COMBIVERT **F6**

INSTRUCTIONS FOR USE | **INSTALLATION F6 HOUSING 4**

Translation of the original manual
Document 20116235 EN 03

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 with the CE mark on the unit name plate, that the device 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

The warranty on design, material or workmanship for the acquired device is given in the current terms and conditions.

Here you will find our current terms and 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 beyond of our control and therefore exclusively the responsibility of the machine manufacturer, system integrator or 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 application. However, they are considered for information only without responsibility. This also applies to any violation of industrial property rights of a third-party.

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

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

Copyright

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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
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
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
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
I^2t-monitoring	Software function for thermal monitoring of the motor winding
IEC	International standard
IP xx	Degree of protection (xx for level)
KTY	Silicium temperature sensor (polarized)
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 60947-8	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 will lead to the loss of any liability claims.

NOTICE

Hazards and risks through ignorance.

► Read the instruction manual!

► 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

Design-related 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. There is no compliance with applicable safety standards any more.
- 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 converter 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 for reliable fit of device connections in order to minimize contact resistance and avoid 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 touch exposed parts.
- ► For any work on the unit switch off the supply voltage and secure it against switching on.
- ► Wait until the drive has stopped in order, that perhaps regenerative energy can be generated.
- ► Wait until the DC link capacitors are discharged (5 minutes). Verify by measuring the 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 to drive converter and motor everytime.
- ► Install all required covers and protective devices for operation.
- ► The control cabinet shall be kept closed during operation.

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 accordly to the specified minimum / maximum values for the opperation.
- Drive converters are only intended for permanent connection. Cross-sections of protective earth conductors should be interpreted in accordance with *DIN IEC 60364-5-54*.
- 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 as "PELV circuit".
- Within systems or machines the person installing electrical wiring must ensure that on existing or new wired safe ELV circuits the EN requirement for safe insulation is still met!
- For drive converters that are not isolated from the supply circuit (in accordance with *EN 61800-5-1*) 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.

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 with additional safety or protective measures in accordance with their requirements have to be checked, when using drive converters, to be in accordance with the given application notes or recommendation when using these!

1.4.1 EMC-compatible installation

Observance of the limit values required by EMC law is the responsibility of the manufacturer of the installation or machine.

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 converter.

Because of the noise suppression capacitors the test generator will immediately trigger with current error.

Accordng 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. At any unit it can be expected with an insulating resistance > 20 MΩ!

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 cooling water 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.

Observe the following instructions if the drive converter for more than one year was not in operation before start-up.
www.keb.de/fileadmin/media/Manuals/knowledge/04_techinfo/00_general/ti_format_capacitors_0400_0001_gbr.pdf

NOTICE

Continuous duty (S1) with average duty > 60%!

Premature aging of electrolytic capacitors!

- ► Use mains choke with maximum U_k = 4%.

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. Control release 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 on the input

For applications that require cyclic switching on and off 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 proof

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.

► 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 squeaking.

► In the case of liquid-cooled drive converters, make a visual leak test of the cooling circuit for leaks and corrosion must be carried out.

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. Thereafter 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 the operation at synchronous and asynchronous motors. The COMBIVERT can be extended with a safety module for the use in safety-oriented applications. It can be operated with a fieldbus module at different fieldbus systems. The control board has a system comprehensive operating concept.

The COMBIVERT meets the requirements of the Low-Voltage Directive. The harmonized standards of the series *EN 61800-5-1* for drive 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 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 KEB COMBIVERT F5 is used in machines, which work under exceptional conditions or if essential functions, life-supporting measures or an extraordinary safety step must be fulfilled, the necessary reliability and security must be ensured by the machine builder.

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:	30...55 kW / 400 V
Housing:	4

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
- Comprehensive 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 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, mounted version	
										2: Liquid cooler, mounted version	
										3: Air-cooler, through-mount version IP54	
										4: Liquid cooler, through-mount version IP54	
										5: Air-cooler, through-mount version IP20	
								Fieldbus (at control type)		1: EtherCAT® [1] (K) / Real-Time Ethernet bus module [3] (A)	
										2: VARAN (K)	
							Switching frequency, software current limit, over 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						1: Safety module type 1 / STO at control type K	
										3: Safety module type 3	
			Control type							APPLICATION A: Multi-encoder interface and CAN® [2] on Board, Slot for fieldbus and safety module	
										COMPACT K: Multi-encoder interface, CAN® [2] and STO on Board, EtherCAT® [1] or VARAN on Board	
		Series								COMBIVERT F6	
	Inverter 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 company 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 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 environmental conditions

Storage		**Standard**	**Class**	**Descriptions**
Surrounding temperature		*EN 60721-3-1*	1K4	-25…55 °C
Relative humidity		*EN 60721-3-1*	1K3	5…95 % (without condensation)
Storage height		–	–	Max. 3000 m above sea level
Transport		**Standard**	**Class**	**Descriptions**
Surrounding temperature		*EN 60721-3-2*	2K3	-25…70 °C
Relative humidity		*EN 60721-3-2*	2K3	95 % at 40 °C (without condensation)
Operation		**Standard**	**Class**	**Descriptions**
Surrounding temperature		*EN 60721-3-3*	3K3	5…40 °C (extended to -10…45 °C)
Coolant inlet temperature	Air	–	–	5…40 °C (-10…45 °C)
	Liquid	–	–	5…40 °C
Relative humidity		*EN 60721-3-3*	3K3	5…85 % (without condensation)
Version and degree of protection		*EN 60529*	IP20	Protection against foreign material > ø12.5 mm 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*	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 3.0 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	–	–	Rated operating pressure: 10 bar 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.

Inverter size			**19**	**20**	**21**	**22**
Housing			**4**			
Rated apparent output power		S_{out} / kVA	42	52	62	76
Max. rated motor power		P_{mot} / kW	30	37	45	55
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	66	82	99	121
Rated input current @ U_N = 480V		I_{IN_UL} / A	57	71	85	106
Output voltage		U_{out} / V	0...U_{in} respectively (U_{in_dc} / √2)			
Output frequency	2)	f_{out} / Hz	0...599			
Output phases			3			
Rated output current @ U_N = 400 V		I_N / A	60	75	90	110
Rated output current @ U_N = 480 V		I_{N_UL} / A	52	65	77	96
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	4	4	2	2
Max. switching frequency	4)	f_{S_max} / kHz	16	16	16	16
Power dissipation at nominal operating	3)	P_D / W	698	896	895	1082
Overload current over time		I_{OL} / %	=> *„Overload characteristic (OL)“*			
Maximum current 0Hz / 50Hz at f_S = 2 kHz		I_{Max_Out} / %	176 / 180	141 / 180	117 / 180	111 / 180
Maximum current 0Hz / 50Hz at f_S = 4 kHz		I_{Max_Out} / %	135 / 180	108 / 180	90 / 153	82 / 138
Maximum current 0Hz / 50Hz at f_S = 8 kHz		I_{Max_Out} / %	88 / 156	70 / 125	58 / 104	51 / 93
Maximum current 0Hz / 50Hz at f_S = 16 kHz		I_{Max_Out} / %	46 / 86	37 / 69	31 / 57	24 / 47
Max. braking current		I_{B_max} / A	93			105
Min. brake resistance value		R_{B_min} / Ω	9			8
Protection function for braking transistor (GTR7)			Short-circuit monitoring			

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

Inverter size			19	20	21	22
Rated input current @ U_N = 400V		I_{IN} / A	66	82	99	121
Rated input current @ U_N = 480V		I_{IN_UL} / A	57	71	85	106
Rated input current @ U_{N_dc} = 565V	1)	I_{IN_dc} / A	81	101	121	148
Rated input current @ U_{N_dc} = 680V	1)	$I_{IN\_dc\_UL}$ / A	70	88	104	129

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.

Inverter size			19	20	21	22
Rated output current @ U_N = 400V		I_N / A	60	75	90	110
Rated output current @ U_N = 480V		I_{N_UL} / A	52	65	77	96
Rated Output overload (60 s)	1)	I_{60s} / %	150			
Overload current	1)	I_{OL} / %	=> *„Overload characteristic (OL)“*			
Software current controller	2)	I_{lim} / %	150			
Overcurrent	1)	I_{OC} / %	180			

Table 12: Output currents 400 V units

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

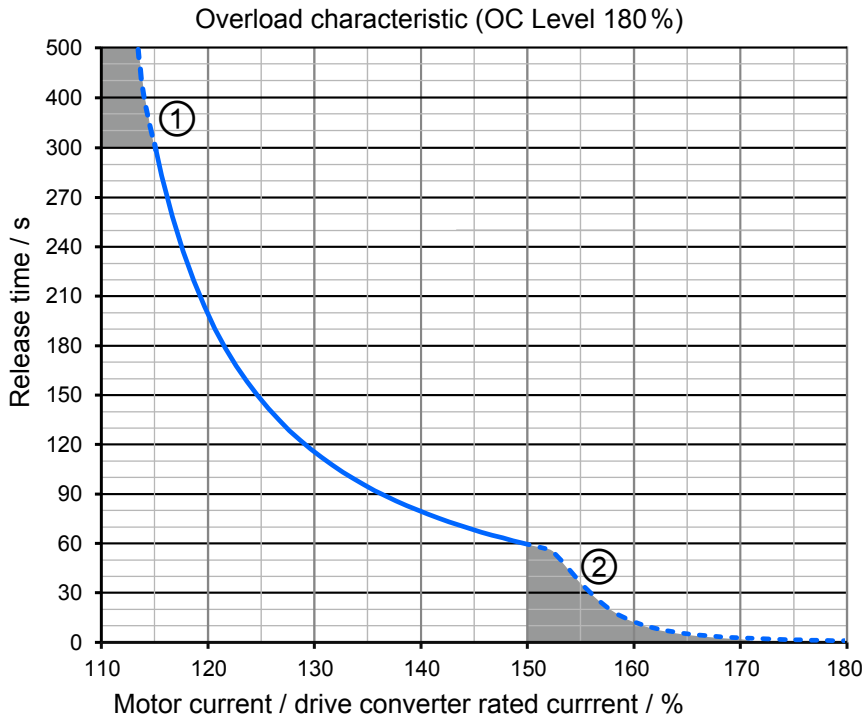
2) Limitation of the current setpoint in closed-loop operation. This setpint limit is not active in v/f operation.

3.2.3.1 Overload characteristic (OL)

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

Restrictions:

- The thermal design of the heat sink is based on the rated 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 (OL)

On exceeding a load of 105 % the overload integrator starts. When falling below the integrator counts backwards. If the integrator achieves 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 300 s.

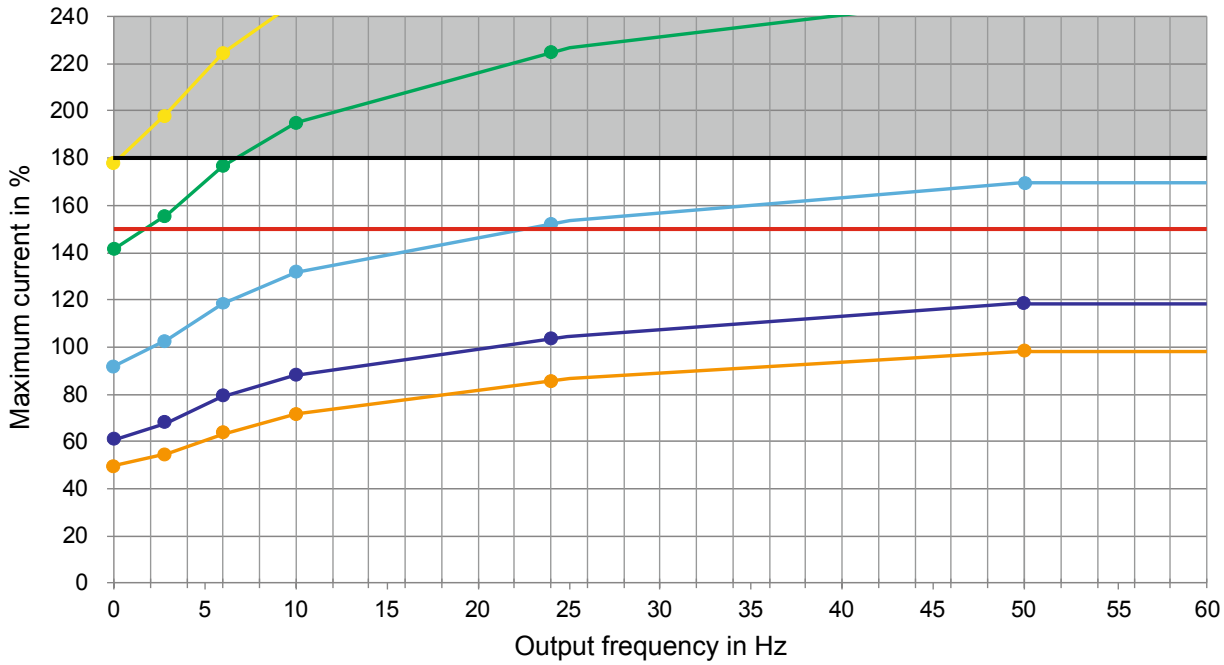
3.2.3.2 Frequency-dependent maximum current (OL2)

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 characteristics indicate the permissible maximum current for the output frequency values 0 Hz, 3 Hz, 6 Hz, 10 Hz 25 Hz and 50 Hz. If the switching frequencies are different, there is an interpolation between the characteristics. Unit size 19 is represented exemplary.



Legend	
	Overcurrent *Ioc*
	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 19

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

Frequency-dependent maximum current

Inverter size		**19 (4 kHz)**					
Output frequency	**f_{out} / Hz**	**0**	**3**	**6**	**10**	**25**	**50**
Frequency-dependent maximum current @ *fs* I_{lim} / %	2 kHz	176	180	180	180	180	180
	4 kHz	135	150	168	180	180	180
	8 kHz	88	98	111	123	143	157
	12 kHz	63	72	80	88	105	115
	16 kHz	46	53	60	65	78	87

Table 13: Frequency-dependent maximum current for unit size 19

Inverter size		**20 (4 kHz)**					
Output frequency	**f_{out} / Hz**	**0**	**3**	**6**	**10**	**25**	**50**
Frequency-dependent maximum current @ *fs* I_{lim} / %	2 kHz	141	156	174	180	180	180
	4 kHz	108	120	134	147	168	180
	8 kHz	70	79	89	99	114	125
	12 kHz	51	57	64	71	84	92
	16 kHz	37	43	48	52	62	69

Table 14: Frequency-dependent maximum current for unit size 20

Inverter size		**21 (2 kHz)**					
Output frequency	**f_{out} / Hz**	**0**	**3**	**6**	**10**	**25**	**50**
Frequency-dependent maximum current @ *fs* I_{lim} / %	2 kHz	117	130	145	159	180	180
	4 kHz	90	100	112	122	140	153
	8 kHz	59	66	74	82	95	105
	12 kHz	42	48	53	59	70	77
	16 kHz	31	36	40	43	52	58

Table 15: Frequency-dependent maximum current for unit size 21

Inverter size		**22 (2 kHz)**					
Output frequency	**f_{out} / Hz**	**0**	**3**	**6**	**10**	**25**	**50**
Frequency-dependent maximum current @ *fs* I_{lim} / %	2 kHz	111	124	136	146	165	180
	4 kHz	82	93	104	113	127	138
	8 kHz	51	59	66	72	84	94
	12 kHz	35	40	45	49	58	65
	16 kHz	24	28	31	36	42	47

Table 16: Frequency-dependent maximum current for unit size 22

3.2.4 Switching frequency and temperature

Inverter size			19	20	21	22
Rated switching frequency	1)	f_{SN} / kHz	4		2	
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	95		
Temperature for derating the switching frequency		T_{DR} / °C	80			
Temperature for uprating the switching frequency		T_{UR} / °C	70			
Temperature for switching to rated switching frequency		T_{EM} / °C	85			

Table 17: 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, 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

Inverter size			19	20	21	22
Power dissipation at nominal operating	1)	P_D / W	698	896	895	1082
Power dissipation at DC supply		P_{D_dc} / W	555	713	665	791

Table 18: Power dissipation of the 400V 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

Inverter size	Fuse / A				
	U_N = 400V gG (IEC)	U_N = 480V class „J“		U_N = 480V gR	
	SCCR 30 kA	SCCR		SCCR 30 kA	Type
		5 kA	10 kA		
19	80	70	–	80	SIBA 20 189 20.80 EATON 170M1366
20	100	90	–	100	SIBA 20 189 20.100 EATON 170M1367
21	125	110	–	125	SIBA 20 189 20.125 EATON 170M1368
22	160	–	125	125	SIBA 20 189 20.125 EATON 170M1368

Table 19: 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*.

Inverter size		19	20	21	22
Rated DC link voltage @ U_N = 400V	U_{N_dc} / V	565			
Rated DC link voltage @ U_{N_UL} = 480V	$U_{N\_UL\_dc}$ / 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	81	101	121	148
Rated current @ U_{in_dc} = 680 V	$I_{in\_UL\_dc}$ / A	70	88	104	129
Rated current @ U_{out_dc} = 565 V	I_{Out_dc} / A	81	101	121	148
Rated current @ U_{out_dc} = 680 V	$I_{Out\_dc\_UL}$ / A	70	88	104	129
DC switch-off level braking resistor [1)]	U_B / V	780			
Max. braking current	I_{B_max} / A	93			105
Min. brake resistance value	R_{B_min} / Ω	9			8
Protection function for braking transistor (GTR7)		Short-circuit monitoring			
DC link capacity	C / µF	2380	2720	3400	4080

Table 20: 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 has fallen below the minimum brake resistance value!

► The minimum brake resistance value must not fall below!

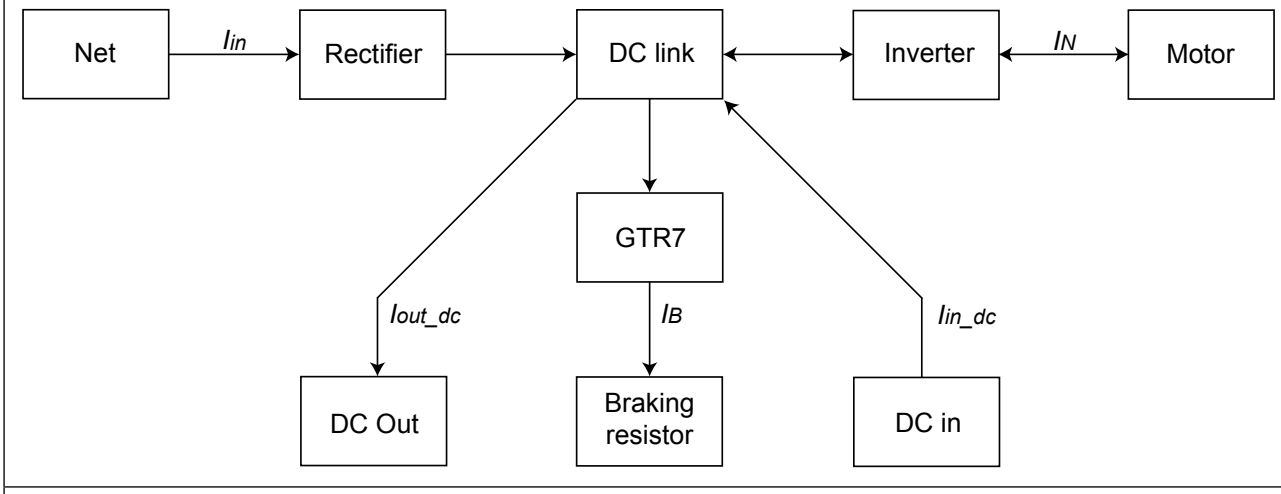


Figure 3: Block diagram of the energy flow

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

Inverter size		19	20	21	22
Interior fan	Number	1			
	Speed-variable	yes			
Heat sink fan	Number	2			
	Speed-variable	yes			

Table 21: Fan

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

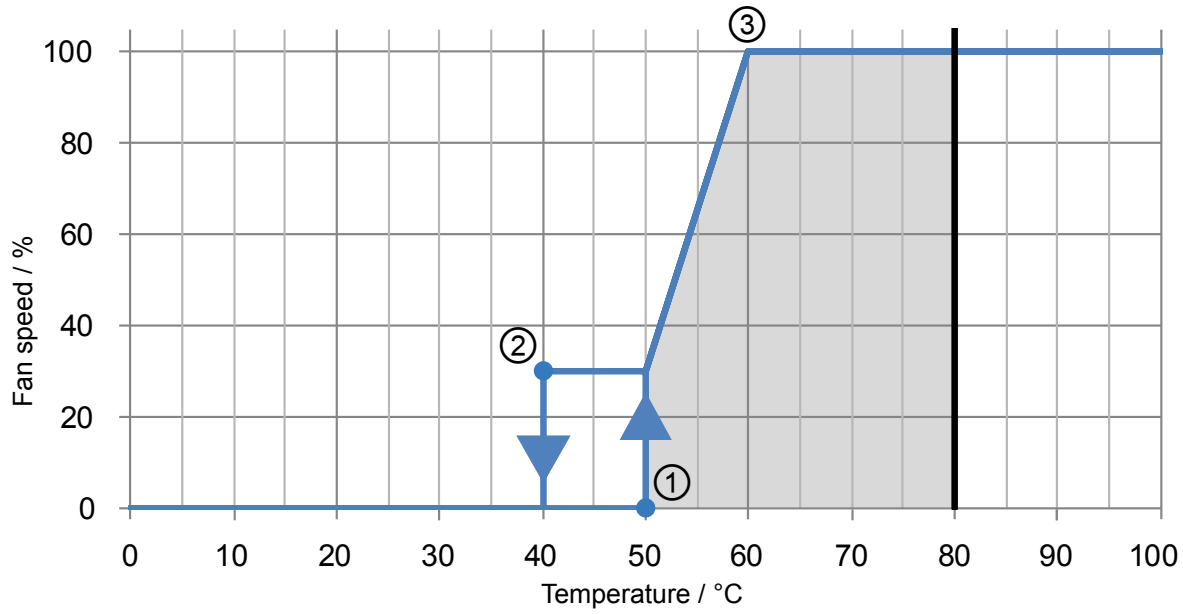
ATTENTION

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	
	Temperature curve
	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

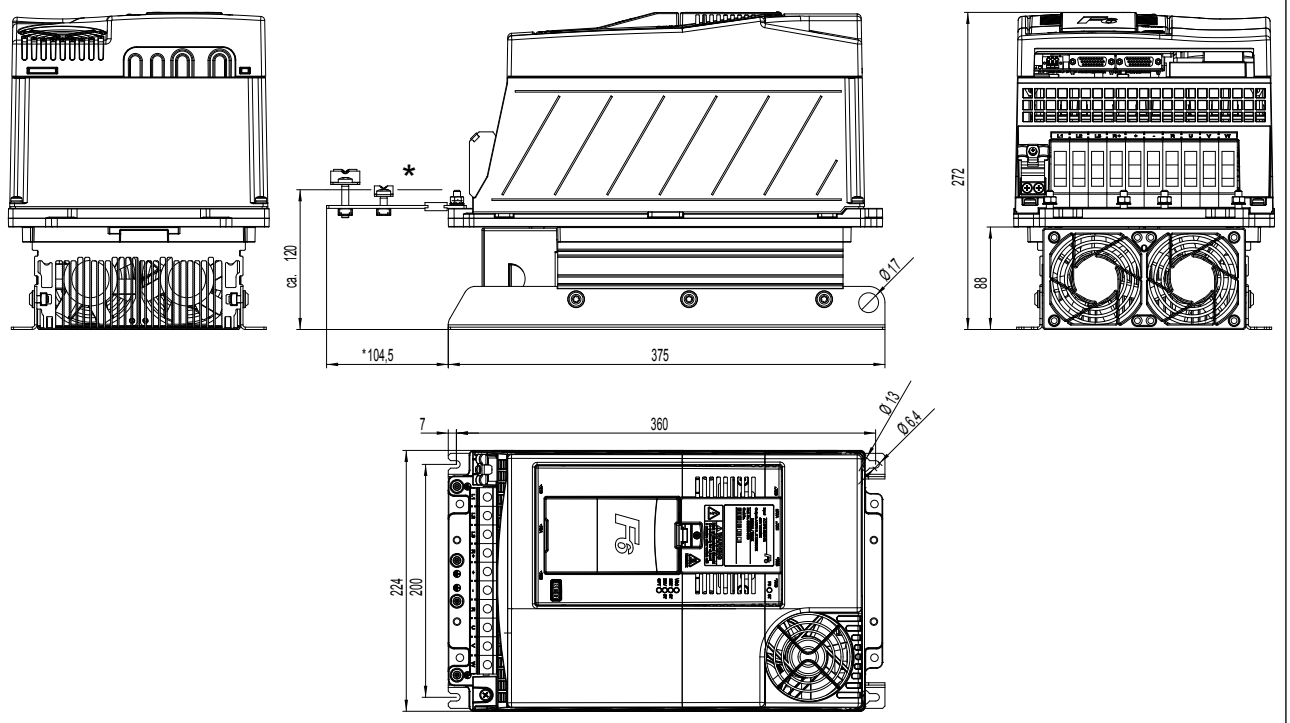
The switching point for the switch-on temperature and the maximum speed level of the fans are adjustable. The following table shows the default values.

Fan		Heat sink	Interior
Switch-on temperature	*t* / °C	50	45
Maximum speed level	*t* / °C	60	55

Table 22: Switching points of the fans

3.3 Dimensions and weights

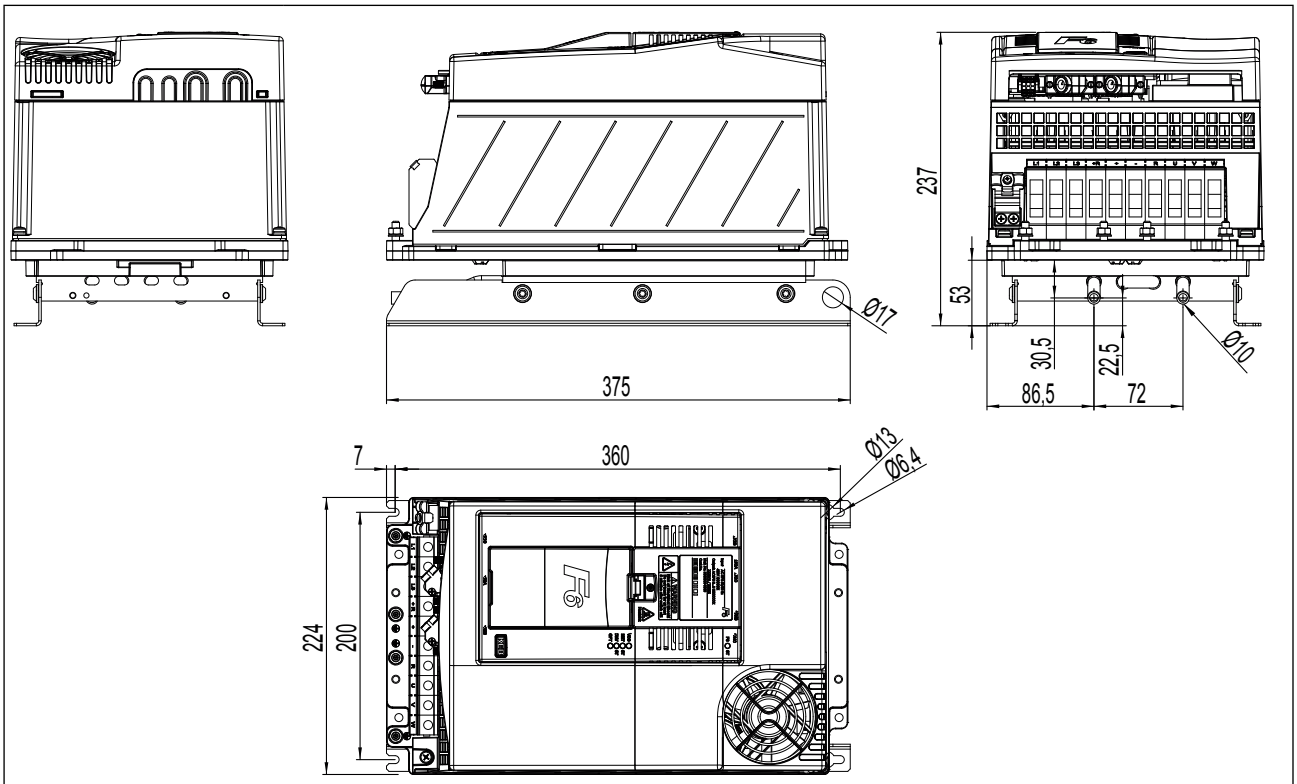
3.3.1 Built-in version air cooler



Housing	4
Weight	13.8 kg
Dimensions	All dimensions in mm
*	Optional shield plate

Figure 5: Dimensions mounted version air cooler

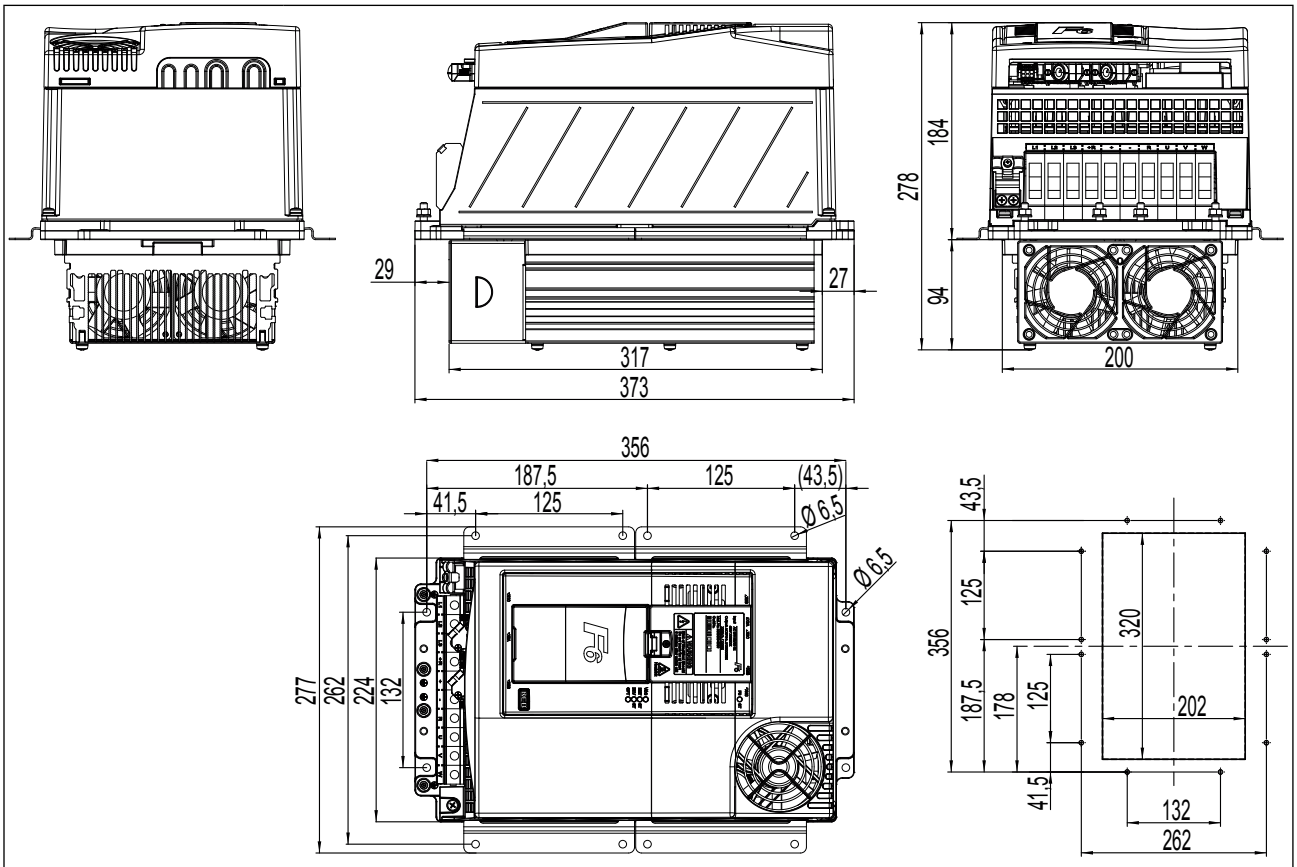
3.3.2 Built-in version water cooler



Housing	4
Weight	12.2 kg
Dimensions	All dimensions in mm

Figure 6: Dimensions built-in version water cooler

3.3.3 Through-mount version air-cooler IP20, IP54



Housing	4
Weight	13.6 kg
Dimensions	All dimensions in mm

Figure 7: Dimensions through-mount version air-cooler IP20, IP54

IP54 zone: heat sink underneath the mounting plate.

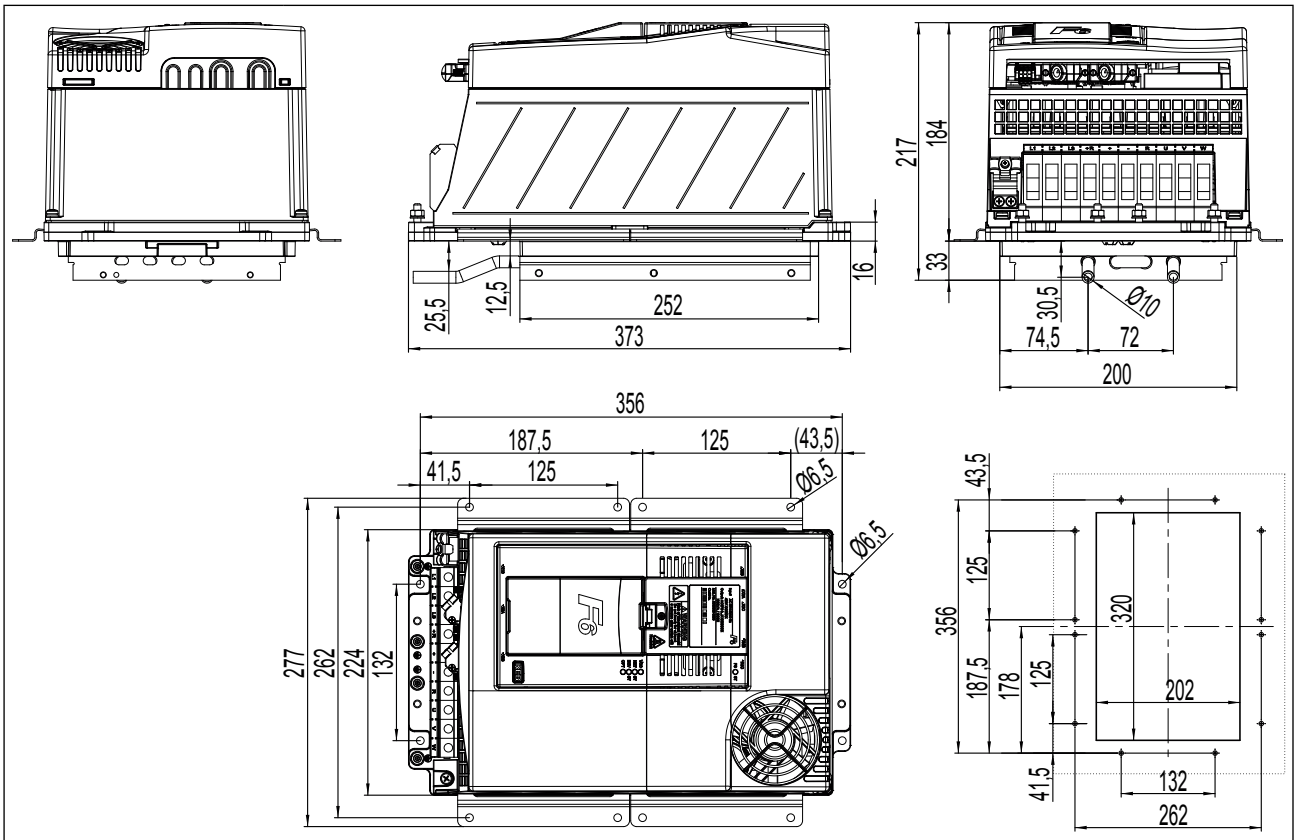
For proper installation, the enclosed seal (40F6T45-0002) must be installed between heat sink and housing (e.g. cabinet wall). The tightness must be checked after the installation. If properly installed, the separation to the housing corresponds to degree of protection IP54. However, the fans must be 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.

3.3.4 Through-mount version water-cooler IP20, IP54



Housing	4
Weight	12 kg
Dimensions	All dimensions in mm

Figure 8: Dimensions push-through version water-cooler IP20, IP54

IP54 zone: heat sink underneath the mounting plate.

For proper installation, the enclosed seal (40F6T45-0002) 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.

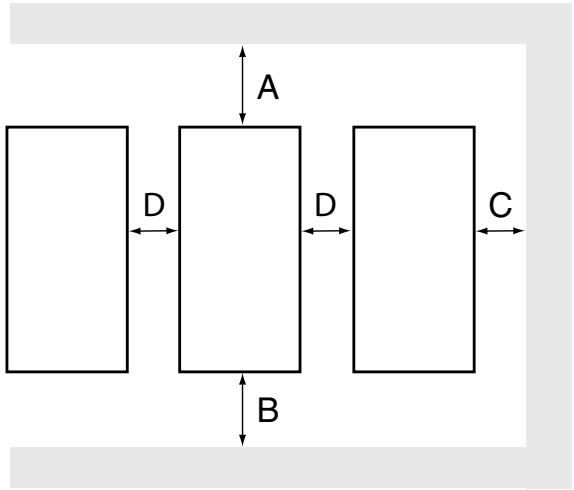
IP20 zone: device above the mounting plate.

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.

3.3.5 Control cabinet installation

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.

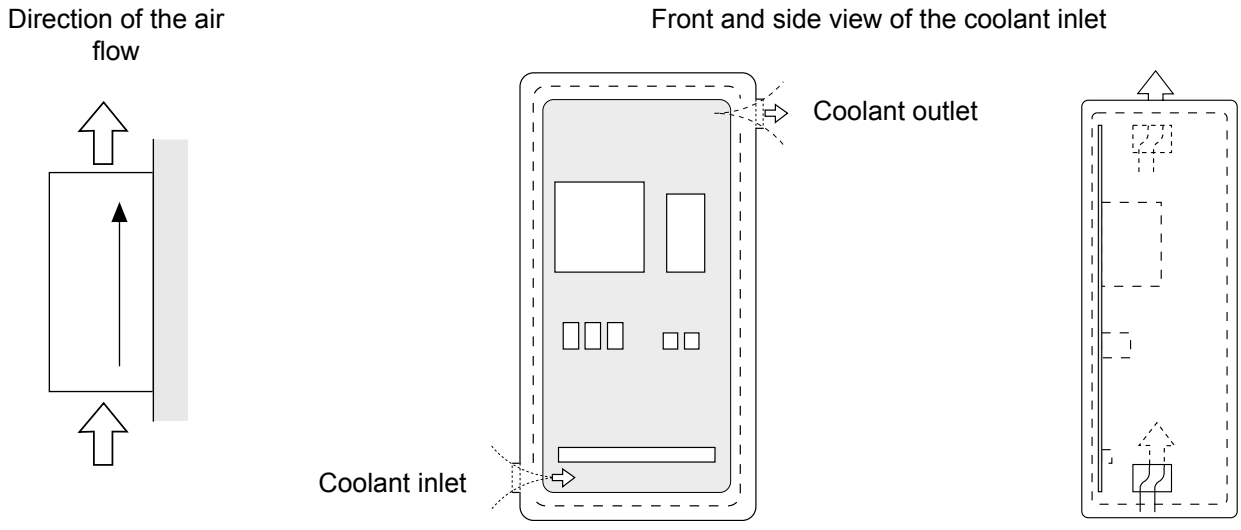


Figure 10: Control cabinet ventilation

4 Installation and Connection

4.1 Overview of the COMBIVERT F6

Housing 4	No.	Name	Description
	1	–	Shield clambs for shielded control lines.
	2	–	Attachment points for optional shield plate. The shielding e.g. from the motor cable is laid on the mounting plate in the control cabinet or on the shielding plate 00F6V80-4001 (optionally available).
	3	–	LEDs (see the manual for control unit chapter „Overview“) For control card COMPACT: FS without function. For control card APPLICATION: Status display of the safety module.
	4	–	Interior fan
	5	PE	Protective earth; at connection to protective earth each terminal may be assigned only once.
	6	X1A	Power circuit terminals for: • Mains input • Braking resistor • DC supply • Motor connection

Figure 11: F6 housing 4 top view

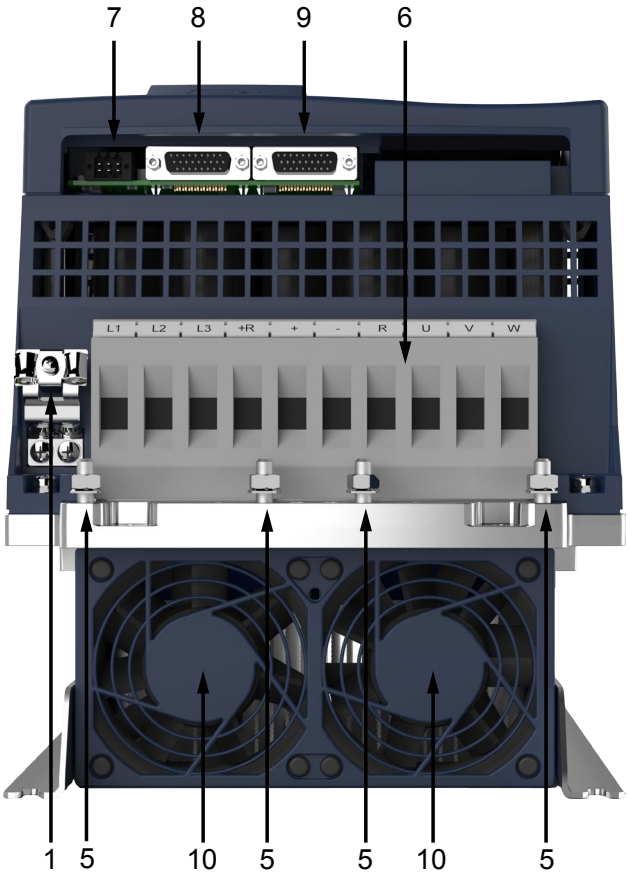
Housing 4	No.	Name	Description
	1	–	Shield clambs for shielded control lines.
	5	PE	Protective earth; at connection to protective earth each terminal may be assigned only once.
	6	X1A	Power circuit terminals for: • Mains input • Braking resistor • DC supply • Motor connection
	7	X1C	Motor temperature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

Figure 12: F6 housing 4 front view

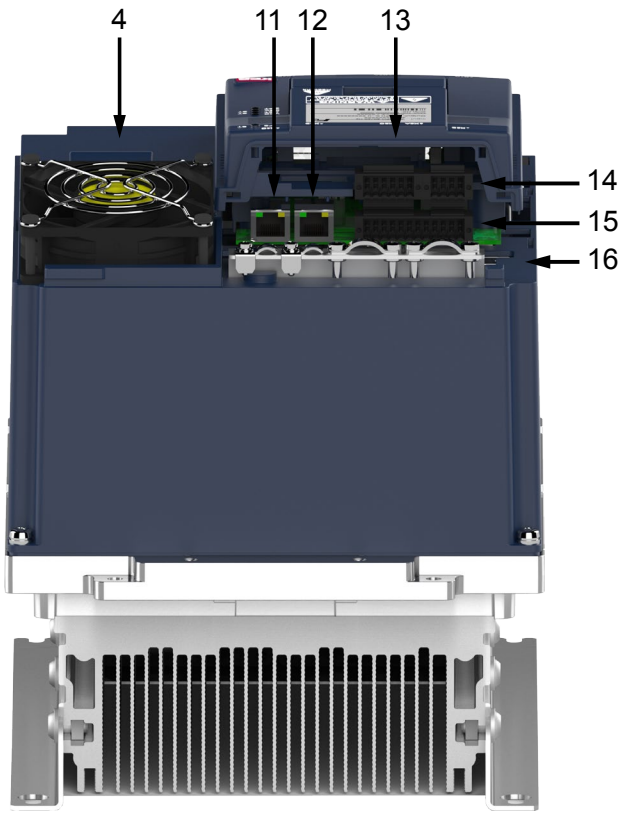
Housing 4	No.	Name	Description
	4	–	Interior fan
	11	X4C	Fieldbus interface (out)
	12	X4B	Fieldbus interface (in)
	13	X2C	CAN bus / analog inputs and outputs
	14	X2B	Safety functions / 24 V DC voltage supply / 2 digital outputs
	15	X2A	Control terminal block for digital inputs and outputs.
	16	–	Shield clambs for shielded control lines.

Figure 13: F6 housing 4 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
https://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_f6-cu-k-inst-20144795_en.pdf

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

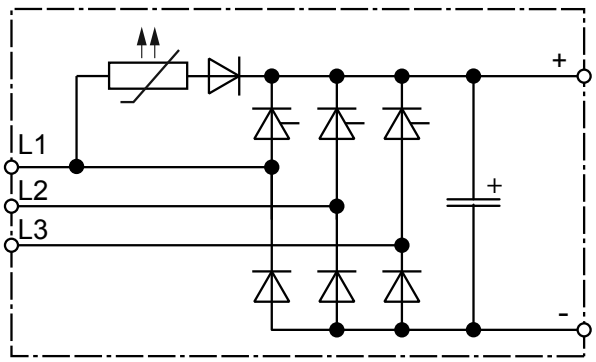
4.2 Connection of the power unit

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 4 can be supplied by mains via terminals L1, L2 and L3.

The use of DC terminals for feed-in is permitted only permitted with external precharging.

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

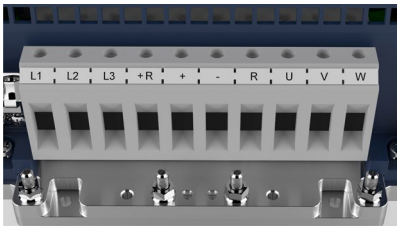
X1A	Name	Function	Cross-section for terminal connection	Tightening torque
	L1	Mains connection 3-phase	Flexible line with wire-end ferrule 1.5...35 mm² (without wire-end ferrule up to max. 50 mm²) UL: flexible line without wire-end ferrule AWG 16...1	3.2...3.7 Nm 28...32 lb inch
	L2			
	L3			
	+R	Connection for braking resistor (between +R and R)		
	+	DC connection, connection for interconnected operation		
	-			
	R	Connection for braking resistor (between +R and R)		
	U	Motor connection		
	V			
	W			

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	Connection type	Tightening torque
PE, ⏚	Connection for protective earth	M6 threaded pin with nut for 6.5 mm cable lug	6.1...12 Nm 54...106 lb inch

Figure 16: Connection for protective earth

Incorrect installation of the PE connection

Only M6 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.

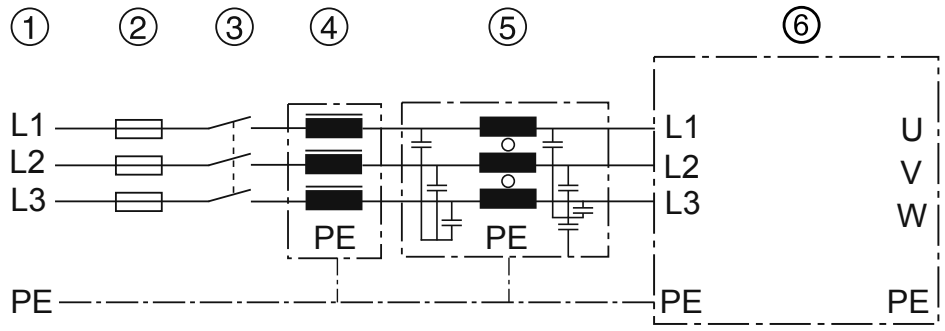
The functional earth may not be wired green / yellow!

Notes on EMC-compatible installation can be found here.

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

4.2.3 AC 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 cable 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 or when under permanent drive load (continuous duty).

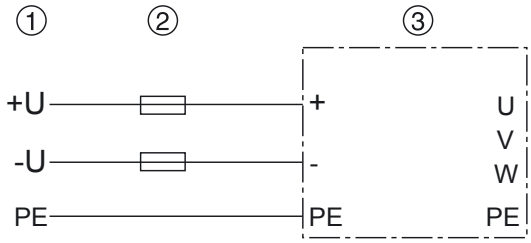
The term "hard" power system means that the nodal point power (S_{Net}) of the mains is very high (>> 200) compared to the rated output power of the drive converter (S_{out}).

$k = \frac{S_{Net}}{S_{out}} >> 200$	e.g.	$k = \frac{2\,\text{MVA (supply transformer)}}{62\,\text{kVA (21F6)}} = 33$	—>	no choke required

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

The use of DC terminals for feed-in is permitted only permitted with external precharging.

4.2.4.2 Terminal block X1A DC connection

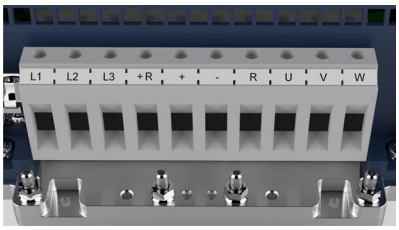
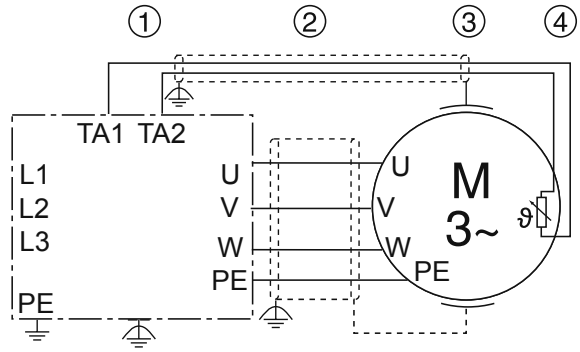
X1A	Name	Function	Cross-section for terminal connection	Tightening torque
	+, -	DC connection, connection for interconnected operation	Flexible line with wire-end ferrule 1.5...35 mm² (without wire-end ferrule up to max. 50 mm²) UL: flexible line without wire-end ferrule AWG 16...1	3.2...3.7 Nm 28...32 lb inch

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 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) => *Instruction manual „Control circuit“*

Figure 20: Wiring of the motor

4.2.5.2 Terminal block X1A motor connection

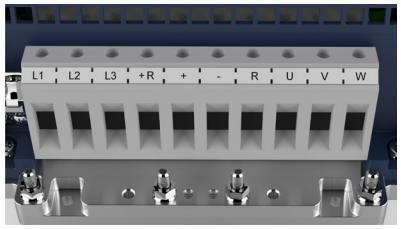
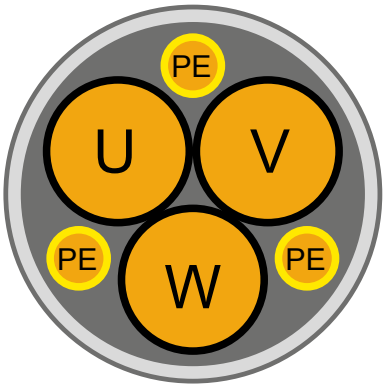
X1A	Name	Function	Cross-section for terminal connection	Tightening torque
	U, V, W	Motor connection	Flexible line with wire-end ferrule 1.5...35 mm² (without wire-end ferrule up to max. 50 mm²) UL: flexible line without wire-end ferrule AWG 16...1	3.2...3.7 Nm 28...32 lb inch

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 line length)
- better EMC properties (reduction of the common-mode output currents to earth)



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

Inverter size	**Max. motor cable length shielded according** *EN 61800-3* **Category C2**		**max. leakage current (at f_N ≤ 100 Hz)**
	Motor cable (standard)	**Motor cable (low capacitance)**	
19	25 m	50 m	< 5 mA
20			
21			
22			

Table 23: Max. motor cable length

The cable 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:

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

4.2.5.6 Motor cable cross-section

The motor cable cross-section is dependent

- on the characteristic of the output current (e.g. non-sinusoidal).
- 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

ATTENTION

Incorrect behavior of the motor!

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

ATTENTION

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 KTY84/PTC evaluation is implemented in the COMBIVERT F6. The desired operating mode can be adjusted via the software.If the evaluation is not required, it must be deactivated via software (=> *F6 Programming manual*).

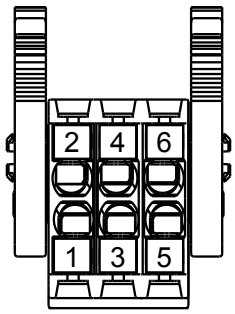
X1C	PIN	Name	Description
	1	BR+	Brake control / output +
	2	BR-	Brake control / output -
	3	reserved	–
	4	reserved	–
	5	TA1	Temperature detection / output +
	6	TA2	Temperature detection / output -

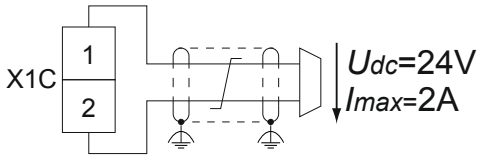
Figure 23: Terminal block X1C brake control and temperature connection

ATTENTION

Malfunctions due to incorrect line or laying!

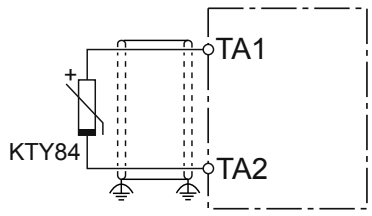
Malfunctions of the control due to capacitive or inductive coupling.

- ► Do not lay the KTY or PTC line of the motor (also shielded) together with the control line
- ► KTY or PTC line inside the motor line is only permissible with double shielding!
- ► The input of the temperature detection has basic isolation.



The voltage to the control of a brake is decoupled from the internal voltage supply. The brake works only with external voltage supply.

Figure 24: 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.

Figure 25: 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

Fire risk without monitoring!

► The operation without external wiring for the monitoring of the braking resistor is only permitted with an intrinsically safe braking resistor!

ATTENTION

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!

⚠ 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

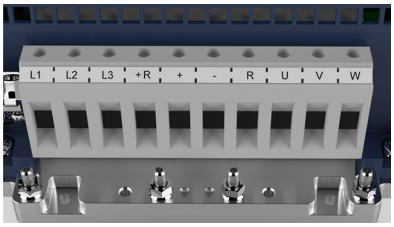
X1A	Name	Function	Cross-section for terminal connection	Tightening torque
	+R, R	Connection for braking resistor (between +R and R)	Flexible line with wire-end ferrule 1.5...35 mm² (without wire-end ferrule up to max. 50 mm²) UL: flexible line without wire-end ferrule AWG 16...1	3.2...3.7 Nm 28...32 lb inch

Figure 26: Terminal block X1A connection braking resistor

4.2.6.3 Wiring of an intrinsically safe braking resistor

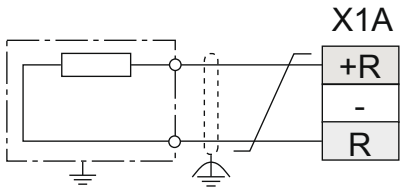


Figure 27: Wiring of an intrinsically safe braking resistor

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

http://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.

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

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

4.3 Accessories

4.3.1 Filters and chokes

Voltage class	Drive convertersize	HF filter	Mains choke 50 Hz / 4 % U_k
400 V	19	20E6T60-3000	19Z1B04-1000
	20	20E6T60-3000	20Z1B04-1000
	21	22E6T60-3000	21Z1B04-1000
	22	22E6T60-3000	22Z1B04-1000

Table 24: Filters and chokes

The specified filters and chokes are designed for rated operation.

4.3.2 Shield plate mounting kit

Name	Material number
Shield plate mounting kit	00F6V80-4001

Table 25: Shield plate mounting kit

4.3.3 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 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 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“*

ATTENTION

Avoid 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 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	generated Ion	Standard potential	Material	generated 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
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 26: Electro-chemical voltage series / standard potentials against hydrogen

5.3 Requirements on the coolant

The requirements on the coolant are depending on the ambient conditions, as well as from the used cooling system.

General requirements on 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 27: Requirements on the coolant

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 28: Special requirements for open and half-open cooling systems

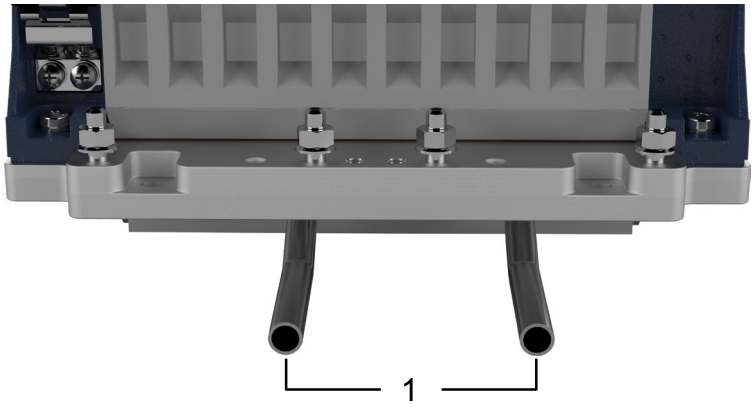
Damages at the unit which are caused by clogged, corroded heat sinks or other obvious operating errors, leads to the loss of the warranty claims.

5.4 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.



No.	Description
1	Open pipe ends for the connection of the cooling system Pipe diameter outside: 10 mm Pipe diameter inside: 7...8 mm

Figure 28: Open pipe ends for the connection of the cooling system

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.

5.5 Coolant temperature and moisture condensation

The inlet temperature may not exceed 40°C. The maximum heat sink temperature is 90°C or 95°C depending on the power unit and overload capacity => *„Switching frequency and temperature“*. To ensure a safe operation the coolant output temperature must be 10K below this 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.

The user must guarantee that any moisture condensation is avoided!

In order to avoid moisture condensation, there are the following possibilities.

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 29: 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.

ATTENTION

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!

5.6 Coolant heating

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

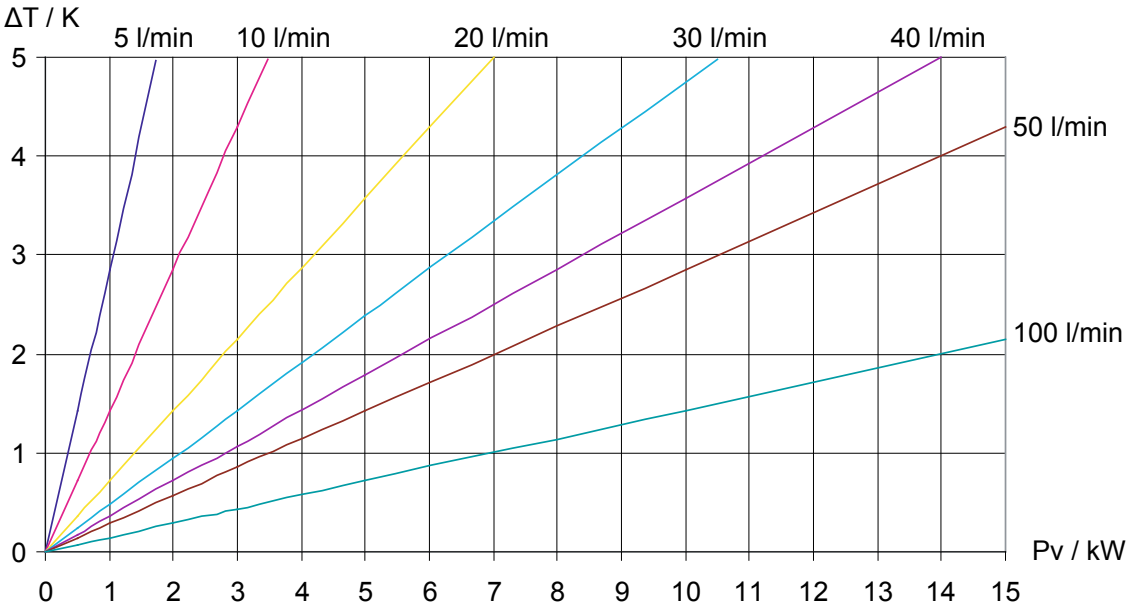


Figure 29: Coolant heating depending on power loss and flow rate with water

5.7 Typical pressure drop of the heat sink

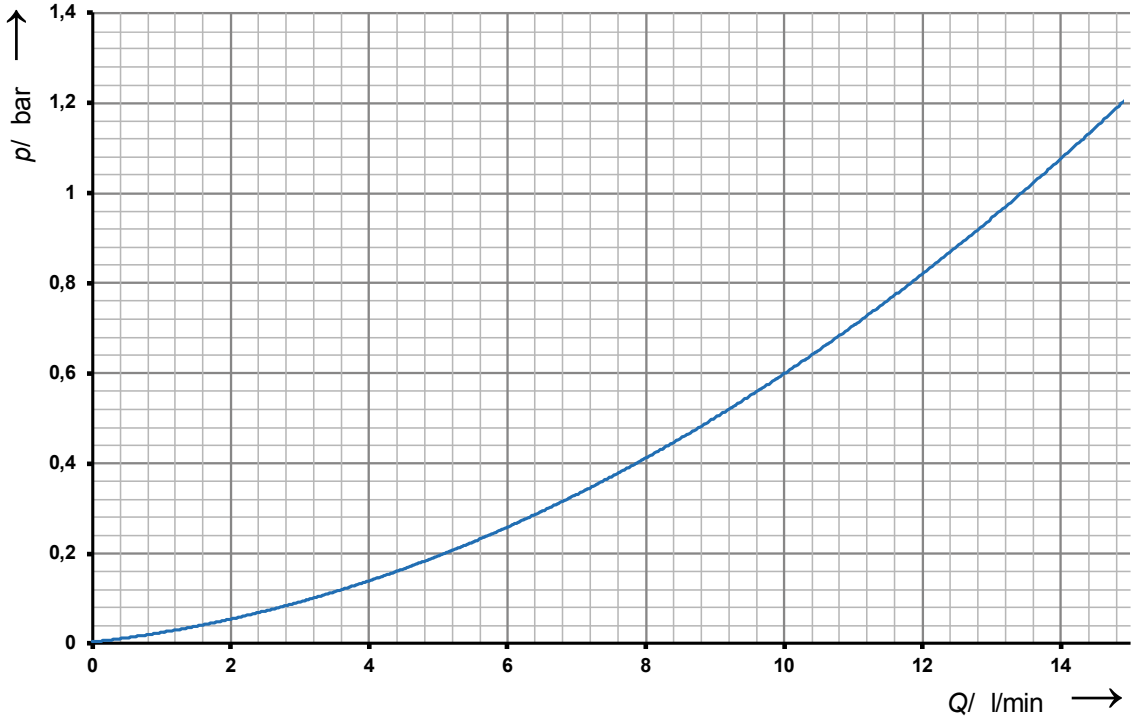


Figure 30: Typical pressure drop depending on the flow rate

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 informations and documentation“

6.2 UL certifications

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

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

- All models: Maximum Surrounding Air Temperature: 45 °C
- Use 75°C Copper Conductors Only
  This marking is only applicable for all power field wiring terminals.
- Models 19F6 and 20F6: Suitable For Use On A Circuit Capable Of Delivering Not More Than 5000 rms Symmetrical Amperes, 480 Volts Maximum when protected by Class J Fuses, see instruction manual for Branch Circuit Protection details.

  Models 21F6 and 22F6: 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.

  All models: 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 EATON, Type 170M1368, see instruction manual for Branch Circuit Protection details.

  CSA: For Canada, this marking shall be provided on the device or on a separate label shipped with the device.

  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.
- 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”
- For installations according to Canadian National Standard C22.2 No. 274-13:
  For use in Pollution Degree 2 and Overvoltage Category III environments only.
- Control Circuit Overcurrent Protection Required or equivalent.
- 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.
- Internal Overload Protection Operates prior to reaching the 130% of the Motor Full Load Current, see manual for adjustment instructions or equivalent wording.

6.3 Further informations and documentation

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

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

Instruction and information for construction and development
- Input fuses in accordance with UL
- Programming manual for control and power unit
- Motor configurator to select the appropriate drive converter, as well as to create downloads for the parameterization of the drive converter

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

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

7 Revision History

Version	Date	Description
00	2016-04	Prototype
00	2016-09	Pre-series
01	2017-02	Pre-series, unit size 22 added, new CI
02	2017-07	Series, UL certification included, water cooling
03	2018-09	Technical data corrections. Figures of the overload characteristics adapted.

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