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 100 µs (Parameter is22=3)*	1.25 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	2.5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	10 kHz	tbd	tbd	tbd	tbd	tbd	tbd

Table 13: Frequency-dependent maximum current for unit size 27

Unit size		**28**					
Rated switching frequency		**tbd kHz**					
Output frequency	**f_{out} / Hz**	**0**	**1.5**	**6**	**10**	**25**	**50**
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 62.5 µs (Parameter is22=0)*	2 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	4 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	8 kHz	tbd	tbd	tbd	tbd	tbd	tbd
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 71.4 µs (Parameter is22=1)*	1.75 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	3.5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	7 kHz	tbd	tbd	tbd	tbd	tbd	tbd
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 83.3 µs (Parameter is22=2)*	1.5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	3 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	6 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	12 kHz	tbd	tbd	tbd	tbd	tbd	tbd
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 100 µs (Parameter is22=3)*	1.25 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	2.5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	10 kHz	tbd	tbd	tbd	tbd	tbd	tbd

Table 14: Frequency-dependent maximum current for unit size 28

Unit size		**29**					
Rated switching frequency		**tbd kHz**					
Output frequency	**f_{out} / Hz**	**0**	**1.5**	**6**	**10**	**25**	**50**
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 62.5 µs (Parameter is22=0)*	2 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	4 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	8 kHz	tbd	tbd	tbd	tbd	tbd	tbd
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 71.4 µs (Parameter is22=1)*	1.75 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	3.5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	7 kHz	tbd	tbd	tbd	tbd	tbd	tbd
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 83.3 µs (Parameter is22=2)*	1.5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	3 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	6 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	12 kHz	tbd	tbd	tbd	tbd	tbd	tbd
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 100 µs (Parameter is22=3)*	1.25 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	2.5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	10 kHz	tbd	tbd	tbd	tbd	tbd	tbd

Table 15: Frequency-dependent maximum current for unit size 29

Unit size		**30 (OC level: 150%)**					
Rated switching frequency		**2 kHz**					
Output frequency	**f_{out} / Hz**	**0**	**1.5**	**6**	**10**	**25**	**50**
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 62.5 µs (Parameter is22=0)*	2 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	4 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	8 kHz	tbd	tbd	tbd	tbd	tbd	tbd
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 71.4 µs (Parameter is22=1)*	1.75 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	3.5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	7 kHz	tbd	tbd	tbd	tbd	tbd	tbd
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 83.3 µs (Parameter is22=2)*	1.5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	3 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	6 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	12 kHz	tbd	tbd	tbd	tbd	tbd	tbd
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 100 µs (Parameter is22=3)*	1.25 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	2.5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	5 kHz	tbd	tbd	tbd	tbd	tbd	tbd
	10 kHz	tbd	tbd	tbd	tbd	tbd	tbd

Table 16: Frequency-dependent maximum current for unit size 30 (OC level: 150%)

Unit size		**30 (OC level: 180%)**					
Rated switching frequency		**2 kHz**					
Output frequency	f_{out} / Hz	**0**	**1.5**	**6**	**10**	**25**	**50**
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 62.5 µs (Parameter is22=0)*	2 kHz	72	95	127	139	158	172
	4 kHz	40	56	77	86	100	110
	8 kHz	17	27	37	42	49	54
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 71.4 µs (Parameter is22=1)*	1.75 kHz	72	95	126	139	158	172
	3.5 kHz	48	86	89	99	114	126
	7 kHz	23	35	47	53	61	68
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 83.3 µs (Parameter is22=2)*	1.5 kHz	72	95	127	139	158	172
	3 kHz	56	76	102	113	129	141
	6 kHz	29	42	57	64	74	82
	12 kHz	9	16	22	24	28	31
Frequency-dependent maximum current @ *fs* I_{lim} / % *Basic Time Period = 100 µs (Parameter is22=3)*	1.25 kHz	72	95	127	139	158	172
	2.5 kHz	64	85	114	126	144	156
	5 kHz	35	49	667	75	87	96
	10 kHz	13	22	29	33	38	42

Table 17: Frequency-dependent maximum current for unit size 30 (OC level: 180%)

3.2.4 Switching frequency and temperature

Unit size			27	28	29	30
Rated switching frequency	1)	f_{SN} / kHz	tbd	tbd	tbd	2
Max. switching frequency	1)	f_{S_max} / kHz	tbd	tbd	tbd	12
Min. switching frequency	1)	f_{S_min} / kHz	tbd	tbd	tbd	1.25
Max. heat sink temperature		T_{HS} / °C	tbd	tbd	tbd	97
Temperature for derating the switching frequency		T_{DR} / °C	tbd			85
Temperature for uprating the switching frequency		T_{UR} / °C	tbd			75
Temperature for switching to rated switching frequency		T_{EM} / °C	tbd			90

Table 18: 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 in such a way that at rated conditions the heat sink overtemperature threshold is not exceeded.

For device size 30 with an OC level of 180 %, only a cyclic duration factor of 80% at 45°C surrounding temperature is permissible!

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, in order to prevent 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

Unit size			27	28	29	30
Power dissipation at nominal operating	1)	P_D / W	tbd	tbd	tbd	5000

Table 19: 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	Fuse / A		
	U_N = 400V gG (IEC)	U_N = 480V class „J“	U_N = 480V gR
	SCCR 100 kA	SCCR 30 kA	SCCR 100 kA
27	500	tbd	tbd
28	500	tbd	tbd
29	630	tbd	tbd
30	630	tbd	tbd

Table 20: 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		27	28	29	30
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			
Rated current @ U_{in_dc} = 565 V	I_{IN_dc} / A	380	469	583	723
Rated current @ U_{in_dc} = 680 V	$I_{IN\_dc\_UL}$ / A	383	458	525	605
Rated current @ U_{out_dc} = 565 V	I_{Out_dc} / A	380	469	583	723
Rated current @ U_{out_dc} = 680 V	$I_{Out\_dc\_UL}$ / A	383	458	525	605
DC switch-off level braking resistor [1)]	U_B / V	780			
Max. braking current	I_{B_max} / A	380			
Min. brake resistance value	R_{B_min} / Ω	2,2			
Protection function for braking transistor (GTR7)		Short-circuit monitoring			
DC link capacity	C / µF	18600			

Table 21: 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.*

ATTENTION

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

► The minimum brake resistance value must not fall below!

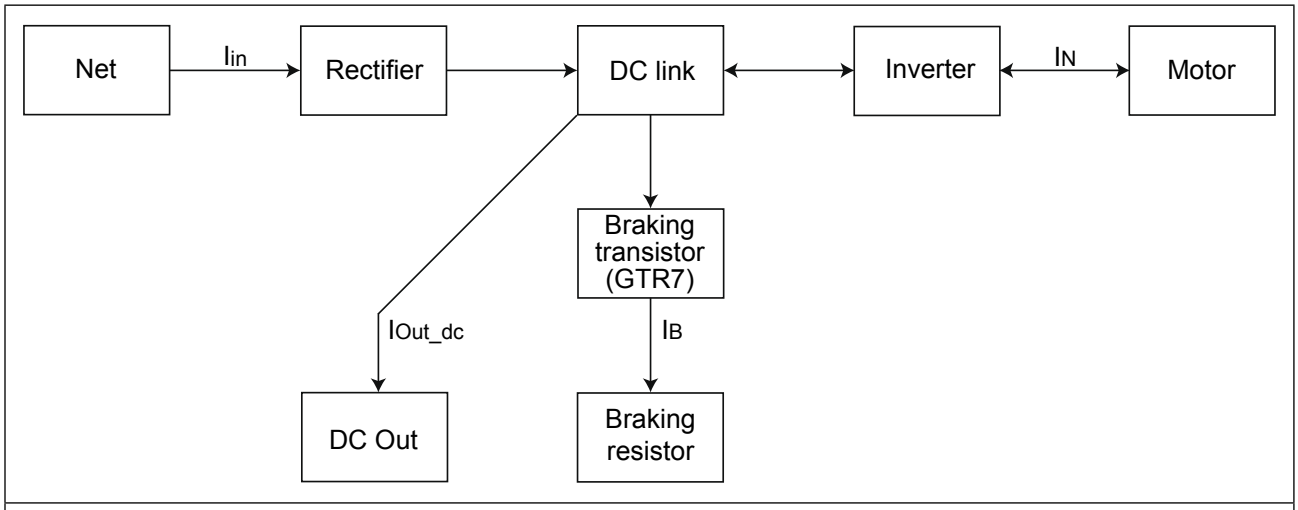


Figure 4: Block diagram of the energy flow

ATTENTION

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		27	28	29	30
Interior fan	Number	2			
	Speed varaible	yes			
Heat sink fan	Number	2			
	Speed variable	yes			

Figure 5: Fan

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

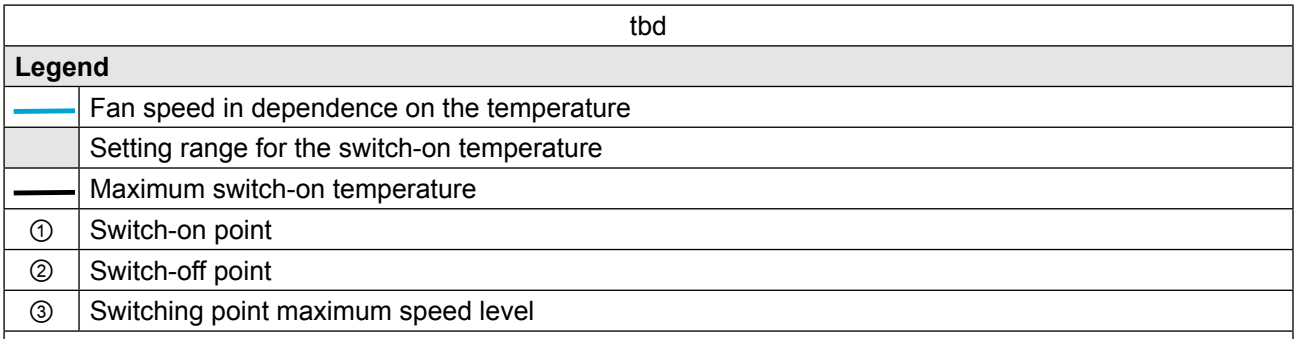
ATTENTION

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 6: Switching behaviour of the fans example heat sink fan

3.2.8.2 Switching points of the fans

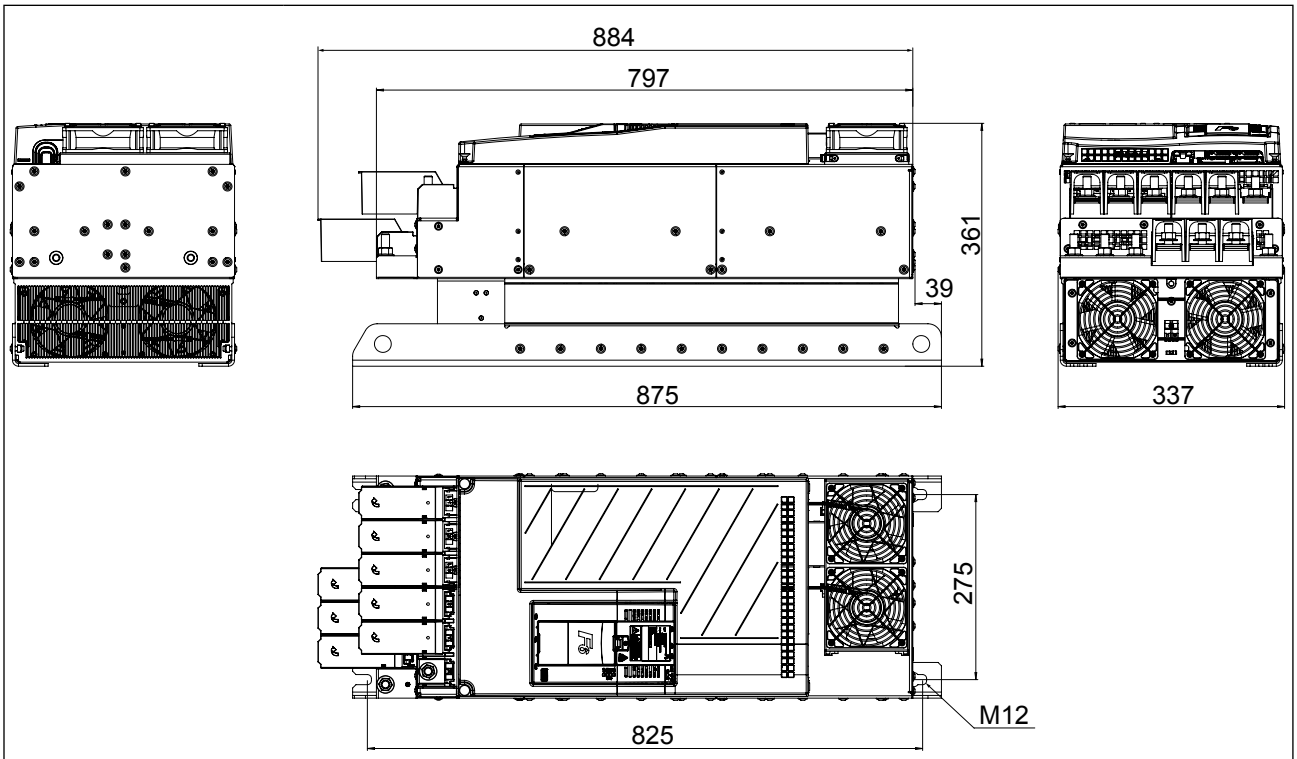
The switching point for the switch-on temperature and the maximum speed level of the fans are adjustable. The following table shows the default values.

Fan		Heat sink	Interior
Switch-on temperature	*T* / °C	tbd	tbd
Maximum speed level	*T* / °C	tbd	tbd

Table 22: Switching points of the fans

3.3 Dimensions and weights

3.3.1 Built-in version air cooler

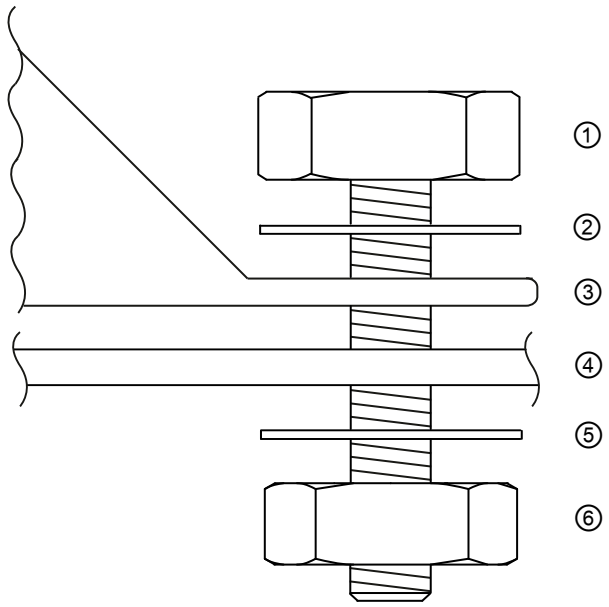


Housing	8
Weight	85 kg
Dimensions	All dimensions in mm

Figure 7: Dimensions built-in version air cooler

3.3.2 Control cabinet installation

3.3.2.1 Mounting to the mounting plate

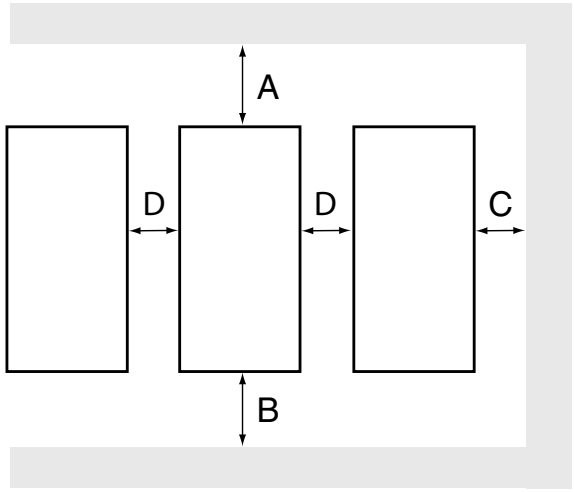


Legend	
①	M12 screw
②	Washer
③	Drive converter foot
④	Mounting plate
⑤	Washer
⑥	Nut for M12 screw
Tightening torque	xx Nm / xx lb inch

Figure 8: Mounting to the mounting plate

3.3.2.2 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 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 9: Mounting distances

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

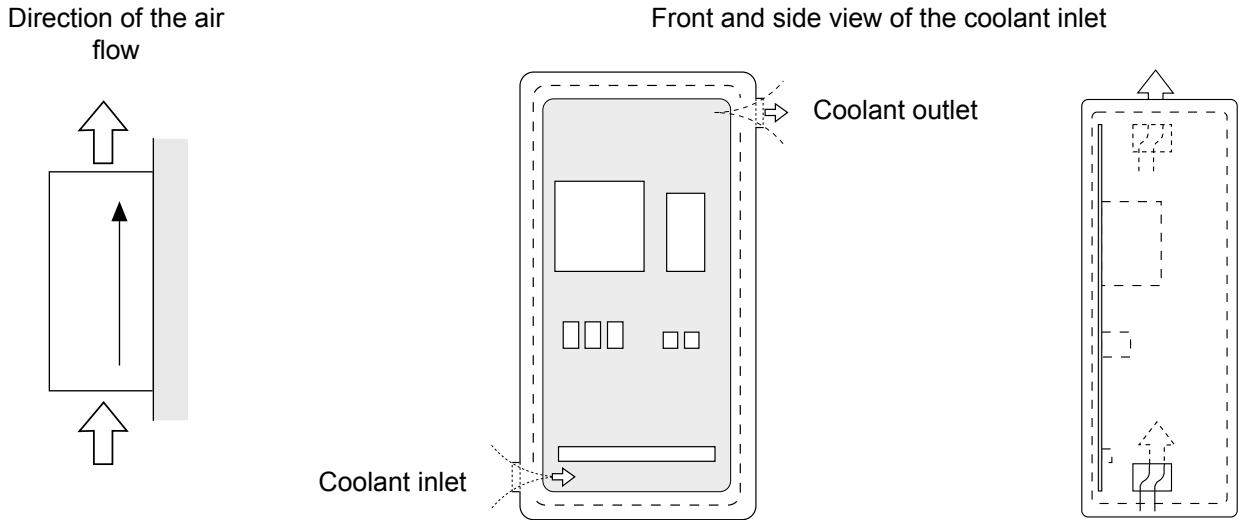


Figure 10: Control cabinet ventilation

4 Installation and Connection

4.1 Overview of the COMBIVERT F6

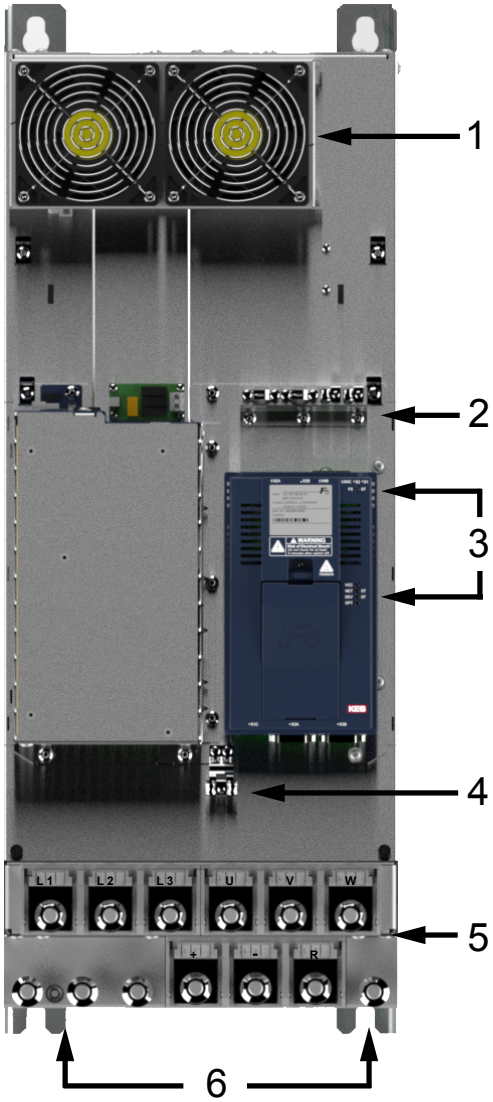
Housing 8	No.	Name	Description
	1	---	Interior fan
	2 / 4	---	Shield clambs for shielded control lines
	3	---	LEDs (see the manual for control unit chapter „Overview“) For control card COMPACT: FS without function. For control card APPLICATION and PRO: Status indication of the safety module
	5	X1A	Power circuit terminals for: • Mains input • Braking resistor • DC voltage interface • Motor connection
	6	PE	Protective earth; at connection to protective earth each terminal may be assigned only once

Figure 11: F6 housing 8 top view

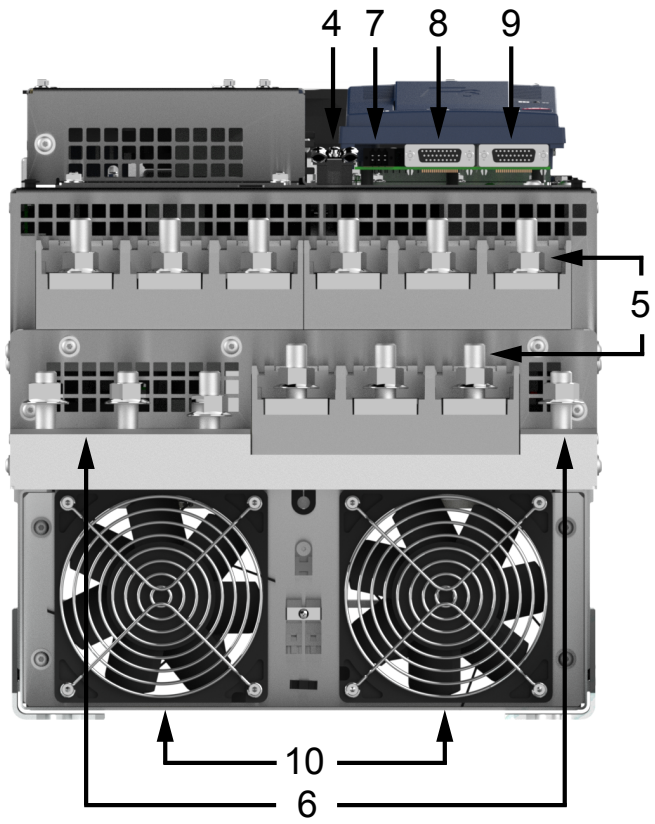
Housing 8	No.	Name	Description
	4	---	Shield clambs for shielded control lines
	5	X1A	Power circuit terminals for: • Mains input • Braking resistor • DC voltage interface • Motor connection
	6	PE	Protective earth; at connection to protective earth each terminal may be assigned only once
	7	X1C	Motor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

Figure 12: F6 housing 8 front view

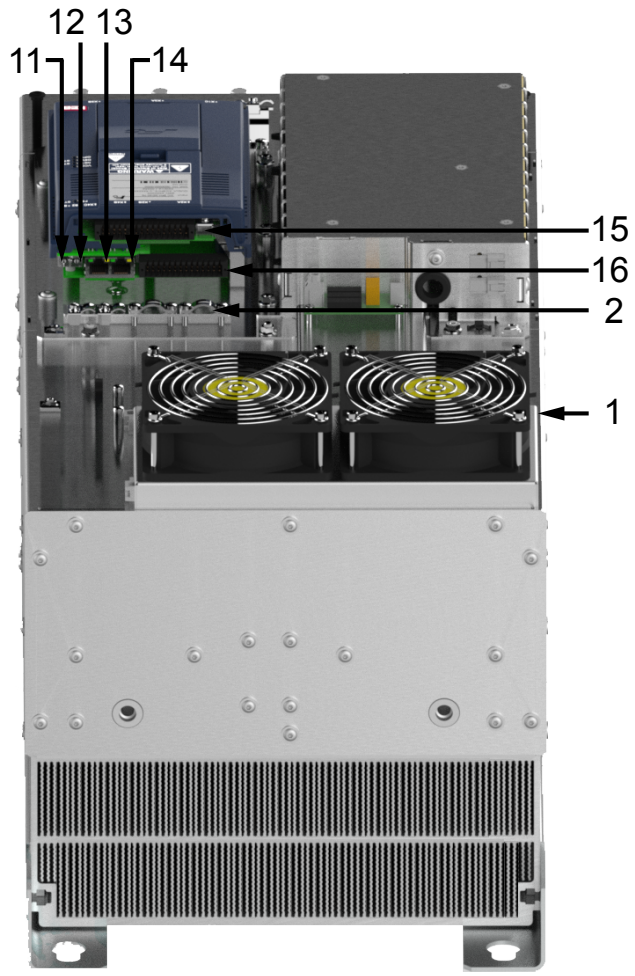
Housing 8	No.	Name	Description
	1	---	Interior fan
	2	---	Shield clambs for shielded control lines
	11	S1	Rotary coding switch A
	12	S2	Rotary coding switch B
	13	X4C	Fieldbus interface (out)
	14	X4B	Fieldbus interface (in)
	15	X2B	Safety module
	16	X2A	Connection for: • CAN bus • analog inputs and outputs • digital inputs and outputs • 24 V DC voltage supply

Figure 13: F6 housing 8 rear view with control board APPLICATION

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

Instructions for use COMBIVERT F6 control board APPLICATION
https://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_f6-cu-a-inst-20118593_en.pdf

Instructions for use COMBIVERT F6 control board COMPACT
https://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_f6-cu-k-inst-20144795_en.pdf

Instructions for use COMBIVERT F6 control board PRO
https://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_f6-cu-p-inst-20182705_en.pdf

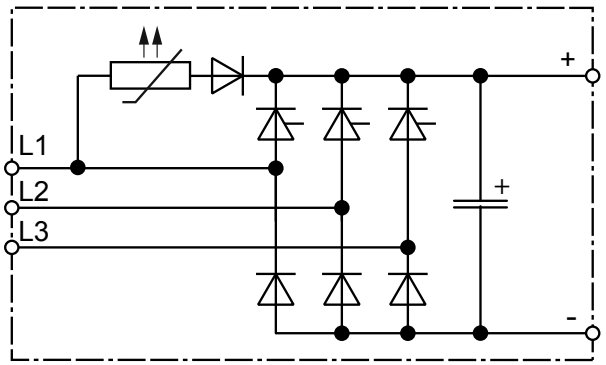
4.2 Connection of the power unit

ATTENTION

Destruction of the drive converter!

► Never exchange mains input and motor output!

4.2.1 Connection of the voltage supply



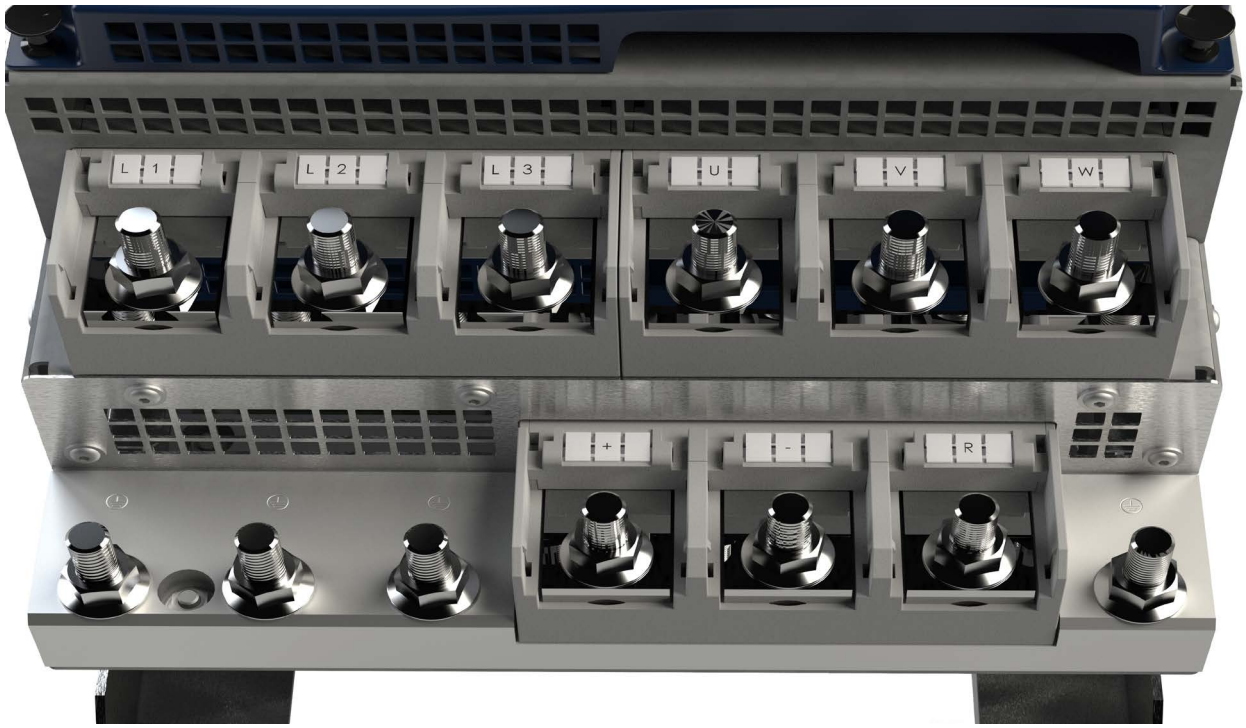
The COMBIVERT F6 housing 8 can be supplied by mains via terminals L1, L2 and L3.

Figure 14: 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. The unit displays in this state „ERROR load shunt fault“. When switching the control release during this error, the device switches off. After cooling, restarting is possible without limitation.

4.2.1.1 Terminal block X1A for 400 V units



Legend

Name	Function	Terminal connection	Tightening torque	Max. number of conductors
L1	Mains connection 3-phase	12 mm stud for M12 cable lugs	35 Nm 310 lb inch	2
L2				
L3				
U	Motor connection			
V				
W				
+	DC connection, connection for interconnected operation			
-				
R	Connection for braking resistor (between + and R)			

Figure 15: Terminal block X1A for 400 V units

4.2.2 Protective earth and function earth

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

4.2.2.1 Protective earth

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

⚠ CAUTION

Electric shock due to incorrect dimensioning!

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

Name	Function	Terminal connection	Tightening torque
⏚	Connection for protective earth	12 mm threaded pin for M12 cable lugs	35 Nm 310 lb inch

Figure 16: Connection for protective earth

Incorrect assembly of the PE connection

Pre-mounted M12 screws and M12 nuts with flange must be used to attach the PE tubular-cable-lugs.

4.2.2.2 Functional earthing

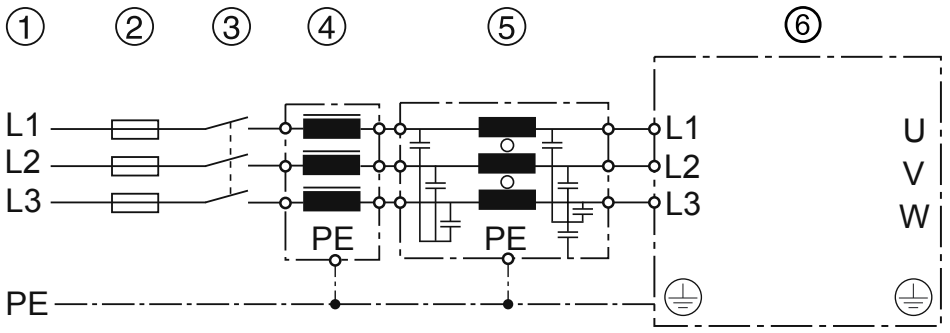
A functional earthing may also be necessary, if for EMC requirements additional potential equalization between devices or parts of the system must be available.

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 connection

4.2.3.1 AC supply 400 V / 3-phase



No.	Typ	Description	
①	Mains voltage	3-phase 400 V	
	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 17: Connection of the mains supply 400 V / 3-phase

4.2.3.2 Supply line

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

- input current of the drive converter
- used line type
- installation and ambient temperatures
- applicable local electrical regulations

The application engineer is responsible for the design!

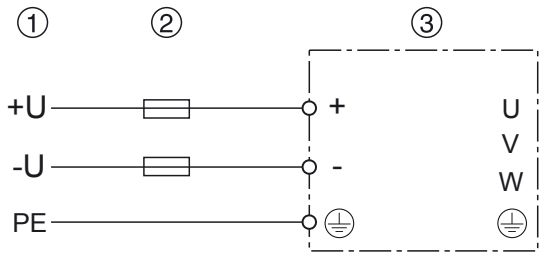
4.2.3.3 Note on hard power systems

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 (high short-circuit power) or when under permanent drive load (continuous duty).

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

4.2.4 DC connection

4.2.4.1 Connection at DC voltage supply



Legend		
1	DC voltage	400 / 480 V class: U_{dc} = 390...780 V
2	Fuses	Type aR
		Pay attention to the permissible voltage range!
		max. occurring DC voltage of 840 V
3	KEB COMBIVERT	F6

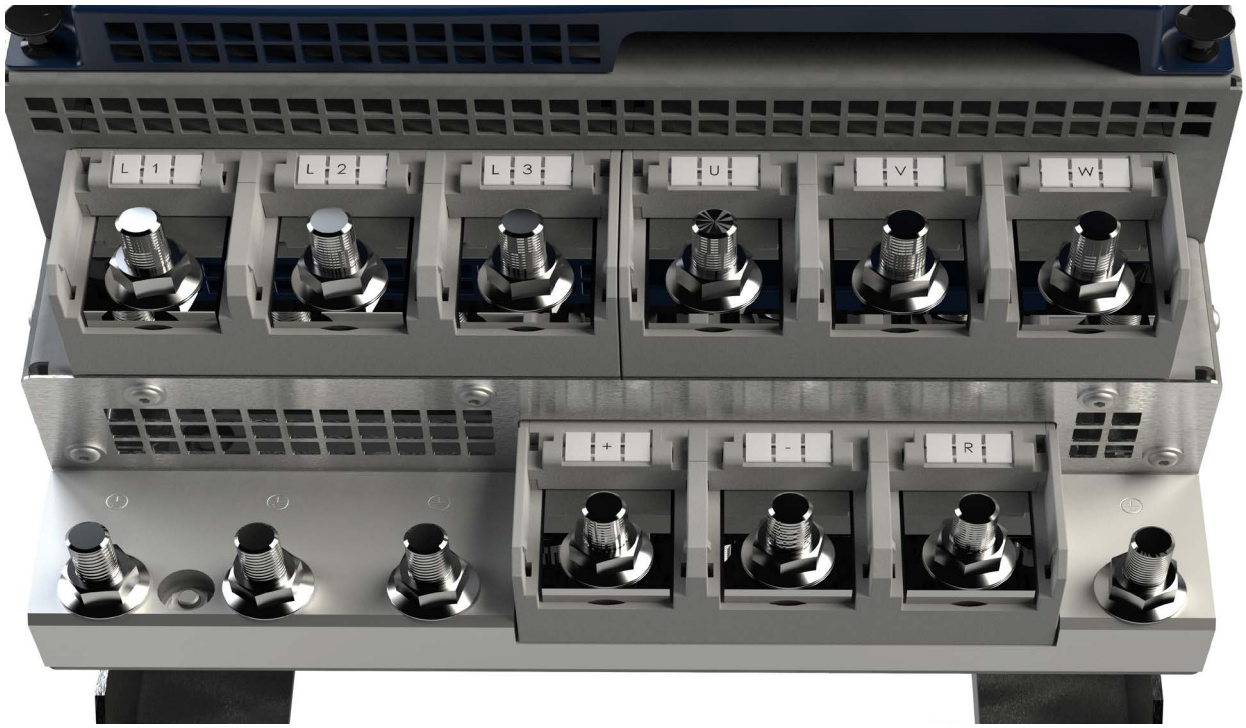
Figure 18: Connection at DC voltage supply

⚠ WARNING

Destruction of the drive converter!

► The + and - terminals must not be used for DC voltage supply!

4.2.4.2 Terminal block X1A DC connection



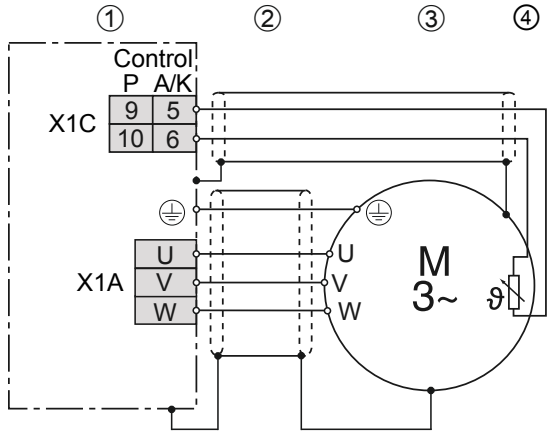
Legend

Name	Function	Terminal connection	Tightening torque	Max. number of conductors
+	DC connection, connection for interconnected operation	12 mm stud for M12 cable lugs	35 Nm 310 lb inch	2
-				

Figure 19: Terminal block X1A DC connection

4.2.5 Connection of the motor

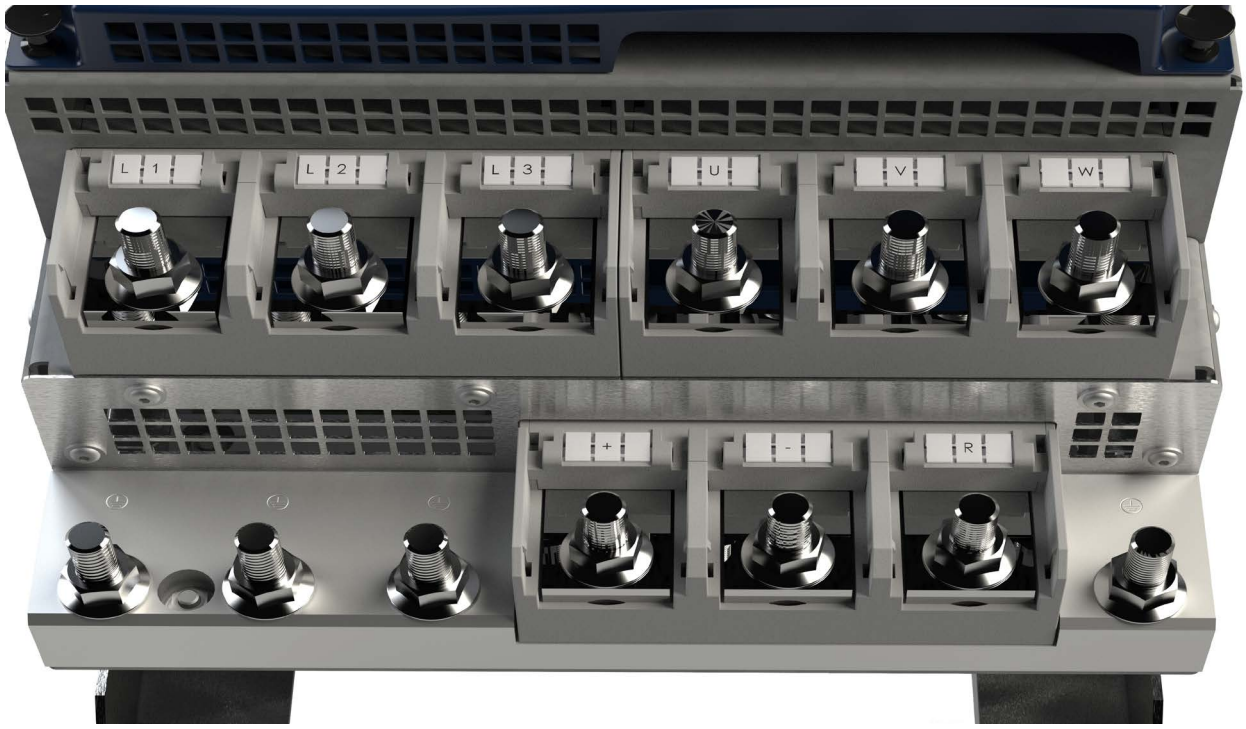
4.2.5.1 Wiring of the motor



Legend	
1	KEB COMBIVERT
2	Apply motor cables, 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 unit“*

Figure 20: Wiring of the motor

4.2.5.2 Terminal block X1A motor connection



Legend

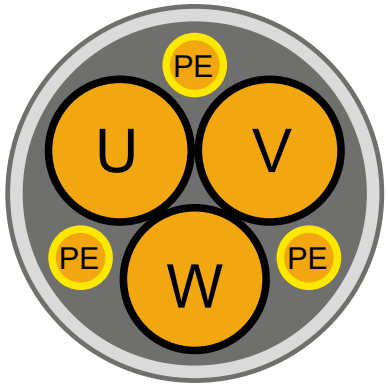
Name	Function	Terminal connection	Tightening torque	Max. number of conductors
U	Motor connection	12 mm stud for M12 cable lugs	35 Nm 310 lb inch	2
V				
W				

Figure 21: Terminal block X1A motor connection

4.2.5.3 Selection of the motor line

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

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



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

Figure 22: Symmetrical motor line

4.2.5.4 Motor cable length and conducted interferences at AC supply

The maximum motor line length is depending on the capacity of the motor cable as well as on the EMC emitted interference. External measures must be taken here (e.g. the use of a line filter). The following information is valid for the operation under rated conditions and the use of KEB listed filters under chapter => *„Filters and chokes“*!

Inverter size	Max. motor cable length shielded according *EN 61800-3* Category C2		max. leakage current (at $f_N \leq 100$ Hz)
	Motor cable (standard)	Motor cable (low capacitance)	
27	50 m	100 m	< 5 mA
28			
29			
30			

Table 23: 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 25 m.

4.2.5.5 Motor cable length for parallel operation of motors

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

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

4.2.5.6 Motor cable cross-section

The motor cable cross-section is dependent

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

4.2.5.7 Interconnection of the motor

ATTENTION

Incorrect behavior of the motor!

► In general, the connection instructions of the motor manufacturer are always valid.

ATTENTION

Protect motor against voltage peaks!

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

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

A switchable temperature evaluation is implemented in the COMBIVERT.

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

The desired operating mode can be adjusted via software (dr33). If the evaluation is not required, it must be deactivated via software (parameter pn33 = 7) => *Programming manual*

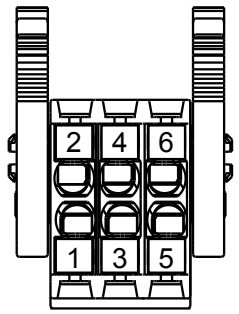
X1C	PIN	Name	Description
	1	BR+	Brake control / output +
	2	BR-	Brake control / output -
	3	reserved	–
	4	reserved	–
	5	TA1	Temperature detection / output +
	6	TA2	Temperature detection / output -

Figure 23: Terminal block X1C for control board APPLICATION and COMPACT

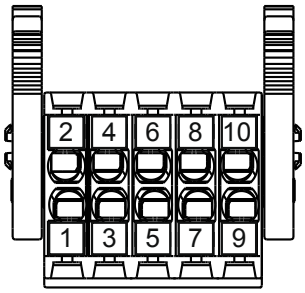
X1C	PIN	Name	Description
	1	BR+	Brake control / output +
	2	BR-	Brake control / output -
	3	0V	For supply of the checkback inputs
	4	24Vout	
	5	DIBR1	Checkback input 1 for brake and relay
	6	DIBR2	Checkback input 2 for brake and relay
	7	reserved	–
	8	reserved	–
	9	TA1	Temperature detection / output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

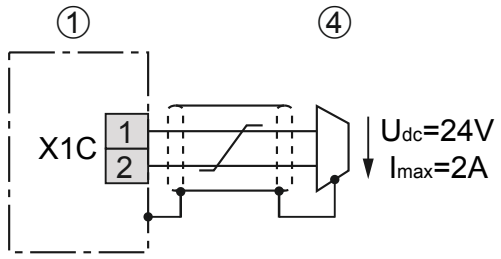
Figure 24: Terminal block X1C for control board PRO

ATTENTION

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.



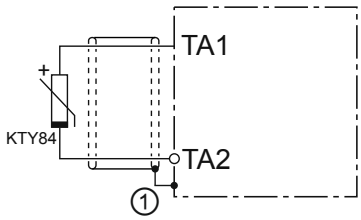
①	COMBIVERT
④	Brake

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 25: 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 26: Connection of a KTY sensor

ATTENTION

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

Risk of fire when using braking resistors!

► The risk of fire can almost be eliminated by using the internal evaluation for F6 drive converters of the housings 3 to 9. The evaluation is always active as soon as the brake transistor is active.

ATTENTION

Destruction of the drive converter if the value has fallen below the minimum brake resistance value!

► The minimum brake resistance value must not fall below! => *„Table 7: Overview of the 400V unit data“*

⚠ CAUTION

Hot surfaces caused by load of the braking resistor!

Burning of the skin!

► Cover hot surfaces safe-to-touch.

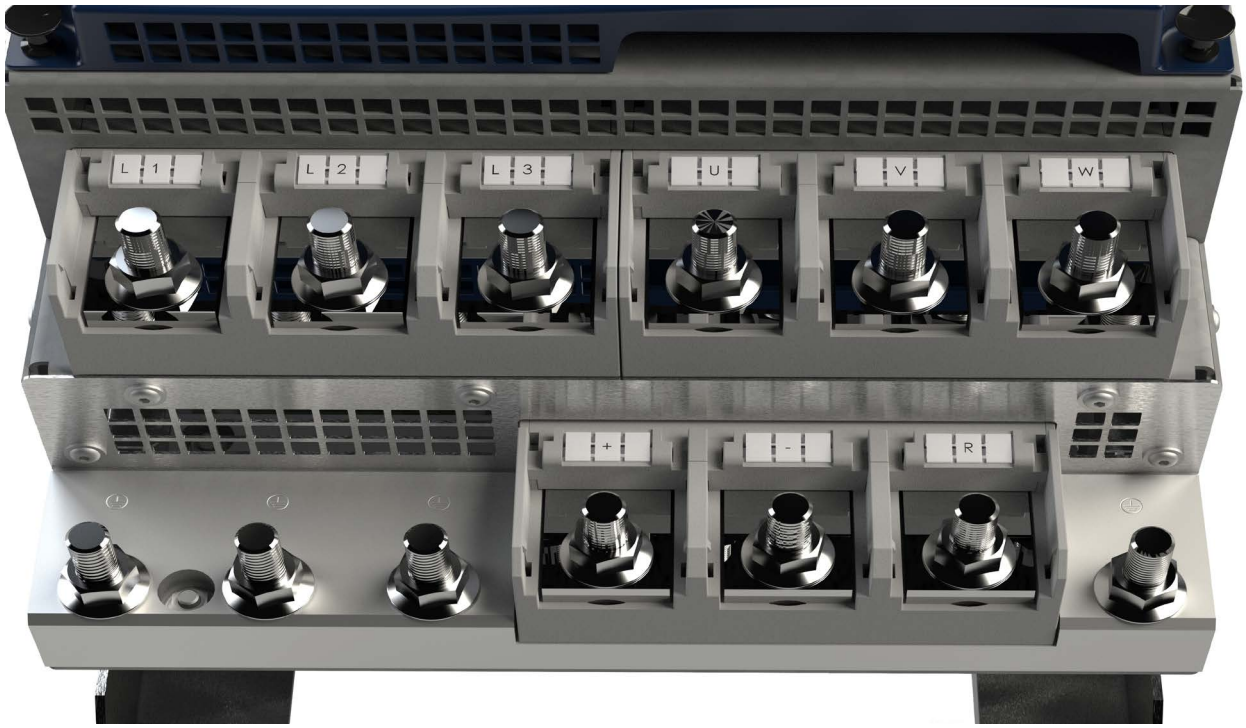
► Before touching, check the surface.

► 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
http://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



Legend

Name	Function	Terminal connection	Tightening torque	Max. number of conductors
+	Connection for braking resistor (between + and R)	12 mm stud for M12 cable lugs	35 Nm 310 lb inch	2
R				

Figure 27: Terminal block X1A connection braking resistor

4.2.6.3 Using a non-intrinsically safe braking resistor

Using a non-intrinsically safe braking resistor with extended temperature monitoring

=> *https://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	Inverter size	HF filter	Mains choke 50 Hz / 4 % U_k
400 V	27	27E6T60-3000	27Z1B04-1000
	28	tbd	28Z1B04-1000
	29	tbd	29Z1B04-1000
	30	tbd	30Z1B04-1000

Table 24: 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 non-intrinsically safe braking resistors

http://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_braking-resistors-20116737_en.pdf

5 Certification

5.1 CE-Marking

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

For more information about the CE Declarations of Conformity
=> *„Further information and documentation“*.

5.2 UL certifications

In preparation

5.3 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

6 Revision History

Version	Date	Description
00	2017-08	Creation of a prototype
00	2018-05	Creation of the pre-series manual
01	2019-01	Changes of technical data Figures of the overload characteristics adapted.

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