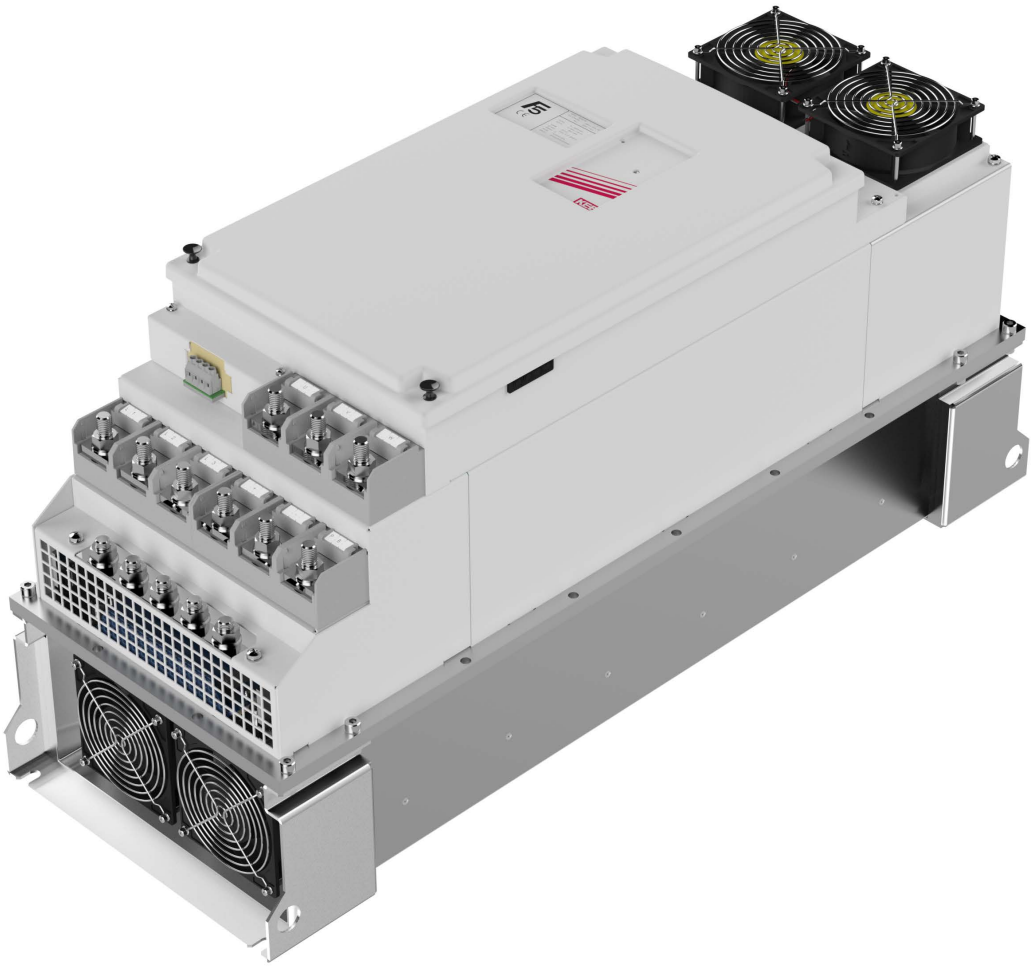

COMBIVERT **F5/F6**

INSTRUCTIONS FOR USE | **INSTALLATION F5/F6 HOUSING P**

Translation of the original manual
Document 20164377 EN 02 | Mat.No. 00F50EB-KP02

Preface

The hardware and software described in this document are products of KEB. The information contained in this document is valid at the time of publishing. KEB reserves the right to update this document in response to misprints, mistakes or technical changes.

Signal words and symbols

Certain procedures within this document can cause safety hazards during the installation or operation of the device. Refer to the safety warnings in this document when performing these procedures. Safety signs are also located on the device where applicable. A safety warning is marked by one of the following warning signs:

⚠ DANGER	Dangerous situation, which will cause death or serious injury iif this safety warning is ignored.
⚠ WARNING	Dangerous situation, which may cause death or serious injury if this safety warning is ignored.
⚠ CAUTION	Dangerous situation, which may cause minor injury if this safety warning is ignored.
NOTICE	Situation, which can cause damage to property if this safety warning is ignored.

RESTRICTION

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

Used for informational messages or recommended procedures.

More symbols

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

Note to further documentation.
www.keb.de/service/downloads

Laws and guidelines

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

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

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

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

The use of our units in the target products is outside of our control and therefore lies exclusively in the area of responsibility of the customer.

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

Tests can only be done within the intended end use of the product (application) by the customer. They must be repeated, even if only parts of hardware, software or the unit adjustment are modified.

Copyright

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Glossary

0V	Earth-potential-free common point
1ph	1-phase mains
3ph	3-phase mains
AC	AC current or voltage
AFE	From 07/2019 AIC replaces the previous name AFE
AFE filter	From 07/2019 AIC filter replaces the previous name AFE filter
AIC	Active Infeed Converter
AIC filter	Filter for Active Infeed Converter
Application	The application is the intended use of the KEB product
ASCL	Asynchronous sensorless closed loop
Auto motor ident.	Automatically motor identification; calibration of resistance and inductance
AWG	American wire gauge
B2B	Business-to-business
BiSS	Open source real-time interface for sensors and actuators (DIN 5008)
CAN	Fieldbus system
CDF	Cyclic duration factor
CDM	Complete drive module including auxiliary equipment (control cabinet)
COMBIVERT	KEB drive controller
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
EMS	Energy Management System
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 controller
GND	Reference potential, ground
GTR7	Braking transistor
HF filter	High frequency filter to the mains
Hiperface	Bidirectional encoder interface of the company Sick-Stegmann
HMI	Human machine interface (touch screen)
HSP5	Fast, serial protocol
HTL	Incremental signal with an output voltage (up to 30V) -> TTL
IEC	International standard
IP xx	Degree of protection (xx for level)
KEB product	The KEB product is subject of this manual
KTY	Silicium temperature sensor (polarized)
Manufacturer	The manufacturer is KEB, unless otherwise specified (e.g. as manufacturer of machines, engines, vehicles or adhesives)
MCM	American unit for large wire cross sections
Modulation	Means in drive technology that the power semiconductors are controlled
MTTF	Mean service life to failure
NN	Sea level
OC	Overcurrent
OH	Overheat
OL	Overload
OSSD	Output signal swithching device; - an output signal that is checked in regular intervals on its shutdown. (safety technology)
PDS	Power drive system incl. motor and measuring probe
PE	Protective earth
PELV	Protective Extra Low Voltage
PFD	Term used in the safety technology (EN 61508-1...7) for the size of error probability

PFH	Term used in the safety technology (EN 61508-1...7) for the size of error probability per hour
PLC	Programmable logic controller
Pt100	Temperature sensor with R0=100Ω
Pt1000	Temperature sensor with R0=1000Ω
PTC	PTC-resistor for temperature detection
PWM	Pulse width modulation
RJ45	Modular connector with 8 lines
SCL	Synchronous sensorless closed loop
SELV	Safety Extra Low Voltage (<60 V)
SIL	The safety integrity level is a measure for quantifying the risk reduction. Term used in the safety technology (EN 61508 -1...7)
SS1	Safety function „Safe stop 1“ in accordance with IEC 61800-5-2
SSI	Synchronous serial interface for encoder
STO	Safety function „Safe Torque Off“ in accordance with IEC 61800-5-2
TTL	Incremental signal with an output voltage up to 5 V
USB	Universal serial bus
VARAN	Real-time Ethernet bus system

Standards for drive controllers

Product standards that apply directly to the drive controller

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 controller 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 controller

DGUV regulation 3	Electrical installations and equipment
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
DIN EN 60939-1	Passive filter units for electromagnetic interference suppression - Part 1: Generic specification (IEC 60939-1:2010); German version EN 60939-1:2010

1 Basic Safety Instructions

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

The following safety instructions have been created by the manufacturer for the area of electric drive technology. They can be supplemented by local, country- or application-specific safety instructions. This list is not exhaustive. Violation of the safety instructions by the customer, user or other third party leads to the loss of all resulting claims against the manufacturer.

NOTICE

Hazards and risks through ignorance.

► Read the instructions for use !

► Observe the safety and warning instructions !

► If anything is unclear, please contact KEB Automation KG !

1.1 Target group

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

- Knowledge and understanding of the safety instructions.
- Skills for installation and assembly.
- Start-up and operation of the product.
- Understanding of the function in the used machine.
- Detection of hazards and risks of the electrical drive technology.
- Knowledge of *DIN IEC 60364-5-54.*
- Knowledge of national safety regulations.

1.2 Transport, storage and proper use

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

Transport of drive controllers with an edge length >75 cm

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

► Transport of drive controllers on suitable pallets.

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

NOTICE

Damage to the coolant connections

Bending of the tubes!

► Never place the device on the coolant connections

Drive controllers contain electrostatic sensitive components.

► Avoid contact.

► Wear ESD-protective clothing.

Do not store drive controllers

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

1.3 Installation

⚠ DANGER

Do not operate in an explosive environment!

► The 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 controller accordingly when using lifting gear.

To prevent damages to the device:

- Make sure that no components are bent and/or isolation distances are changed.
- The device must not be put into operation in case of mechanical defects.
- Do not allow moisture or mist to penetrate the unit.
- Avoid dust permeating the device. Allow for sufficient heat dissipation if installed in a dust-proof housing.
- Note installation position and minimum distances to surrounding elements. Do not cover the ventilation openings.
- Mount the drive controller according to the specified degree of protection.
- Make sure that no small parts fall into the 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 controller.
- Follow all safety instructions!

1.4 Electrical connection

⚠ DANGER

Voltage at the terminals and in the device!

Danger to life due to electric shock !

- ► Never work on the open device or never touch exposed parts.
- ► For any work on the unit switch off the supply voltage, secure it against switching on and check absence of voltage by measuring at the input terminals.
- ► Wait until all drives has been stopped in order that no regenerative energy can be generated.
- ► Await capacitor discharge time (5 minutes). Check absence of voltage by measuring at the DC terminals.
- ► If personal protection is required, install suitable protective devices for drive converters.
- ► Never bridge upstream protective devices (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 controllers.
www.keb.de/fileadmin/media/Techinfo/dr/tn/ti_dr_tn-rcd-00008_en.pdf

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

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

- The electrical installation shall be carried out in accordance with the relevant requirements.
- Cable cross-sections and fuses must be dimensioned by the user according to the specified minimum/maximum values for the application.
- 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/dr/emv/0000neb0000.pdf

1.4.2 Voltage test

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

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

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

1.4.3 Insulation measurement

An insulation measurement (in accordance with *EN 60204-1* chapter 18.3) with DC 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 controller 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 controller if parameterization is compatible to application.
- ► Securing a unit solely with software-supported functions is not sufficient. It is imperative to install external protective measures (e.g. limit switch) that are independent of the drive controller.
- ► Secure motors against automatic restart.

⚠ CAUTION

High temperatures at heat sink and coolant!

Burning of the skin!

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

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

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

www.keb.de/fileadmin/media/Techinfo/dr/tn/ti_dr_tn-format-capacitors-00009_en.pdf

NOTICE

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

Premature ageing of the electrolytic capacitors!

- ► Mains choke with U_k = 4% absolutely necessary.

Switching at the output

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

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

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

Switching at the input

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

Short-circuit resistance

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

Exceptions:

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

1.6 Maintenance

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

► Check system for loose screws and plugs and tighten if necessary.

► Clean drive controller from dirt and dust deposits. Pay attention especially to cooling fins and protective grid of the fans.

► Examine and clean extracted air filter and cooling air filter of the control cabinet.

► Check the function of the fans of the drive controller. The fan must be replaced in case of audible vibrations or squeak.

► In the case of liquid-cooled drive controllers a visual test of the cooling circuit for leaks and corrosion must be carried out.The cooling circuit must be completely empty if a unit shall be switched off for a longer period. The cooling circuit must be blown out additionally with compressed air at temperatures below 0°C.

1.7 Repair

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

⚠ DANGER

Unauthorized exchange, repair and modifications!

Unpredictable malfunctions!

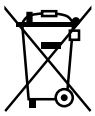
- ► The function of the drive controller is dependent on its parameterization. Never replace without knowledge of the application.
- ► Modification or repair is permitted only by KEB Automation KG authorized personnel.
- ► Only use original manufacturer parts.
- ► Infringement will annul the liability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

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

1.8 Disposal

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

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



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

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

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

The packaging must be feed to paper and cardboard recycling.

2 Product description

The F5 / F6 series are drive controllers optimized for operation at synchronous and asynchronous motors. The COMBIVERT can be equipped with a control board for the use in safety-related applications. Furthermore, it can be operated at different fieldbus systems. The control board has a system-overlapping operating concept.

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

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

2.1 Specified application

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

The technical data as well as information concerning the supply conditions shall be taken from the nameplate and from the instructions for use and shall be strictly observed.

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

Restrictions

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 controller can assume unpredictable operating conditions in error case, wrong parameterization, due to faulty connection or improper intervention or repairs. This can be:

- Wrong direction of rotation
- Motor speed too high
- Motor runs into limitation
- Motor may still carry live current when at rest
- Automatic restart

2.2 Improper use

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

2.3 Product features

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

Unit type:	Drive controller
Series:	COMBIVERT F5 / F6
Power range:	200…315 kW as Single Drive 400…560 kW as Master / Slave system 630…900 kW as Master / Slave / Slave system
Housing:	P

The COMBIVERT F5 / F6 is characterized by the following features:

- Operation of three-phase asynchronous motors and three-phase synchronous motors
- Operating modes open-loop or closed-loop with and without speed feedback
- Fieldbus interface F5 is realized by operator
- Fieldbus interface F6 supports the following systems directly: EtherCAT, VARAN or CAN
- System-overlapping operating concept
- Wide operating temperature range
- Low switching losses due to IGBT - power unit
- Low noise development due to high switching frequencies
- **Different heat sink concepts**
  - Air cooler as built-in version
  - Air cooler as push-through version
  - Liquid cooler as built-in version
  - Liquid cooler as push-through version
  - Liquid cooler with stainless steel tubes as built-in version
- Easily replaceable fans
- Depending on the operating mode, the torque limits and s-curves are adjustable (to protect the gear box)
- General protective functions of the COMBIVERT series against overcurrent, over-voltage and overtemperature
- Analog and digital inputs and outputs
- Potential-free relay output
- Brake control and supply
- Motor protection by I^2t
- KTY, PT100 and PTC input
- Diagnostic interface

2.4 Part code

x x x x x x x - x x x x		
	Heat sink design	A: Air cooler with internal fan power supply
		D: Air cooler with external fan power supply
		V: Liquid cooling system built-in version [1]
		W: Liquid cooling system push-through version [1]
		Z: Liquid cooling system with stainless steel tubes Built-in version [1]
		At special/customer unit consecutive numbering
	Encoder interface	0: Without encoder interface (F5)
		M: Multi encoder (F6)
		At special/customer unit consecutive numbering
	Switching frequency, Current controller limit, Overcurrent	0: 2 kHz / 125 % / 150 %
		1: 4 kHz / 125 % / 150 %
		4: 2 kHz / 150 % / 180 %
		2: 8 kHz / 125 % / 150 %
		At special/customer unit consecutive numbering
	Voltage / Connection	9: 3ph 400 V AC
		B: 3ph 690 V AC
		D: 690 V DC without precharging
		V: 400 V DC without precharging
		At special/customer unit consecutive numbering
	Housing	P
	Variants	0: Without braking transistor
		1: With braking transistor
		A: Such as 0, but control board with safety relay
		B: Such as 1, but control board with safety relay
	Control type	A: V/f software F5+ without STO
		E: SCL software F5+ without STO
		H: ASCL software F5+ without STO
		K: V/f software F5+ with STO / F6 with EtherCAT [2]
		P: SCL software F5+ with STO
		L: ASCL software F5+ with STO
	Series	F5: COMBIVERT F5
		F6: COMBIVERT F6
	Device size	28…39

Table 1: Part code

[1] *After changing the type code, the different liquid coolers are listed separately. The old designation is H.*

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

3 Technical data

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

3.1 Operating conditions

3.1.1 Climatic environmental conditions

Storage		**Standard**	**Class**	**Description**
Ambient temperature		*EN 60721-3-1*	1K4	-25…55 °C
Relative humidity		*EN 60721-3-1*	1K3	5…95 % (without condensation)
Storage height		–	–	Max. 3000 m above sea level
Transport		**Standard**	**Class**	**Description**
Ambient temperature		*EN 60721-3-2*	2K3	-25…70 °C
Relative humidity		*EN 60721-3-2*	2K3	95 % at 40 °C (without condensation)
Operation		**Standard**	**Class**	**Description**
Ambient 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)
Type of protection		*EN 60529*	IP20	Protection against foreign bodies > ø12.5 mm No protection against water Non-conductive pollution, occasional condensation when PDS is not active.
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. • From 2000 m, the control board has only basic insulation to the mains. Additional measures must be taken for the wiring of the control unit.

Table 2: Climatic ambient conditions

3.1.2 Mechanical ambient conditions

Storage	**Standard**	**Class**	**Description**
Vibration limits	*EN 60721-3-1*	1M2	Vibration amplitude 1.5 mm (2…9 Hz) Acceleration amplitude 5 m/s² (9…200 Hz)
Shock limit values	*EN 60721-3-1*	1M2	40 m/s²; 22 ms
Transport	**Standard**	**Class**	**Description**
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**	**Description**
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

Table 3: Mechanical environmental conditions

3.1.3 Chemical / mechanical active substances

Storage		**Standard**	**Class**	**Description**
Contamination	Gases	*EN 60721-3-1*	1C2	–
	Solids		1S2	–
Transport		**Standard**	**Class**	**Description**
Contamination	Gases	*EN 60721-3-2*	2C2	–
	Solids		2S2	–
Operation		**Standard**	**Class**	**Description**
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	Description
Overvoltage category	*EN 61800-5-1*	III	–
	EN 60664-1		–
Pollution degree	*EN 60664-1*	2	Non-conductive pollution, occasional condensation when PDS is not active

Table 5: Device classification

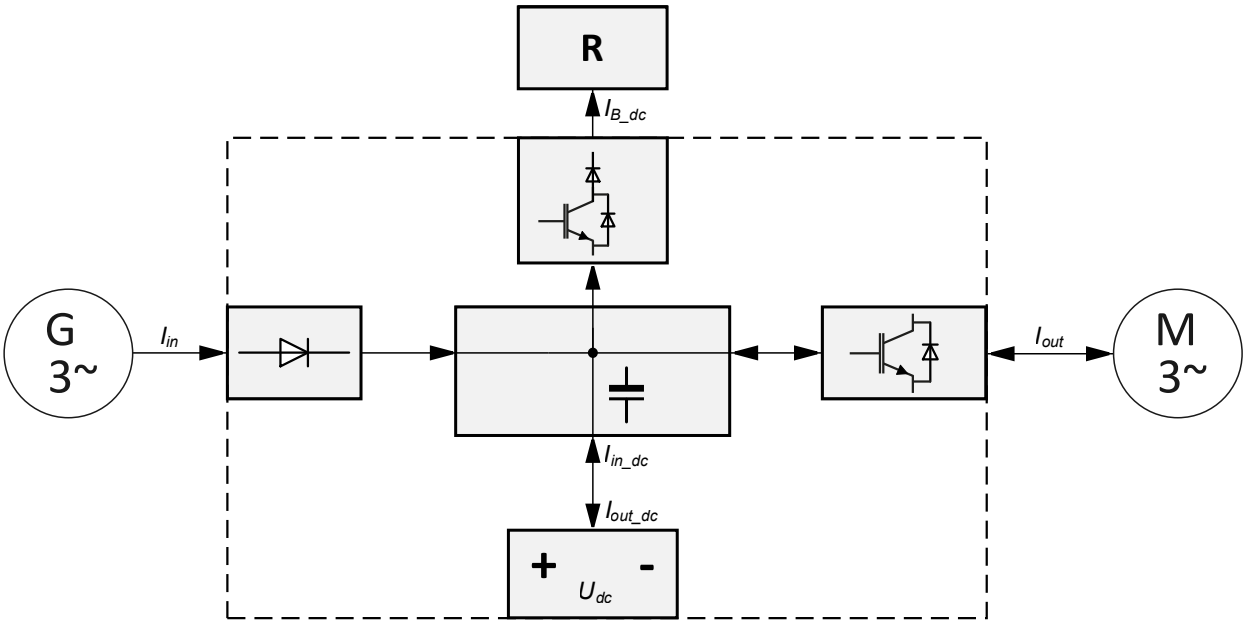
3.1.4.2 Electromagnetic compatibility

The specified values only apply to devices with an external filter.

EMC emitted interference	Standard	Class	Description
Conducted interference emissions	*EN 61800-3*	C2	–
Radiated interferences	*EN 61800-3*	C2	–
Interference immunity	**Standard**	**Level**	**Description**
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
Conducted immunity, induced by high-frequency fields	*EN 61000-4-6*	10 V	0.15...80 MHz
Electromagnetic fields	*EN 61000-4-3*	10 V/m 3 V/m 1 V/m	80 MHz...1 GHz 1.4...2 GHz 2...2.7 GHz
Voltage variation / voltage drop	*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 unsymmetries	*EN 61000-2-4*	–	≤ 3 %

Table 6: Electromagnetic compatibility

3.2 Block diagram of energy flow in the device



Legend			
U_{in}	Input voltage range	I_{out_dc}	Output current DC connection
I_{in}	Mains input current	I_{B_dc}	Braking current PB connection
I_{in_dc}	Input current DC connection	I_{out}	Output current motor
U_{dc}	Operating voltage range DC connection	R	Braking resistor
G	Generator	M	Motor
	DC link		Input circuit
	Inverter		Braking transistor
	DC connection		Drive controller

Figure 1: Block diagram of energy flow in the device

3.3 Technical data 400V class

3.3.1 Single Drive

Device size			28	29	30
Housing				P	
Module number				1	
Rated power					
Rated motor power		P_{mot} / kW	200	250	315
Rated apparent output power		S_{out} / kVA	256	319	395
Drive controller (input)					
Rated input voltage		U_N / V		400 (UL: 480)	
Input voltage range		U_{in} / V		305…528 ±0 %	
Mains phases				3	
Mains frequency		f_N / Hz		50 / 60 ±2	
Rated input current		I_{in} / A	385	483	598
Rated input current UL		I_{in_UL} / A	336	417	517
Permitted mains forms				TN, TT, IT [1], Δ mains [2]	
Permissible mains fuse gG/gL	3)			=> *„8 Protection of drive controllers“*	
Drive controller (output)					
Output voltage	4)	U_{out} / V		0…U_{in}	
Output frequency	5)	f_{out} / Hz		0...599	
Min. output frequency at continuous full load		f_{out_min} / Hz		3	
Output phases				3	
Rated output current		I_{out} / A	370	460	570
Rated output current UL		I_{out_UL} / A	320	398	493
Standstill current at 4 kHz	6)	I_{out_ST} / A	259	322	399
Max. short time current 30s	7)	I_{OL} / %		125	
Overcurrent	12)	I_{OC} / %	150	150/180	150
Min. switching frequency (rated switching frequency)		f_{S_min} / kHz		2	
Max. switching frequency		f_{S_max} / kHz		8	4
Overload characteristic				=> *„10 Characteristics“*	
Power dissipation					

Switching frequency		f_S / kHz	2	4	8	2	4	8	2	4
Total power dissipation	8)	P_D / kW	3.5	4.1	5.4	4.3	4.9	6.8	5.3	6.2

Cable cross-section					
Motor cable cross-section				=> *„6.4.6 Cable cross-sections“*	
Max. motor cable length shielded				=> *„6.4.7 Motor cable lengths“*	
DC link data					
DC link capacity		C_{int} / µF	16200	19800	
Max. external DC link capacity	9)	C_{ext_max} / µF		19800	
Precharging current	8)	I_{pre} / A		98	
Power OFF DC		U_{Poff_dc} / V		200	
Undervoltage level DC		U_{UP_dc} / V		240	
Overvoltage level DC		U_{OP_dc} / V		840	
Operating voltage range DC	13)	$U_{\_dc}$ / V		390...780	
Rated input current DC		I_{in_dc} / A	469	580	– [14]
Rated input current UL DC		$I_{in\_UL\_dc}$ / A	403	502	– [14]
Rated output current DC	17)	I_{out_dc} / A	469	580	–
Rated output current UL DC	17)	$I_{out\_UL\_dc}$ / A	403	502	–

continued on the next page

Device size			28			29			30	
Housing						**P**				
Module number						**1**				
Braking option										
Min. braking resistor	10)	$R_{\_min}$ / Ω				2.1				
Max. braking current	10)	I_{B_max} / A				380				
Switching level braking transistor		U_{B_dc} / V				780				
Monitoring braking transistor (K1 / K2)	11)	U_{mon_dc} / V				24				
		I_{mon_dc} / A				2				
Operating conditions air cooler										
Switching frequency		f_S / kHz				2			–	
Max. heat sink temperature (OH)	16)	$t_{\_max}$ / °C				90			–	
External fan power supply		U_{ext_dc} / V				24			–	
		I_{ext_dc} / A	2.5		4 15)	2.5		4 15)	–	
Operating conditions liquid cooler										
Switching frequency		f_S / kHz	2	4	8	2	4	8	2	4
Max. heat sink temperature (OH)	16)	$t_{\_max}$ / °C	90	73	60	90	73	60	90	73
ΔT Flow/return flow		ΔT / K				3...6				
Flow temperature typical		t_{in_typ} / °C				25				
Flow temperature maximum		t_{in_max} / °C				40				
Liquid cooler content		V / l				0.8				
Volume flow		Q / l/min	=> *„5.2 Diagrams of the cooling design“*							
Pressure drop		Δp_v / bar								
Max. permissible operating pressure		$p_{\_max}$ / bar				10				
Other data										
Insulation resistance @ U_{dc} = 500 V	1) 13)	R_{iso} / MΩ				1.69				
Max. weight air cooler		$m_{\_max}$ / kg				97.5				
Max. weight liquid cooler		$m_{\_max}$ / kg				96				

Table 7: Technical data of the 400V class - Single Drive

1) *Restrictions when using HF filters.*
2) *Phase conductor grounded mains are only permissible without HF filters.*
3) *Fusing according to UL UL => „8 Protection of drive controllers“.*
4) *The voltage at the motor is dependent on the series-connected units and on the control method.*
5) *The output frequency is to be limited in such way that 1/10 of the switching frequency is not exceeded.Devices with higher maximum output frequency are subject to export restrictions and are only available upon request.*
6) *Max. current before the OL2 function triggers.*
7) *With the regulated operating modes 5 % are to be subtracted as control reserve.*
8) *Applies to rated input voltage 400 V, 25 °C ambient temperature.*
9) *Maximum additional chargeable capacity per module.*
10) *Data apply to a switching level for the braking transistor of 780 V DC.*
11) *=> „7 Wiring diagrams“. UL, C-UL E120782 UL508, CSA C22.2 No.14; UL1604 (class I, Division 2, Group A, B, C, D); 277V AC 8A, General use, 24 V DC 6A, General use, B300, R300 250 V AC / max. 2A, 24 V DC / max. 2A (Pilot Duty).*
12) *180 % only at rated switching frequency.*
13) *The internal fans are switched off below the operating voltage range.*
14) *Only possible as DC version without precharging.*
15) The use of stronger heat sink fans for adaption to the ambient conditions or at higher overload (180 %) is possible after consultation with KEB.
16) *The specifications apply to devices without derating of the switching frequency.*
17) *The specifications only apply if there is parallely no power output via the motor connection terminals U / V / W.*

NOTICE

Malfunctions due to asymmetrical running!

► An input choke is absolutely necessary.

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

3.3.2 Master / slave system

Device size			32	33	34	35
Housing			P			
Module number			2			
Rated power						
Rated motor power		P_{mot} / kW	400	450	500	550
Rated apparent output power		S_{out} / kVA	492	554	616	693
Drive controller (input)						
Rated input voltage		U_N / V	400 (UL: 480)			
Input voltage range		U_{in} / V	305…528 ±0 %			
Mains phases			3			
Mains frequency		f_N / Hz	50 / 60 ±2			
Rated input current		I_{in} / A	746	840	935	1050
Rated input current UL		I_{in_UL} / A	646	726	810	910
Permitted mains forms			TN, TT, IT [1], Δ mains [2]			
Permissible mains fuse gG / gL	3)		=> *„8 Protection of drive controllers“*			
Drive controller (output)						
Output voltage	4)	U_{out} / V	0…U_{in}			
Output frequency	5)	f_{out} / Hz	0...599			
Min. output frequency at continuous full load		f_{out_min} / Hz	3			
Output phases			3			
Rated output current		I_{out} / A	710	800	890	1000
Rated output current UL		I_{out_UL} / A	615	692	770	867
Standstill current at 4 kHz	6)	I_{out_ST} / A	497	560	623	700
Max. short time current 30s	7)	I_{OL_max} / %	125			
Overcurrent		I_{OC} / %	150			
Min. switching frequency (rated switching frequency)		f_{S_min} / kHz	2			
Max. switching frequency		f_{S_max} / kHz	8		4	
Overload characteristic			=> *„10.1 Overload characteristic“*			
Power dissipation						
Switching frequency		f_S / kHz	2	4	8	2	4	8	2	4	2	4
Total power dissipation	8)	P_D / kW	6.8	7.8	10.4	7.6	8.8	12	8.5	9.6	9.5	11
Cable cross-section						
Motor cable cross-section			=> *„6.4.6 Cable cross-sections“*			
Max. motor cable length shielded			=> *„6.4.7 Motor cable lengths“*			
DC link data						
DC link capacity	13)	C_{int} / µF	19800			
Max. external DC link capacity	9)	C_{ext_max} / µF	19800			
Precharging current	8) 13)	I_{pre} / A	98			
Power OFF DC		U_{Poff_dc} / V	200			
Undervoltage level DC		U_{UP_dc} / V	240			
Overvoltage level DC		U_{OP_dc} / V	840			
Operating voltage range DC	12)	$U_{\_dc}$ / V	390...780			
Rated input current DC		I_{in_dc} / A	895	1009	1123	1261
Rated input current UL DC		$I_{in\_UL\_dc}$ / A	775	872	971	1093
Rated output current DC	16)	I_{out_dc} / A	895	1009	1123	1261
Rated output current UL DC	16)	$I_{out\_UL\_dc}$ / A	775	872	971	1093

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Device size			**32**		**33**		**34**		**35**	
Housing			**P**							
Module number			**2**							
Braking option										
Min. braking resistor	10) 13)	R_{min} / Ω	2.1							
Max. braking current	10) 13)	$I_{B\_max\_dc}$ / A	380							
Switching level braking transistor		U_{B_dc} / V	780							
Monitoring braking transistor (K1 / K2)	11) 13)	U_{mon_dc} / V	24							
		I_{mon_dc} / A	2							
Operating conditions air cooler										
Switching frequency		f_S / kHz	2	4	2	4	2		2	
Max. heat sink temperature (OH)	15)	t_{max} / °C	90							
External fan power supply		U_{ext_dc} / V	24							
	13)	I_{ext_dc} / A	2.5	4 14)	2.5	4 14)	2.5	4 14)	4	
Operating conditions liquid cooler										
Switching frequency		f_S / kHz	2	4	8	2	4	8	2	4	2	4
Max. heat sink temperature (OH)	15)	t_{max} / °C	90	73	60	90	73	60	90	73	90	73
ΔT Flow/return flow series connection		ΔT / K	6...10							
ΔT Flow/return flow parallel connection		ΔT / K	3...7							
Flow temperature typical		t_{in_typ} / °C	25							
Flow temperature maximum		t_{in_max} / °C	40							
Liquid cooler content	13)	V / l	0.8							
Volume flow		Q / l/min	=> *„5.2 Diagrams of the cooling design“*							
Pressure drop		Δp_V / bar								
Max. permissible operating pressure		p_{max} / bar	10							
Other data										
Insulation resistance @ U_{dc} = 500 V	1) 13)	R_{iso} / MΩ	1.69							
Max. weight air cooler	13)	m_{max} / kg	97.5							
Max. weight liquid cooler	13)	m_{max} / kg	96							

Table 8: Technical data of the 400 V class master / slave

1) *Restrictions when using HF filters.*
2) *Phase conductor grounded mains are only permissible without HF filters.*
3) *Fusing according to UL => „8 Protection of drive controllers“.*
4) *The voltage at the motor is dependent on the series-connected units and on the control method.*
5) *The output frequency is to be limited in such way that 1/10 of the switching frequency is not exceeded.Devices with higher maximum output frequency are subject to export restrictions and are only available upon request.*
6) *Max. current before the OL2 function triggers.*
7) *With the regulated operating modes 5 % are to be subtracted as control reserve.*
8) *Applies to rated input voltage 400 V, 25 °C ambient temperature.*
9) *Maximum additional chargeable capacity per module.*
10) *Data apply to a switching level for the braking transistor of 780 V DC.*
11) *=> „7 Wiring diagrams“. UL, C-UL E120782 UL508, CSA C22.2 No.14; UL1604 (class I, Division 2, Group A, B, C, D); 277 VAC 8A, General use, 24 V DC 6A, General use, B300, R300 250 V AC / max. 2A, 24 V DC / max. 2A (Pilot Duty).*
12) *The internal fans are switched off below the operating voltage range.*
13) *These data are valid per module.*
14) The use of stronger heat sink fans for adaption to the ambient conditions or at higher overload (180 %) is possible after consultation with KEB.
15) *The specifications apply to devices without derating of the switching frequency.*
16) *The specifications only apply if there is parallely no power output via the motor connection terminals U / V / W.*

NOTICE

Malfunctions due to asymmetrical running!

► An input choke is absolutely necessary.

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

3.3.3 Master / slave / slave system

Device size			36	37	38
Housing				**P**	
Module number				**3**	
Rated power					
Rated motor power		P_{mot} / kW	630	710	800
Rated apparent output power		S_{out} / kVA	797	921	1005
Drive controller (input)					
Rated input voltage		U_N / V		400 (UL: 480)	
Input voltage range		U_{in} / V		305…528 ±0 %	
Mains phases				3	
Mains frequency		f_N / Hz		50 / 60 ±2	
Rated input current		I_{in} / A	1208	1397	1523
Rated input current UL		I_{in_UL} / A	1045	1209	1318
Permitted mains forms				TN, TT, IT [1], Δ mains [2]	
Permissible mains fuse gG / gL	3)			=> *„8 Protection of drive controllers“*	
Drive controller (output)					
Output voltage	4)	U_{out} / V		0…U_{in}	
Output frequency	5)	f_{out} / Hz		0...599	
Min. output frequency at continuous full load		f_{out_min} / Hz		3	
Output phases				3	
Rated output current		I_{out} / A	1150	1330	1450
Rated output current UL		I_{out_UL} / A	996	1151	1255
Standstill current at 4 kHz	6)	I_{out_ST} / A	805	931	1015
Max. short time current 30s	7)	I_{OL_max} / %		125	
Overcurrent		I_{OC} / %		150	
Min. switching frequency (rated switching frequency)		f_{S_min} / kHz		2	
Max. switching frequency		f_{S_max} / kHz		8	4
Overload characteristic				=> *„10 Characteristics“*	
Power dissipation					
Switching frequency		f_S / kHz	2 / 4 / 8	2 / 4 / 8	2 / 4
Total power dissipation	8)	P_D / kW	10.5 / 12.4 / 16.8	11.9 / 14.3 / 19.5	13.5 / 15.8
Cable cross-section					
Motor cable cross-section				=> *„6.4.6 Cable cross-sections“*	
Max. motor cable length shielded				=> *„6.4.7 Motor cable lengths“*	
DC link data					
DC link capacity	13)	C_{int} / µF		19800	
Max. external DC link capacity	9)	C_{ext_max} / µF			
Precharging current	8) 13)	I_{pre} / A		98	
Power OFF DC		U_{Poff_dc} / V		200	
Undervoltage level DC		U_{UP_dc} / V		240	
Overvoltage level DC		U_{OP_dc} / V		840	
Operating voltage range DC	12)	$U_{\_dc}$ / V		390...780	
Rated input current DC		I_{in_dc} / A	1451	1678	1824
Rated input current UL DC		$I_{in\_UL\_dc}$ / A	1255	1451	1582
Rated output current DC	16)	I_{out_dc} / A	1451	1678	1824
Rated output current UL DC	16)	$I_{out\_UL\_dc}$ / A	1255	1451	1582

continued on the next page

Device size			36			37			38	
Housing			P							
Module number			3							
Braking option										
Min. braking resistor	10) 13)	R_{min} / Ω	2.1							
Max. braking current	10) 13)	$I_{B\_max\_dc}$ / A	380							
Switching level braking transistor		U_{B_dc} / V	780							
Monitoring braking transistor (K1 / K2)	11) 13)	U_{mon_dc} / V	24							
		I_{mon_dc} / A	2							
Operating conditions air cooler										
Switching frequency		f_S / kHz	2						–	
Max. heat sink temperature (OH)	14)	t_{max} / °C	90						–	
External fan power supply		U_{ext_dc} / V	24						–	
	13)	I_{ext_dc} / A	2.5	4 14)		2,5	4 14)		–	
Operating conditions liquid cooler										
Switching frequency		f_S / kHz	2	4	8	2	4	8	2	4
Max. heat sink temperature (OH)	14)	t_{max} / °C	90	73	60	90	73	60	90	73
ΔT Flow/return flow series connection		ΔT / K	9...12							
ΔT Flow/return flow parallel connection		ΔT / K	3...7							
Flow temperature typical		t_{in_typ} / °C	25							
Flow temperature maximum		t_{in_max} / °C	40							
Liquid cooler content	13)	V / l	0.8							
Volume flow		Q / l/min	=> *„5.2 Diagrams of the cooling design“*							
Pressure drop		Δ_{pv} / bar								
Max. permissible operating pressure		p_{max} / bar	10							
Other data										
Insulation resistance @ U_{dc} = 500 V	1) 13)	R_{iso} / MΩ	1.69							
Max. weight air cooler	13)	m_{max} / kg	97.5							
Max. weight liquid cooler	13)	m_{max} / kg	96							

Table 9: Technical data of the 400 V class master / slave / slave

1) *Restrictions when using HF filters.*
2) *Phase conductor grounded mains are only permissible without HF filters.*
3) *Fusing according to UL => „8 Protection of drive controllers“.*
4) *The voltage at the motor is dependent on the series-connected units and on the control method.*
5) *The output frequency is to be limited in such way that 1/10 of the switching frequency is not exceeded.Devices with higher maximum output frequency are subject to export restrictions and are only available upon request.*
6) *Max. current before the OL2 function triggers.*
7) *With the regulated operating modes 5 % are to be subtracted as control reserve.*
8) *Applies to rated input voltage 400 V, 25 °C ambient temperature.*
9) *Maximum additional chargeable capacity per module.*
10) *Data apply to a switching level for the braking transistor of 780 V DC.*
11) *=> „7 Wiring diagrams“. UL, C-UL E120782 UL508, CSA C22.2 No.14; UL1604 (class I, Division 2, Group A, B, C, D); 277 VAC 8A, General use, 24 V DC 6A, General use, B300, R300 250 V AC / max. 2A, 24 V DC / max. 2A (Pilot Duty).*
12) *The internal fans are switched off below the operating voltage range.*
13) *These data are valid per module.*
14) The use of stronger heat sink fans for adaption to the ambient conditions or at higher overload (180 %) is possible after consultation with KEB.
15) *The specifications apply to devices without derating of the switching frequency.*
16) *The specifications only apply if there is parallely no power output via the motor connection terminals U / V / W.*

NOTICE

Malfunctions due to asymmetrical running!

► An input choke is absolutely necessary.

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

3.4 Technical data 690V class

3.4.1 Single Drive

Device size			**28**		**29**		**30**	
Housing			**P**					
Module number			**1**				**2**	**1**
Rated power								
Rated motor power		P_{mot} / kW	200		250		315	
Rated apparent output power		S_{out} / kVA	269		335		412	
Drive controller (input)								
Rated input voltage		U_N / V	690					
Input voltage range		U_{in} / V	450…760 ±0 %					
Mains phases			3					
Mains frequency		f_N / Hz	50 / 60 ±2					
Rated input current		I_{in} / A	232		288		355	
Permitted mains forms			TN, TT, IT [1], Δ mains [2]					
Permissible mains fuse gG/gL	3)		=> *„8 Protection of drive controllers“*					
Drive controller (output)								
Output voltage	4)	U_{out} / V	0…U_{in}					
Output frequency	5)	f_{out} / Hz	0...599					
Min. output frequency at continuous full load		f_{out_min} / Hz	3					
Output phases			3					
Rated output current		I_{out_UL} / A	225		280		345	
Standstill current at 4 kHz	6)	I_{out_ST} / A	158		196		245	
Max. short time current 30s	7)	I_{OL_max} / %	125					
Overcurrent		I_{OC} / %	150					
Min. switching frequency (rated switching frequency)		f_{S_min} / kHz	2					
Max. switching frequency		f_{S_max} / kHz	4				2	
Overload characteristic			=> *„10 Characteristics“*					
Power dissipation								
Switching frequency		f_S / kHz	2	4	2	4	2	
Total power dissipation	8)	P_D / kW	3.4	– [15]	4.3	– [15]	5.4	
Cable cross-section								
Motor cable cross-section			=> *„6.4.6 Cable cross-sections“*					
Max. motor cable length shielded			=> *„6.4.7 Motor cable lengths“*					
DC link data								
DC link capacity		C_{int} / µF	8800					
Max. external DC link capacity	9)	C_{ext_max} / µF	8800					
Precharging current	8)	I_{pre} / A	168				168 [13]	168
Power OFF DC		U_{Poff_dc} / V	300					
Undervoltage level DC		U_{UP_dc} / V	360					
Overvoltage level DC		U_{OP_dc} / V	1200					
Operating voltage range DC	12)	$U_{\_dc}$ / V	670...1100					
Rated input current DC		I_{in_dc} / A	284		363		435	
Rated output current DC	16)	I_{out_dc} / A	284		363		435	

continued on the next page

Device size			28		29		30	
Housing			P					
Module number			1				2	1
Braking option								
Min. braking resistor	10) 13)	$R_{\_min}$ / Ω	4.7					
Max. braking current	10) 13)	I_{B_max} / A	255					
Switching level braking transistor		U_{B_dc} / V	1140					
Monitoring braking transistor (K1 / K2)	11) 13)	U_{mon_dc} / V	24					
		I_{mon_dc} / A	2					
Operating conditions air cooler								
Switching frequency		f_S / kHz	2					–
Max. heat sink temperature (OH)	14)	$t_{\_max}$ / °C	90					–
External fan power supply	13)	U_{ext_dc} / V	24					–
		I_{ext_dc} / A	4					–
Operating conditions liquid cooler								
Switching frequency		f_S / kHz	2	4	2	4	–	2
Max. heat sink temperature (OH)	14)	$t_{\_max}$ / °C	90	– 15)	90	– 15)	–	90
ΔT Flow/return flow		ΔT / K	3...6					
Flow temperature typical		t_{in_typ} / °C	25					
Flow temperature maximum		t_{in_max} / °C	40					
Liquid cooler content		V / l	0.8					
Volume flow		Q / l/min	=> *„5.2 Diagrams of the cooling design“*					
Pressure drop		Δp_v / bar						
Max. permissible operating pressure		$p_{\_max}$ / bar	10					
Other data								
Insulation resistance @ U_{dc} = 500 V	1) 13)	R_{iso} / MΩ	1.69					
Max. weight air cooler		$m_{\_max}$ / kg	97.5					
Max. weight liquid cooler		$m_{\_max}$ / kg	96					

Table 10: Technical data of the 690V class - Single Drive

1) *Restrictions when using HF filters.*
2) *Phase conductor grounded mains are only permissible without HF filters.*
3) *Fusing according to UL => „8 Protection of drive controllers“.*
4) *The voltage at the motor is dependent on the series-connected units and on the control method.*
5) *The output frequency is to be limited in such way that 1/10 of the switching frequency is not exceeded.Devices with higher maximum output frequency are subject to export restrictions and are only available upon request.*
6) *Max. current before the OL2 function triggers.*
7) *With the regulated operating modes 5 % are to be subtracted as control reserve.*
8) *Applies to rated input voltage 690 V, 25 °C ambient temperature.*
9) *Maximum additional chargeable capacity per module.*
10) *Data apply to a switching level for the braking transistor of 1140 V DC.*
11) *=> „7 Wiring diagrams“. UL, C-UL E120782 UL508, CSA C22.2 No.14; UL1604 (class I, Division 2, Group A, B, C, D); 277 VAC 8A, General use, 24 V DC 6A, General use, B300, R300 250 V AC / max. 2A, 24 V DC / max. 2A (Pilot Duty).*
12) *The internal fans are switched off below the operating voltage range.*
13) *The data are valid per module.*
14) *The specifications apply to devices without derating of the switching frequency.*
15) *This version only upon request.*
16) *The specifications only apply if there is parallely no power output via the motor connection terminals U / V / W.*

NOTICE

Malfunctions due to asymmetrical running!

► An input choke is absolutely necessary.

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

3.4.2 Master / slave system

Device size			32	33	34	35
Housing			P			
Module number			2			
Rated power						
Rated motor power		P_{mot} / kW	400	450	500	560
Rated apparent output power		S_{out} / kVA	514	598	657	741
Drive controller (input)						
Rated input voltage		U_N / V	690			
Input voltage range		U_{in} / V	450…760 ±0 %			
Mains phases			3			
Mains frequency		f_N / Hz	50 / 60 ±2			
Rated input current		I_{in} / A	443	515	567	639
Permitted mains forms			TN, TT, IT [1], Δ mains [2]			
Permissible mains fuse gG / gL	3)		=> *„8 Protection of drive controllers“*			
Drive controller (output)						
Output voltage	4)	U_{out} / V	0…U_{in}			
Output frequency	5)	f_{out} / Hz	0...599			
Min. output frequency at continuous full load		f_{out_min} / Hz	3			
Output phases			3			
Rated output current		I_{out_UL} / A	430	500	550	620
Standstill current at 4 kHz	6)	I_{out_ST} / A	301	343	385	427
Max. short time current 30s	7)	I_{OL_max} / %	125			
Overcurrent		I_{OC} / %	150			
Min. switching frequency (rated switching frequency)		f_{S_min} / kHz	2			
Max. switching frequency		f_{S_max} / kHz	4			2
Overload characteristic			=> *„10.1 Overload characteristic“*			
Power dissipation						
Switching frequency		f_S / kHz	2 / 4	2 / 4	2 / 4	2
Total power dissipation	8)	P_D / kW	6.5 / – [15]	7.7 / – [15]	8.5 / – [15]	9.6
Cable cross-section						
Motor cable cross-section			=> *„6.4.6 Cable cross-sections“*			
Max. motor cable length shielded			=> *„6.4.7 Motor cable lengths“*			
DC link data						
DC link capacity	13)	C_{int} / µF	8800			
Max. external DC link capacity	9)	C_{ext_max} / µF	8800			
Precharging current	8) 13)	I_{pre} / A	168			
Power OFF DC		U_{Poff_dc} / V	300			
Undervoltage level DC		U_{UP_dc} / V	360			
Overvoltage level DC		U_{OP_dc} / V	1200			
Operating voltage range DC	12)	$U_{\_dc}$ / V	670...1100			
Rated input current DC		I_{in_dc} / A	542	649	715	806
Rated output current DC	16)	I_{out_dc} / A	542	649	715	806

continued on the next page

Device size			**32**		**33**		**34**		**35**
Housing			**P**						
Module number			**2**						
Braking option									
Min. braking resistor	10) 13)	R_{min} / Ω	4.7						
Max. braking current	10) 13)	I_{B_max} / A	255						
Switching level braking transistor		U_{B_dc} / V	1140						
Monitoring braking transistor (K1 / K2)	11) 13)	U_{mon_dc} / V	24						
		I_{mon_dc} / A	2						
Operating conditions air cooler									
Switching frequency		f_S / kHz	2						
Max. heat sink temperature (OH)	14)	t_{max} / °C	90						
External fan power supply		U_{ext_dc} / V	24						
	13)	I_{ext_dc} / A	4						
Operating conditions liquid cooler									
Switching frequency		f_S / kHz	2	4	2	4	2	4	2
Max. heat sink temperature (OH)	14)	t_{max} / °C	90	– 15)	90	– 15)	90	– 15)	90
ΔT Flow/return flow series connection		ΔT / K	6...10						
ΔT Flow/return flow parallel connection		ΔT / K	3...7						
Flow temperature typical		t_{in_typ} / °C	25						
Flow temperature maximum		t_{in_max} / °C	40						
Liquid cooler content	13)	V / l	0.8						
Volume flow		Q / l/min	=> *„5.2 Diagrams of the cooling design“*						
Pressure drop		Δ_{pv} / bar							
Max. permissible operating pressure		p_{max} / bar	10						
Other data									
Insulation resistance @ U_{dc} = 500 V	1) 13)	R_{iso} / MΩ	1.69						
Max. weight air cooler	13)	m_{max} / kg	97.5						
Max. weight liquid cooler	13)	m_{max} / kg	96						

Table 11: Technical data of the 690 V class master / slave

1) *Restrictions when using HF filters.*
2) *Phase conductor grounded mains are only permissible without HF filters.*
3) *Fusing according to UL => „8 Protection of drive controllers“.*
4) *The voltage at the motor is dependent on the series-connected units and on the control method.*
5) *The output frequency is to be limited in such way that 1/10 of the switching frequency is not exceeded.Devices with higher maximum output frequency are subject to export restrictions and are only available upon request.*
6) *Max. current before the OL2 function triggers.*
7) *With the regulated operating modes 5 % are to be subtracted as control reserve.*
8) *Applies to rated input voltage 690 V, 25 °C ambient temperature.*
9) *Maximum additional chargeable capacity per module.*
10) *Data apply to a switching level for the braking transistor of 1140 V DC.*
11) *=> „7 Wiring diagrams“. UL, C-UL E120782 UL508, CSA C22.2 No.14; UL1604 (class I, Division 2, Group A, B, C, D); 277 V AC 8A, General use, 24 V DC 6A, General use, B300, R300 250 V AC / max. 2A, 24 V DC / max. 2A (Pilot Duty).*
12) *The internal fans are switched off below the operating voltage range.*
13) *These data are valid per module.*
14) *The specifications apply to devices without derating of the switching frequency.*
15) *This version only upon request.*
16) *The specifications only apply if there is parallely no power output via the motor connection terminals U / V / W.*

NOTICE

Malfunctions due to asymmetrical running!

► An input choke is absolutely necessary.

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

3.4.3 Master / slave / slave system

Device size			**36**	**37**	**38**	**39**
Housing			**P**			
Module number			**3**			
Rated power						
Rated motor power		P_{mot} / kW	630	710	800	900
Rated apparent output power		S_{out} / kVA	849	980	1076	1213
Drive controller (input)						
Rated input voltage		U_N / V	690			
Input voltage range		U_{in} / V	450…760 ±0 %			
Mains phases			3			
Mains frequency		f_N / Hz	50 / 60 ±2			
Rated input current		I_{in} / A	731	845	927	1045
Permitted mains forms			TN, TT, IT [1], Δ mains [2]			
Permissible mains fuse gG / gL	[3]		=> *„8 Protection of drive controllers“*			
Drive controller (output)						
Output voltage	[4]	U_{out} / V	0…U_{in}			
Output frequency	[5]	f_{out} / Hz	0...599			
Min. output frequency at continuous full load		f_{out_min} / Hz	3			
Output phases			3			
Rated output current		I_{out_UL} / A	710	820	900	1015
Standstill current at 4 kHz	[6]	I_{out_ST} / A	490	567	615	710
Max. short time current 30s	[7]	I_{OL_max} / %	125			
Overcurrent		I_{OC} / %	150			
Min. switching frequency (rated switching frequency)		f_{S_min} / kHz	2			
Max. switching frequency		f_{S_max} / kHz	4		2	
Overload characteristic			=> *„10.1 Overload characteristic“*			
Power dissipation						
Switching frequency		f_S / kHz	2	4	2	4	2	2
Total power dissipation	[8]	P_D / kW	10.8	– [15]	12.7	– [15]	13.9	15.8
Cable cross-section						
Motor cable cross-section			=> *„6.4.6 Cable cross-sections“*			
Max. motor cable length shielded			=> *„6.4.7 Motor cable lengths“*			
DC link data						
DC link capacity	[13]	C_{int} / µF	8800			
Max. external DC link capacity	[9]	C_{ext_max} / µF	8800			
Precharging current	[8] [13]	I_{pre} / A	168			
Power OFF DC		U_{Poff_dc} / V	300			
Undervoltage level DC		U_{UP_dc} / V	360			
Overvoltage level DC		U_{OP_dc} / V	1200			
Operating voltage range DC	[12]	$U_{\_dc}$ / V	670...1100			
Rated input current DC		I_{in_dc} / A	895	1034	1135	1280
Rated output current DC	[16]	I_{out_dc} / A	895	1034	1135	1280

continued on the next page

Device size			36		37		38	39
Housing			P					
Module number			3					
Braking option								
Min. braking resistor	10) 13)	$R_{\_min}$ / Ω	4.7					
Max. braking current	10) 13)	I_{B_max} / A	255					
Switching level braking transistor		U_{B_dc} / V	1140					
Monitoring braking transistor (K1 / K2)	11) 13)	U_{mon_dc} / V	24					
		I_{mon_dc} / A	2					
Operating conditions air cooler								
Switching frequency		f_S / kHz	2					–
Max. heat sink temperature (OH)	14)	$t_{\_max}$ / °C	90					–
External fan power supply		U_{ext_dc} / V	24					–
	13)	I_{ext_dc} / A	4					–
Operating conditions liquid cooler								
Switching frequency		f_S / kHz	2	4	2	4	2	2
Max. heat sink temperature (OH)	14)	$t_{\_max}$ / °C	90	– 15)	90	– 15)	90	90
ΔT Flow/return flow series connection		ΔT / K	9...12					
ΔT Flow/return flow parallel connection		ΔT / K	3...7					
Flow temperature typical		t_{in_typ} / °C	25					
Flow temperature maximum		t_{in_max} / °C	40					
Liquid cooler content	13)	V / l	0.8					
Volume flow		Q / l/min	=> *„5.2 Diagrams of the cooling design“*					
Pressure drop		Δ_{pv} / bar						
Max. permissible operating pressure		$p_{\_max}$ / bar	10					
Other data								
Insulation resistance @ U_{dc} = 500 V	1) 13)	R_{iso} / MΩ	1.69					
Max. weight air cooler	13)	$m_{\_max}$ / kg	97.5					
Max. weight liquid cooler	13)	$m_{\_max}$ / kg	96					

Table 12: Technical data of the 690 V class master / slave / slave

1) *Restrictions when using HF filters.*
2) *Phase conductor grounded mains are only permissible without HF filters.*
3) *Fusing according to UL => „8 Protection of drive controllers“.*
4) *The voltage at the motor is dependent on the series-connected units and on the control method.*
5) *The output frequency is to be limited in such way that 1/10 of the switching frequency is not exceeded.Devices with higher maximum output frequency are subject to export restrictions and are only available upon request.*
6) *Max. current before the OL2 function triggers.*
7) *With the regulated operating modes 5 % are to be subtracted as control reserve.*
8) *Applies to rated input voltage 690 V, 25 °C ambient temperature.*
9) *Maximum additional chargeable capacity per module.*
10) *Data apply to a switching level for the braking transistor of 1140 V DC.*
11) *=> „7 Wiring diagrams“. UL, C-UL E120782 UL508, CSA C22.2 No.14; UL1604 (class I, Division 2, Group A, B, C, D); 277 VAC 8A, General use, 24 V DC 6A, General use, B300, R300 250 V AC / max. 2A, 24 V DC / max. 2A (Pilot Duty).*
12) *The internal fans are switched off below the operating voltage range.*
13) *These data are valid per module.*
14) *The specifications apply to devices without derating of the switching frequency.*
15) *This version only upon request.*
16) *The specifications only apply if there is parallely no power output via the motor connection terminals U / V / W.*

NOTICE

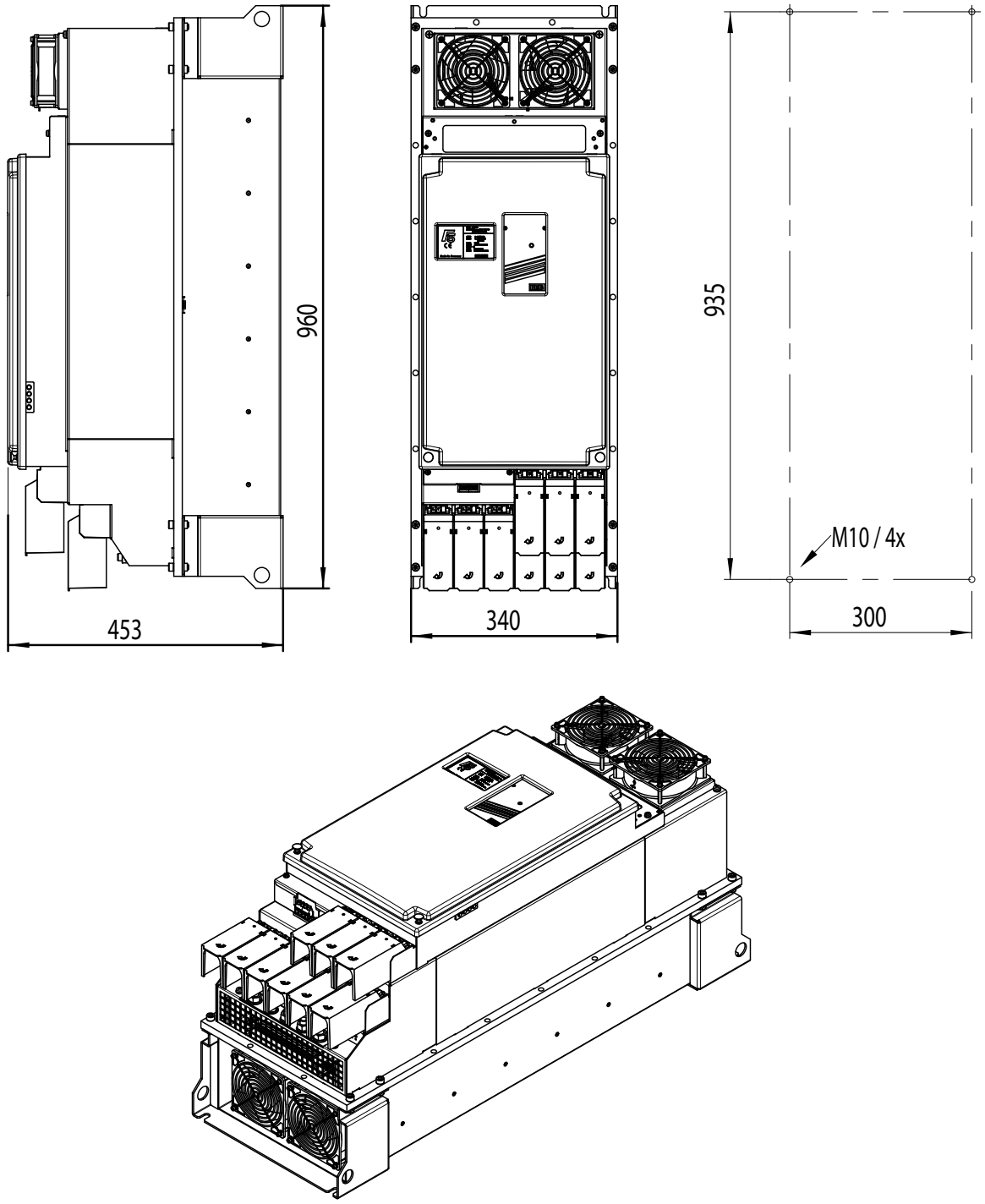
Malfunctions due to asymmetrical running!

► An input choke is absolutely necessary.

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

3.5 Dimensions and weights

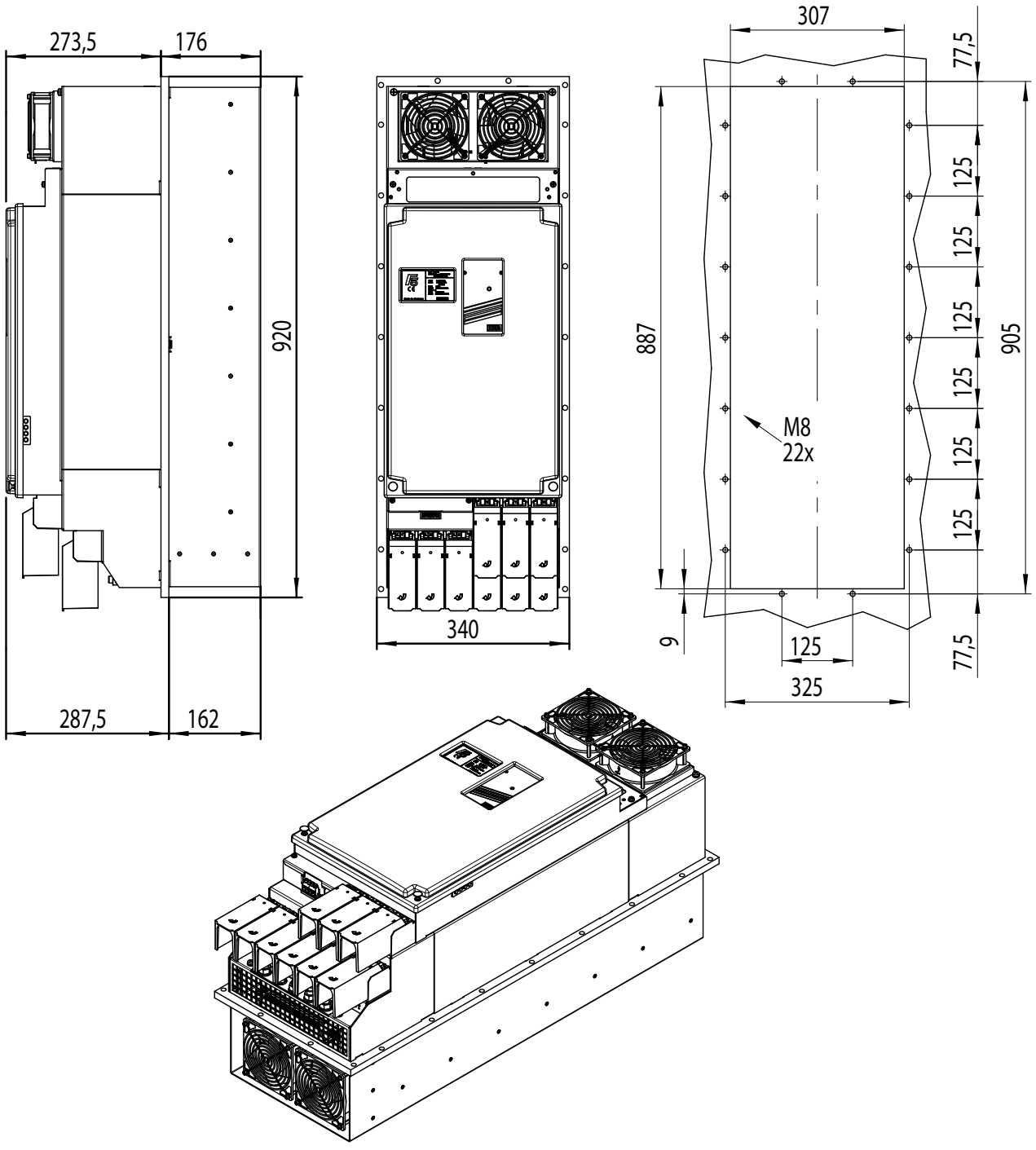
3.5.1 Dimensions air cooler built-in version



Housing	P
Weight	97.5 kg
Dimensions	All dimensions in mm

Figure 2: Dimensions air cooler built-in version

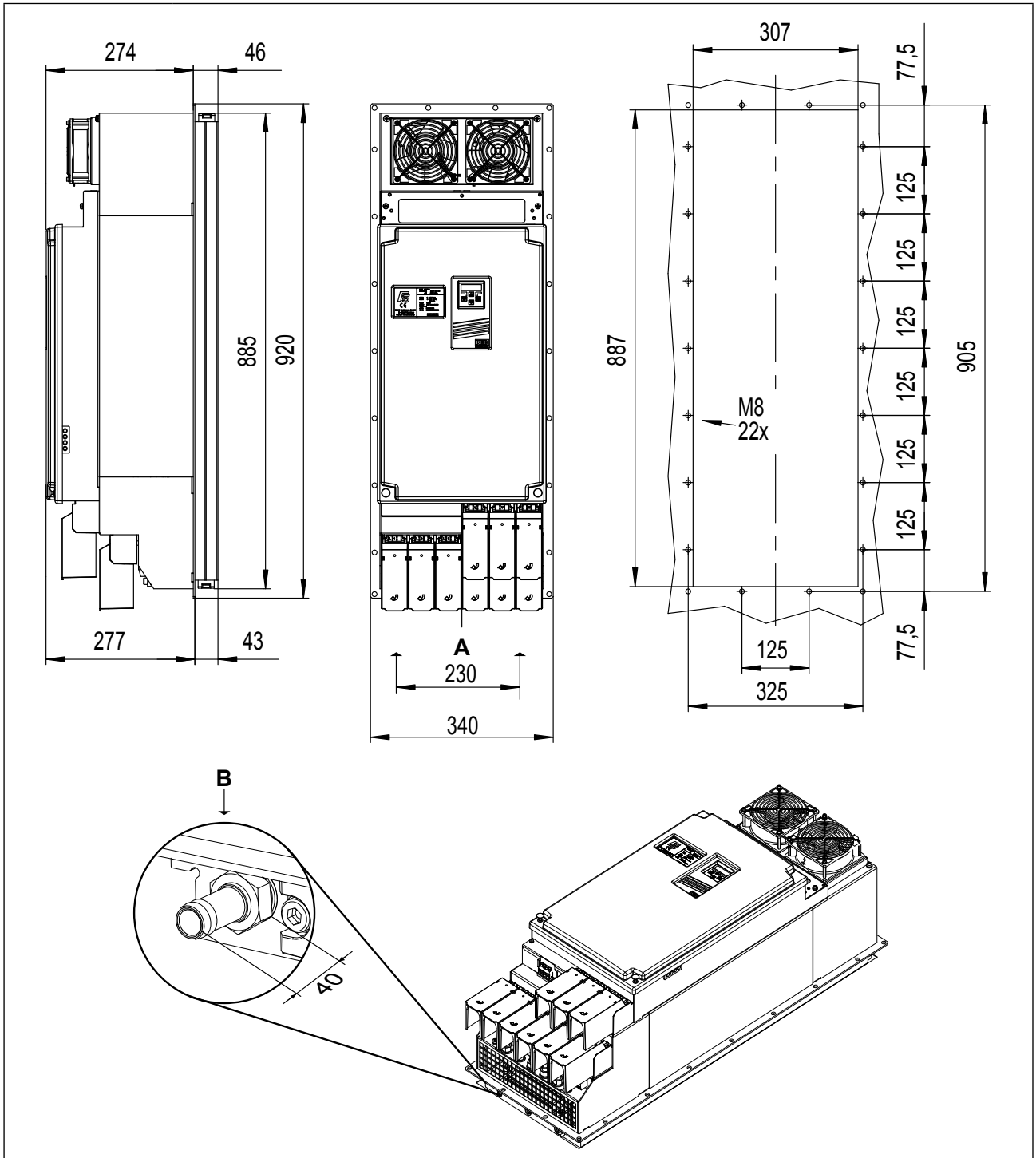
3.5.2 Dimensions air cooler push-through version



Housing	P
Weight	96 kg
Dimensions	All dimensions in mm
Optional	Seal for IP54 can be mounted on top or bottom side (=> *„11.3 Connections to the coolant“*)

Figure 3: Dimensions air cooler push-through version

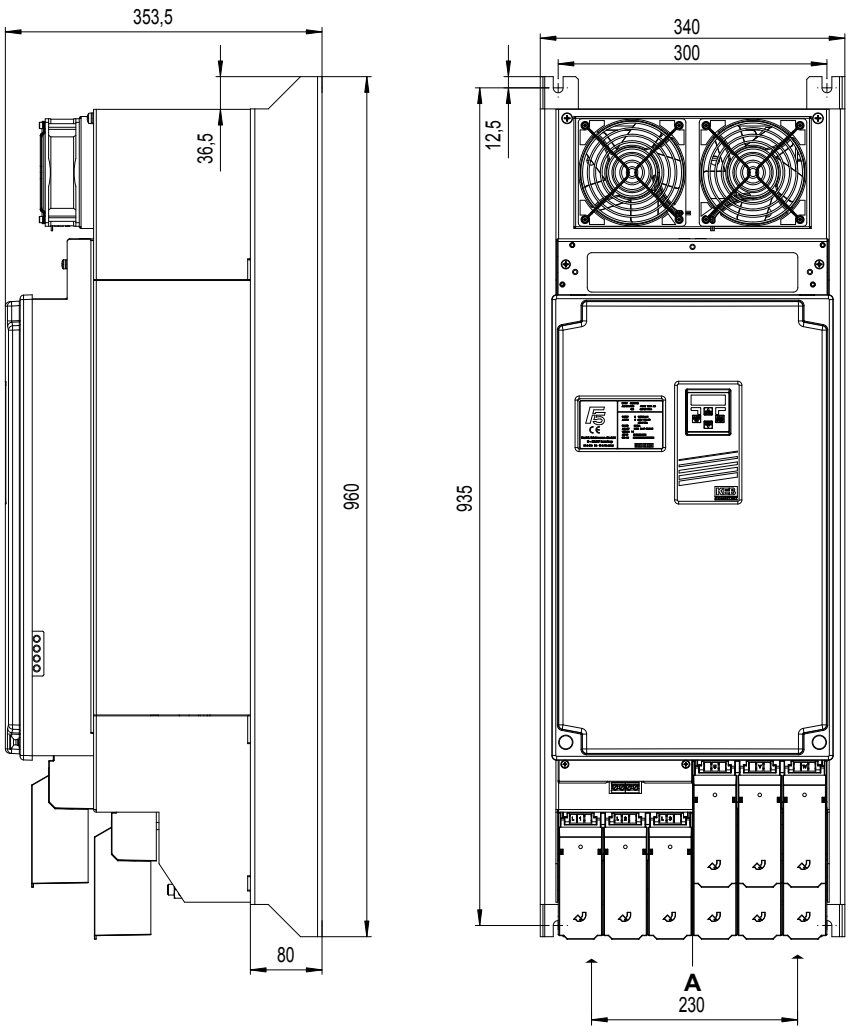
3.5.3 Dimensions liquid cooler push-through version

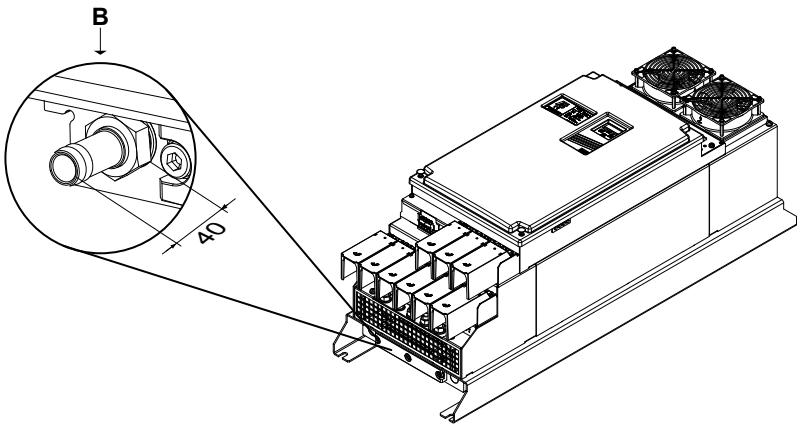


Housing	P
A	Distance between liquid connections
B	Accessories for hose connection pieces (=> *„11.3 Connections to the coolant“*)
Weight	95 kg
Dimensions	All dimensions in mm
Optional	Seal for IP54 can be mounted on top or bottom side (=> *„11.3 Connections to the coolant“*)

Figure 4: Dimensions liquid cooler push-through version

3.5.4 Dimensions liquid cooler built-in version

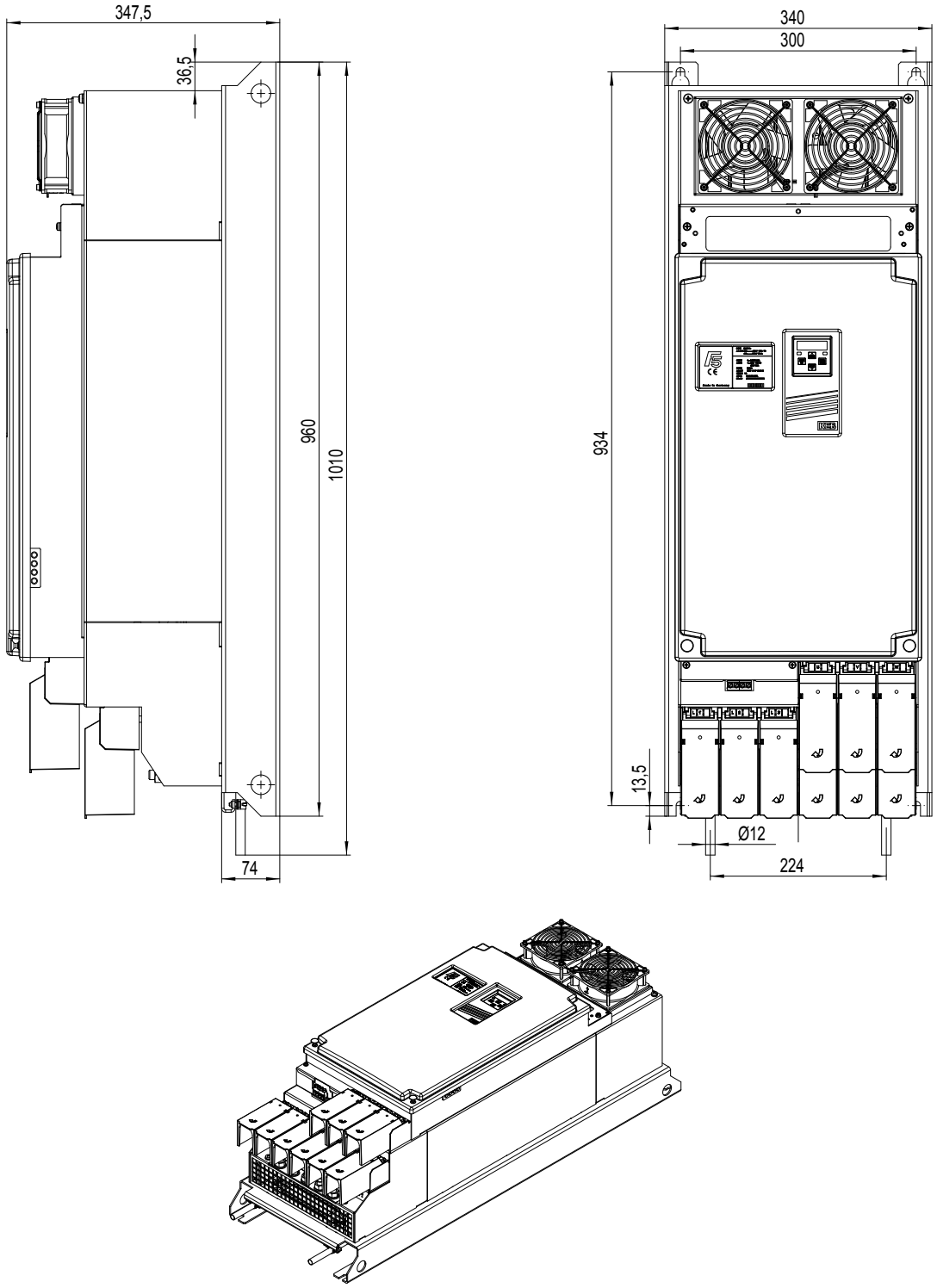




Housing	P
A	Distance between liquid connections
B	Accessories for hose connection pieces (=> *„11.3 Connections to the coolant“*)
Weight	96 kg
Dimensions	All dimensions in mm

Figure 5: Dimensions liquid cooler built-in version

3.5.5 Dimensions liquid cooler built-in version with stainless steel tube



Housing	P
Weight	96 kg
Dimensions	All dimensions in mm
Optional	Functional nut (=> *„11.3 Connections to the coolant“*)

Figure 6: Dimensions liquid cooler built-in version with stainless steel tube

4 Mechanical installation

4.1 Control cabinet installation

4.1.1 General instructions

To ensure the connection between master / slave systems, the distances between the modules may not be exceeded => *„4.1.2 Mounting distances“*.

4.1.2 Mounting distances

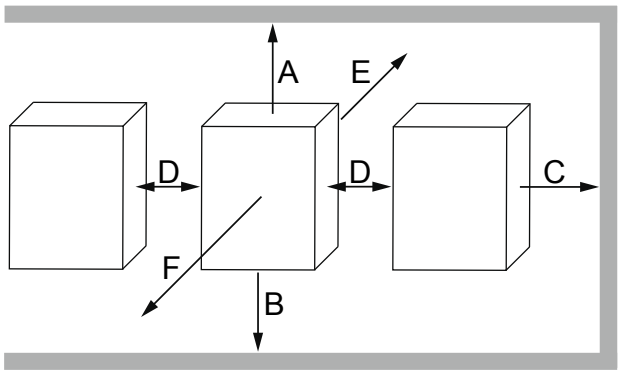
Mounting distances	Dimension	Distance in mm	Distance in inch
	A	150	6
	B	100	4
	C	100	4
	D [1]	50…230	2…9
	E	0	0
	F [2]	50	2
		Cabinet wall	
	[1] Max. distance for master/slave systems is given by the Sub-D connection between the modules. [2] Distance to preceding elements in the cabinet door.		

Figure 7: Mounting distances

Installation of the drive controller

For reliable operation, the drive controller must be mounted without clearance on a smooth, closed, bare metal mounting plate.

4.1.3 Mounting instructions for control cabinet installation

KEB recommends to use the following mounting materials with the appropriate quality for mounting the drive controllers.

Required material	Tightening torque
Screw M8 - 8.8	25 Nm 220 lb inch
Screw M10 - 8.8	50 Nm 442 lb inch
Washer 12 - 200 HV	—

Table 13: Mounting instructions for control cabinet installation

4.1.4 Optional mounting aids

Two mounting aids are available as an accessory. They are attached at the drive controller and by way this enables the transport by lifting devices.

Depending on the heat sink models, a mounting bracket or two eye bolts are available as assembly aids.

Heat sink	Liquid cooler	Air cooler
Mounting bracket	✓	✗
Ring bolt	✓	✓

The mounting bracket is directly mounted at the frame, the eye bolts are screwed into the rear wall on the face side.

Alternatively, in the air-cooled version, the eye bolts can also be screwed into the heat sink on the face side.

Further information about accessories => *„11.2 Assembly aids“*.

Figure 8: Optional mounting aids

4.2 Cooling system

The KEB COMBIVERT in P housing is available with air and liquid cooling system.
The system manufacturer must ensure the dissipation of the power loss.

NOTICE

Interruptions of the cooling circuit can destroy the device!

► When connecting the cooling circuit, it is essential to follow the instructions in chapter => *„5 Operation of liquid-cooled devices“*.

⚠ CAUTION

High temperatures at heat sink and coolant!

Burning of the skin!

► Cover hot surfaces in a touch-safe manner.

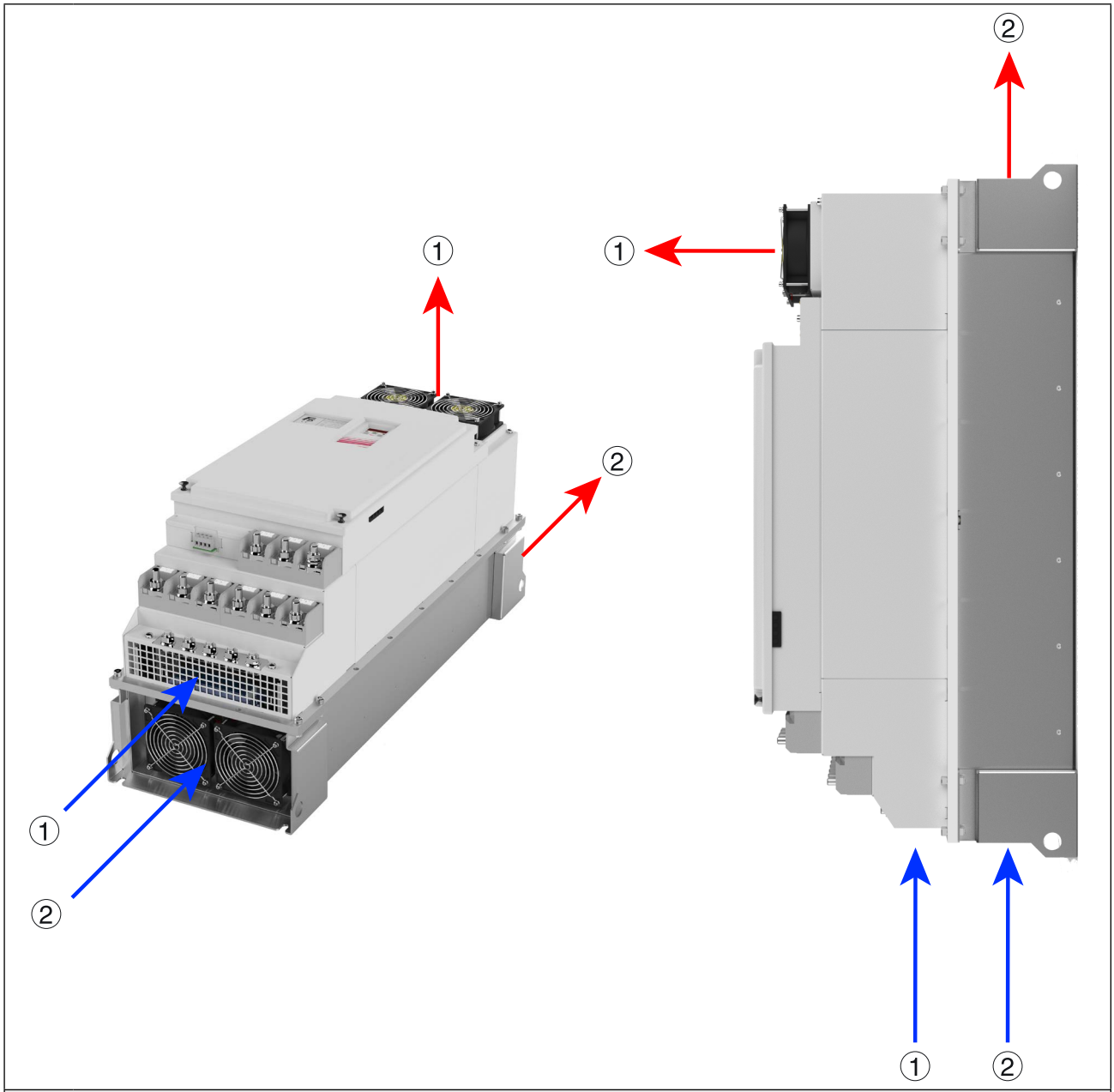
► Allow the device to cool down before carrying out any work.

► If necessary, attach warning signs to the system.

► Check the surface and coolant lines before touching them.

4.2.1 Air cooler

- The drive controller must be mounted vertically in the control cabinet.
- The connection terminals must be located on the bottom side.
- Sufficient ventilation of the device must be ensured by the system manufacturer.



Legend	
①	Air flow direction through the interior
②	Air flow direction at the heat sink
	Cold air
	Warm air

Figure 9: Ventilation

4.2.2 Liquid cooling

- The liquid coolers are designed for the connection to an available cooling system.
- The dissipation of the power loss must be ensured by the machine builder.
- In order to avoid moisture condensation, the minimum inlet temperature may not decrease the ambient temperature.
- No aggressive coolant shall be used.
- Measures against contamination and calcination must be done externally.

4.2.3 Connection of the liquid cooling to 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 significantly lower.
- Preferably also a monitoring of the pH value of the coolant should be installed.
- Pay attention to a corresponding cable 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 added according to the cooling system and the local conditions.
- Pay attention to flux direction and check tightness!

Extrusion casting heat sink

- Screw in the connecting duct according to the mounting instructions (=> *„11.3 Connections to the coolant“*).
- The connection to the coolant must be carried out with flexible, pressure-resistant hoses and secured with clamps.

Aluminium heat sink with pressed stainless steel tubes

- Connection to the cooling circuit can be made with the aid of function nuts (=> *„11.3 Connections to the coolant“*) and the use of elastic, pressure-resistant hoses.

Volume flow meter and temperature monitoring
The use of volume flow meters as well as temperature monitoring is recommended.

NOTICE

Damages at the device!

► A discontinuous mode is not recommended, this can lead to a reduction of the service life.

► The max. pressure in the cooling system may not exceed 10 bar.

► The cooling flow must always be started before starting the COMBIVERT.

4.3 Series connection cooling circuit

4.3.1 General instructions

- Does the drive controller system work at rated operation the execution of the coolant circuit can be carried out in a series circuit.
- It should be noted that the temperature is analog measured in the slave devices and an error signal is given digitally to the master.
- The coolant return flow should always be attached at the master in order to display real temperatures.
- The volume flow to be selected depends on the size of the device, the output current at rated operation and the resulting power loss for the drive controller system.
- The correlation between total power dissipation, volume flow and temperature difference are shown in the diagram *„5.2.3 Series connection of liquid coolers“*and must be within the recommended operational range.

NOTICE

Short circuit due to condensation!

► The maximum temperature difference between flow and return flow must not be exceeded.

NOTICE

Erosion in the liquid cooler!

► Select a volume flow up to a maximum of 30l/min.

NOTICE

Damage due to overpressure!

► Series connection of liquid-cooled devices with stainless steel tubes is not permitted, since the total system pressure can increase above 10 bar.

► => *„5.2.2 Pressure drop aluminium heat sink with stainless steel tubes“*.

NOTICE

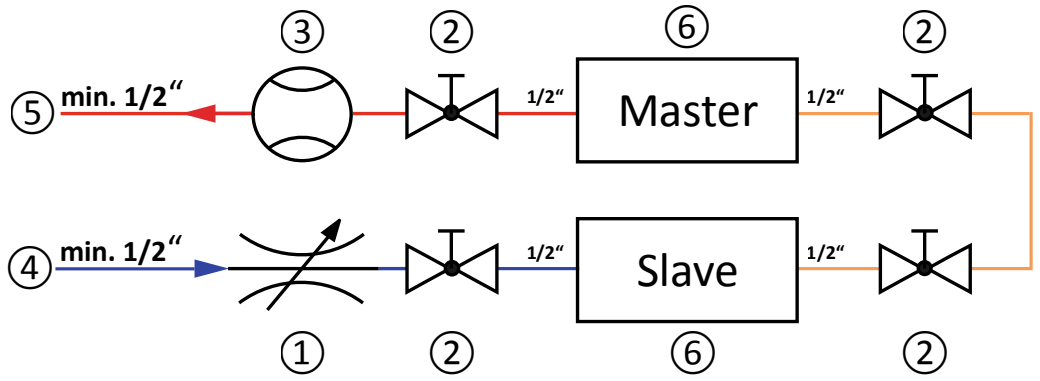
Damage due to missing cooling!

► The cooling flow must always be started before starting the COMBIVERT.

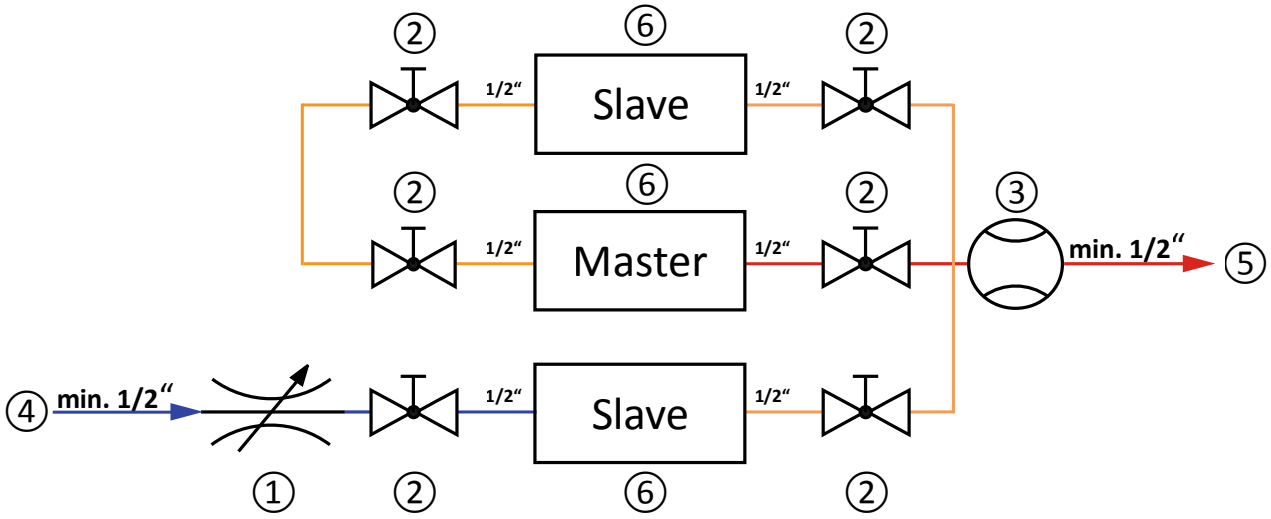
4.3.2 Connection diagram series connection cooling circuit

This connection scheme is only an installation proposal and does not replace professional planning and execution.

Coolant connection for a master / slave system



Coolant connection for a master / slave / slave system



Legend			
1	Throttle valve 10...40 l/min	4	Flow entire system
2	Ball valve / stop valve	5	Return flow entire system
3	Volume flow meter	6	Drive controller

Figure 10: Connections to the coolant series connection

NOTICE

Damage due to overheating!

- ► Only parallel connection of the coolant circuit is permissible for aluminium heat sinks with stainless steel tubes.

4.4 Parallel connection of the coolant circuit

4.4.1 General instructions

- The connection of the coolant circuit as a parallel version is also possible in rated operation. Mandatory for special applications.
- The total volume flow to be selected depends on the size of the device, the output current at rated operation and the resulting power dissipation for the drive controller system.
- The correlation between total power dissipation, volume flow and temperature difference are shown in the diagram *„5.2.4 Parallel connection of liquid coolers“* and must be within the recommended operational range.

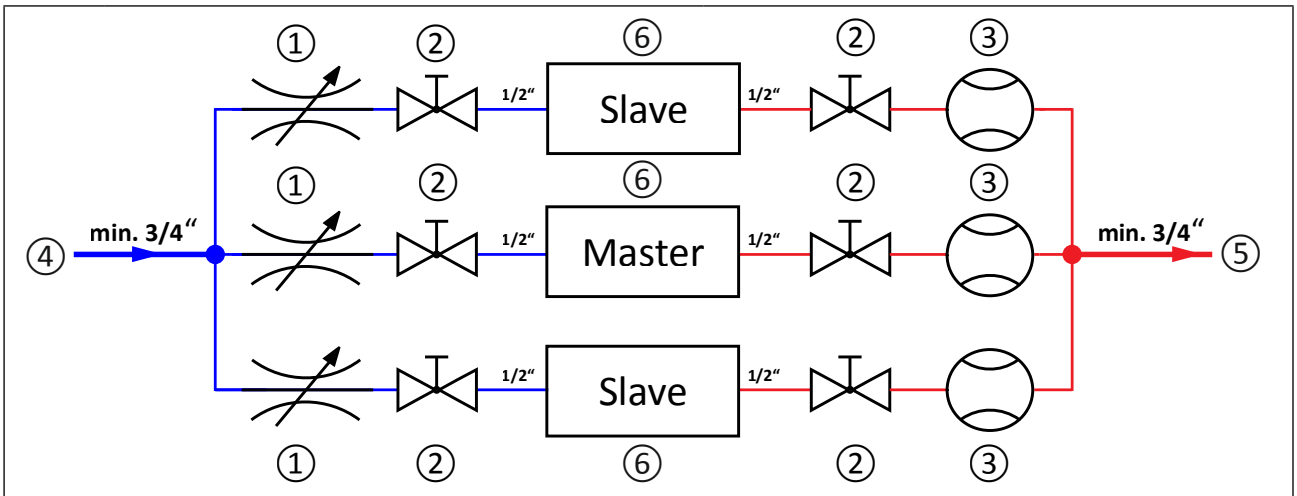
NOTICE

Damage due to non-observance!

- ► The maximum temperature difference (ΔT) between flow and return flow may not exceed 7K.
- ► If the volume flow (above 30 l/min per module) is selected too large, increases the risk of erosion in the liquid cooler.
- ► The cooling flow must always be started before starting the KEB COMBIVERT.
- ► The use of a volume flow meter and a temperature monitoring is mandatory required.

4.4.2 Connection scheme parallel connection of the cooling circuit

This connection scheme is only an installation proposal and does not replace professional planning and execution.



Legend			
1	Throttle valve 10...40 l/min	4	Flow entire system
2	Ball valve / stop valve	5	Return flow entire system
3	Volume flow meter	6	Drive controller

Figure 11: Connections to the coolant parallel connection

5 Operation of liquid-cooled devices

5.1 General information

In continuous operation liquid-cooled drive controllers are operated with lower temperature than air-cooled devices. This has positive effects on lifetime-relevant components such as fan and DC link circuit capacitors and power modules (IGBT). Also the temperature dependent switching losses are positively effected. The use of liquid-cooled KEB COMBIVERT drive controllers is offered in the drive technology, because there are process-caused coolants available with some applications.

5.1.1 Pressure in the liquid cooler

Concept of pressure	Value	Description
System test pressure	20 bar	Hydrostatic pressure used to test the integrity and tightness of the heat sink.
Operating pressure	=> *„5.2 Diagrams of the cooling design“*	Internal pressure that occurs at a certain point in time as a function of the volume flow in the heat sink.
Max. permissible operating pressure	10 bar	Highest temporary pressure, including pressure surge, which the heat sink will resist.

Table 14: Pressure in the liquid cooler

5.1.2 Material of the heat sink

Design system	Material (voltage)	Connection
Extrusion casting heat sink	Aluminium (-1.67 V)	2 x hose connection G1/2 with mounting nut
Aluminium heat sink with pressed pipes	Stainless steel (-1.04V)	Outer pipe diameter Ø 12 mm for 2 x function nuts (optional)

Table 15: Heat sink and operating pressure

The aluminium liquid coolers are sealed with sealing rings and posses a surface protection (anodized) even in the ducts.

NOTICE

Deformation of the heat sink!

- ► In order to avoid a deformation of the heat sink and the damages thereby, the indicated max. operating pressure may not be exceeded briefly also by pressure peaks.
- ► Observe pressure equipment directive 2014/68/EU.

5.1.3 Materials in the cooling cicuit

- For all metallic elements in contact with the coolant (electrolyte) in the cooling circuit, select a material which generates a low voltage difference to the heat sink (see electrochemical voltage series). This prevents contact corrosion and/or pitting corrosion.
- Other materials must be examined in each case before employment.
- 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.

- For liquid coolers with stainless steel tube, we recommend the use of stainless steel or nickel plated brass cable glands.
- For liquid coolers as extrusion casting heat sink, we recommend the use of aluminium or ZnNi coated steel tubes.

NOTICE

Corrosion caused by wrong materials!

No liability due to occurring damage!

► Use only specified materials.

Electro-chemical voltage series / standard potentials against hydrogen					
Material	generated Ion	Standard potential	Material	generated Ion	Standard potential
Lithium	Li^{+}	-3.04 V	Cobald	Co^{2+}	-0.28 V
Potassium	K^{+}	-2.93 V	Nickel	Ni^{2+}	-0.25 V
Calcium	Ca^{2+}	-2.87 V	Tin	Sn^{2+}	-0.14 V
Sodium	Na^{+}	-2.71 V	Lead	Pb^{3+}	-0.13 V
Magnesium	Mg^{2+}	-2.38 V	Iron	Fe^{3+}	-0.037 V
Titan	Ti^{2+}	-1.75 V	Hydrogen	$2H^{+}$	0.00 V
Aluminium	Al^{3+}	-1.67 V	Copper	Cu^{2+}	0.34 V
Manganese	Mn^{2+}	-1.05 V	Carbon	C^{2+}	0.74 V
Zinc	Zn^{2+}	-0.76 V	Silver	Ag^{+}	0.80 V
Chrome	Cr^{3+}	-0.71 V	Platinum	Pt^{2+}	1.20 V
Iron	Fe^{2+}	-0.44 V	Gold	Au^{3+}	1.42 V
Cadmium	Cd^{2+}	-0.40 V	Gold	Au^{+}	1.69 V

Table 16: Electro-chemical voltage series / standard potentials against hydrogen

5.1.4 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:

Requirements	Description
Suspended particles	The size and proportion of suspended solids in the cooling water should not exceed the following values: < 100 µm < 10 mg per litre.
pH-value	Aluminum is particularly corroded by lixiviums and salts. The optimal pH value for aluminum should be in the range of 7.5… 8.0.
Abrasive substances	Abrasive substances as used in abrasive (quartz sand), clogging the cooling circuit.
Copper cuttings	Copper cuttings can attach the aluminum and this leads to a galvanic corrosion. Copper should not be used together with aluminum due to electro-chemical voltage difference.
Hard water	The cooling water may not cause scale deposits or loose excretions. The total hardness should be between 7...20 °dH, the carbon hardness at 3...10 °dH.
Soft water	Soft water (< 7 °dH) corrodes the material.
Frost protection	An appropriate antifreeze must be used for applications when the heat sink or the coolant is exposed temperatures below zero. Use only products of one manufacturer for a better compatibility with other additives.We recommend the antifreeze AntifrogenN from the company Clariant with a maximum volume fraction of 52 %.
Corrosion protection	Additives can be used as corrosion protection. In combination with frost protection the corrosion protection must have a concentration of 20…25 Vol %, in order to avoid a change of the additives.

Table 17: Requirements on the coolant

5.1.5 Requirements for open and half-open cooling systems

Requirement	Measure
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 coolant-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 18: Requirements for open and half-open cooling systems

NOTICE

Damages at the device!

Loss of warranty!

► Avoid clogged, corroded heat sinks or other obvious usage failures.

5.1.6 Coolant temperature

- The flow temperature may not exceed 40 °C.
- The maximum overheat temperature is 60 °C, 73 °C or 90 °C depending on the power unit and overload capacity.
- The coolant temperature is specified in the technical data.
- Higher flow temperatures only after consultation with KEB.

The flow temperature should be chosen depending on the volume flow, so that at rated operating the heatsink temperature is always 10 K below the overheat temperature level. As a result, a sporadic shutdown is avoided.

5.1.7 Moisture condensation

High air humidity and high temperatures can lead to moisture condensation. Moisture condensation is considered to be a threat to the drive controller. The drive controller can be destroyed by any short-circuits that may occur.

NOTICE

Destruction due to short circuit!

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

5.1.8 Supply of temper coolant

- Supply of temper coolant is possible by using heatings in the cooling circuit for the control of the coolant temperature.
- The following dew point table shows the coolant inlet temperature as a function of ambient temperature and air humidity.

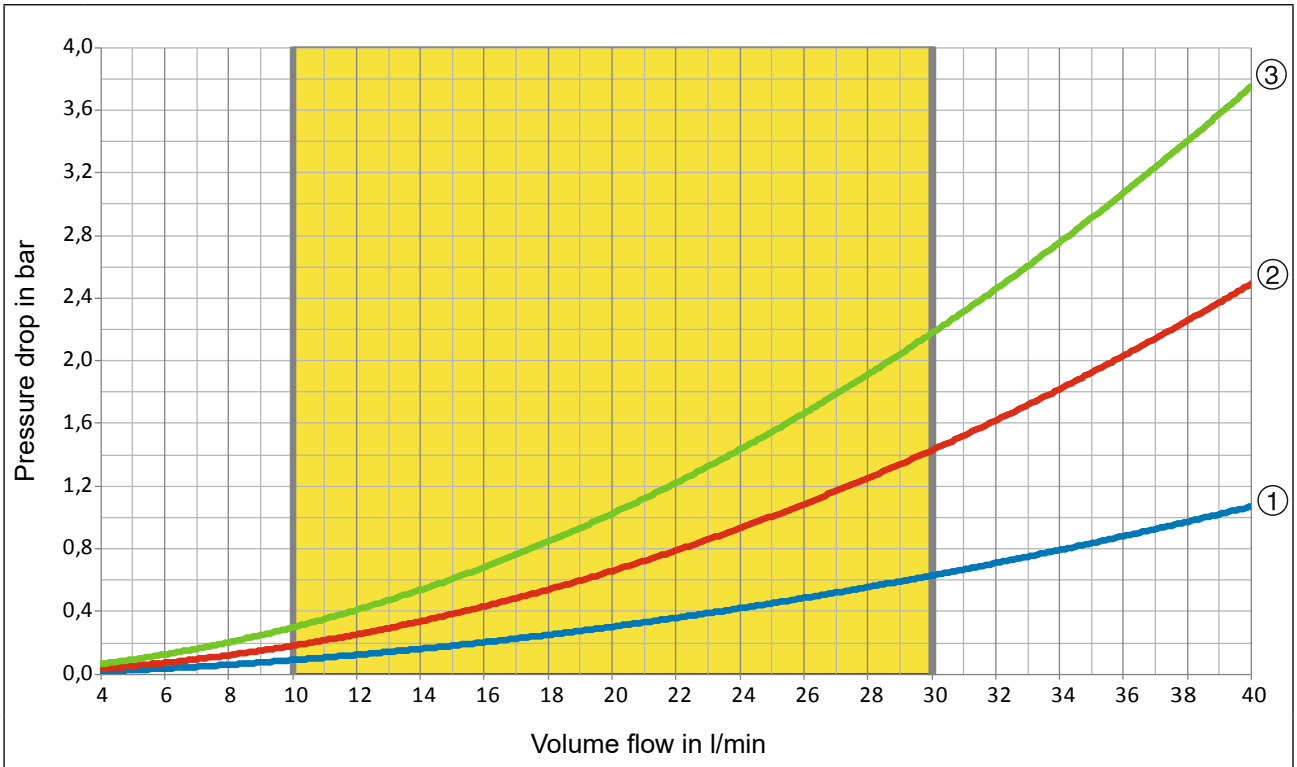
Air humidity in % / Environment temperature in °C	10	20	30	40	50	60	70	80	90	100
-25	-45	-40	-36	-34	-32	-30	-29	-27	-26	-25
-20	-42	-36	-32	-29	-27	-25	-24	-22	-21	-20
-15	-37	-31	-27	-24	-22	-20	-18	-16	-15	-15
-10	-34	-26	-22	-19	-17	-15	-13	-11	-11	-10
-5	-29	-22	-18	-15	-13	-11	-8	-7	-6	-5
0	-26	-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 in °C									

Table 19: Supply of temper coolant

5.2 Diagrams of the cooling design

5.2.1 Pressure drop aluminium extrusion casting heat sink

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



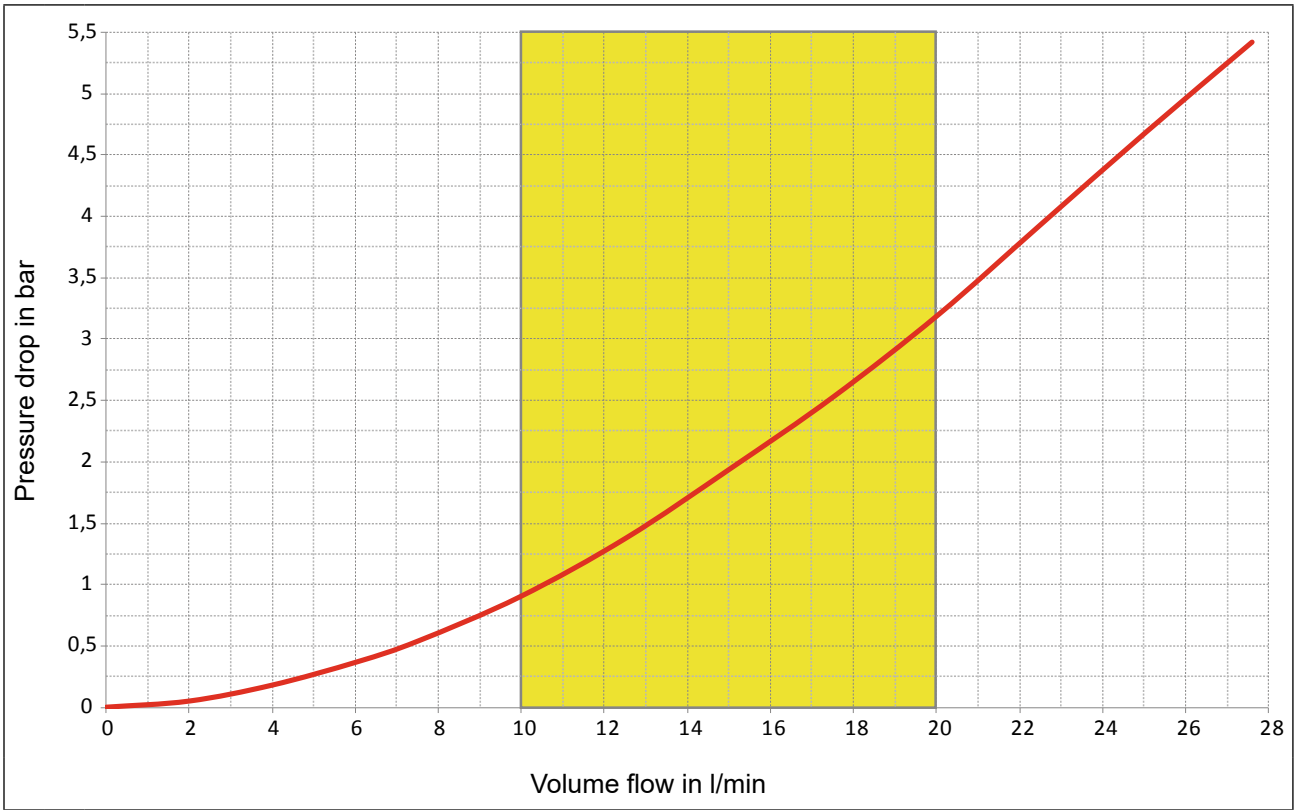
Legend	
	Recommended working range: 10...30 l/min
1	Single Drive
2	Series connection master / slave system
3	Series connection master / slave / slave system

Figure 12: Pressure drop of the heat sink as a function of the volume flow

The selection of the connection diagram (series or parallel connection) of the cooling circuit depends on the total power dissipation of the drive controller system.

5.2.2 Pressure drop aluminium heat sink with stainless steel tubes

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



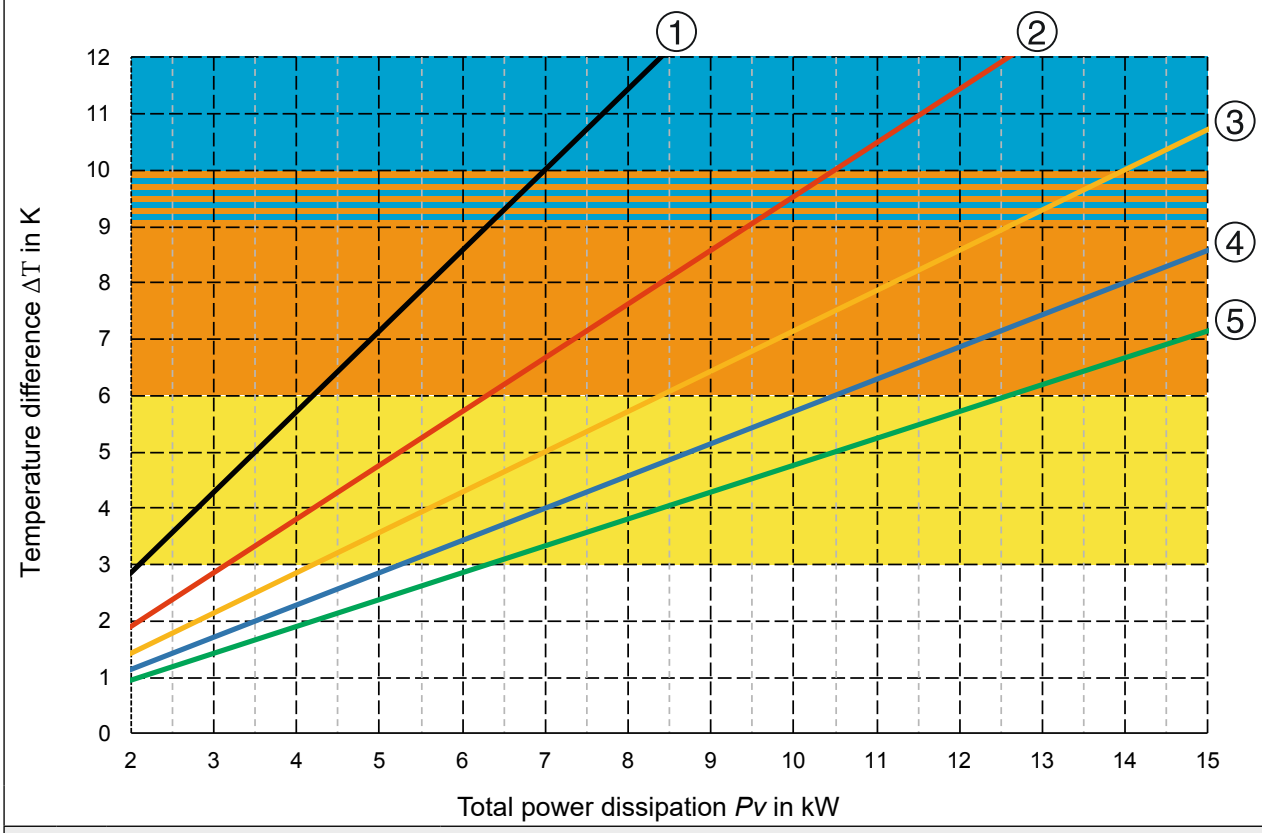
Legend	
	Recommended working range: 10...20 l/min

Figure 13: Pressure drop of the heat sink as a function of the volume flow (stainless steel cooler)

Only parallel connection of the coolant circuit is permissible for aluminium heat sinks with stainless steel tubes.

5.2.3 Series connection of liquid coolers

- Volume flow as a function of total power dissipation and temperature difference.
- The diagram below applies to the series connection of liquid coolers.



Legend		
Recommended working range		
	Master / Slave / Slave	ΔT = 9...12 K
	Master / Slave	ΔT = 6...10 K
	Single Drive	ΔT = 3...6 K
Volume flow		
1	10 l/min	
2	15 l/min	
3	20 l/min	
4	25 l/min	
5	30 l/min	

Figure 14: Volume flow and temperature difference for series connection

NOTICE

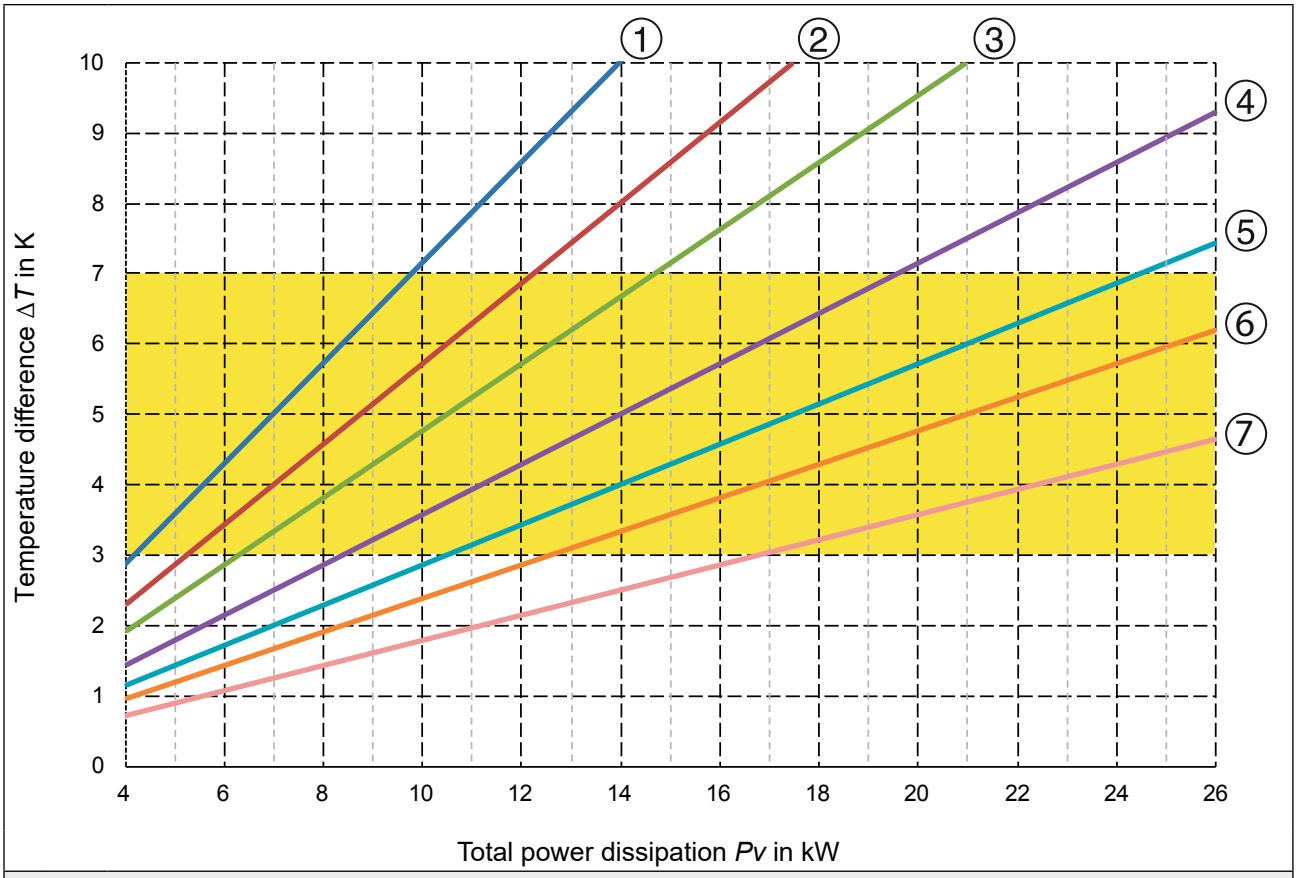
Damage due to overpressure!

► Series connection of liquid-cooled devices with stainless steel tubes is not permitted, since the total system pressure can increase above 10 bar.

► => *„5.2 Diagrams of the cooling design“*.

5.2.4 Parallel connection of liquid coolers

- Volume flow as a function of total power dissipation and temperature difference.
- The diagram below applies to the parallel connection of liquid coolers.



Legend	
Recommended working range	
	ΔT = 3...7 K
Volume flow	
1	20 l/min
2	25 l/min
3	30 l/min
4	40 l/min
5	50 l/min
6	60 l/min
7	80 l/min

Figure 15: Volume flow and temperature difference for parallel connection

- The points 1...7 are each based on the total volume flow of the drive controller system.
- The total volume flow should be divided by the number of modules.The determined value for the volume flow is set for each module by means of throttle valves.

6 Electrical installation

6.1 General information

This chapter contains the information which must be observed when selecting the wires, the protective measures and wiring in the control cabinet.

Current laws and local regulations must always be observed when planning and carrying out the installation. KEB assumes no liability for installations where laws, local and / or other regulations have not been complied with. If the recommendations given by KEB are not observed, you might experience problems when using the drive controller which are not covered by the warranty.

NOTICE

Exclusion of liability in case of non-observance!

► Current laws and local regulations must always be observed when planning and carrying out the installation.

The specified cable cross-sections are recommendations for dimensioning and serve as guide values for multicore copper cables. They are valid for a maximum ambient temperature of 40 °C and for open installation. This must be considered accordingly in case of deviating ambient conditions and local regulations => *"6.4.6 Cable cross-sections"*.

6.1.1 Wiring

- Lay noise-affected or noise sensitive cables as far apart from each other as possible (minimum 200 mm).
- If the distance cannot be maintained, additional shielding measures must be provided.
- Cables must be routed as closely as possible to earthed housing parts, mounting plates or cabinet frames. This reduces noise emissions and noise injections.
- Crossings of cables of different classes are to be tolerated, parallel laying should be avoided.
- If another laying is not possible, cross the cables at right angles, especially if the signals are sensitive and interference emitted.
- Cores of signal and data lines that are not used must be earthed at both ends.
- Avoid long lines and interference sources in order to prevent additional coupling points.
- Ground unused lines on one side in the control cabinet.
- Establish ground connections with the largest possible cross-section to other control cabinets, system components and decentralized devices.
- Avoid larger conductor loops.

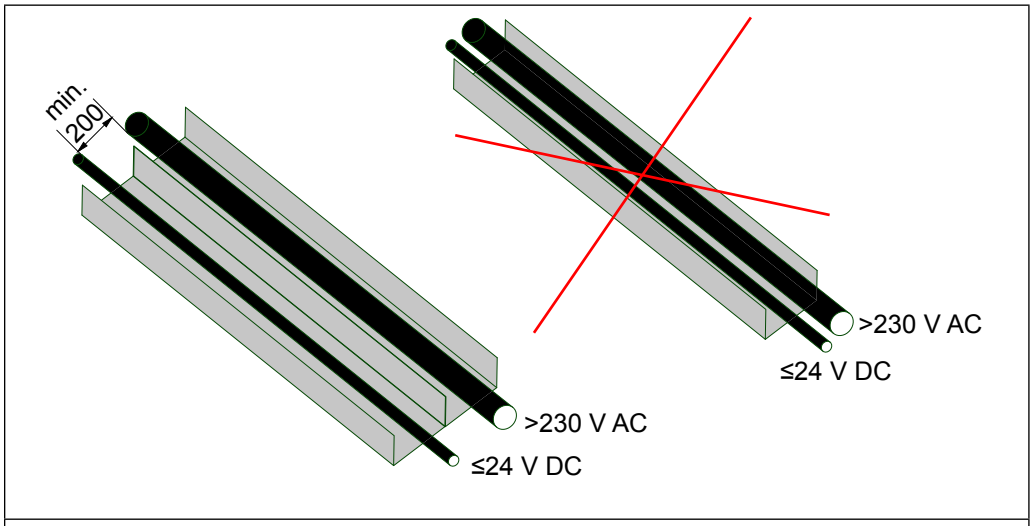


Figure 16: Laying the cables

6.1.2 Connection of the shield connection

- Cable shields must not be used for power supply.
- A cable shield must not assume the function of an N or PE conductor.
- Always lay cable shields over a large surface.
- Do not extend the cable shield by unshielded wire connections to the earthing point. This reduces the shielding effect by up to 90 %.
- Lay the cable shield over a large surface directly after the entry point of the control cabinet.

6.1.3 Connection of the protective earth

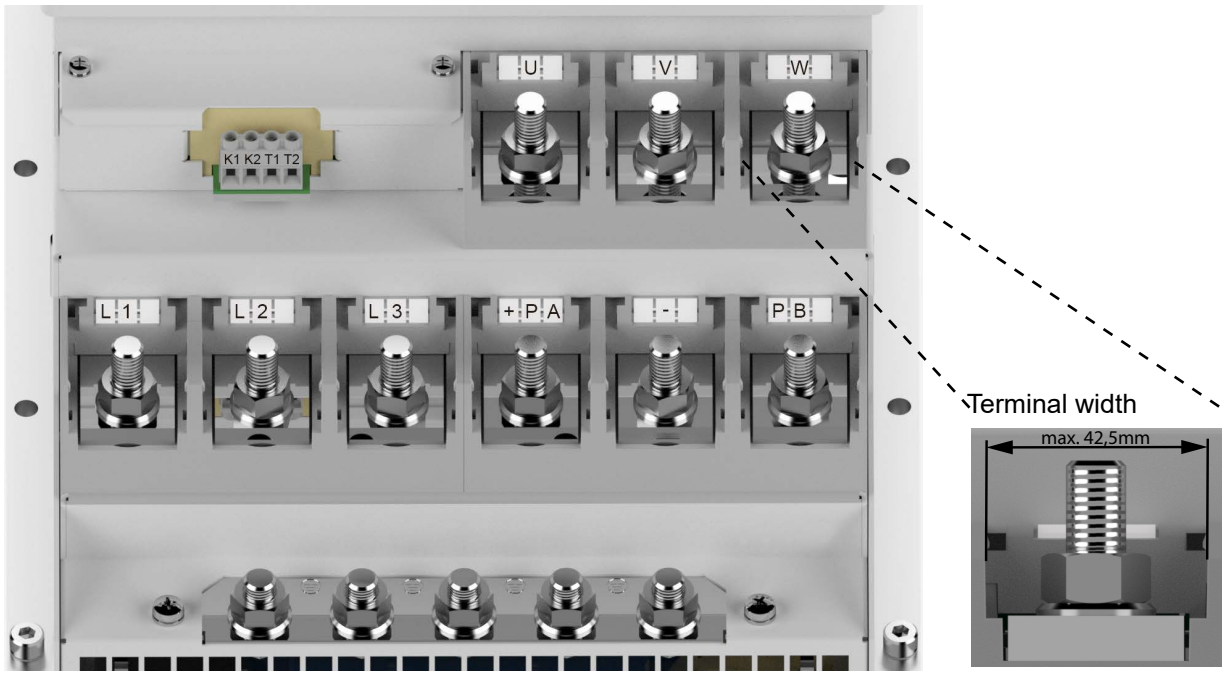
- The drive controller or the control cabinet in which the drive controller is installed must be connected to protective earth at the installation site.
- Use a protective earth conductor that corresponds at least half the cross-section of the cables used to supply the power terminals.
- An earthing stud is provided at the drive controller for connecting the motor protective earth.
- The resistance of the protective earth should be 0.1 Ω or less.
- According to *EN 61800-5-1*, the minimum cross-section of the protective earth conductor must comply with the local safety regulations for protective earth conductors for equipment with high leakage current.

⚠ WARNING

Injuries due to indirect contact!

► The device only meets the requirements for protection against indirect contact if the protective earth conductor is correctly connected.

6.2 Connection terminals power unit



Terminal	Function	No. [1]
L1, L2, L3	Mains connection	1
U, V, W	Motor connection	
+PA, PB	Connection for braking resistor	
+PA, –	Connection for regenerative unit	
T1, T2	Connection for temperature sensor (only single drive / master)	2
K1, K2	Monitoring braking transistor (Connection values => *"3 Technical data"*)	
⏚	Connection for shielding /earthing	1

Figure 17: Connection terminals of the power circuit

[1] *The assignment of the numbers refers to the table => "6.2.1 Permitted cable cross-sections and tightening torques of the terminals".*

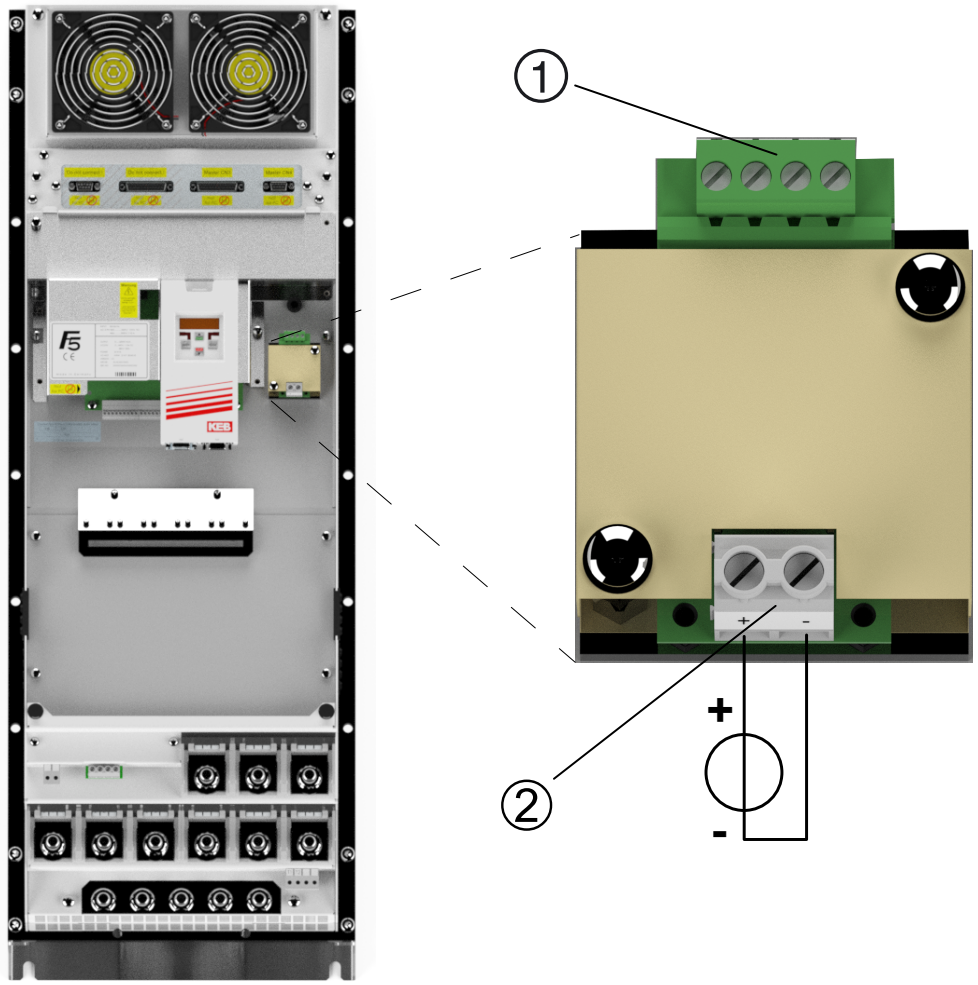
6.2.1 Permitted cable cross-sections and tightening torques of the terminals

No.	Cable cross-section				Maximum tightening torque	
	mm²		AWG / MCM		Nm	lb inch
	min	max	min	max		
1[1]	M12 stud for ring crimp connector max. 2 ring crimp connectors => *"6.4.6 Cable cross-sections"*				35	310
2	0.2	4	24 AWG	10 AWG	0.6	5.3

Table 20: Permissible cable cross-sections and tightening torques of the terminals

[1] *Input studs/nuts shall be connected with UL listed ring crimp connectors (ZMVV).*

6.2.2 External fan power supply



Terminal block			
①		Only internal use	
②		External fan power supply	
Terminals		**Supply voltage**	
+, -		DC 24 V ±10 %	
Current draw per module		**Spare fuse(s)**	
2.5A or 4A		3.15A Type gG	
Cable cross-section		**Maximum tightening torque**	
mm²	**AWG / MCM**	**Nm**	**lb inch**
4	10	0.6	5.3

Figure 18: External fan power supply

6.3 Mains connection

NOTICE

Destruction of the drive controller!

► Never interchange the mains input and motor connection.

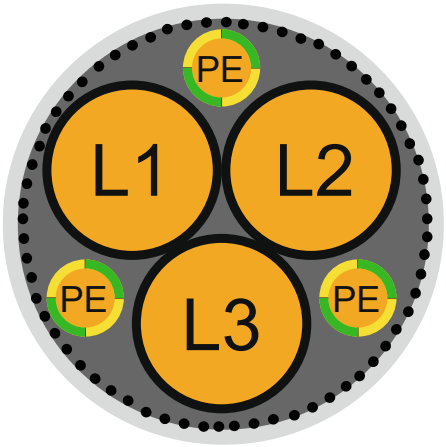
6.3.1 Note about hard mains

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

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

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

6.3.2 Recommended type of mains cable



Symmetrical shielded cables are recommended for high motor power.

- Type of cable: 2XSLCYK-J.
- The protective earth conductor is tripartited and uniformly placed between the phase lines.
- Compliance with the requirements according to *EN 12502-1...5*.

Figure 19: Cross-section type of mains cable

6.4 Motor connection

6.4.1 General instructions

- The motor cables must be designed to the maximum continuous current.
- They are valid for 0...100 Hz (up to 300 Hz the cable losses increase by approx. 25 % due to the skin effect).
- The IGBT modules cause high-frequency interferences, the longer the motor cable length the higher the discharge to the earth potential.
- The consequence is an increase of conducted interferences on the mains side.
- If the motor cables are too long, damping of the mains filters is no longer sufficient and the permissible interference limits are exceeded.
- At the output of the drive controller, pulses of approximately 1.35-fold of the mains voltage and very short rise times are generated independently of the output frequency.
- This is the case for all drive controllers with modern IGBT inverter technology.
- The voltage of the pulses can almost double at the motor connections depending on the characteristics of the motor cable.
- This can lead to additional load of the motor and the motor cable insulation.
- Modern speed-controlled drives with their fast rising voltage pulses and high switching frequencies can cause current pulses through the motor bearings which can gradually damage the bearing raceways.

NOTICE

Protect motor against voltage peaks!

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

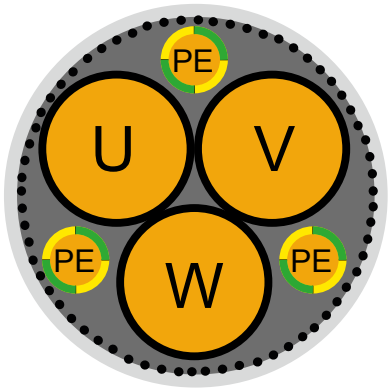
► Drive controller switch at the output with a high rate of voltage rise. Voltage peaks that endanger the insulation system at the motor can occur especially in case of long motor cables (> 15 m). A motor choke, a dv/dt filter or sine-wave filter can be used to protect the motor.

6.4.2 Selection of the motor cable

Correct selection and laying of the motor cable is very important for high motor ratings:

- Smaller load of the motor bearings by bearing currents.
- Improved EMC characteristics.
- Lower symmetrical operating capacities.
- Less losses by transient currents.
- Due to the high currents, shielded motor cables can be connected in parallel between drive controller and motor.
- All three phases must passing through each shielded motor cable.
- The required cross-section is described in section => *“6.4.6 Cable cross-sections”*.
- To keep asymmetry as small as possible, all motor cables should have the same length.
- The shielding must be placed always with large surface on both sides (mounting plate and motor housing).

6.4.3 Recommended type of the motor cable



Symmetrical shielded cables are recommended for high motor power.

- Type of cable: 2XSLCYK-J.
- The protective earth conductor is tripartited and uniformly placed between the phase lines.
- Compliance with the requirements according to *EN 12502-1...5*.

Figure 20: Cross-section type of the motor cable

6.4.4 Connection of the motor

As a standard the connection of the motor must be carried out in accordance with the following table:

230 / 400 V motor		**400 / 690 V motor**	
230 V	400 V	400 V	690 V
Delta	Star	Delta	Star

Table 21: Connection of the motor

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

6.4.5 Calculation of the motor voltage

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

Component	**Reduction / %**	***Example:***
Mains choke U_k	*4*	*Closed-loop drive controller with mains and motor choke on a non-rigid supply system:* *400 V mains voltage - 15 % = 340 V motor voltage*
Drive controller open-loop	*4*	
Drive controller closed-loop	*8*	
Motor choke U_k	*1*	
Non-rigid supply system	*2*	

Table 22: Example of motor voltage calculation

6.4.6 Cable cross-sections

The motor cable cross-section depends

- on the form 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 used cable.
- on ambient conditions such as bundling and temperature.

Rated cross-section in mm²	Rated current [1] in A
50	168
70	207
95	250
120	292
150	335
185	382
240	453

Table 23: Cable cross-sections

[1] *Valid for multicore cables. The factors for ambient temperature, parallel cable laying, current carrying capacity and laying factor are not taken into consideration for the technical data of the current.*

6.4.7 Motor cable lengths

The permissible cable length is reduced if the minimum cross-section of the motor connection is distributed across several cables.

- The maximum cable lengths are specified for the recommended type of cable.
- The permissible cable lengths depend on the number of cables per phase.
- Longer cables may only be provided after consultation with KEB.
- The specified cable lengths represent the actual distance between drive controller and motor.

In case of parallel connection of motor cables, the cable capacitance is doubling, which leads to higher leakage currents between drive controller and motor. These should always be kept as small as possible.

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

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

Maximum permissible motor cable lengths			
Number of cables per phase	**Ring crimp connector**	**Cable lengths in m**	
		Without sine-wave filter / Motor choke	**With sine-wave filter**
1	M12	100	500
2		35	177

Table 24: Maximum permissible motor cable lengths

6.5 DC connection

6.5.1 General instructions

- The DC connection terminals of the device can be used for power supply or power consumption.
- Appropriate external DC fuses must be designed by the system manufacturer.
- If external devices shall be connected to master / slave systems, the DC links must be connected with DC fuses. => *“7 Wiring diagrams”.*
- DC operating voltage range [U_{dc}] for 400 / 690 V mains voltages.
  => *“3 Technical data”*.
- The maximum permanent current carrying capacity of the DC terminals is 580 A.
- DC fuses can be found in chapter => *“8 Protection of drive controllers”*.
- Chapter => *“3 Technical data”* contains information on the DC input current for each device size at rated operation.
- The available current for external devices depends on the size of the device and the motor power output.

NOTICE

Exceeding the limit leads to the destruction of the unit!

► The maximum input power per module is 395 kVA.

6.6 Temperature detection T1, T2

Parameter In.17 displays in high byte the installed temperature input of the drive controller. The KEB COMBIVERT F5 / F6 is delivered as standard with switchable PTC / KTY evaluation. The desired function is adjusted with Pn.72 (dr33 at F6) and operates in accordance with the following table:

In.17	Function of T1, T2	Pn.72 (dr33)	Resistance	Display ru.46 (F6 => ru28)	Error/Warning [1]
5xh	KTY84	0	< 215 Ω	Detection error 253	x
			498 Ω	1°C	– [2]
			1 kΩ	100°C	x [2]
			1.722 kΩ	200°C	x [2]
			> 1811 Ω	Detection error 254	x
	PTC (according to *EN 60947-8*)	1	< 750 Ω	T1-T2 closed	–
			0.75…1.65 kΩ (reset resistance)	T1-T2 closed	–
			1.65…4 kΩ (tripping resistance)	T1-T2 open	x
			> 4 kΩ	T1-T2 open	x
6xh	PT100	–	upon request		

Table 25: Temperature detection T1, T2

[1] *The column is valid at factory setting. The function must be programmed accordingly with parameters Pn.12, Pn.13, Pn.62 and Pn.72 for F5 in operating mode GENERAL.*

[2] *Disconnection is depending on the adjusted temperature in Pn.62 (F6 => pn11/14).*

The behaviour of the drive controller in case of error/warning is defined with parameters Pn.12 (CP.28), Pn.13 (F6 => pn12/13).

Dependent on the application the temperature input can be used for the following functions:

Function motor temperature display	Mode (F5 => Pn.72; F6 => dr33)
Motor temperature display and monitoring	KTY84
Motor temperature monitoring	PTC
Temperature control for liquid-cooled motors [1]	KTY84
General fault sensing	PTC

Table 26: Function motor temperature display

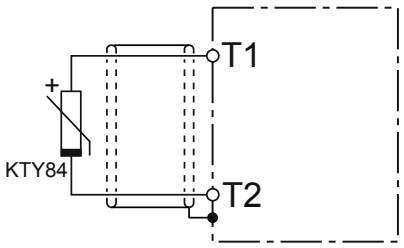
[1] *If the temperature input is used for other functions, the motor temperature control at liquid-cooled drive controllers can be done indirectly via the liquid cooling circuit of the drive controller.*

NOTICE

Malfunctions due to incorrect installation!

- ► Do not lay KTY or PTC cable of the motor (also shielded) together with control cable!
- ► KTY or PTC cable only permissible with double shielding within the motor cable!

6.6.1 Use of the temperature input in KTY mode



KTY sensors are poled semiconductors and must be operated in forward direction! Connect anode to T1! Non-observance leads incorrect measurement in the upper temperature range. Protection of the motor winding is no longer guaranteed.

Figure 21: Connection of a KTY sensor

NOTICE

Errors due to incorrect measurements!

► KTY sensors may not be combined with other devices.

Examples for the construction and programming of a temperature control with KTY84 evaluation can be taken from the F5 application manual.

6.6.2 Use of the temperature input in PTC mode

If the temperature input is operated in PTC mode, all possibilities are available for the user within the specified resistance range. This can be:

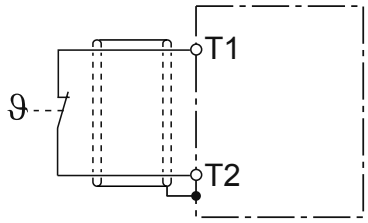
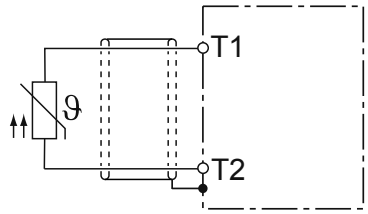
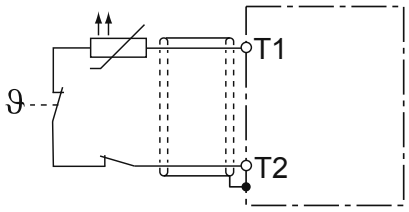
Thermal contact (NC contact)	
Temperature sensor (PTC)	
Mixed sensor chain	

Figure 22: Wiring example in PTC mode

The function can be switched off with Pn.12 = “7“ (CP.28) if no evaluation of the input is desired (standard in operating mode GENERAL). Alternatively a bridge can be installed between T1 and T2.

6.7 Connection of a braking resistor

⚠ CAUTION

Braking resistors dissipate the produced energy of the motor into heat during generatoric operation.

Burns and fire risk due to high surface temperatures.

- ► Pay attention to appropriate protection against contact and fire.
- ► The mains voltage must always be switched off in case of a defective braking transistor (fire risk).
- ► If direct contact cannot be avoided due to structural reasons, affix the warning "Hot surfaces".

⚠ DANGER

Regenerative operation

Risk of death due to electric shock!

The drive controller remains in operation in spite of switched off power supply in regenerative operation.

- ► An error must be released by external wiring which switches the modulation off in the drive controller. This can occur e.g. at terminals T1/T2 or via digital input.
- ► The drive controller must be programmed accordingly in each case.

The use of a KEB regenerative unit is reasonable for applications which produce a lot of regenerative energy. Regeneration of excess energy into the mains.

6.7.1 Monitoring braking transistor

General instructions

- The function "monitoring braking transistor" is standard for housing P with braking option.
- It must be wired according to the wiring diagrams.
- This circuit offers a direct protection in case of a defective braking transistor.
- If the braking transistor is defective, a relay opens the terminals K1 / K2.
- Terminals K1 / K2 are integrated into the holding circuit of the coupling relay for the input contactor, so the mains voltage is switched off in error case.
- Regenerative operation is also secured by the internal fault disconnection.
- Chapter => *"7 Wiring diagrams"* contains examples of how to wire the integrated relay via terminals K1 / K2.

6.7.2 External braking resistor without temperature monitoring

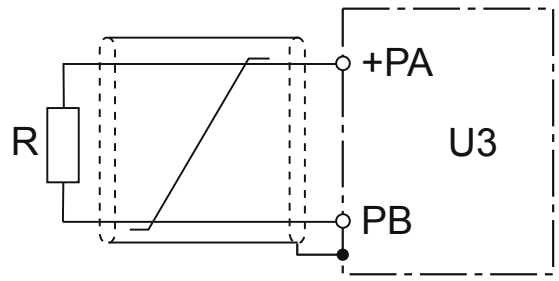
External braking resistors are available for air-cooled and liquid-cooled devices.

NOTICE

Fire risk!

► Only "intrinsically safe" braking resistors are permissible for operation without temperature monitoring.

An intrinsically safe braking resistor will melt internally like a fuse in case of overload due to overheating. There is no short circuit or earth fault. As a result, the drive controller changes to "Error! Overvoltage" with the next deceleration process (when the braking resistor is required).



Legend	
R	Braking resistor
+PA	Connection for braking resistor +
PB	Connection for braking resistor -
U3	Drive controller

Figure 23: Intrinsically safe braking resistor without temperature monitoring

Technical data and design of intrinsically safe braking resistors.
www.keb.de/fileadmin/media/Manuals/dr/ma_dr_safe-braking-resistors-20106652_en.pdf

6.7.3 External braking resistor with overheat protection

Chapter => *"7 Wiring diagrams"* contains examples how to connect external braking resistors with overtemperature protection.

Technical data and design of non-intrinsically safe braking resistors.
www.keb.de/fileadmin/media/Manuals/dr/ma_dr_braking-resistors-20116737_en.pdf

6.7.4 Sub-mounted braking resistors without overheat protection

- Sub-mounted braking resistors are only available for liquid-cooled devices.
- Terminal PB is not available for this device version.

Sub-mounted braking resistors are not suitable to convert large amounts of regenerative energy into heat. They are intended to intercept regenerative peaks.

6.8 Temperature switch braking resistor, mains and motor choke

6.8.1 General instructions

The following must be observed when wiring the temperature switches of the braking resistor, mains and motor choke:

- All cables must be laid separately from each other.
- If the various temperature switches are connected in series, EMC interference from the motor side can be coupled back to the input. => *"6.1.1 Wiring"*.
- Chapter => *"7 Wiring diagrams"* contains examples of how the temperature switches are connected to the control board.
- The used digital inputs must be parameterized to external error.

6.8.2 Parameterization of the control board

Device series	Parameter	Description	Function	Default value
F5	di.02	digital input selection	set inputs	112 I2+I2+I3 [1)]
	di.11	I1 function external error 8192	external error	8192
	di.12	I2 function external error 8192		
	di.13	I3 function external error 8192		
F6	di.00	digital inputs logic	set inputs	7 I2+I2+I3 [1)]
	pn.30	prog. error	source set inputs	7 I2+I2+I3

Table 27: Parameterization of the control board

[1)] *Depending on the number of the used inputs.*

6.9 Connection of the master / slave wiring

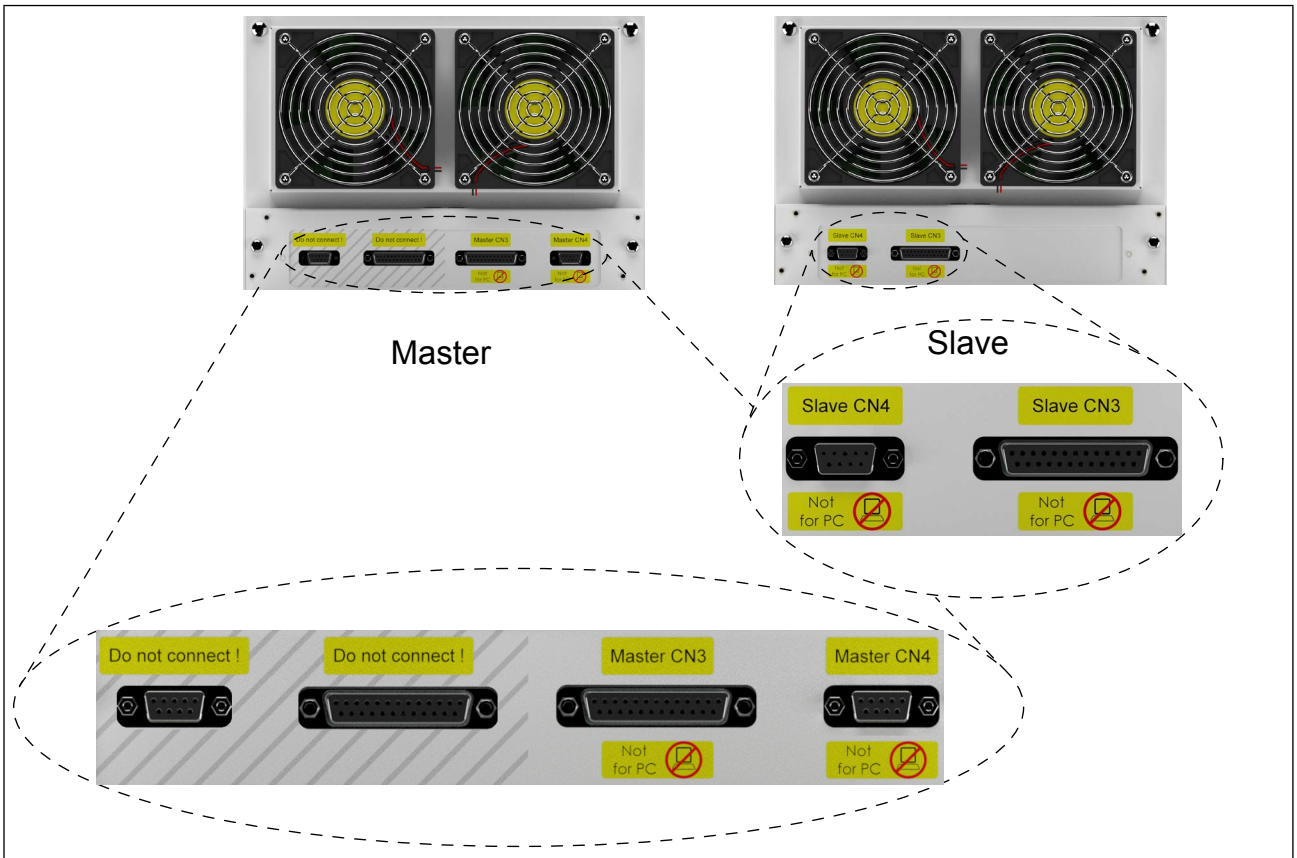
6.9.1 Connection master / slave

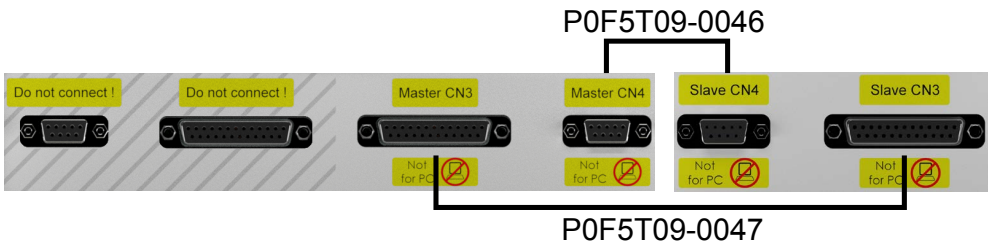
- Make sure that the SUB-D connection is connected correctly.
- Tighten SUB-D connectors.

NOTICE

Destruction of the devices!

► Do not ground SUB-D cable between master and slave!





Material number	Type	Length in m
P0F5T09-0046	SUB-D connector 9-pole (included in delivery)	0.75
P0F5T09-0047	SUB-D connector 25-pole (included in delivery)	0,75
P0F5T09-0031	SUB-D connector 9-pole (optional)	1.0
P0F5T09-0048	SUB-D connector 25-pole (optional)	1.0

Figure 24: Connection master / slave

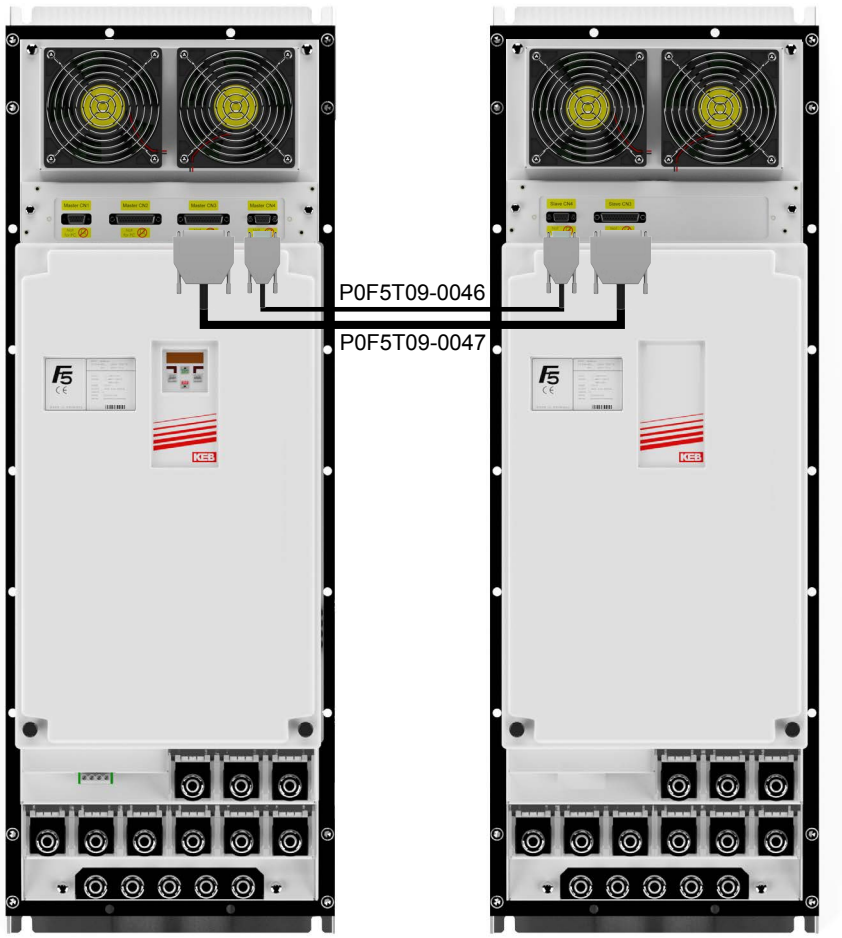
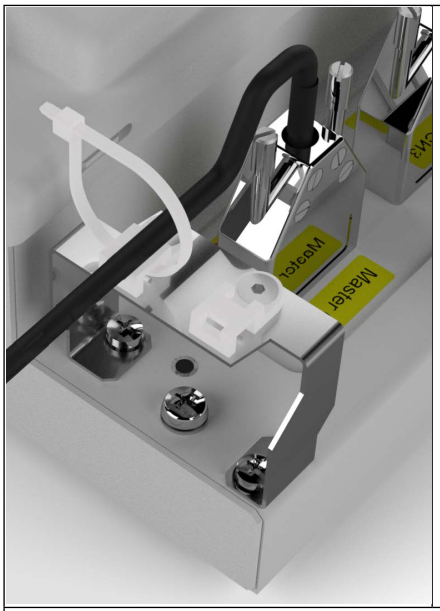


Figure 25: Master/slave connections



The connection cables can be attached to the supplied cable clamps using cable ties.

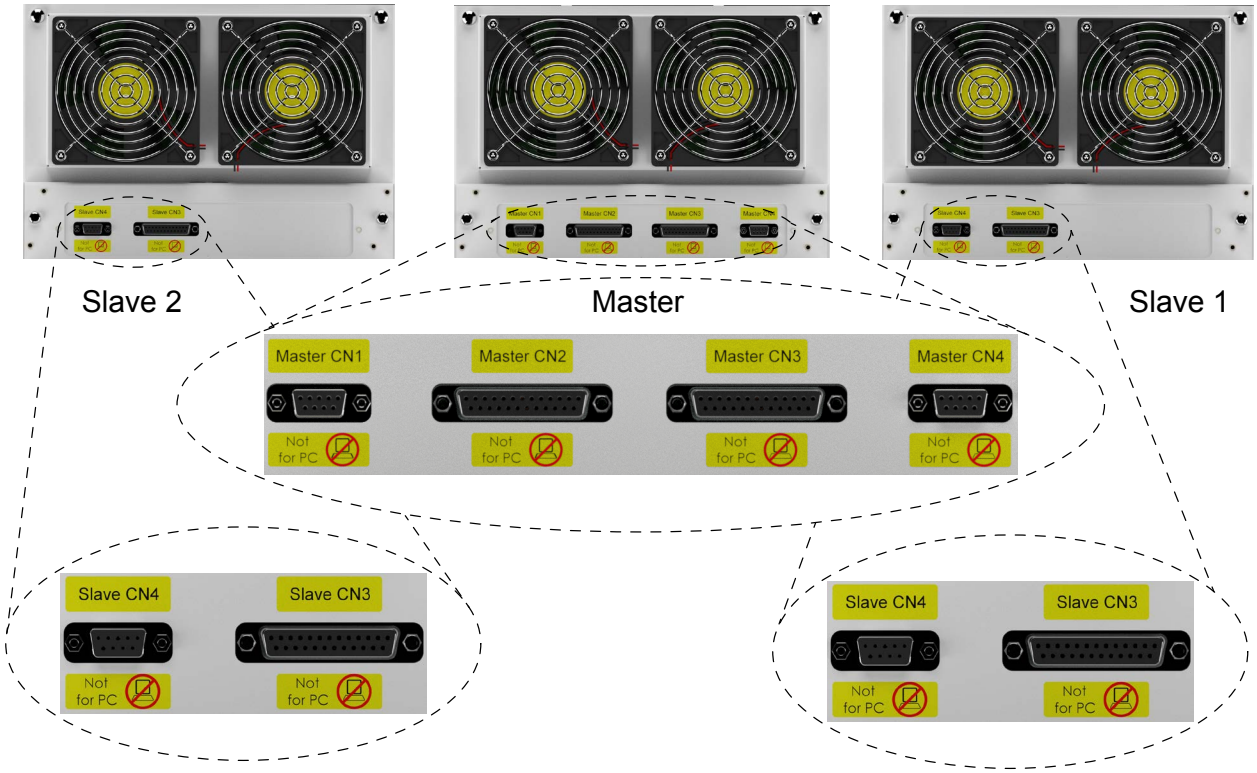
Figure 26: Cable clamps master/slave connections

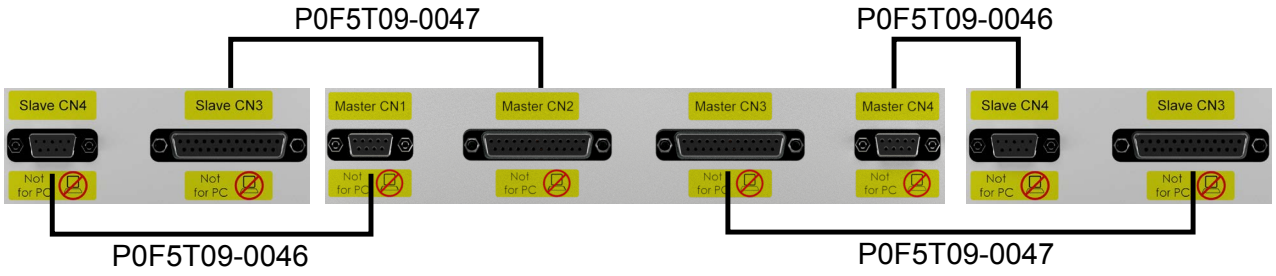
6.9.2 Connection master / slave / slave

NOTICE

Destruction of the devices!

► Do not ground SUB-D cable between master and slave!





Material number	Type	Length in m
P0F5T09-0046	SUB-D connector 9-pole (included in delivery)	0.75
P0F5T09-0047	SUB-D connector 25-pole (included in delivery)	0.75
P0F5T09-0031	SUB-D connector 9-pole (optional)	1.0
P0F5T09-0048	SUB-D connector 25-pole (optional)	1.0

Figure 27: Connection master / slave / slave

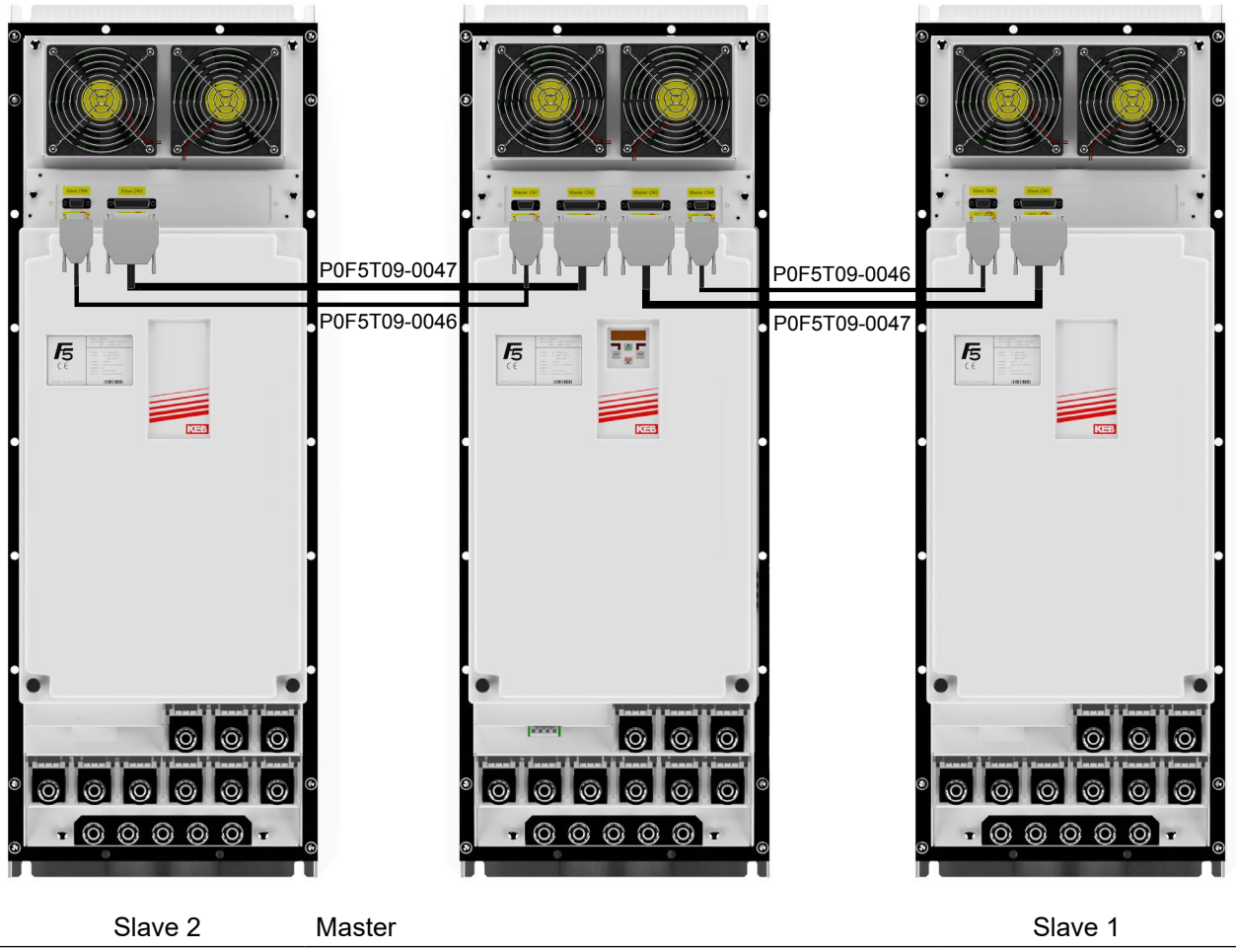
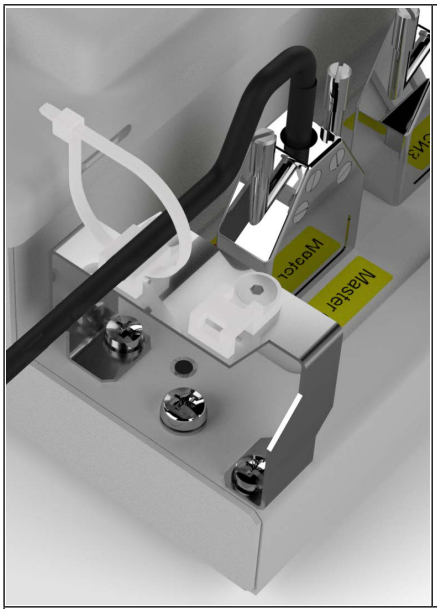


Figure 28: Master/slave/slave connections



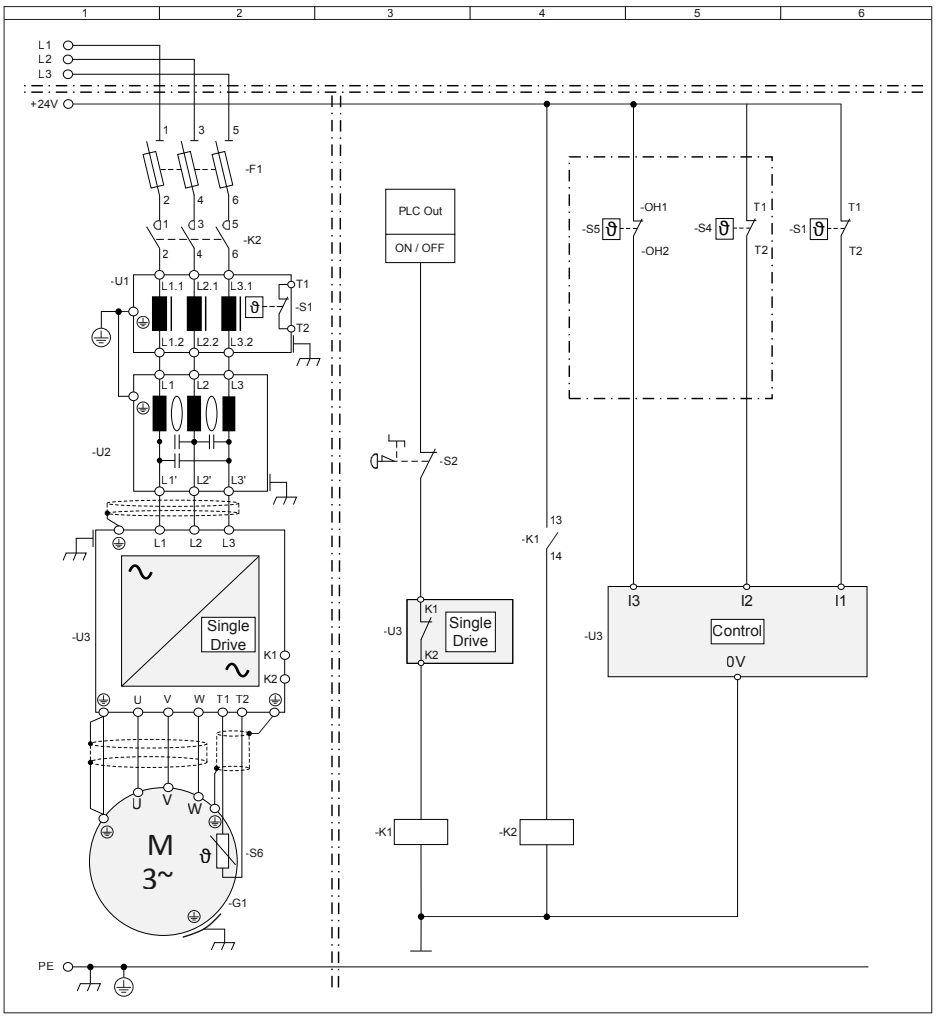
The connection cables can be attached to the supplied cable clamps using cable ties.

Figure 29: Cable clamps master/slave/slave connections

7 Wiring diagrams

7.1 Device size 28...30

7.1.1 Mains and control connection

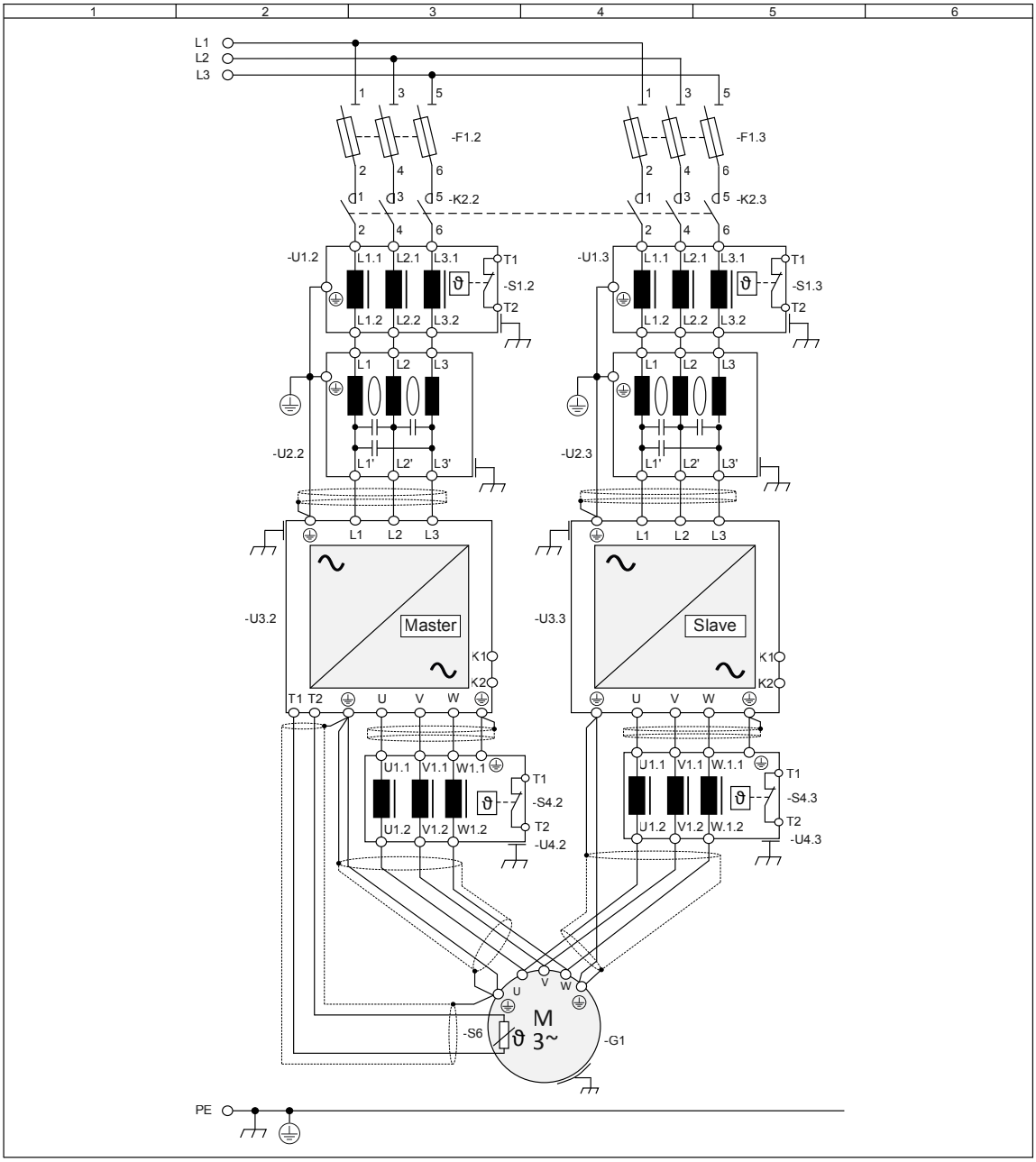


Legend			
F1	Mains fuse	S1	Temperature switch mains choke
K1	Coupling relay	S2	Emergency stop button / switch
K2	Main contactor	S6	Temperature switch motor
U1	Mains choke	G1	Motor
U2	HF filter	**Optional**	
U3	COMBIVERT single drive	S4	Temperature switch motor choke
DO1	PLC digital output	S5	Temperature switch braking resistor

Figure 30: Mains and control connection

7.2 Device size 32...35

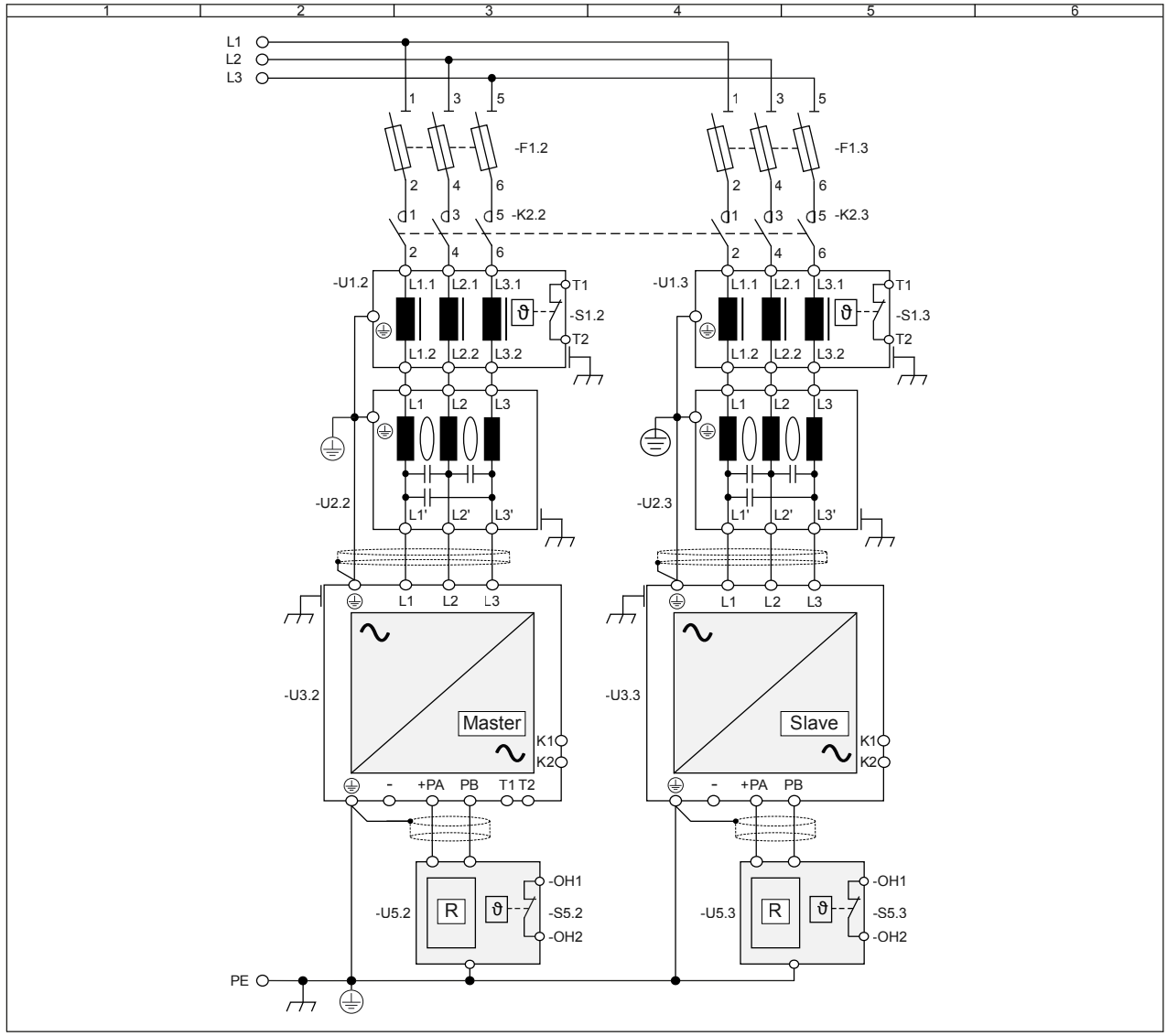
7.2.1 Mains and motor connection master/slave system



Legend			
F1.2/F1.3	Mains fuse	U4.2/U4.3	Symmetry chokes motor
K2.2/K2.3	Mains contactor	G1	Motor
U1.2/U1.3	Mains choke	S1.2/S1.3	Temperature switch mains choke
U2.2/U2.3	HF filter	S4.2/S4.3	Temperature switch motor choke
U3.2	COMBIVERT master	S6	Motor temperature switch
U3.3	COMBIVERT slave		

Figure 31: Mains and motor connection master/slave system

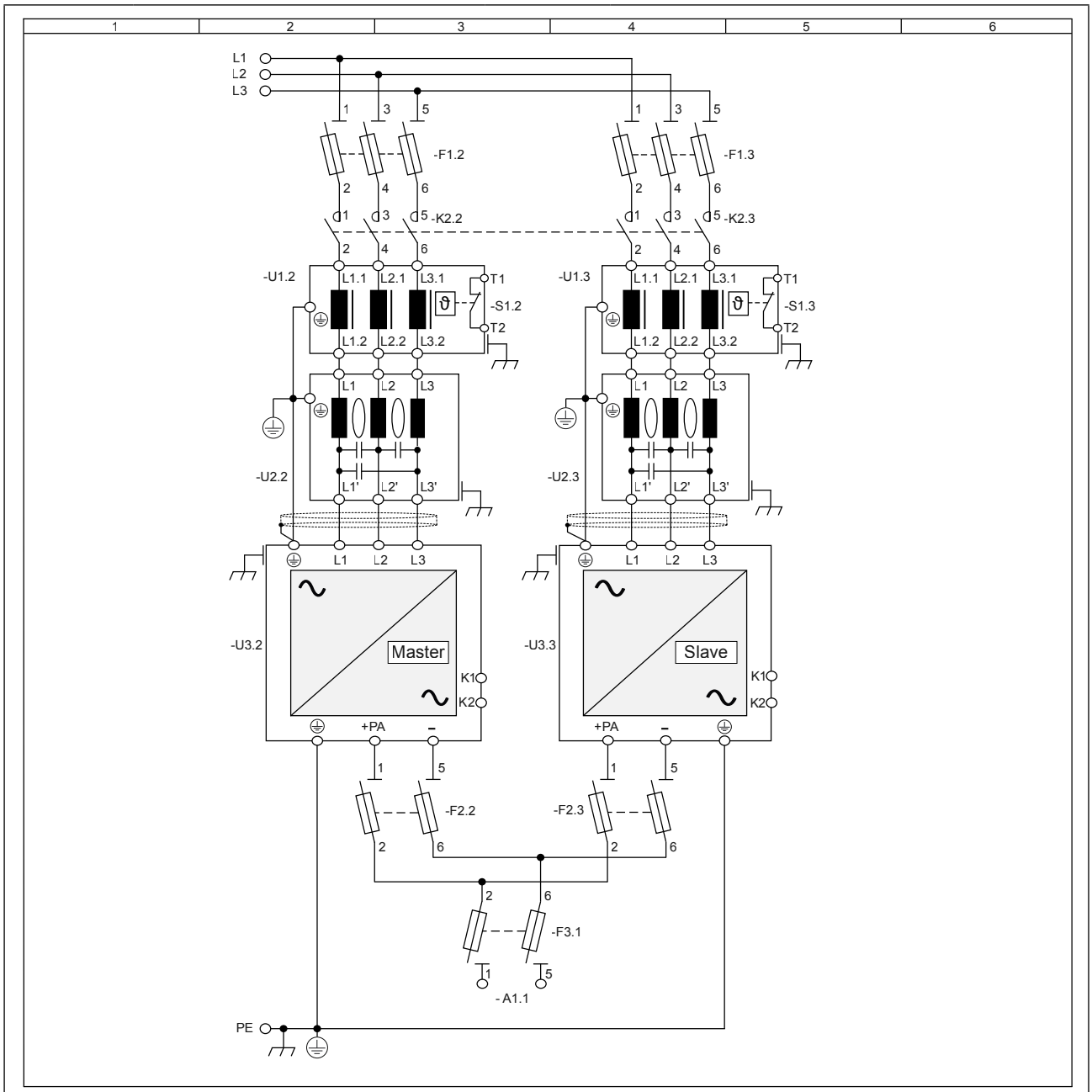
7.2.2 Connection braking resistor master / slave system



Legend			
F1.2 / F1.3	Mains fuse	U3.3	COMBIVERT slave
K2.2 / K2.3	Mains contactor	S1.2 / S1.3	Temperature switch mains choke
U1.2 / U1.3	Mains choke	U5.2 / U5.3	Braking resistor
U2.2 / U2.3	HF filter	S5.2 / S5.3	Temperature switch braking resistor
U3.2	COMBIVERT master		

Figure 32: Connection braking resistor master / slave system

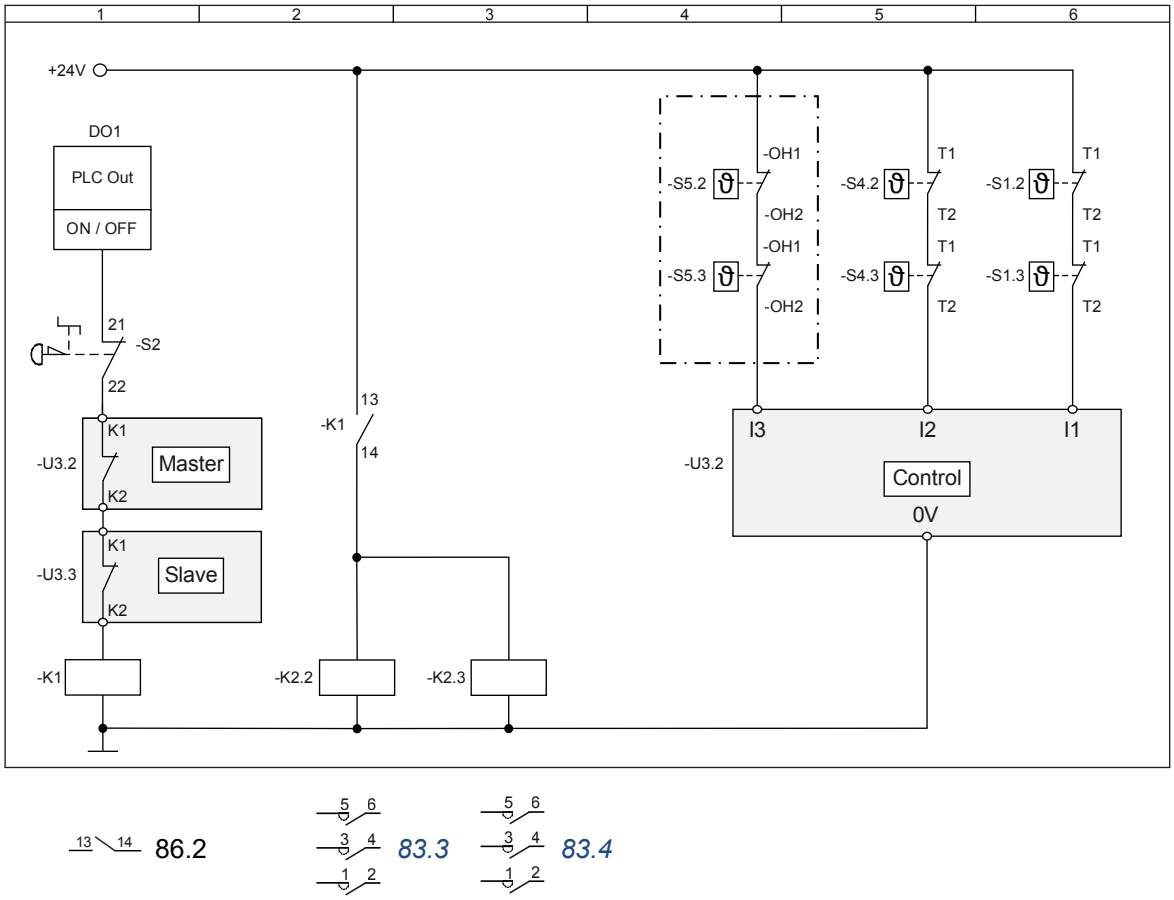
7.2.3 DC connection master/slave system



Legend			
F1.2/F1.3	Mains fuse	U2.2/U2.3	HF filter
F2.2/F2.3	DC fuses	A1.1	Connection external device
F3.1	DC fuse external device	U3.2	COMBIVERT master
K2.2/K2.3	Mains contactor	U3.3	COMBIVERT slave
U1.2/U1.3	Mains choke	S1.2/S1.3	Temperature switch mains choke

Figure 33: DC connection master/slave system

7.2.4 Mains connection master/slave system

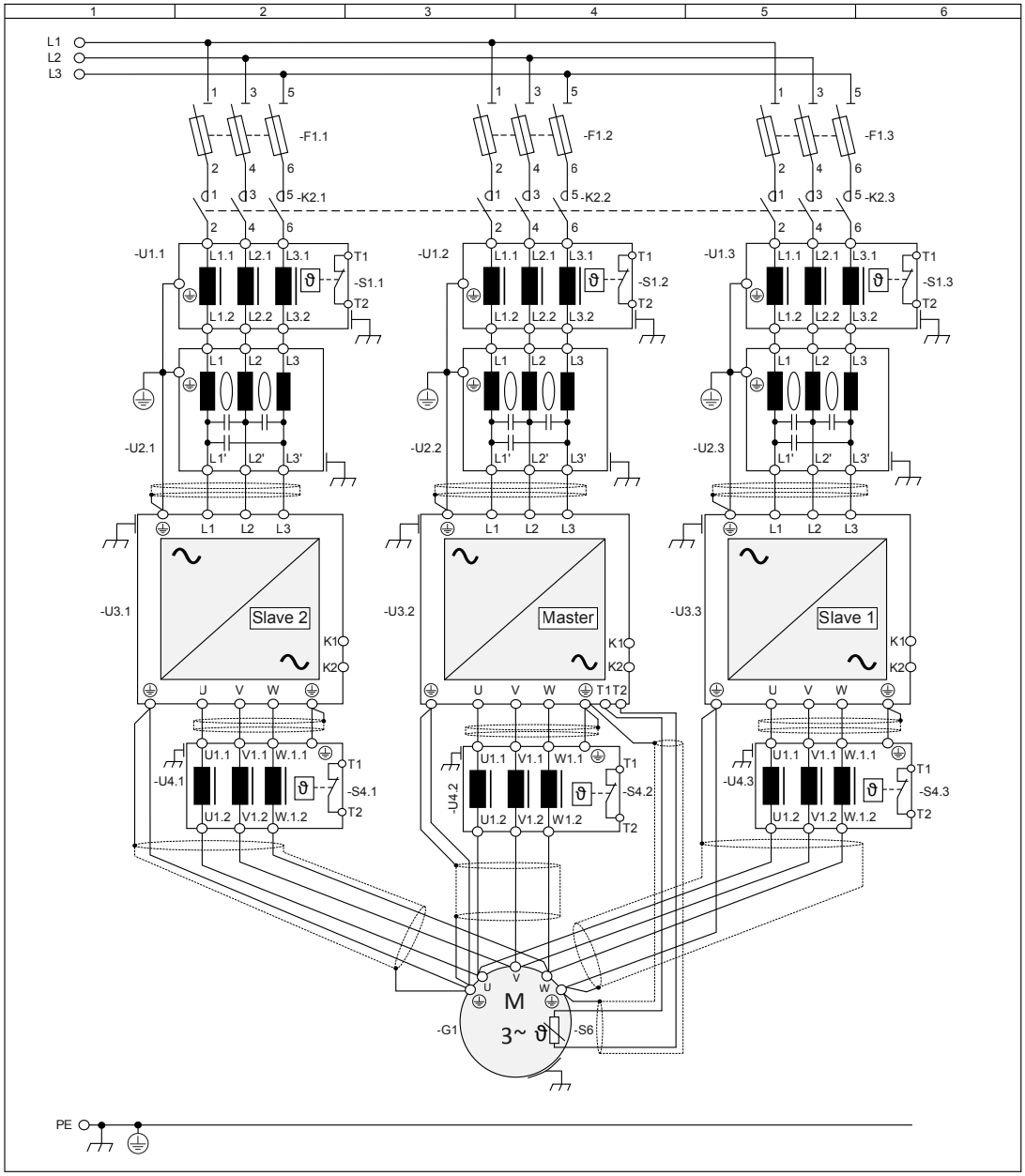


Legend			
DO1	PLC digital output	S1.2/S1.3	Temperature switch mains choke
K1	Coupling relay	S2	Emergency stop button / switch
K2.2/K2.3	Main contactor	S4.2/S4.3	Temperature switch motor choke
U3.2	COMBIVERT master	**Optional**	
U3.3	COMBIVERT slave	S5.2/S5.3	Temperature switch braking resistor

Figure 34: Mains connection master/slave system

7.3 Device size 36...39

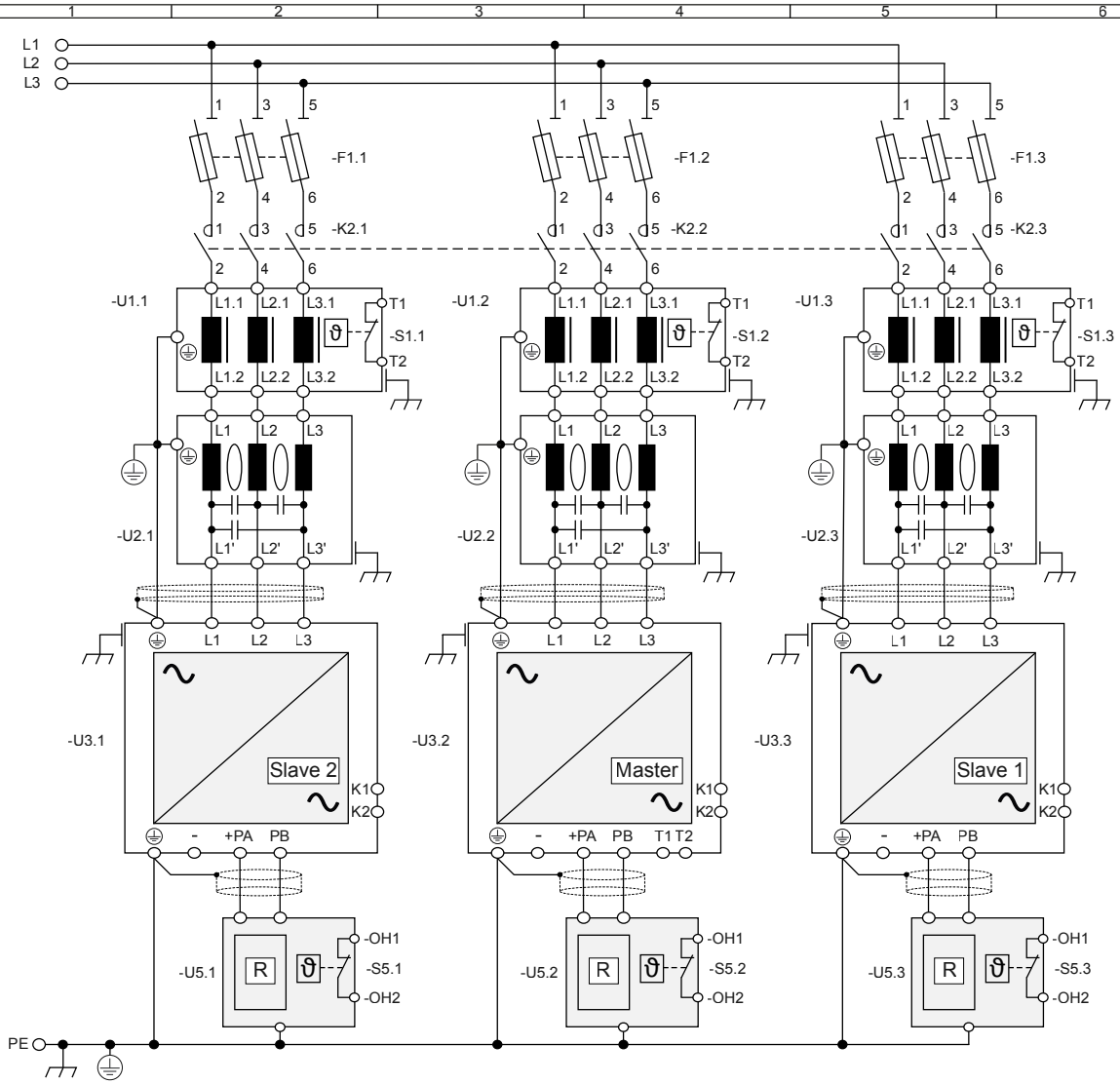
7.3.1 Mains and motor connection master / slave / slave system



Legend			
F1.1 / F1.2 / F1.3	Mains fuse	U3.3	COMBIVERT slave 1
K2.1 / K2.2 / K2.3	Mains contactor	U4.1 / U4.2 / U4.3	Symmetry chokes motor
U1.1 / U1.2 / U1.3	Mains choke	G1	Motor
U2.1 / U2.2 / U2.3	HF filter	S1.1 / S1.2 / S1.3	Temperature switch mains chokes
U3.1	COMBIVERT slave 2	S4.1 / S4.2 / S4.3	Temperature switch motor chokes
U3.2	COMBIVERT master	S6	Motor temperature switch

Figure 35: Mains and motor connection master / slave / slave system

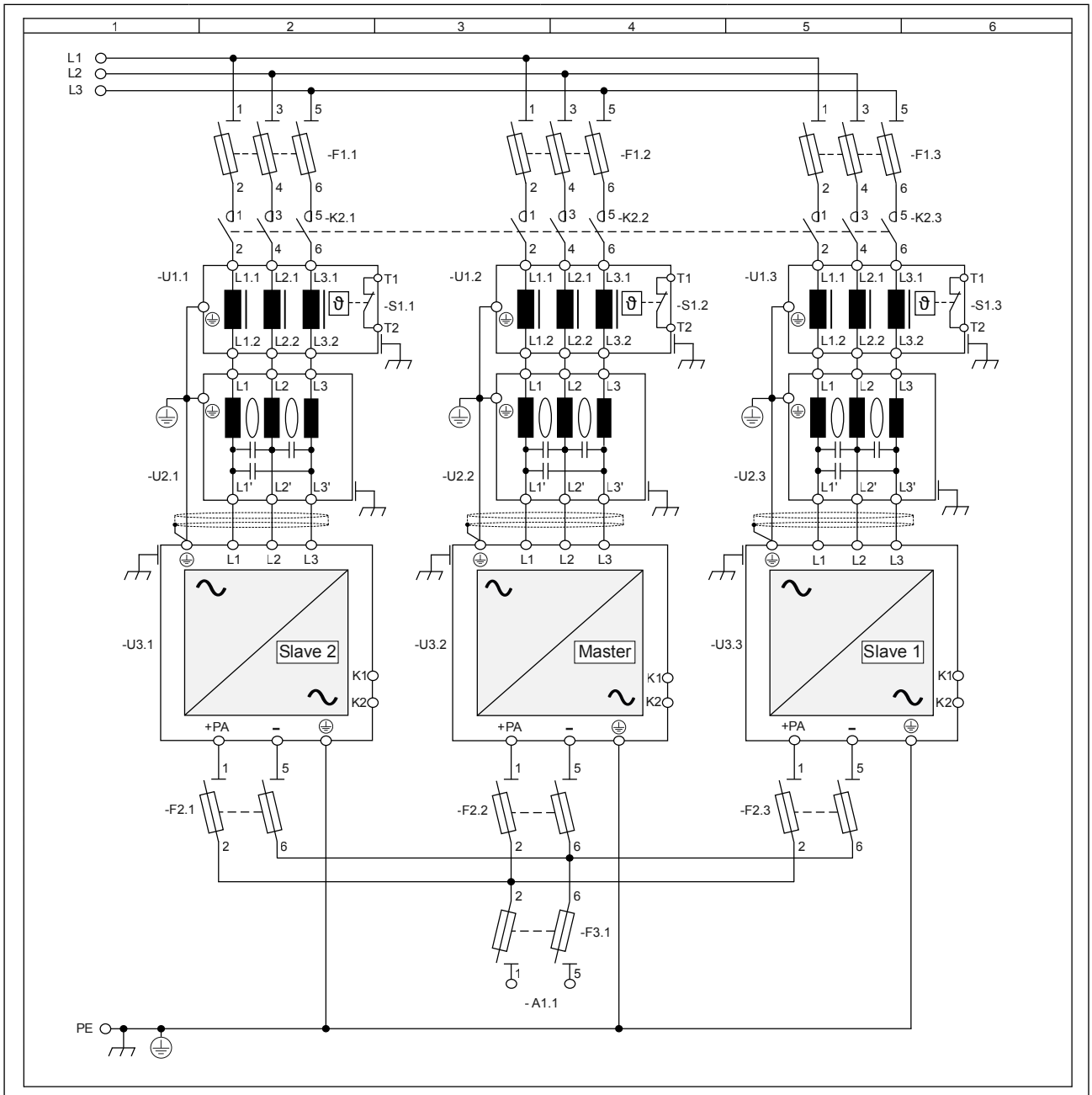
7.3.2 Connection braking resistor master / slave / slave system



Legend			
F1.1 / F1.2 / F1.3	Mains fuse	U3.2	COMBIVERT master
K2.1 / K2.2 / K2.3	Mains contactor	U3.3	COMBIVERT slave 1
U1.1 / U1.2 / U1.3	Mains choke	U5.1 / U5.2 / U5.3	Braking resistor
U2.1 / U2.2 / U2.3	HF filter	S5.1 / S5.2 / S5.3	Temperature switch braking resistor
U3.1	COMBIVERT slave 2	S1.1 / S1.2 / S1.3	Temperature switch mains choke

Figure 36: Connection braking resistor master / slave / slave system

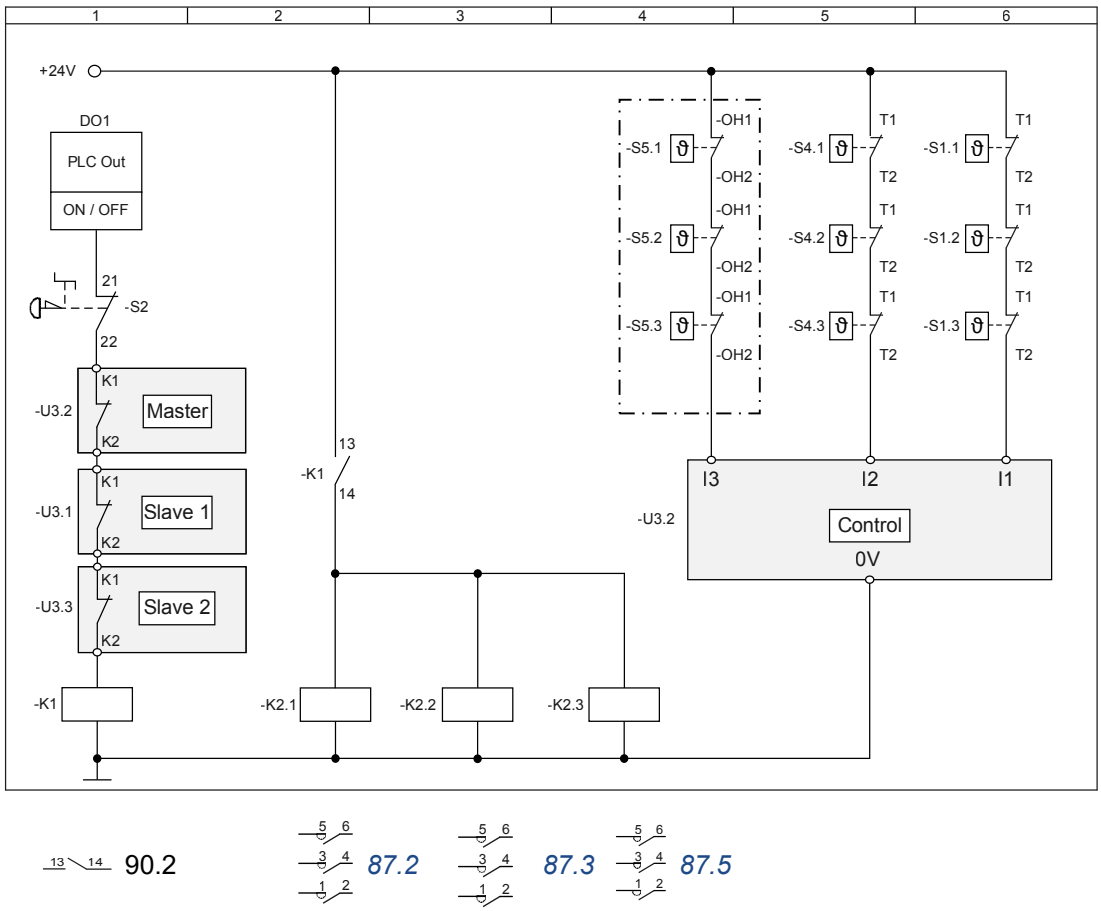
7.3.3 DC connection master/slave/slave system



Legend			
F1.1/F1.2/F1.3	Mains fuse	U2.1/U2.2/U2.3	HF filter
F2.1/F2.2/F2.3	DC fuses	A1.1	Connection external device
F3.1	DC fuse external device	U3.2	COMBIVERT master
K2.1/K2.2/K2.3	Mains contactor	U3.3	COMBIVERT slave 1
U1.1/U1.2/U1.3	Mains choke	U3.1	COMBIVERT slave 2

Figure 37: DC connection master/slave/slave system

7.3.4 Mains connection master/slave/slave system



Legend			
DO1	PLC digital output	S1.1/S1.2/S1.3	Temperature switch mains choke
K1	Coupling relay	S2	Emergency stop button / switch
K2.1/K2.2/K2.3	Main contactor	S4.1/S4.2/S4.3	Temperature switch motor choke
U3.2	COMBIVERT master		
U3.1	COMBIVERT slave 1	**Optional**	
U3.3	COMBIVERT slave 2	S5.1/S5.2/S5.3	Temperature switch braking resistor

Figure 38: Mains connection master/slave/slave system

8 Protection of drive controllers

All indications are permitted maximum values and apply to each module.

Use the following fuses in the mains cable:
(rated current maximum 100 kA SCCR)

Type / Size	400 V CE gG	480 V UL RK5/J	600 V USA[1] J	690 V CE gG
28	500	400	350	400
29	630	500	400	500
30	630	600	450	500
32	500	400	350	400
33	500	450	350	400
34	630	500	400	500
35	630	400	450	500
36	500	500	350	400
37	630	600	350	400
38	630	600	400	500
39	–	–	450	500

Table 28: Protection of drive controllers

[1] *Version without UL approval.*

8.1 Use of circuit breakers

Drive controller F5 / F6	Input voltage in V	UL 489 MCCB in A	Siemens Cat. No.
28	480 / 3ph	400	3VL400/JG-frame
29	480 / 3ph	600	3VL400X/LG-frame
30	480 / 3ph	600	3VL400X/LG-frame
32	480 / 3ph	2 x 400	2x 3VL400/JG-frame
33	480 / 3ph	2 x 600	2x 3VL400X/LG-frame
34	480 / 3ph	2 x 600	2x 3VL400X/LG-frame
35	480 / 3ph	2 x 600	2x 3VL400X/LG-frame
36	480 / 3ph	3 x 500	3x 3VL400X/LG-frame
37	480 / 3ph	3 x 600	3x 3VL400X/LG-frame
38	480 / 3ph	3 x 600	3x 3VL400X/LG-frame

Table 29: Use of circuit breakers

9 Certification

9.1 CE Marking

CE marked drive controllers and servo drives 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 informations and documentation”.*

9.2 UL Marking

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

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

- Only for F5 series:

  Control Board Rating (max. 30Vdc, 1A)

  Encoder Board Rating (max. 30 VDC, 1A)

  F5/F6 Series:

  Terminal Block for thermal sensor T1-T2 : 10V, 0.01A

  Only For Drives with Brake Resistor Option (see page 10):

  Relay Contact K1-K2: 250Vac/max.2A, 24Vdc/max.2A, R300
- „Maximum Surrounding Air Temperature 45°C“
- Wiring Terminals marked to indicate proper connections for the power supply, load and control circuit.
- „Use 75°C Copper Conductors Only“
- Fan supply and Motor Thermal Protection Terminals - Torque Value for Field Wiring Terminals, the value to be according to the R/C Terminal Block used.
- Input/Output connections - „Input/output Studs/Nuts shall be connected with UL Listed Ring Connectors (ZMVV/ZMVV7) rated 600 V and suitable ampere rating (min. 125% of Input/Output Currents).The tightening torque value of the Nuts needs to be 310 lb-in. (35 Nm)”
- "Devices are intended for use in pollution degree 2 environment „ (or similar wording)
- ”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”, or the equivalent“.
- “Motor Overload Protection:

  These devices do not incorporate an internal solid state motor overload protection and are intended to be used with motors having thermal protectors in or on the motors”

- “Motor Over temperature Protection:

  These devices are not provided with load and speed sensitive overload protection and thermal memory retention up on shutdown or loss of power (for details see NEC, article 430.126(A)(2)”.
- Only for F6 series:

  “For Connector X3A/X3B on Control Board 2FK6:

  Only use KEB Cable assembly Cat.No. 00H6 L41 - 0xxx or 00H6 L53 - 2xxx (where x = any digit) and use strain relief provisions as described in the instruction manual”

In order to comply with CSA C22.2 No. 274-13 (cUL) following external Filters and Mains Chokes manufactured by KEB Automation KG or Transcoil Inc. need to be installed:

Voltage class	Inverter size / Mod.	Filter			Mains choke			Alt. Choke
400/480 V	28/1	1	x	28E4T60-1001	1	x	28Z1B04-1000	28Z1B05-1002
	29/1	1	x	30E4T60-1001	1	x	29Z1B04-1000	29Z1B05-1002
	29/2	2	x	26E4T60-1001	2	x	25Z1B04-1000	25Z1B05-1002
	30/1	1	x	30E4T60-1001	1	x	30Z1B04-1000	30Z1B05-1002
	30/2	2	x	26E4T60-1001	2	x	27Z1B04-1000	27Z1B05-1002
	31/2	2	x	28E4T60-1001	2	x	28Z1B04-1000	28Z1B05-1002
	32/2	2	x	28E4T60-1001	2	x	28Z1B04-1000	28Z1B05-1002
	32/3	3	x	26E4T60-1001	3	x	25Z1B04-1000	25Z1B05-1002
	33/2	2	x	28E4T60-1001	2	x	28Z1B04-1000	28Z1B05-1002
	33/3	3	x	26E4T60-1001	2	3	27Z1B04-1000	27Z1B05-1002
	34/2	2	x	30E4T60-1001	2	x	29Z1B04-1000	29Z1B05-1002
	34/3	3	x	26E4T60-1001	2	3	27Z1B04-1000	27Z1B05-1002
	35/2	2	x	30E4T60-1001	2	x	30Z1B04-1000	30Z1B05-1002
	35/3	3	x	28E4T60-1001	3	x	28Z1B04-1000	28Z1B05-1002
	36/3	3	x	28E4T60-1001	3	x	28Z1B04-1000	28Z1B05-1002
	37/3	3	x	30E4T60-1001	3	x	29Z1B04-1000	29Z1B05-1002
	38/3	3	x	30E4T60-1001	3	x	30Z1B04-1000	30Z1B05-1002

Table 30: External filters and chokes

Detailed wiring Instructions for the external Filters and Mains Chokes as specified in ILL. No. 19 shall be present in the Installation Instructions of the products.

Short Circuit rating and Branch Circuit Protection, series F5 and F6 :

Following marking shall be provided:

All 480V Models:

„Suitable For Use On A Circuit Capable Of Delivering Not More Than 100 kA rms Symmetrical Amperes, 480 Volts Maximum when Protected by Class J or RK5 Fuses, rated ___ Amperes as specified in table I”:

or when Protected by A Circuit Breaker Having an Interrupting rating Not Less than 100 kA rms Symmetrical Amperes, 480V maximum, rated ___ Amperes as specified in table I”:

Table I Branch Circuit Protection of inverter series F5/F6 – P – housing:

a) Class J or RK5 Fuses as specified below:

Inverter F5/F6	Input Voltage [V]	UL 248 Fuse type J or RK5 [A]
28	480 / 3ph	3x400
29	480 / 3ph	3x500
29	480 / 3ph	2 x 3x300
30	480 / 3ph	3x600
30	480 / 3ph	2 x 3x350
31	480 / 3ph	2 x 3x400
32	480 / 3ph	2 x 3x400
32	480 / 3ph	3 x 3x300
33	480 / 3ph	2 x 3x450
33	480 / 3ph	3 x 3x350
34	480 / 3ph	2 x 3x500
34	480 / 3ph	3 x 3x400
35	480 / 3ph	2 x 3x600
35	480 / 3ph	3 x 3x400
36	480 / 3ph	3 x 3x500
37	480 / 3ph	3 x 3x600
38	480 / 3ph	3 x 3x600

Table 31: UL fuses

b) Inverse Time Circuit Breaker as specified below:

Inverter	Input Voltage [V]	UL 489 MCCB [A]	Siemens Cat. No.
28	480 / 3ph	400	3VL400/JG-frame
29	480 / 3ph	600	3VL400X/LG-frame
29	480 / 3ph	2 x 400	2x 3VL400/JG-frame
30	480 / 3ph	600	3VL400X/LG-frame
30	480 / 3ph	2 x 400	2x 3VL400/JG-frame
31	480 / 3ph	2 x 400	2x 3VL400/JG-frame
32	480 / 3ph	2 x 400	2x 3VL400/JG-frame
32	480 / 3ph	3 x 400	3x 3VL400/JG-frame
33	480 / 3ph	2 x 600	2x 3VL400X/LG-frame
33	480 / 3ph	3 x 400	3x 3VL400/JG-frame
34	480 / 3ph	2 x 600	2x 3VL400X/LG-frame
34	480 / 3ph	3 x 400	3x 3VL400/JG-frame
35	480 / 3ph	2 x 600	2x 3VL400X/LG-frame
35	480 / 3ph	3 x 400	3x 3VL400/JG-frame
36	480 / 3ph	3 x 500	3x 3VL400X/LG-frame
37	480 / 3ph	3 x 600	3x 3VL400X/LG-frame
38	480 / 3ph	3 x 600	3x 3VL400X/LG-frame

Table 32: Cable protection switch

9.3 Further informations and documentation

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

General instructions

- EMC and safety instructions
- Manuals for 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 controller and to create downloads for parameterizing the drive controller

Approvals and approbations

- Declaration of conformity CE
- TÜV certificate
- FS certification

Others

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

10 Characteristics

10.1 Overload characteristic

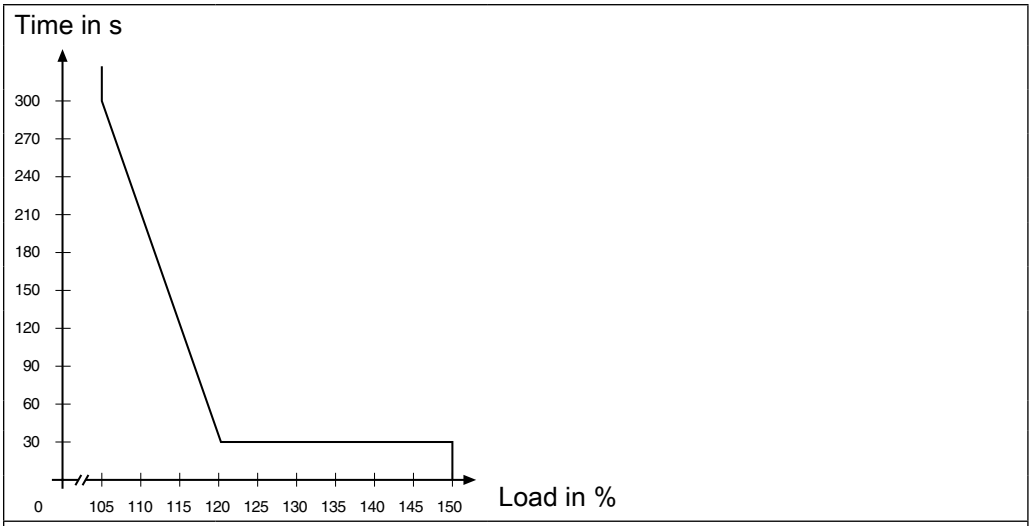


Figure 39: Overload characteristic

On exceeding a load of 105% the overload integrator starts. When falling below the integrator counts backwards. If the integrator achieves the overload characteristic that corresponds to the drive controller, error E.OL is triggered.

10.2 Overload protection in the lower speed range

Applies only to operating modes MULTI and SERVO.

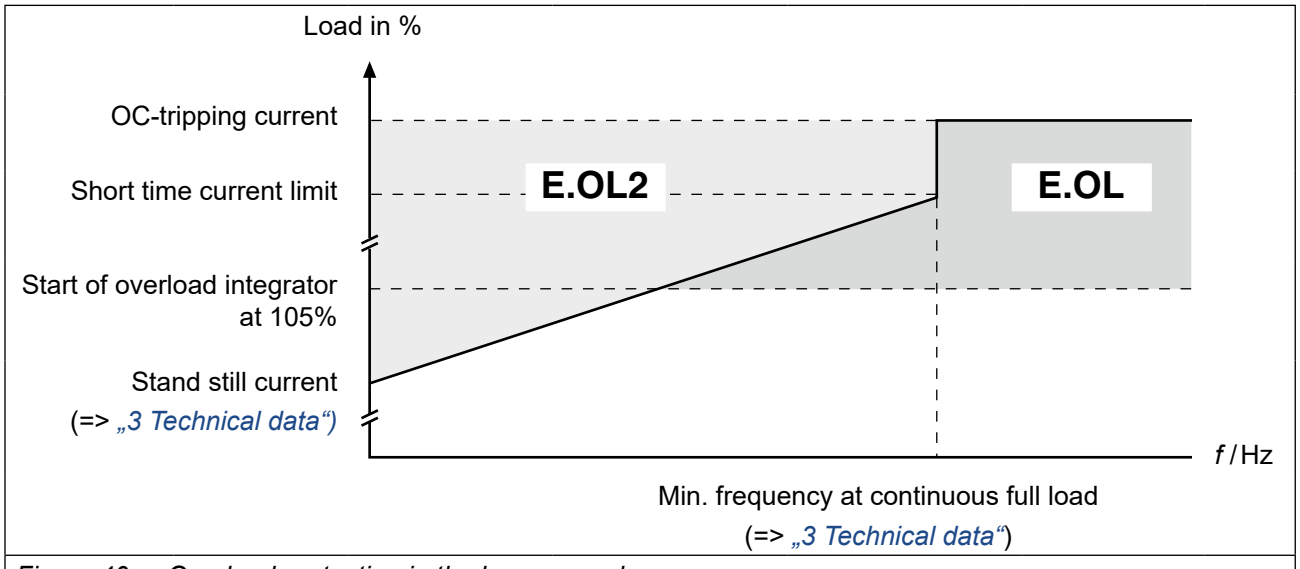


Figure 40: Overload protection in the lower speed range

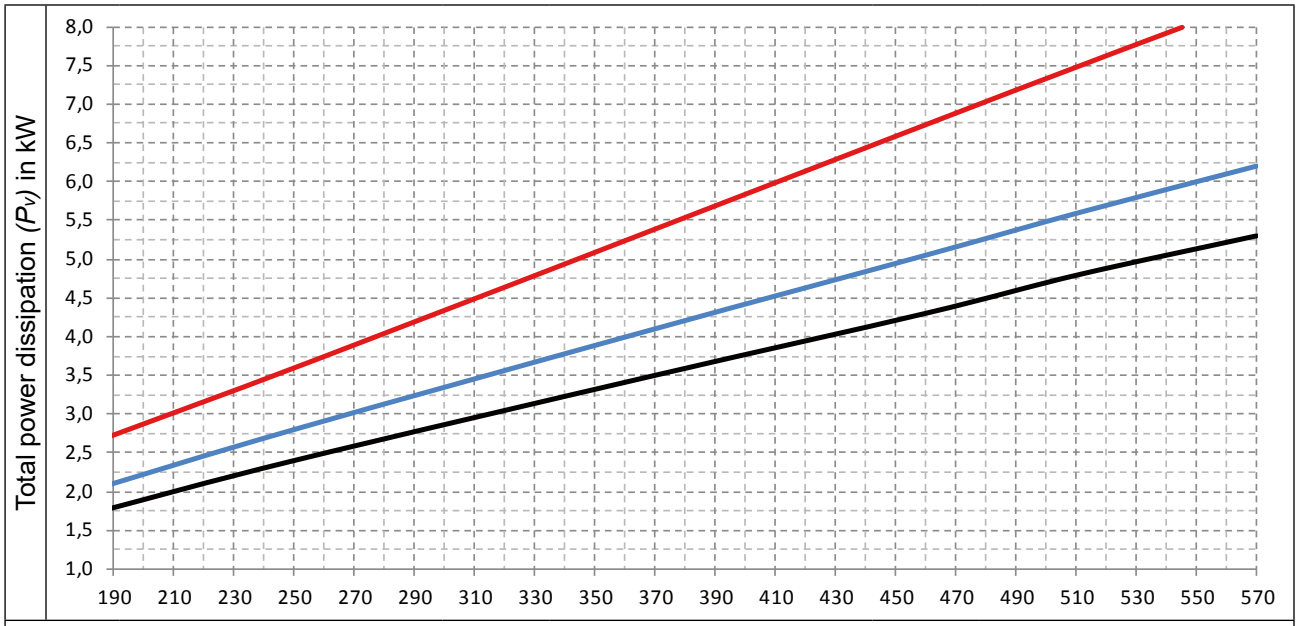
A PT1 element (t = 280 ms) starts if the permissible current is exceeded. After its sequence of operation the error E.OL2 is triggered.

10.3 Power dissipation of the 400V class at rated operation

The following diagram shows the total power dissipation as a function of the output current per module at

- different switching frequencies.
- 50 Hz output frequency.
- 25 °C ambient temperature.

10.3.1 Power dissipation of different switching frequencies



Legend					
	8 kHz		4 kHz		2 kHz

Figure 41: Power dissipation of different switching frequencies 400V class

Determination of power dissipation with parallel connected modules:

► Divide the output current by the number of modules.

► Determine the power dissipation from the upper diagram with the determined output current for a module.

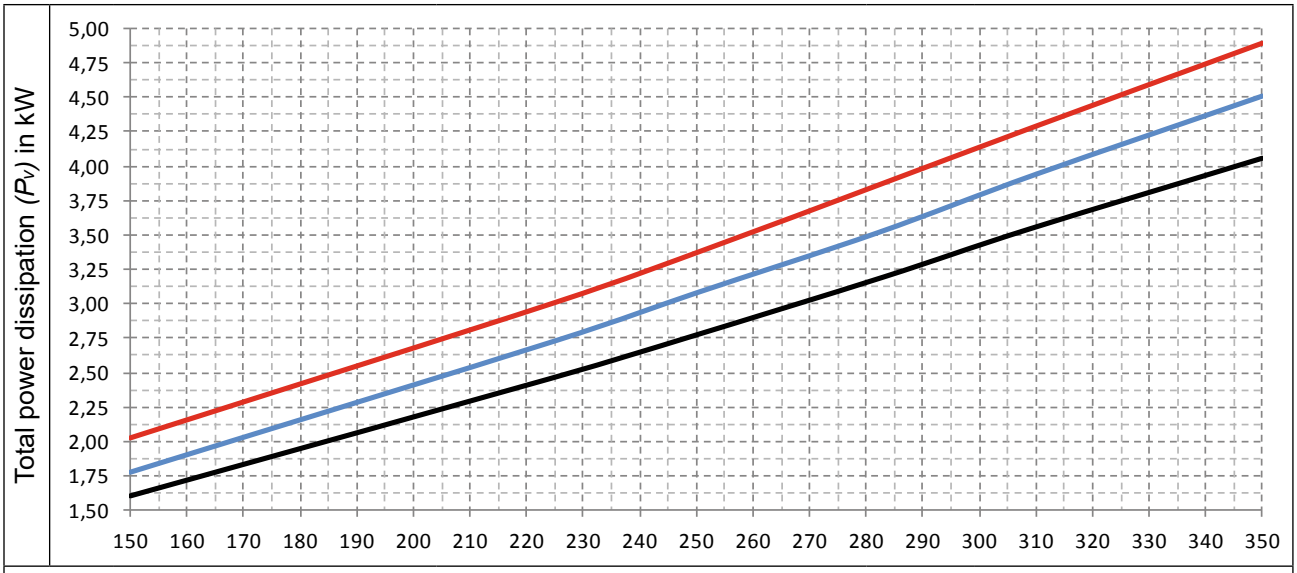
► Multiply the power dissipation with the number of modules.

10.4 Power dissipation of the 690V class at rated operation

The following diagram shows the total power dissipation as a function of the output current per module at

- 50 Hz output frequency.
- 25 °C ambient temperature.

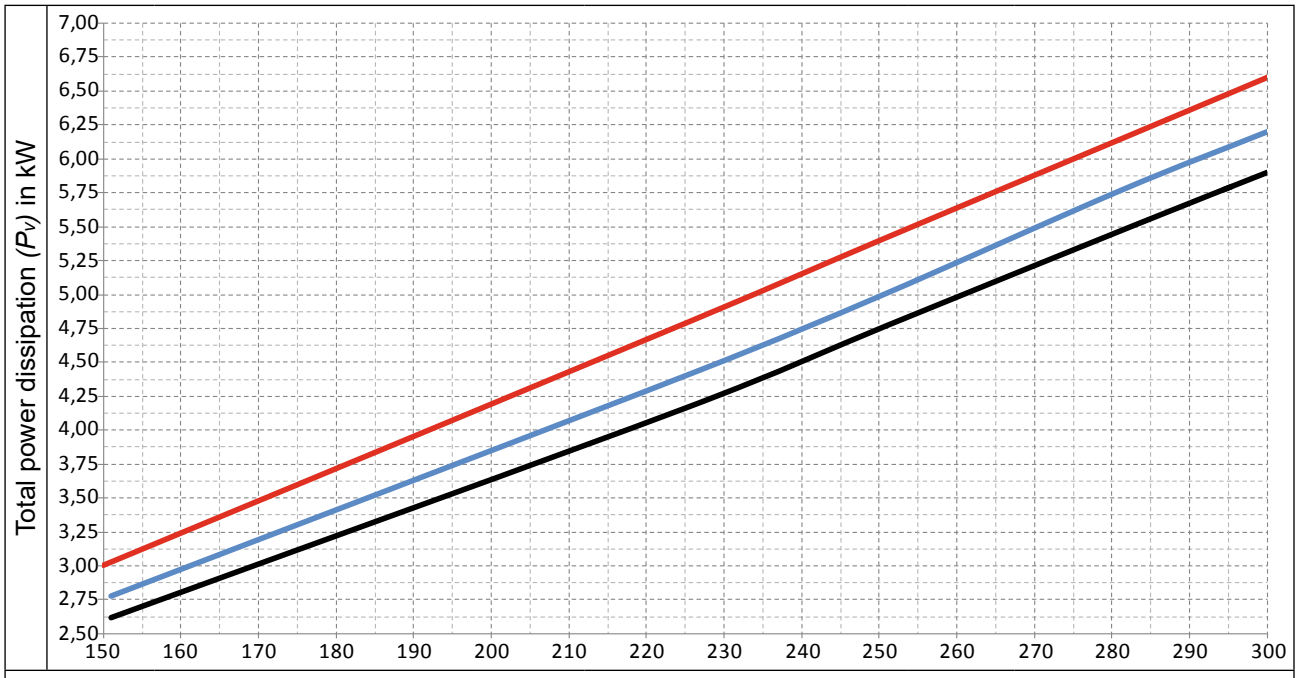
10.4.1 Power dissipation at 2 kHz switching frequency



Legend					
	690 V + 10 %		690 V		690 V - 10 %

Figure 42: Power dissipation at 2 kHz switching frequency 690V class

10.4.2 Power dissipation at 4 kHz switching frequency



Legend					
	690 V + 10 %		690 V		690 V - 10 %

Figure 43: Power dissipation at 4 kHz switching frequency 690V class

11 Accessories

11.1 Filter and chokes

Class	Device size	Filter		Mains choke		Setting	Motor choke		Setting
400 V	28	1x	28E4T60-1001	1x	28Z1B04-1000		1x	29Z1A04-1001	
	29		30E4T60-1001		29Z1B04-1000				
	30		30E4T60-1001		30Z1B04-1000			31Z1A04-1000	
	32	2x	28E4T60-1001	2x	28Z1B04-1000		2x	29Z1A04-1001	
	33		28E4T60-1001		28Z1B04-1000				
	34		30E4T60-1001		29Z1B04-1000			31Z1A04-1000	
	35		30E4T60-1001		30Z1B04-1000				
	36	3x	28E4T60-1001	3x	28Z1B04-1000		3x	29Z1A04-1001	
	37		30E4T60-1001		29Z1B04-1000				
	38		30E4T60-1001		30Z1B04-1000			31Z1A04-1000	
690 V	28	1x	30E5T60-8001	1x	28Z1B06-1000		1x	29Z1A04-1001	
	29				29Z1B06-1000				
	30				30Z1B06-1000				
	32	2x	30E5T60-8001	2x	28Z1B06-1000		2x	29Z1A04-1001	
	33				29Z1B06-1000				
	34				30Z1B06-1000				
	35				30Z1B06-1000				
	36	3x	30E5T60-8001	3x	29Z1B06-1000		3x	29Z1A04-1001	
	37				30Z1B06-1000				
	38				30Z1B06-1000				
	39				30Z1B06-1000				

Legend			
	Required		Recommended

Table 33: Filter and chokes

11.2 Assembly aids

Assembly aid	Number	Part number	
Mounting bracket	1	00F5ZTB-0001	
Ring bolts Mounting kit	1	00F5ZTB-0002	

Table 34: Assembly aids

11.3 Connections to the coolant

Connection variant	Required number	Part number
Accessory kit hose connection G1/2 with mounting nuts	1	0000650-G14K
Function nut for a pipe diameter of 12mm	2	0000651-FM12
Heat sink seal bottom/upper side IP54	1	P0F5T45-0019

Table 35: Connections to the coolant

11.4 Connecting cable master/slave system

Connecting cable	Required number		Part number
	MS [1]	MSS [2]	
SUB-D plug 9-pole 0.75 (contained in scope of supply)	1	2	P0F5T09-0046
SUB-D plug 25-pole 0.75 (contained in scope of supply)	1	2	P0F5T09-0047
SUB-D plug 9-pole 1.0 (optional)	1	2	P0F5T09-0031
SUB-D plug 25-pole 1.0 (optional)	1	2	P0F5T09-0048

Table 36: Connecting cable master/slave system

[1] *Master/slave system.*

[2] *Master/slave/ slave system.*

11.5 Heat sink fan

Spare part kit	Required number	Part number
Heat sink fan for external supply (24 V/2.5A)	1	P0F5989-1206

Table 37: Heat sink fan

12 Revision history

Revision	Date	Description
2A	2011-04	First published version
2B	2011-11	Technical datas, dimensions, connection of the power circuit, braking resistor and annex C are overworked
2C	2012-01	Master/ slave wiring changed
2D	2012-04	Cooling water directive und water connection revised
2E	2012-04	Use of the temperature input in KTY mode revised
2F	2012-06	Braking resistor adapted to standard series; Shielding for temperature sensors; Master / slave wiring
2G	2013-01	EMC and safety instructions changed
2H	2014-09	Transport instructions inserted
2I	2014-09	UL values added to technical data
2J	2015-03	Revision of the technical data; Fuse values inserted; Coolant diagrams adapted
00	2018-10	change to document number; complete revision of the content
01	2020-05	Mounting of the housing in the control cabinet defined; Editorial changes
02	2023-01	Adaptation of the UL texts; Editorial changes

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