COMBIVERT

F5/F6

GB INSTRUCTION MANUAL

COMBIVERT F5/F6 Power Unit
Housing W 200…400 kW
250...500 kVA

Mat.No.	Rev.
00F50EB-KW00	2F

KEB

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1. Preface

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

1.1 Information on special measures

The used pictograms have following significance:

Danger	Is used, when death or serious bodily injury may be the consequence of non-observance of the measure.
Warning	Is used, when bodily injury and/or substantial property damage may be the consequence of non-observance of the measure.
Caution	Is used, when property damage may be the consequence of non-observance of the measure.
Attention	Is used, when noise sensitive or unrequested operation may be the consequence of non-observance of the measure.
Info	Is used, when a better or simpler result can be the consequence of the measure.

For a special case the instructions can be supplemented by additional pictograms and text.

1.2 Documentation

Attention	**Documentation via www.keb.de**
	Prior to performing any work on the unit, it is absolutely necessary to download and read the documentation, especially the safety precautions and instructions for use. Follow these steps to get the documentation:
Step 1	Read the material number (Mat.No.) from nameplate
Step 2	Input the material number at "www.keb.de => Service => Downloads" and click "search". **Downloads** **Search for specific material numbers** **Please enter a comlete (11-digit) material number.** **Search for:** 15G6DCD3510 search

continued on the next page

Step 3	The entire documentation associated with the device will be displayed, including the instruction manuals in German and English. If available, other translations are also indicated. Make sure that the user understands the provided language.
	**Should you be unable to read or understand the documentation, do not take any further steps. Please inform our support network for further assistance.**

Non-observance of the safety instructions leads to the loss of any liability claims. The safety and warning instructions specified in this manual do not lay claim on completeness. This list is not exhaustive.

1.3 Validity and liability

The use of our units in the target products is beyond of our control and therefore exclusively the responsibility of the machine manufacturer, system integrator or customer.

The information contained in the technical documentation, as well as any user-specific advice in spoken and written and through tests, are made to best of our knowledge and information about the application. However, they are considered for information only without responsibility. This also applies to any violation of industrial property rights of a third-party.

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

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

Danger  **by tamper from unauthorized personnel**	
	Unauthorised opening and tampering may lead to death, bodily injury, property damage and malfunctions. Modification or repair is permitted only by KEB authorized personnel. Infringement will annul the liability for resulting consequences.

The suspension of liability is especially valid also for operation interruption loss, loss of profit, data loss or other damages. The disclaimer will void the warranty. This is also valid, if we referred first to the possibility of such damages.

If single regulations should be or become void, invalid or impracticable, the effectivity of all other regulations or agreements is not affected.

Through multitude applications not each possible case of installation, operation or maintenance can be considered. If you require further information or if special problems arise which are not treated in detail in the documentation, you can request the required information from the local agency of the company KEB Automation KG.

1.4 Copyright

The customer may use the instruction manual as well as further documents or parts from it for internal purposes. Copyrights are with KEB and remain valid in its entirety.

1.5 Specified application

The semiconductors and components used by KEB are developed and designed for use in industrial products. 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.

The operation of our products outside the indicated limit values of the technical data leads to the loss of any liability claims.

Units with safety function are limited to a service life of 20 years. After this time the unit must be replaced.

1.6 Product description

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

Unit type:	Frequency inverter
Series:	COMBIVERT F5/F6
Power range:	200…400 kW
Housing size:	W
Version:	Heat sink with cooling fan (standard)
	Heat sink with cooling fan (through-mount version)
	Water cooling (mounted version) Water cooling (through-mount version)

Features of the power circuits :

- only slight switching losses due to IGBT
- low noise development due to high switching frequency
- extensive safety device for current, voltage and temperature
- voltage and current monitoring in static and dynamic operation
- conditionally short circuit proof and earth-fault proof
- hardware current limit
- integrated cooling fan

1.7 Unit identification

28 . F5 . A 0 W - 9 0 0 A

Cooling		
0	Heat sink with cooling fan	at special/customer unit consecutive numbering
A	Heat sink with cooling fan (varnished)	
C	Water cooling (varnished)	
D	Through-mount version	
H	Water cooling (second version)	

Encoder interface		
0	none	at special/customer unit consecutive numbering

Switching frequency; short time current limit; overcurrent limit		
0	2 kHz; 125 %; 150 %	at special/customer unit special modification or customer ID
1	4 kHz; 125 %; 150 %	

Input identification			
5	400 V DC	N	400 V DC (US unit)
9	3ph 400 V AC	V	Special-/customer unit 400 V DC
L	400 V AC or AC/DC (US unit)	Y	Special-/customer unit 400 V AC or AC/DC

Housing type W

Accessories (A, B and D with safety relay)			
0	none	A	such as 0, but with safety relay
1	Braking transistor	B	such as 1, but with safety relay
3	Braking transistor and integrated filter	D	such as 3, but with safety relay

Control type	
A	APPLICATION
E	MULTI - SCL
G	GENERAL (controlled frequency inverter)
H	MULTI - ASCL
M	MULTI (regulated, field-oriented frequency inverter for three-phase asynchronous motors)

Series F5/F6

Inverter size

Table 1: Unit identification

1.8 Installation instructions

1.8.1 Cooling systems

The KEB COMBIVERT F5/F6 is available for different cooling systems:

Heat sink with cooling fan (mounted version)

The standard version is delivered with heat sink and cooling fan.

Special versions

The dissipation of power loss must be guaranteed by the machine builder.

Flat rear

There is no heat sink at this version. The unit must be mounted on an appropriate ground for heat dissipation.

Water cooling

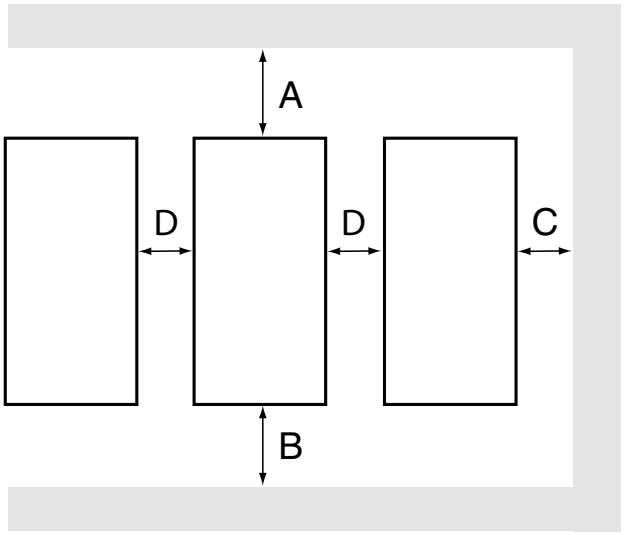
This version is dimensioned for the connection to an available cooling system. The dissipation of the power loss must be ensured by the machine builder. In order to avoid moisture condensation, the minimum inlet temperature may not decrease the ambient temperature. The max. inlet temperature may not exceed 40°C. No aggressive coolant shall be used. Measures against contamination and calcination must be done externally. We recommend a pressure of 4 bar on the cooling system.

Convection (through-mount version)

In this version the heat sink is placed externally with a cutout in the control cabinet.

Warning  **Hot surface**	
	Heat sinks can reach temperatures, which can cause burns when touching. If in case of structural measures a direct contact cannot be avoided, a warning notice "hot surface" must be mounted at the machine.

1.8.2 Control cabinet installation

Mounting distances	Dimen-sion	Distance in mm	Distance in inch
	A	150	6
	B	100	4
	C	30	1,2
	D	30	1,2
	X [1]	50	2

1) Distance to preceding elements in the cabinet door.

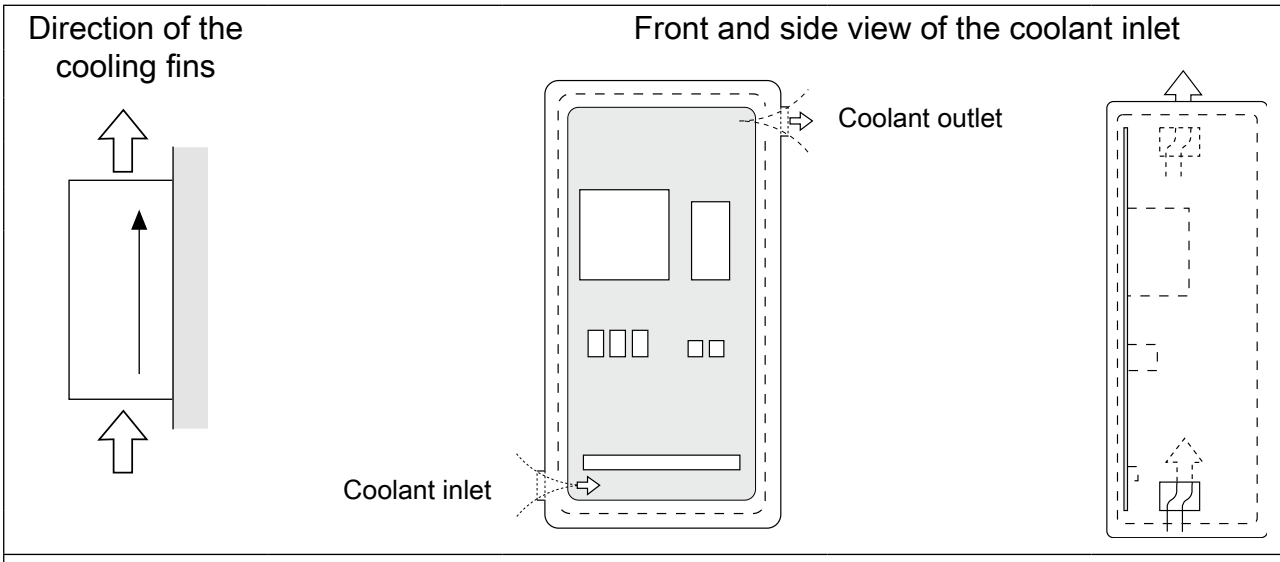


Figure 1: Control cabinet installation

For water cooled devices, see „Annex C“.

1.9 Safety and application notes

Safety and application notes for drive converter
(in accordance with: Low-Voltage Directive 2006/95/EC)

1. General
In operation, drive converter depending on their degree of protection, may have live, uninsulated and possibly also moving or rotating parts, as well as hot surfaces.
In case of inadmissible removal of the required covers, of improper use, wrong installation or maloperation, there is the danger of serious personal injury and damage to property.
For further information, see documentation.
All operations serving transport, installation and commissioning as well as maintenance are to be carried out by skilled technical personnel (Observe IEC 364 or CENELEC HD 384 or DIN VDE 0100 and IEC 664 or DIN/VDE 0110 and national accident prevention rules!).
For the purposes of these basic safety instructions, „skilled technical personnel“ means persons who are familiar with the installation, mounting, commissioning and operation of the product and have the qualifications needed for the performance of their functions.

2. Specified application
Drive converter are components which are intended for the installation in electric systems or machines.
In case of installation in machinery, commissioning of the drive converter (i.e. the starting of normal operation) is prohibited until the machinery has been proved to conform to the provisions of the directive 2006/42/EC (Machinery Directive). Account is to be taken of EN 60204.
The drive converters meet the requirements of the Low-Voltage Directive 2014/35/EC und EMV directive W14/30/EC. The relevant standards are listed in the Declaration of Conformity!
The technical data as well as information concerning the supply conditions shall be taken from the rating plate and from the documentation and shall be strictly observed.

3. Transport, storage
The instructions for transport, storage and proper use shall be complied with.
The climatic conditions shall be in conformity with prEN 50178.

4. Installation
The installation and cooling of the appliances shall be in accordance with the specifications in the pertinent documentation.
The drive converter shall be protected against excessive strains. In particular, no components must be bent or isolating distances altered in the course of transportation or handling. No contact shall be made with electronic components and contacts.
Drive converter contain electrostatic sensitive components which are liable to damage through improper use. Electric components must not be mechanically damaged or destroyed (potential health risks).

5. Electrical connection
When working on live drive converter, the applicable national accident prevention rules (e.g. VBG 4) must be complied with.
The electrical installation shall be carried out in accordance with the relevant requirements (e.g. cross-sectional areas of conductors, fusing, PE connection). For further information, see documentation.
Instructions for the installation in accordance with EMC requirements, like screening, earthing, location of filters and wiring, are contained in the drive converter documentation. They must always be complied with, also for drive converter bearing a CE marking. Observance of the limit values required by EMC law is the responsibility of the manufacturer of the installation or machine.

6. Operation
Installations which include drive converter shall be equipped with additional control and protective devices in accordance with the relevant applicable safety requirements, e.g. act respecting technical equipment, accident prevention rules etc.. Changes to the drive converter by means of the operating software are admissible.
After disconnection of the drive converter from the voltage supply, live appliance parts and power terminals must not be touched immediately because of possibly energized capacitors. In this respect, the corresponding signs and markings on the drive converter must be observed.
During operation, all covers and doors shall be kept closed.

7. Maintenance and servicing
The manufacturer’s documentation shall be followed.
KEEP SAFETY INSTRUCTIONS IN A SAFE PLACE!

2. Technical Data

2.1 Operating conditions

		Standard	Standard/ class	Instructions
Definition acc.		EN 61800-2		Inverter product standard: **rated specifications**
		EN 61800-5-1		Inverter product standard: **general safety**
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.
Ambient conditions during operation				
Climate	Temperature	EN 60721-3-3	3K3	extended to -10…45 °C (use frost protection for water cooling systems and temperatures below zero)
	Humidity		3K3	5…85 % (without condensation)
Mechanical	Vibration		3M1	
Contamination	Gas		3C2	
	Solids		3S2	
Ambient conditions during transport				
Climate	Temperature	EN 60721-3-2	2K3	Drain heat sink completely
	Humidity		2K3	(without condensation)
Mechanical	Vibration		2M1	
	Surge		2M1	max. 100 m/s²; 11 ms
Contamination	Gas		2C2	
	Solids		2S2	
Ambient conditions for the storage				
Climate	Temperature	EN 60721-3-1	1K4	Drain heat sink completely
	Humidity		1K3	(without condensation)
Mechanical	Vibration		1M1	
	Surge		1M1	max. 100 m/s²; 11 ms
Contamination	Gas		1C2	
	Solids		1S2	
Type of protection		EN 60529	IP20	
Environment		IEC 664-1		Pollution degree 2
Definition acc.		EN 61800-3		Inverter product standard: **EMC**
EMC emitted interference				
Cable-based interferences		–	C3 [1)]	Earlier limit value A (B optional) according to EN55011
Radiated interferences		–	C3	Earlier limit value according to EN55011
Interference immunity				
ESD		EN 61000-4-2	8 kV	AD (air discharge) and CD (contact discharge)
Burst - Ports for process measurement control lines and signal interfaces		EN 61000-4-4	2 kV	
Burst - power interfaces		EN 61000-4-4	4 kV	
Surge - power interfaces		EN 61000-4-5	1 / 2 kV	Phase-phase / phase-ground
Electromagnetic fields		EN 61000-4-3	10 V/m	
Cable-fed disturbances, induced by high frequency fields		EN 61000-4-6	10 V	0.15-80MHz
Voltage variation / voltage drop		EN 61000-2-1		+10 %, -15 %; 90 %
Voltage unsymmetries / Frequency changes		EN 61000-2-4		3 %; 2 %

Table 2: Operating conditions

Attention

1) This product can cause high frequency disturbances in residential areas (category c1) which require noise suppression measures.
2) Above 2000 m there is no "safe isolation" of the control.

2.2 Technical data of the 400 V class

Inverter size			28		29		30	31	32
Housing size			W						
Phases			3	2x3	3	2x3	2x3	2x3	2x3
Output rated power		[kVA]	256		319		395	436	492
Max. rated motor power		[kW]	200		250		315	355	400
Output rated current		[A]	370		460		570	630	710
Max. short time current	1)	[A]	463		575		713	787	887
OC-tripping current		[A]	555		690		855	945	1065
Input rated current		[A]	410	2x205	510	2x255	2x315	2x350	2x390
Max. permissible main fuse gG		[A]	550	2x315	700	2x400	2x450	2x550	2x550
Rated switching frequency	5)	[kHz]	2		2		2	2	2
Max. switching frequency	5)	[kHz]	4		2		2	2	2
Power loss at nominal operating		[W]	3500		4200		5100	5600	6400
Power loss at DC supply		[W]	2700		3250		3900	4300	4900
Standstill current at 4 kHz	2)	[A]			–		–	–	–
Min. frequency at continuous full load		[Hz]							
Max. heat sink temperature		[°C]	90		90		90	60 90	60 90
Motor cable cross-section	3)	[mm²]	2x95		2x150		2x185	2x185	2x240
Min. braking resistor	4)	[Ω]	1,2						
Max. braking current	4)	[A]	660						
Input rated voltage	5)	[V]	400 (UL: 480)						
Input voltage range U_{mains}		[V]	305…528 ±0						
Input voltage range at DC supply		[V]	420…746 ±0						
Mains frequency		[Hz]	50 / 60 ±2						
Output voltage	6)	[V]	3 x 0…U_{mains}						
Output frequency	5)	[Hz]	0 - max. 599						
Overload characteristic (see annex)			2						
Cooling mode (L=air; W=water)			W	L	W	L	W L	W L	W L	W L	W L	W L	W L
Ext. fan supply			–		–		–	– x	– x

Table 3: Technical data of the 400 V class

1) *With the regulated operating modes 5 % are to be subtracted as control reserve*
2) *Max. current before the OL2 function triggers (not in operating mode F5 GENERAL)*
3) *Recommended minimum cross section of the motor line for rated power and a cable length of upto 100 m (copper)*
4) *This data is only valid for units with internal brake transistor GTR 7 (see "unit identification")*
5) *The output frequency is to be limited in such way that 1/10 of the switching frequency is not exceeded.Units with higher max. output frequency are subject to export restrictions and are only available on request.*
6) *The voltage of the motor is depending on units which are connected upstream and on the control method (see „Calculation of the motor voltage“)*

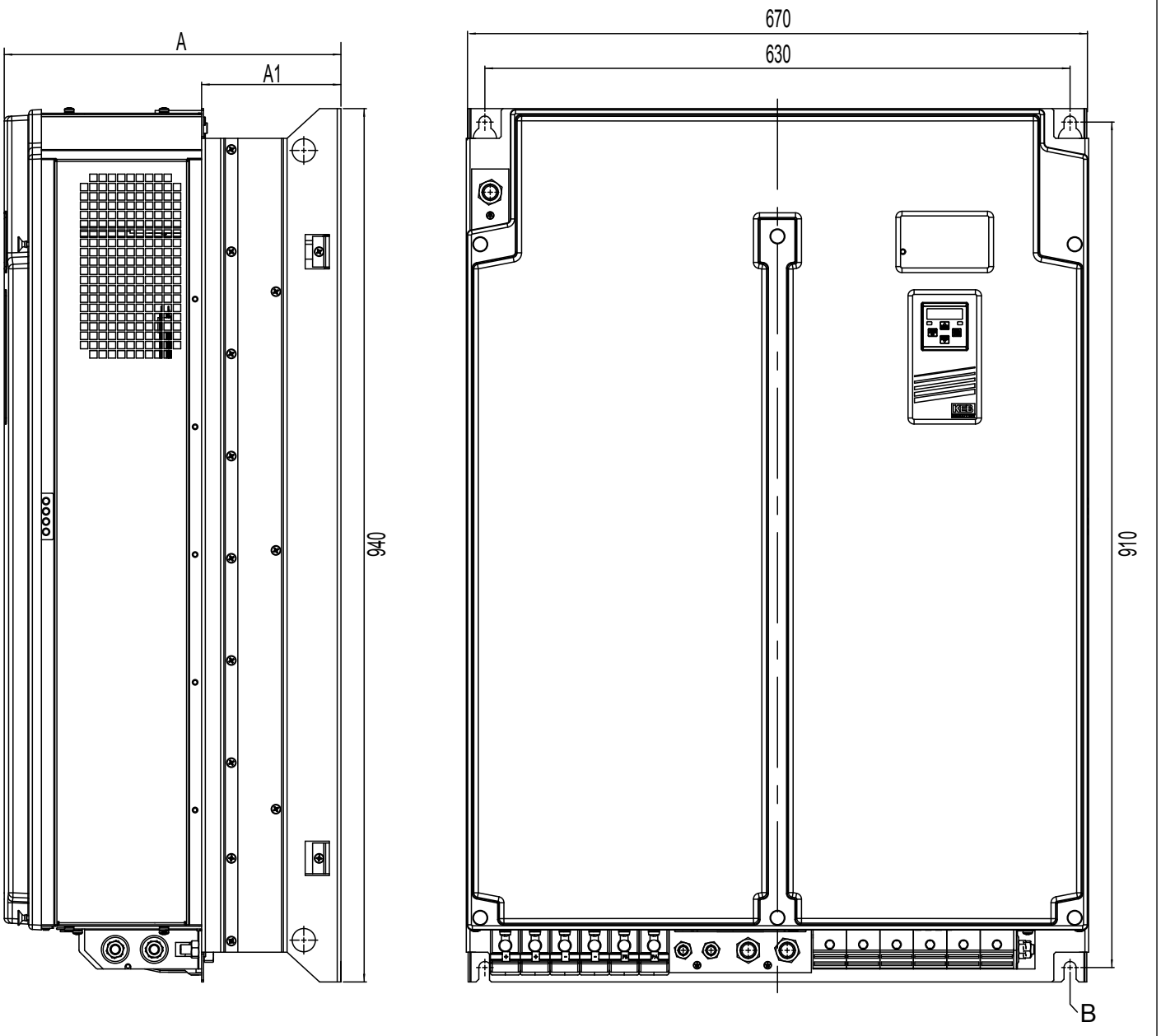
The technical data are for 2/4-pole standard motors. With other pole numbers the inverter must be dimensioned onto the motor rated current. Contact KEB for special or medium frequency motors.

Info Site altitude maximal 2000 m. With site altitudes over 1000 m a derating of 1 % per 100 m must be taken into consideration.

Attention An input choke is absolutely necessary.

2.3 Dimensions and weights

2.3.1 Heat sink with cooling fan (wall mounted version)

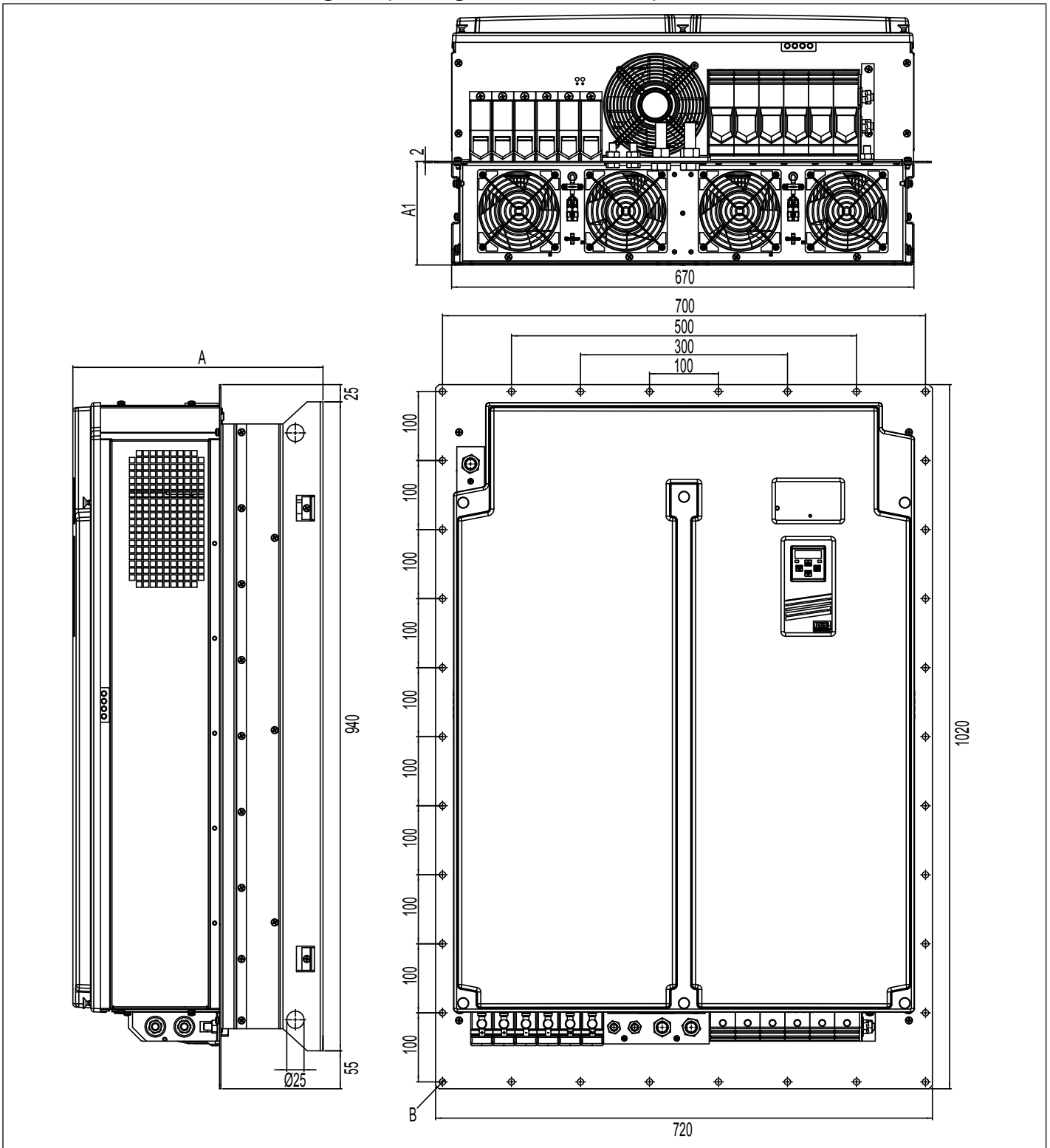


Housing type	A	A1	B	Weight
Standard with sub construction	368	155,5	Ø13	approx. 160 kg*
Standard with sub construction (heightened)	362,5	150	Ø13	

Figure 2: Heat sink with cooling fan (wall mounted version)

* The weight varies depending on the size, cooling and build version.

2.3.2 Heat sink with cooling fan (through-mount version)

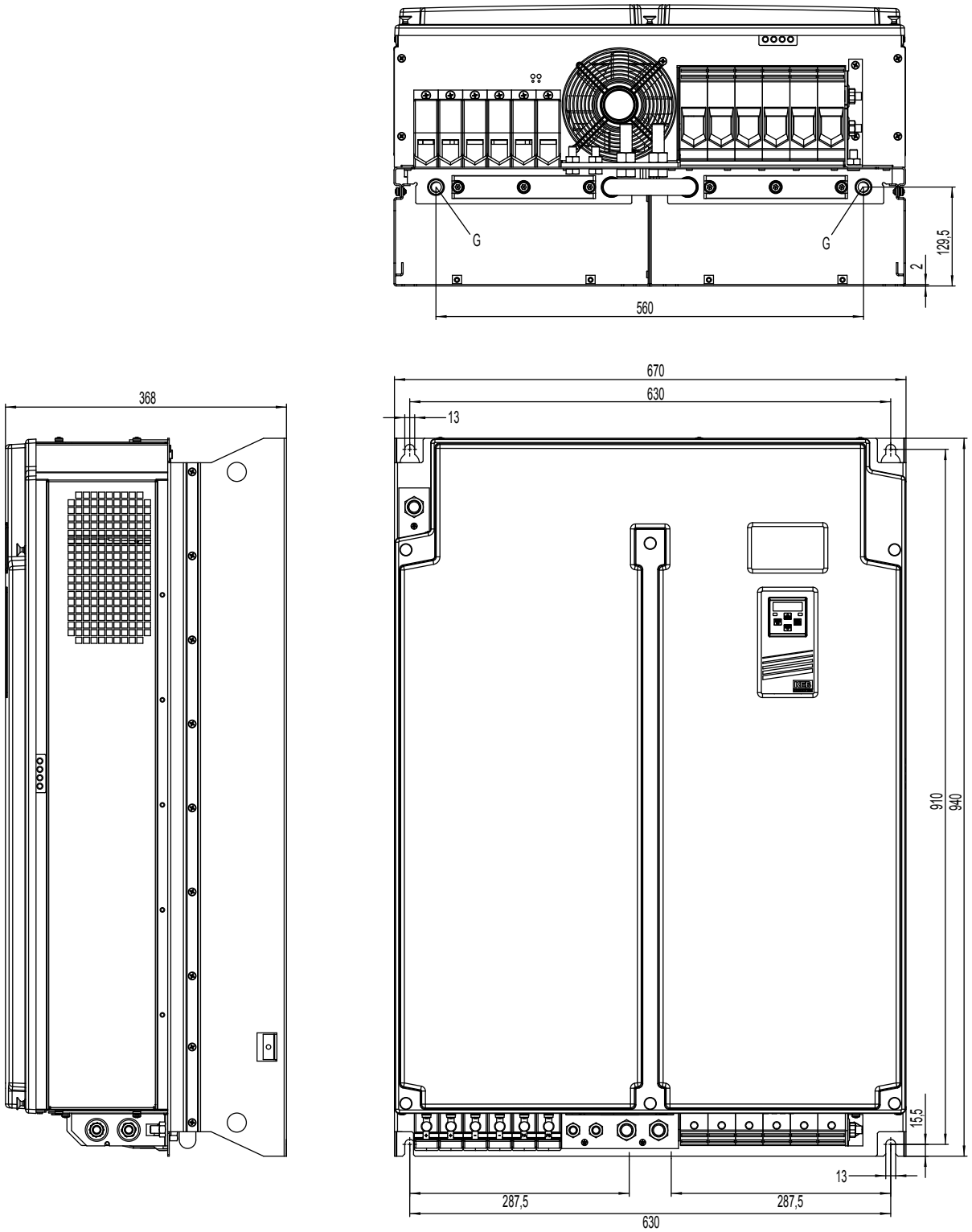


Housing type	A	A1	B	Weight
Through-mount version 2 fans (standard)	368	155,5	Ø 9	approx. 160 kg*
Through-mount version 4 fans (heightened)	362,5	150	Ø 9	

Figure 3: Heat sink with cooling fan (through-mount version)

* The weight varies depending on the size, cooling and build version.

2.3.3 Water-cooled inverter - wall mounted version

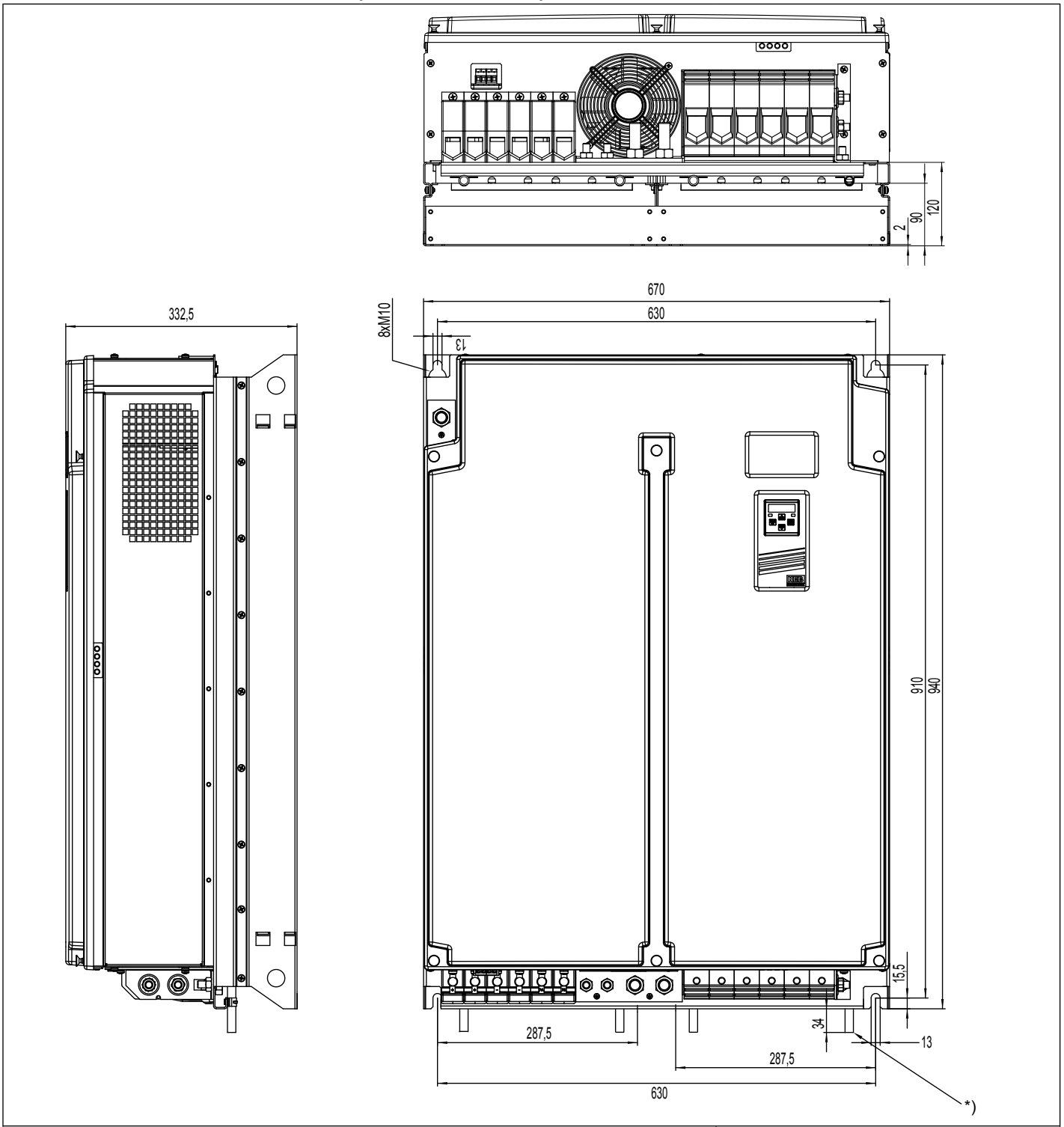


Housing type	G	Weight
Water-cooled heat sink	1/2“	approx. 160 kg*
Water-cooled heat sink with braking resistor	1/2“	

Figure 4: Water-cooled inverter - wall mounted version

* The weight varies depending on the size, cooling and build version.

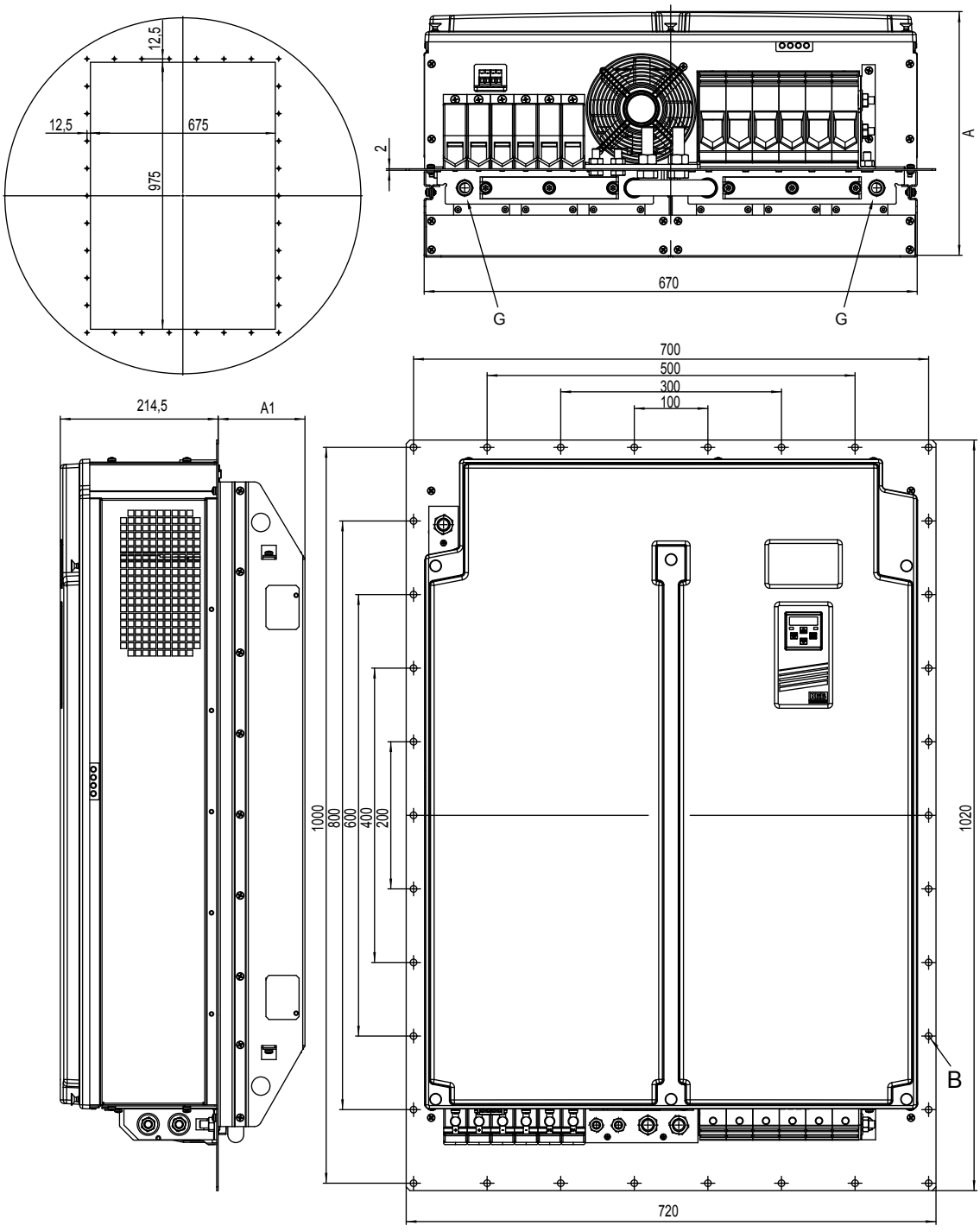
2.3.4 Water-cooled heat sink (second version)- mounted version



Housing type	Weight
Water-cooled heat sink with stainless steel tube	ca. 160 kg*
*) 4 x stainless steel tube 12 mm outside diameter. Connection with commercial cutting ring fittings. Interconnection in series starting from the left side.	
Figure 5: Water-cooled heat sink (second version)- mounted version	

* The weight varies depending on the size, cooling and build version.

2.3.5 Water-cooled inverter - through-mount version



Housing type	A	A1	B	G	Weight
Water-cooled heat sink	370	155,5	Ø 9	1/2“	approx. 160 kg*
Water-cooled heat sink with braking resistor	370	155,5	Ø 9	1/2“	
Water-cooled heat sink (heightened)	332,5	118	Ø 9	1/2“	
Water-cooled heat sink with braking resistor (heightened)	332,5	118	Ø 9	1/2“	

Figure 6: Water-cooled inverter - through-mount version

* The weight varies depending on the size, cooling and build version.

2.4 Terminal strips of the power circuit

Info	All terminal strips following the requirements of the EN 60947-7-1 (IEC 60947-7-1)

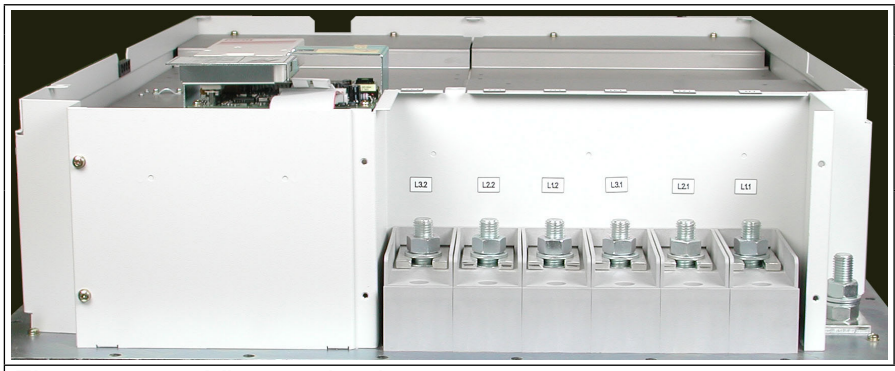
2.4.1 Mains input

The KEB COMBIVERT is dependent on the input rectifier suitable for 3-phase mains supply (B6-rectifier-circuit) or 6-phase (B12-rectifier-circuit). This can be recognized at the input terminals (see picture „Mains input“ und „Mains input 3-phase“).

The B12 rectifier circuit is connected to two 3-phase mains supply phase-shifted by 60 degrees. This effects a reduction of the net reactions at high power. In spite of the electric advantages and increased lifetime, this network configuration is not often realized because of high transformer costs. The DC link of the COMBIVERT with B12 rectifier circuit is dimensioned by such way that connection to a 3-phase mains supply is also possible. The different connection methods are described in chapter „Connection of the power unit“.

Info	All terminal strips following the requirements of the EN 60947-7-1 (IEC 60947-7-1)

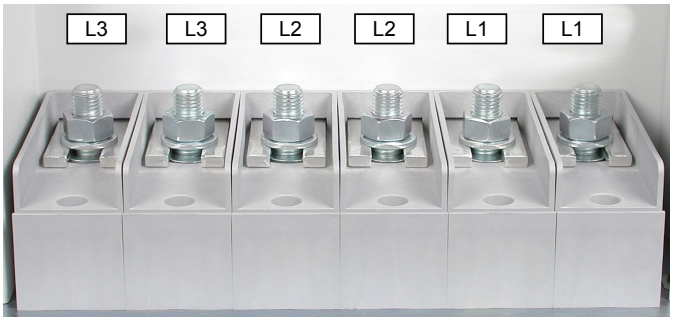
General information to realize a 6-phase mains supply. The voltage of the two mains supplies are electrically shifted by 60 degrees. The following transformers are used to realize such mains supply.		
One transformer with 2 secondary systems	or	Two transformers with one system each
Transformer connection D d0 y11		Transformer connection Y yn0
		Transformer connection Y d11
The primary star connection is selected at direct medium voltage supply. Transformer connections D y0 and D d11 are also used at 690V or 400V supply.		



Name	Function
X1A	Terminal strip mains input
⏚	Connection for protective earth conductor

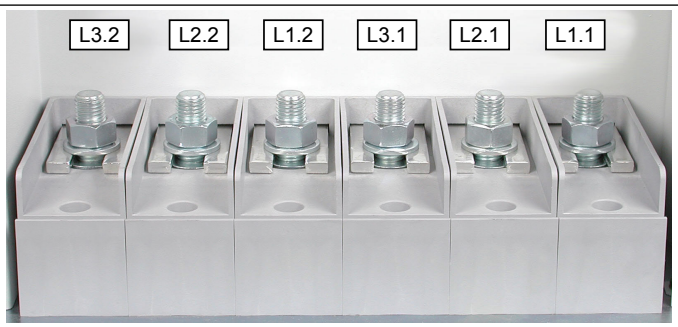
View to the mains input after remove of the cover and cover plate.

Figure 7: View mains input



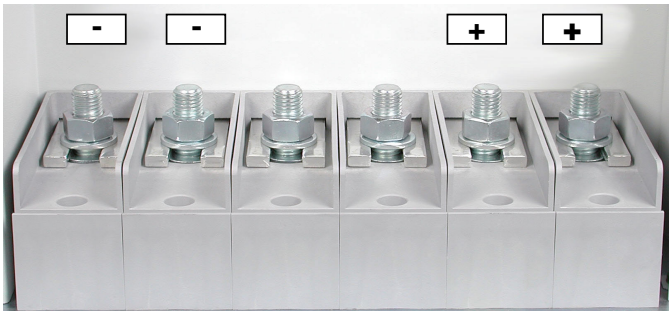
Name	Function
L1, L1	3-phase mains connection; the respective terminals are internal parallel connected
L2, L2	
L3, L3	
Stay bolt 16 mm for ring thimble; Tightening torque 25 Nm (220 lb inch)	
The supply cables must be parallel passed and connected with the respective cross section (see technical data).	

Figure 8: Mains input 3-phase (B6-rectifier)



Name	Function
L1.1, L1.2	6-phase or 2 x 3 phase mains connection
L2.1, L2.2	
L3.1, L3.2	
Stay bolt 16 mm for ring thimble; Tightening torque 25 Nm (220 lb inch)	

Figure 9: Mains input 3-phase (B6-rectifier)



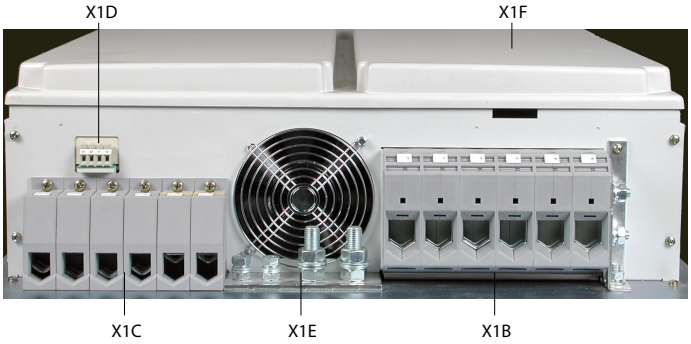
Name	Function
+, +	DC connection
–, –	! no precharging integrated !
Stay bolt 16 mm for ring thimble; Tightening torque 25 Nm (220 lb inch)	

Figure 10: Mains input DC without precharging

Name	Function
⏚	Connection for protective earth conductor
Stay bolt 16 mm for ring thimble; Tightening torque 50 Nm (440 lb inch)	

Figure 11: Protective earth conductor connection

2.4.2 Motor output



Name	Function
X1B	Motor terminal strip
X1C	DC link and braking resistor
X1D	Temperature and GTR monitoring
X1E	Connection for shielding
X1F	Connection for external fan power supply under the front cover (only size 31 and 32 air-cooled)

Figure 12: View motor output side

Name	Function	No.
U, U **V, V** **W, W**	3-phase motor connection	1
⏚	Connection for protective earth conductor	2

The motor lines must be parallel passed and connected with the respective cross section (see technical data).

Figure 13: Motor terminal strip X1B

Permissible cable cross-sections and tightening torques of the terminals

No.	permissible cross-section flexible with wire-end ferrule				Max. tightening torque	
	mm²		AWG/MCM		Nm	lb inch
	min	max	min	max		
1	70	240	00 AWG	500 MCM	25…30	221…265
2	16 mm stay bolt for ring thimble				50	440

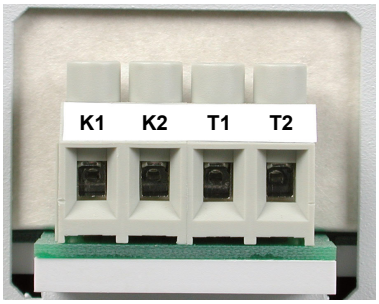
2.4.3 Other terminals

Name	Function	No.
+, +	Plus DC link Input/output (no precharging) Use supply input terminals at DC units!	**1**
–, –	Minus DC link	
PA, PB	Connection for braking resistor (only at internal braking resistor; see unit identification)	

Figure 14: Terminal strip for DC link and braking resistor X1C

Permissible cable cross-sections and tightening torques of the terminals

No.	permissible cross-section flexible with wire-end ferrule				Max. tightening torque	
	mm²		AWG/MCM		Nm	lb inch
	min	max	min	max		
1	50	150	0 AWG	300 MCM	25…30	221…265

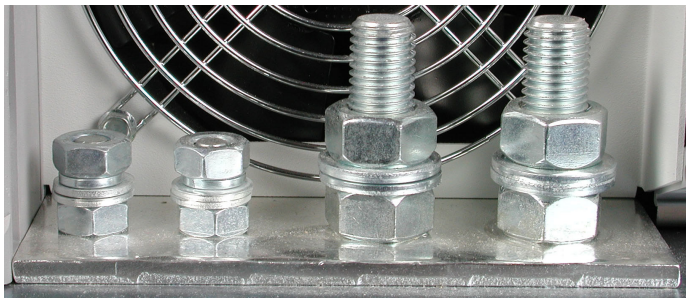


Name	Function	No.
K1, K2	Braking transistor monitoring (optional)	1
T1, T2	Connection for temperature monitoring (see chapter „Temperature detection T1, T2“)	

Figure 15: Terminal strip for temperature detection and braking transistor monitoring X1D

Permissible cable cross-sections and tightening torques of the terminals

No.	permissible cross-section flexible with wire-end ferrule				Max. tightening torque	
	mm²		AWG/MCM		Nm	lb inch
	min	max	min	max		
1	0,2	4	24 AWG	10 AWG	0,6	5

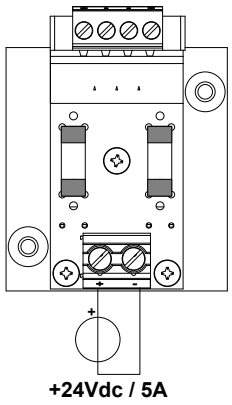


Name	Function	No.
⏚	Connection for shielding	1
	Connection for protective earth conductor	2

Figure 16: Connection for shielding and protective earth conductor X1E

Permissible cable cross-sections and tightening torques of the terminals

No.		Max. tightening torque	
		Nm	lb inch
1	10 mm stay bolt for ring thimble	25	220
2	16 mm stay bolt for ring thimble	50	440



Terminals	+, -
Voltage supply	24 V dc ±10 %
Current input	5 A
Spare fuses	3.15 A Type gG minimum 50 V

Figure 17: Terminal strip for external fan power supply X1F

Permissible cable cross-sections and tightening torques of the terminals

No.	permissible cross-section flexible with wire-end ferrule				Max. tightening torque	
	mm²		AWG/MCM		Nm	lb inch
	min	max	min	max		
1	0,2	4	24 AWG	10 AWG	0,6	5

2.5 Accessories

2.5.1 Filter and chokes

The following table describes the possible modes of connection, which results from COMBIVERT and phases.

Mode of connection	Inverter phases	Phases	Connection picture
3~ –> 3~	3-phase (B6 rectifier)	3-phase	1
6~ –> 3~	6-phase (B12 rectifier)	3-phase	2
6~ –> 6~	6-phase (B12 rectifier)	6-phase	3

Table displays the accessories for a complete interference suppression dependent on the mode of connection. The assembly kit for the complete interference suppression contains filter and mains choke(s). The motor choke must be ordered separately.

Size	Mode of connection	Filter	Mains choke 50 Hz / 4 % Uk	Motor choke 100 Hz / 4 % Uk
28	3~ –> 3~	28E4T60-1001	28Z1B04-1000	2x25Z1F04-1010
	6~ –> 3~	2x25E4T60-1001	2x24Z1B04-1000	
	6~ –> 6~			
29	3~ –> 3~	30E4T60-1001	29Z1B04-1000	2x26Z1F04-1010
	6~ –> 3~	2x25E4T60-1001	2x26Z1B04-1000	
	6~ –> 6~			
30	6~ –> 3~	30E4T60-1001	2x27Z1B04-1000	2x27Z1F04-1010
	6~ –> 6~	2x26E4T60-1001		
31	6~ –> 3~	32E4T60-1001	2x28Z1B04-1000	2x27Z1F04-1010
	6~ –> 6~	2x28E4T60-1001		
32	6~ –> 3~	32E4T60-1001	2x28Z1B04-1000	2x28Z1F04-1010
	6~ –> 6~	2x28E4T60-1001		

Table 4: Connection accessories

Attention With the use of motor chokes the maximum motor line length of 80 m must not be exceeded.

2.6 Connection Power Unit

2.6.1 Mains and motor connection

Caution Exchanging mains and motor connection leads to immediate destruction of the unit.

Attention Pay attention to the supply voltage and the correct polarity of the motor !

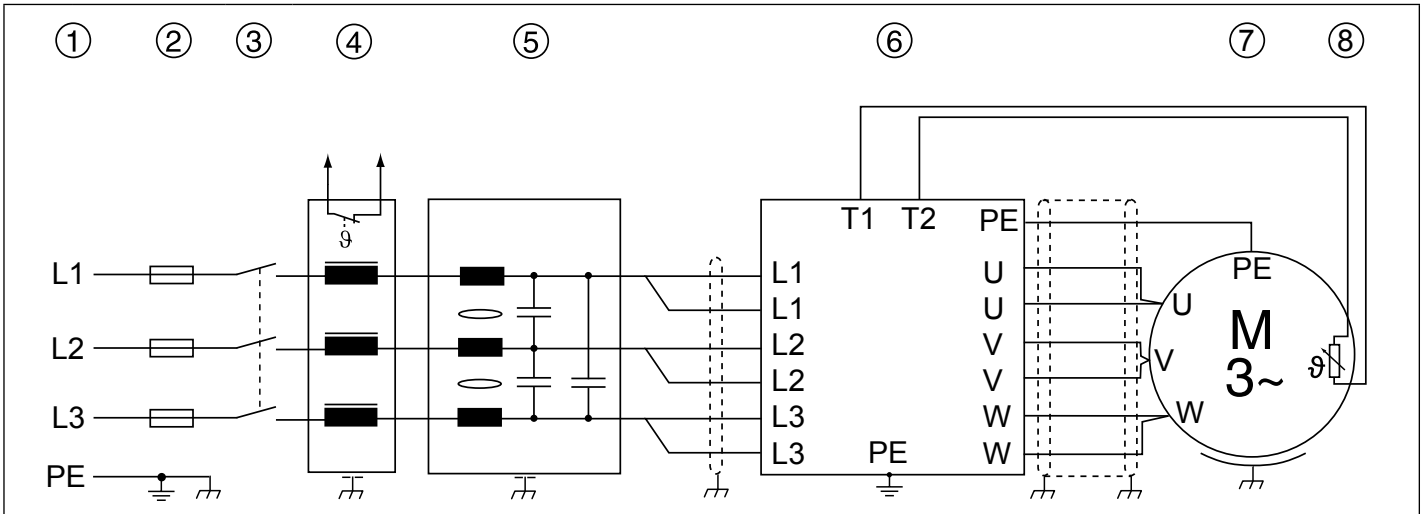


Figure 18: 3-phase COMBIVERT at 3-phase mains

Legend		
	1	Mains supply 3-phase
	2	Mains fuse
	3	Mains contactor
	4	Mains choke (connection of the temperature detection optional)
	5	HF filter
	6	KEB COMBIVERT F5/F6 with 3-phase mains input
	7	Motor (see „Connection of the motor“)
	8	Motor protection temperature sensor (see „temperature detection T1, T2“)

Attention **Overload of mains chokes**

The temperature detection of both mains chokes must be integrated in the opening circuit in order to avoid overload of the chokes in error case.

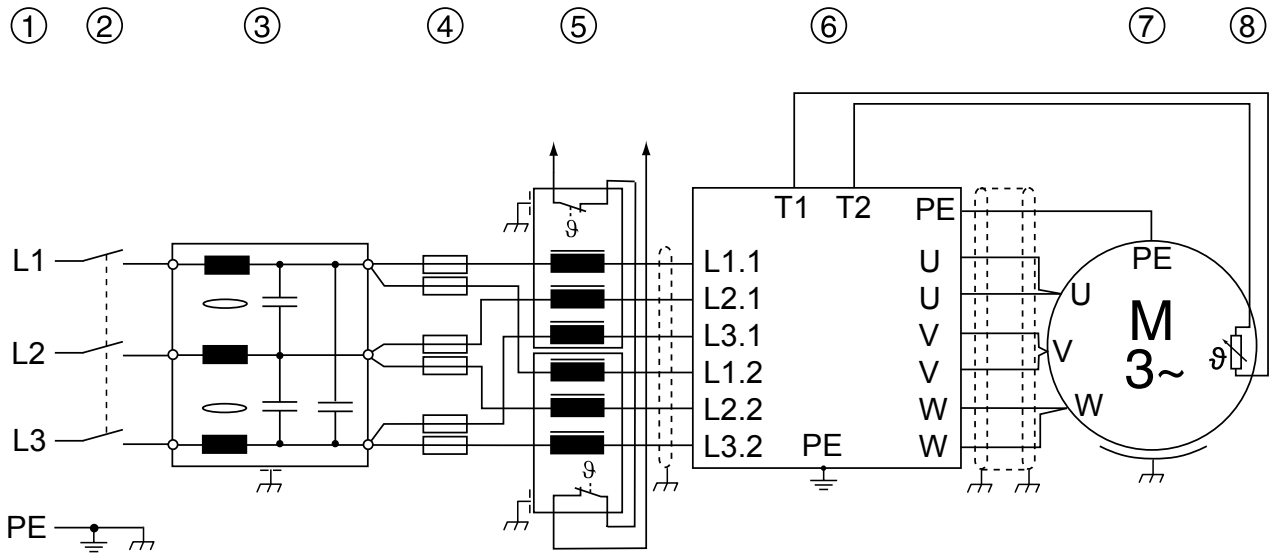


Figure 19: 6-phase COMBIVERT at 3-phase mains

Legend		
	1	Mains supply 3-phase
	2	Mains contactor
	3	HF filter
	4	Mains fuse
	5	Mains choke
	6	KEB COMBIVERT F5/F6 with 6-phase mains input
	7	Motor (see „Connection of the motor“)
	8	Motor protection temperature sensor (see „temperature detection T1, T2“)

Attention **Overload of mains chokes**

The temperature detection of both mains chokes must be integrated in the opening circuit in order to avoid overload of the chokes in error case.

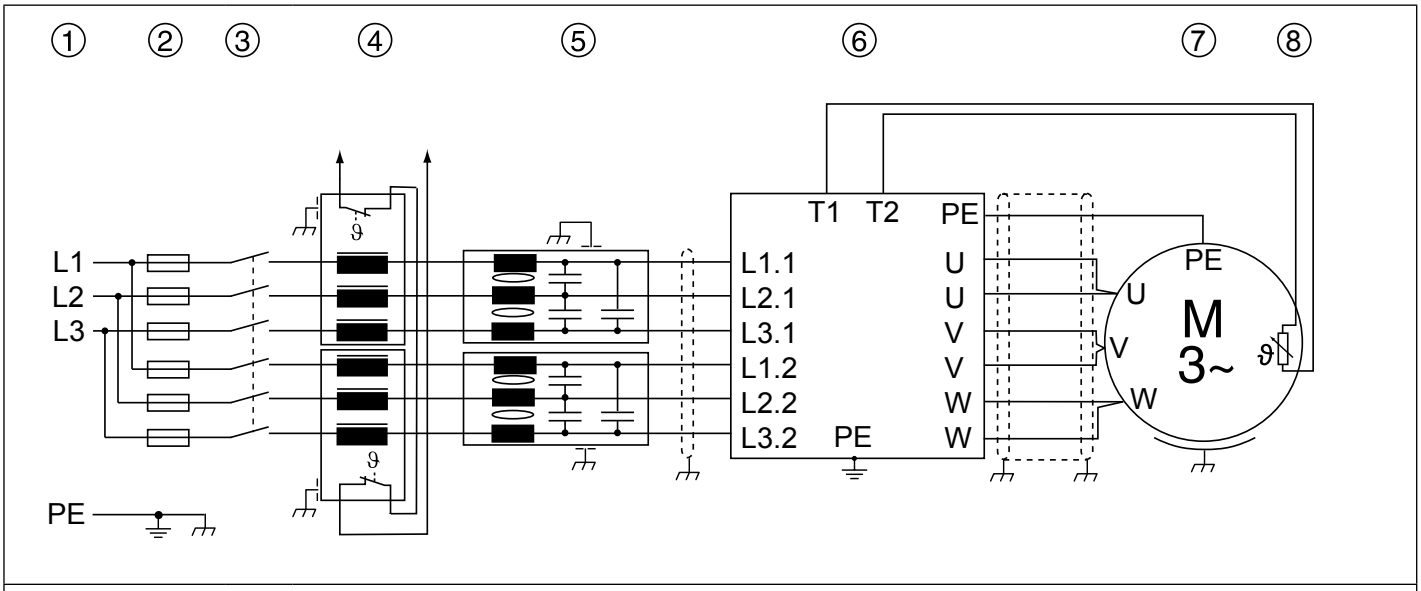


Figure 20: 6-phase COMBIVERT at 3-phase mains

Legend	1	Mains supply 3-phase
	2	Mains fuse
	3	Mains contactor
	4	Mains choke
	5	HF filter
	6	KEB COMBIVERT F5/F6 with 6-phase mains input
	7	Motor (see „Connection of the motor“)
	8	Motor protection temperature sensor (see „temperature detection T1, T2“)

Attention **Overload of mains chokes**

The temperature detection of both mains chokes must be integrated in the opening circuit in order to avoid overload of the chokes in error case.

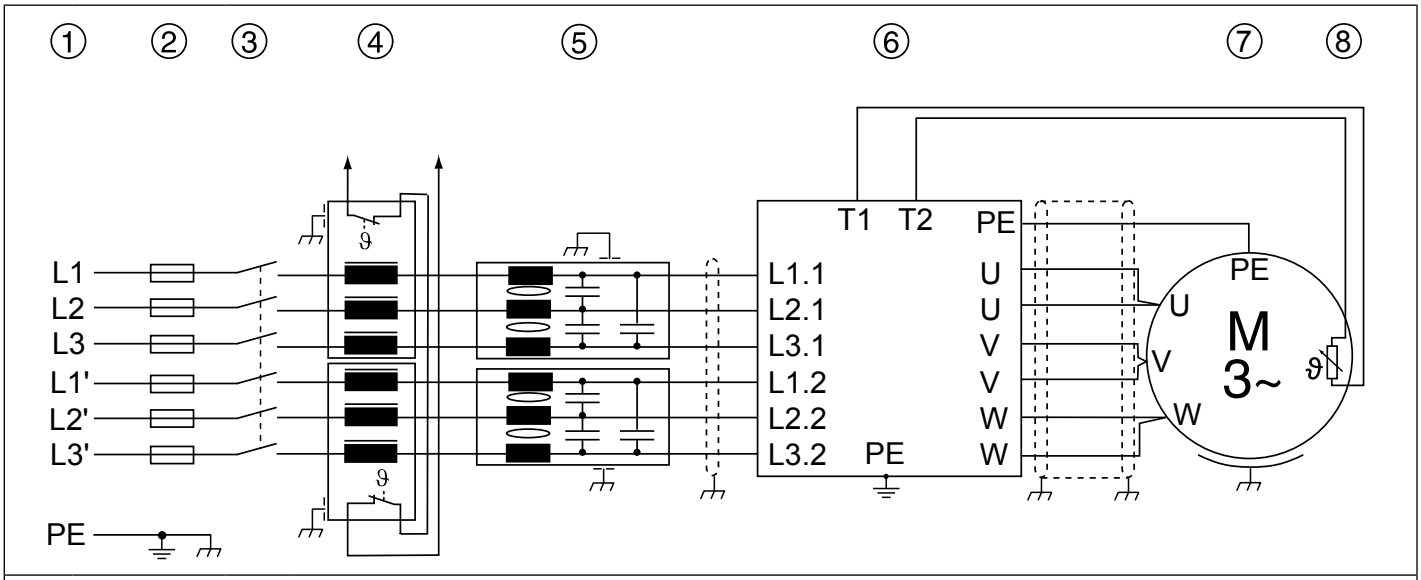


Figure 21: 6-phase COMBIVERT at 6-phase mains

Legend	1	Mains supply 6-phase (neutral point Yn earthing)
	2	Mains fuse
	3	Mains contactor
	4	Mains choke
	5	HF filter
	6	KEB COMBIVERT F5/F6 with 6-phase mains input
	7	Motor (see „Connection of the motor“)
	8	Motor protection temperature sensor (see „temperature detection T1, T2“)

Attention **Overload of mains chokes**

The temperature detection of both mains chokes must be integrated in the opening circuit in order to avoid overload of the chokes in error case.

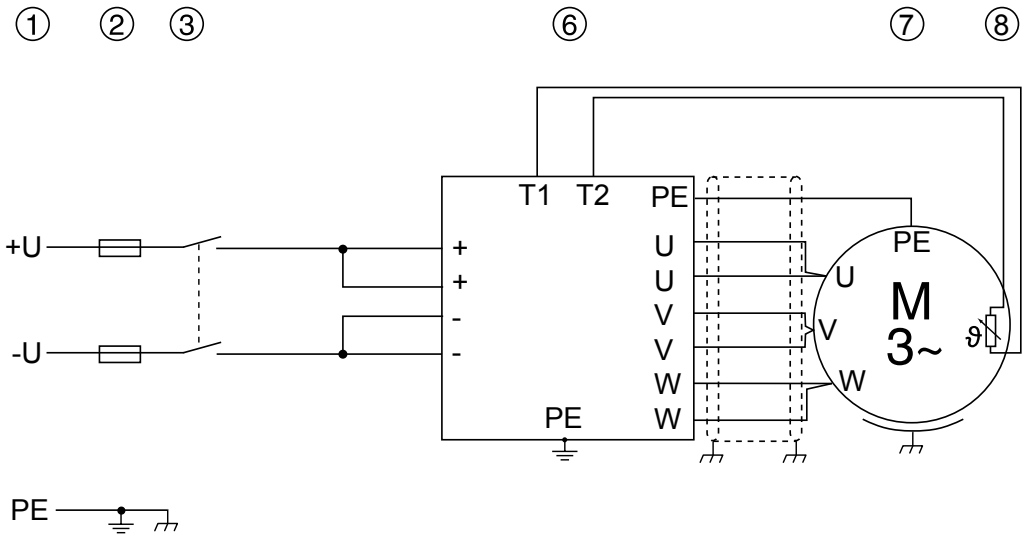


Figure 22: COMBIVERT at DC mains

Legend		
	1	DC supply
	2	DC fuses
	3	Main contactor
	6	KEB COMBIVERT F5/F6 with DC input
	7	Motor (see „Connection of the motor“)
	8	Motor protection temperature sensor (see „temperature detection T1, T2“)

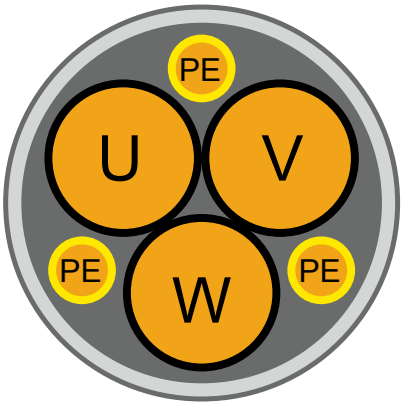
Attention **Overload of mains chokes**

The temperature detection of both mains chokes must be integrated in the opening circuit in order to avoid overload of the chokes in error case.

2.6.2 Selection of the motor cable

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

- lower abrasion of the motor bearings by leakage currents
- improved EMC characteristics
- lower symmetrical operating capacities
- less losses by transient currents



It is recommended to use symmetric shielded motor cables at high motor ratings (>30 kW). At these cables the protective earth conductor is tripartited and uniformly placed between the phase lines.
A cable without protective earth conductor can be used if the local regulations allow this. Then this protective earth conductor must be placed externally. Certain cables accept also the shielding as protective earth conductor.
Pay attention to the data of the cable manufacturer!

Figure 23: Cross section of a shielded motor cable with tripartited protective earth conductor

2.6.3 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
see picture Motor connection in delta connection	see picture Motor connection in star connection	see picture Motor connection in delta connection	see picture Motor connection in star connection

Table 5: Connection of the motor

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

Attention **Protect motor against voltage peaks!**

Inverters switch with dv/dt of approx. 5kV/µs at the output. Voltage peaks at the motor which endanger the insulation system can occur especially in case of long motor lines (> 15 m).
A motor choke, a dv/dt-filter or sine-wave filter can be used for protection of the motor.

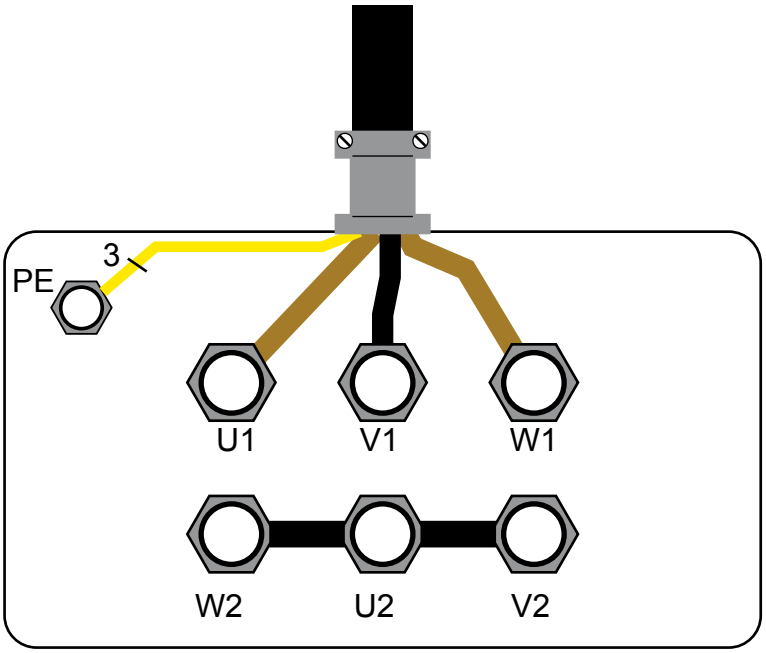


Figure 24: Motor connection in star connection

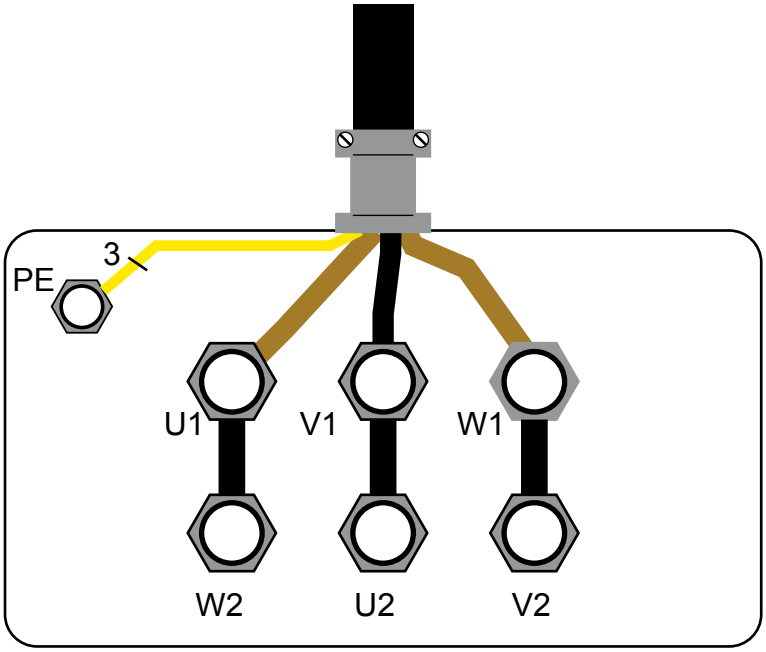


Figure 25: Motor connection in delta connection

2.6.4 Temperature detection T1, T2

Parameter In.17 displays in high byte the installed temperature input of the inverter. As a standard the KEB COMBIVERT F5/F6 is delivered with switchable KTY84/PTC evaluation. The desired function is adjusted with Pn.72 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]
0xh	PTC (in accordance with DIN EN 60947-8)	–	< 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
5xh	KTY84 (standard)	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 (in accordance with DIN 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	–	on inquiry		

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).

Table 6: Temperature detection T1, T2

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

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

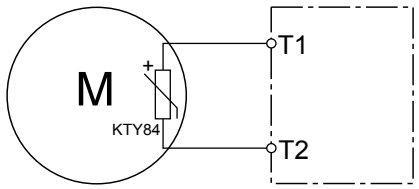
Function	Mode (F5 → Pn.72; F6 → dr33)
Motor temperature display and monitoring	KTY84
Motor temperature monitoring	PTC
Temperature control of water-cooled motors [1]	KTY84
General fault sensing	PTC

1) If the temperature input is used for other functions, the motor temperature control at water-cooled inverters can be done indirectly via the water cooling circuit of the inverter.

Attention KTY or PTC cable

- 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!

2.6.4.1 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 26: Connection of a KTY sensor

Attention KTY sensors may not be combined with other devices. Otherwise wrong measurements would be the consequence.

Info Temperature Control

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

2.6.4.2 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 (see „temperature detection T1, T2“).This can be:

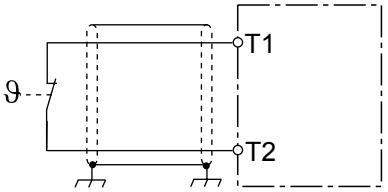
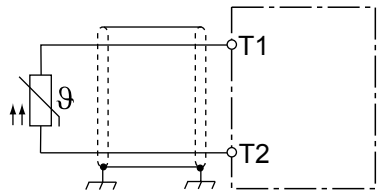
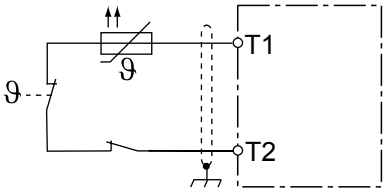
Thermal contact (NC contact)	
Temperature sensor (PTC)	
Mixed sensor chain	

Figure 27: Wiring example in PTC mode

The function can be switched off with Pn.12 = “7“ (CP.28) (standard at F5-General) if no evaluation of the input is desired. Alternatively a bridge can be installed between T1 and T2.

2.6.5 Connection of a braking resistor

Attention **Contact and fire protection**

Braking resistors dissipate the produced energy of the motor into heat during generatoric operation. Thus braking resistors can cause very high surface temperatures. During assembly pay attention to appropriate protection against contact and fire.

Info **Regenerative unit**

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

Caution The mains voltage must always be switched off in order to guarantee fire protection in case of a defective braking transistor.

Caution **at regenerative operation**

The frequency inverter remains in operation in spite of switched off power supply in generatoric operation. An error must be released by external wiring which switches the modulation off in the inverter if no GTR7 evaluation is installed (GTR7 evaluation only at water-cooled units). This can occur e.g. at terminals T1/T2 or via digital input. The frequency inverter must be programmed accordingly in each case.

2.6.5.1 Braking resistor without temperature monitoring

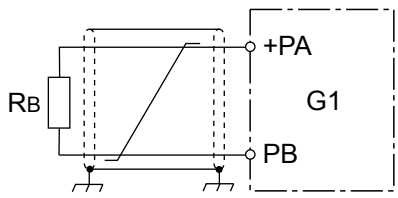


Figure 28: Intrinsically safe braking resistor without temperature monitoring

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

2.6.5.2 Braking resistor with over-heat protection and GTR7 monitoring (water-cooled)

This circuit offers a direct protection with defective GTR7 (braking transistor). At defective braking transistor an integrated relay opens the terminals K1/K2 and error „E.Pu“ is released. Terminals K1/K2 are integrated that into the holding circuit of the input contactor, so the input voltage is switched off in error case. Regenerative operation is also secured by the internal fault disconnection. All other errors of the braking resistor and the input choke are intercepted via a digital input. The input must be programmed to "external error".

Info **Terminals T1/T2 and example picture**
If the PTC/KTY evaluation of the motor at terminals T1/T2 is not used, these terminals can be used instead of the programmable input. The temperature input must be operated in PTC mode (see "Use of the temperature input in PTC mode").
The picture below is only an example and has to be adapted according to the application.

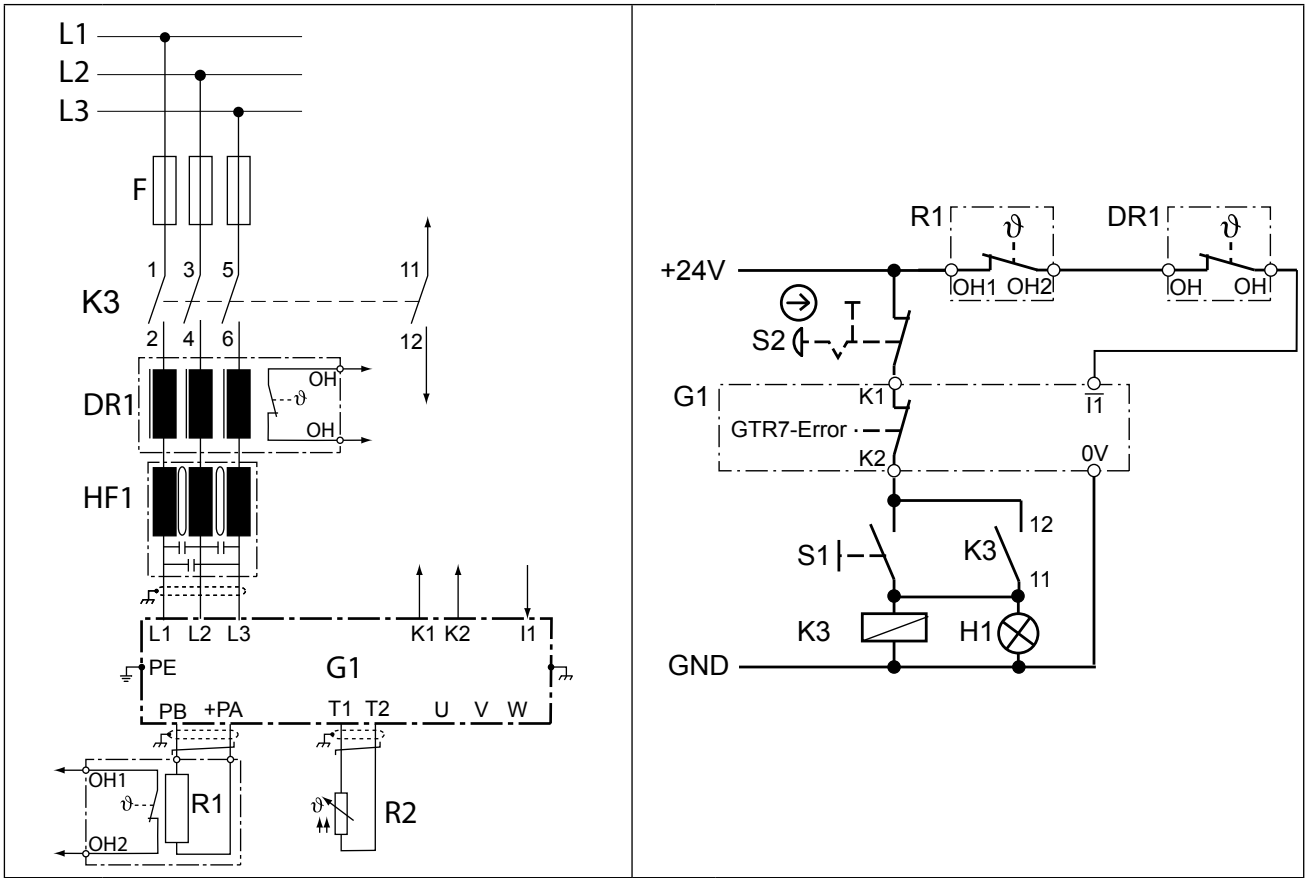


Figure 29: Braking resistor with over-heat protection and GTR7 monitoring

K3	Line contactor with auxiliary contacts	R1	Braking resistor with temperature switch
S1	Key for switch on	R2	PTC or KTY84 sensor e.g. of the motor
S2	Emergency stop circuit braker for switch off	DR1	Mains choke with temperature switch (optional)
H1	Tripping control	HF1	HF filter
G1	Inverter with GTR7 evaluation (relay 30 V DC/ 1A) and programmable input I1		

2.6.5.3 Braking resistor with over-heat protection and GTR7 monitoring (air-cooled)

This circuit offers a direct protection with defective GTR7 (braking transistor). The braking resistor overheats and opens the OH terminals with defective GTR7. The OH terminals open the holding circuit of that the input contactor, so that the input voltage is switched off in error case. An error in inverter is released by opening the auxiliary contacts of K3. Regenerative operation is also secured by the internal fault disconnection. The input must be programmed and inverted to "external error". Automatic restarting after cooling of the braking resistor is prevented by the self-holding circuit of K3.

Info **Terminals T1/T2 and example picture**

If the PTC/KTY evaluation of the motor at terminals T1/T2 is not used, these terminals can be used instead of the programmable input. The temperature input must be operated in PTC mode (see "Use of the temperature input in PTC mode").

The picture below is only an example and has to be adapted according to the application.

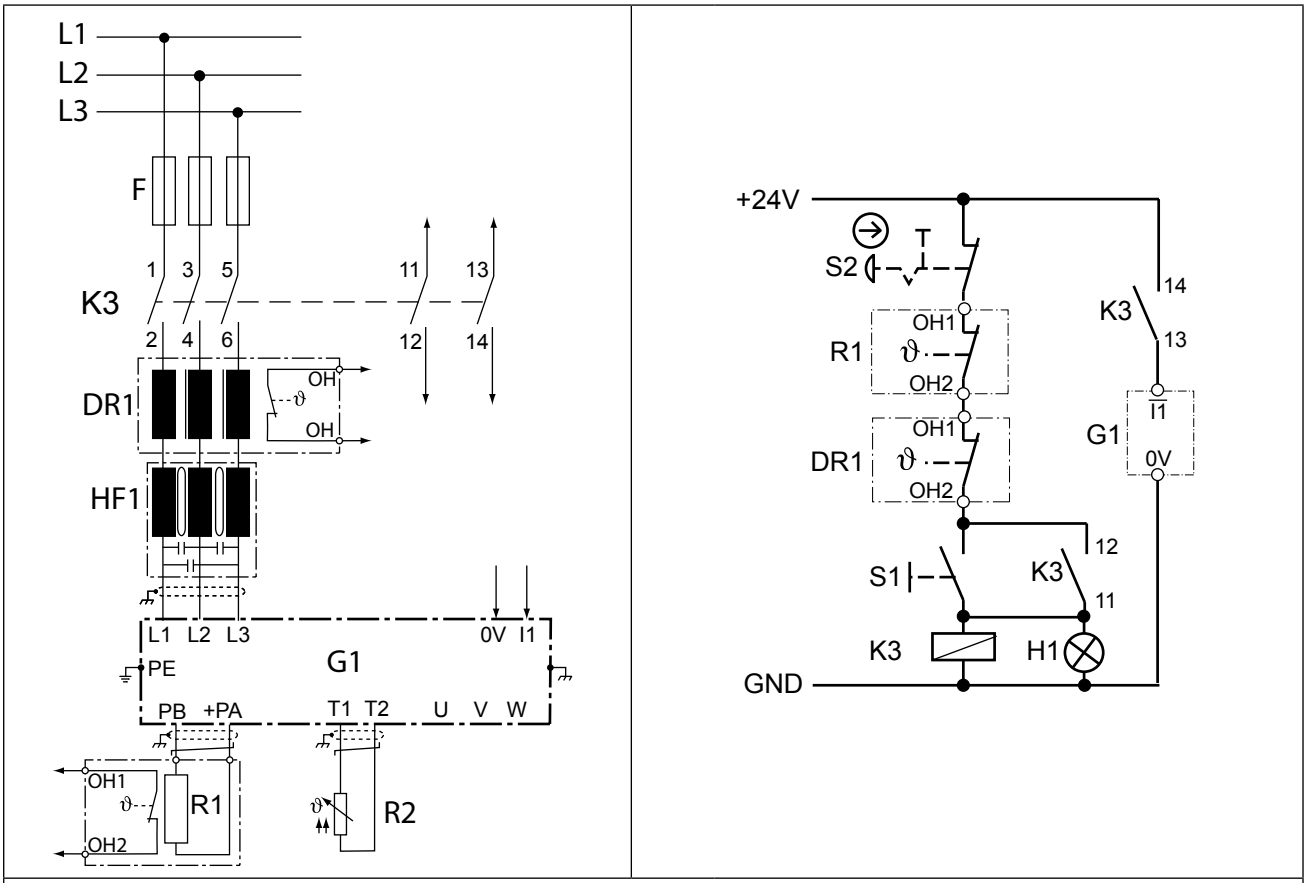
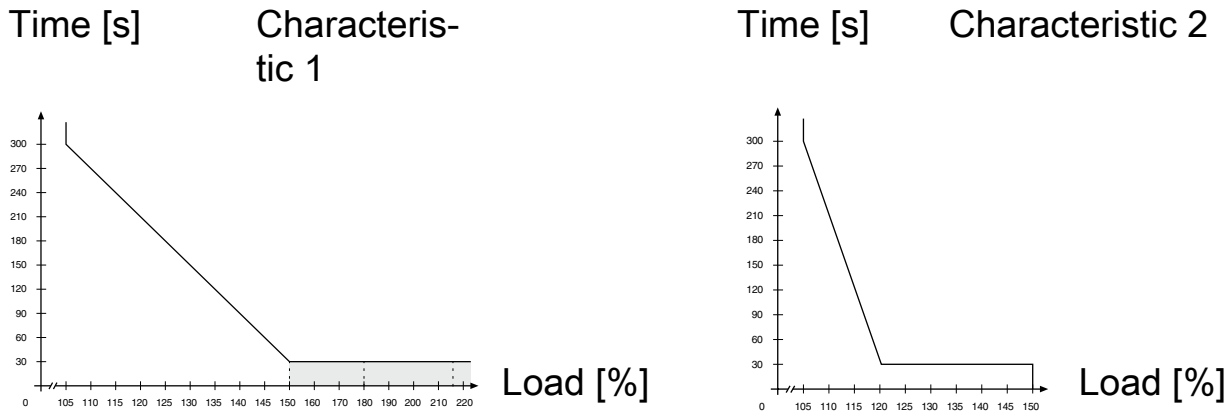


Figure 30: Braking resistor with over-heat protection without GTR7 monitoring

K3	Line contactor with auxiliary contacts	R1	Braking resistor with temperature switch
S1	Key for switch on	R2	PTC/KTY84 sensor e.g. of the motor
S2	Emergency stop circuit braker for switch off	DR1	Mains choke with temperature switch (optional)
H1	Tripping control	HF1	HF filter
G1	Inverter with programmable input I1		

A. Annex A

A.1 Overload characteristic



The characteristic declines device-dependently in this range (see unit identification).

Figure 31: 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 inverter, the error E.OL is triggered.

A.2 Overload protection in the lower speed range

(only operating mode MULTI and SERVO)

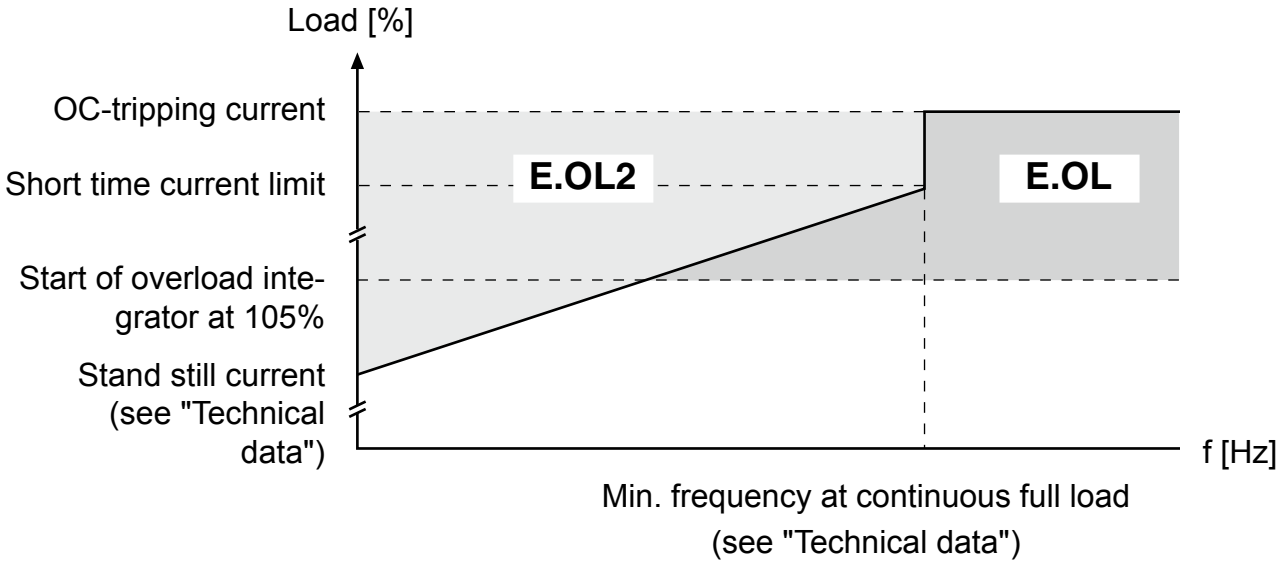


Figure 32: Overload protection in the lower speed range

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

A.3 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:

Mains choke Uk	4 %	Example:
Inverter open loop	4 %	Closed loop inverter with mains- and motor choke at non-rigid supply system: 400 V mains voltage - 15 % = 340 V motor voltage
Inverter closed loop	8 %	
Motor choke Uk	1 %	
Non-rigid supply system	2 %	

Table 7: Calculation of the motor voltage

A.4 Maintenance

All work may only be done by qualified personnel. The security must be ensured as follows:

- Disconnect power supply at MCCB
- Secure against restarting
- Await discharge time of capacitors (if necessary controlling by measurement at „+PA“ and „-“, respectively “++“ and „--“)
- Ensure loss of voltage by measurement

In order to avoid premature ageing and avoidable malfunctions, the measures mentioned below must be carried out in the appropriate cycle.

Cycle	Function
Constant	Pay attention to unusual noises of the motor (e.g. vibrations) as well as of the frequency inverter (e.g. fan).
	Pay attention to unusual smells of the motor or frequency inverter (e.g. evaporation of capacitor electrolyte, braise of the motor winding)
Monthly	Check unit for loose screws and plugs and if necessary tighten up.
	Clean frequency inverter 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.
	Examine function of the fans of the KEB COMBIVERT. The fans must be replaced in case of audible vibrations or squeak.
Annual	Check the connecting ducts for corrosion and change it if necessary for units with water cooling.

Table 8: Maintenance

A.5 Storage

The DC link of the KEB COMBIVERT is equipped with electrolytic capacitors. If the electrolytic aluminium capacitors are stored de-energized, the internal oxide layer is removed slowly. Due to the leakage current the oxide layer is unrenewed. If the capacitor starts running with rated voltage there is a high leakage current which can destroy the capacitor.

In order to avoid defectives, the KEB COMBIVERT must be started up depending on the storage period in accordance with the following specification:

Storage period < 1 year			
• Start-up without special measures			
Storage period 1…2 years			
• Operate frequency inverter one hour without modulation			
Storage period 2…3 years			
• Remove all cables from the power circuit; especially of braking resistor or module			
• Open control release			
• Connect variable transformer to inverter input			
• Increase variable transformer slowly to indicated input voltage (>1 min) and remain at least on the specified time.			
	Voltage class	Input voltage	Residence time
	400 V	0…280 V	15 min
		280…400 V	15 min
		400…500 V	1 h
Storage period > 3 years			
• Input voltages as before, however double the times per year. Eventually change capacitors.			

Table 9: Storage

After expiration of this start-up the KEB COMBIVERT can be operated on nominal rating conditions or delivered to a new storage.

A.5.1 Cooling circuit

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.

B. Annex B

B.1 Certification

B.1.1 CE Marking

CE marked frequency inverter and servo drives were developed and manufactured to comply with the regulations of the Low-Voltage Directive 2006/95/EC.

The inverter or servo drive must not be started until it is determined that the installation complies with the Machine directive (2006/42/EC) as well as the EMC-directive (2004/108/EC) (note EN 60204).

The frequency inverters and servo drives meet the requirements of the Low-Voltage Directive 2006/95/EC. The harmonized standards of the series EN 61800-5-1 in connection with EN 60439-1 and EN 60146 were used.

This is a product of limited availability in accordance with IEC 61800-3. This product may cause radio interference in residential areas. In this case the operator may need to take corresponding measures.

B.1.2 UL Marking

c UL US	Acceptance according to UL is marked at KEB inverters with the adjacent logo on the type plate.

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):

- Control Board Rating (max. 30Vdc, 1A)
- „Maximum Surrounding Air Temperature 45°C“
- Degree of Overload Protection provided internally by the Drive, in percent of full load current.
- Motor protection by adjustment of inverter parameters. For adjustement see application manual parameters Pn.14 and Pn.15.
- Short Circuit rating and fuse type/circuit breaker and size: See page 8A for detailed marking requirements.
- Wiring Terminals marked to indicate proper connections for the power supply, load and control circuit.
- „Use 75°C Copper Conductors Only“
- Motor Output and Motor Thermal Protection Terminals - Torque Value for Field Wiring Terminals, the value to be according to the R/C Terminal Block used.
- Input Terminals - „Input Stud and Nut shall be connected with UL Listed Ring Connectors (ZMVV) rated 600 V and suitable ampere rating (min. 125% of Input Current)“. The Torque Value of the Nuts to be 25 Nm.
- Ground Terminals - „Ground Stud and Nut shall be connected with UL Listed Ring Connectors (ZMVV) rated suitable“. The Torque Value of the Nuts to be 25 Nm.
- ”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“
- Intended for use in pollution degree 2 environment.

Short Circuit rating and Branch Circuit Protection:

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 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 inverters F5/F6 – W – housing:

a) UL 248 Fuses; Class RK5 or J as specified below

Inverter F5 or F6	Input Voltage [V]	UL 248 Fuse Class RK5, J max [A]
28	480 / 3ph	400
29	480 / 3ph	500
30	480 / 1x 3ph	600
	480 / 2x 3ph	2 x 315
31	480 / 2x 3ph	2 x 350
32	480 / 2x 3ph	2 x 400

See Figure 22.

b) UL 489 Circuit Breaker

Inverter F5 or F6	Input Voltage [V]	UL 489 MCCB max [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
30	480 / 2x 3ph	2 x 400	2x 3VL400/JG-frame
31	480 / 2x 3ph	2 x 400	2x 3VL400/JG-frame
32	480 / 2x 3ph	2 x 400	2x 3VL400/JG-frame

See Figure 22.

C. Annex C

C.1 Installation of water-cooled units

In continuous operation water-cooled inverters are operated with lower temperature than air-cooled inverters. 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 water-cooled KEB COMBIVERT frequency inverters is offered in the drive technology, because there are process-caused coolants available with some applications. The following instructions must be observed absolutely when this units are used.

C.1.1 Heat sink and operating pressure

Design system	Material (voltage)	Max. operating pressure	Connecting duct
Extrusion casting heat sink	Aluminium (-1.67 V)	10 bar	00.00.650-G140

Table 10: Heat sink and operating pressure

The heat sinks are sealed with sealing rings and posses a surface protection (anodized) even in the ducts.

Caution **Deformation of the heat sink**

In order to avoid a deformation of the heat sink and the damages involved, the indicated max. operating pressure may not be exceeded briefly also by pressure peaks. Pay attention to the guidelines 97/23/EG of pressure units.

C.1.2 Materials in the cooling cicuit

For the screw connections and also for the metallic articles in the cooling circuit which are in contact with the coolant (electrolyte) a material is to be selected, which forms a small voltage difference to the heat sink in order to avoid contact corrosion and/or pitting corrosion (electro-chemical voltage series, see table "Electro-chemical voltage series"). An aluminum screw connection or ZnNi coated steel screw connection is recommended. 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.

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

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

Electro-chemical voltage series / standard potentials against hydrogen					
Material	generated Ion	Standard potential	Material	generated Ion	Standard potential
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 11: Materials in the cooling cicuit					

C.1.3 Requirements on the coolant

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

Standards	TrinkwV 2001, DIN EN 12502 part 1-5, DIN 50930 part 6, DVGW work sheet W216
VGB Cooling water directive	The VGB cooling water directive (VGB-R 455 P) contains instructions about common process technology of the cooling. Particulary the interactions between cooling water and components of the cooling system are described.
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	Cooling water may not cause scale deposits or loose excretions. It shall have a low total hardness (<20°d) especially carbon hardness.
Soft water	Soft water (<7°dH) corrodes the material.
Frost protection	An appropriate antifreeze must be used for applications when the heat sink or the coolant is exposed temperatures below zero. Use only products of one manufacturer for a better compatibility with other additives.
Corrosion protection	Additives can be used as corrosion protection. In connection with frost protection the antifreeze must have a concentration of 20…25 Vol %, in order to avoid a change of the additives.
Table 12: Requirements on the coolant	

Special requirements for open and semi-open cooling systems:

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

Caution **Damages at the unit**

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

C.1.4 Connection to the cooling system

- Screw in connecting duct in accordance with the manual
- The connection to the coolant must be carried out with flexible, pressure-resistant hoses and secured with clamps.
- Pay attention to flux direction and check tightness!
- The cooling flow must always be started before starting the KEB COMBIVERT.

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

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

C.1.5 Coolant temperature and moisture condensation

The inlet temperature may not exceed 40°C. The maximum heat sink temperature is 60 °C or 90 °C depending on the power unit and overload capacity (see „Technical data“). To ensure a safe operation the coolant output temperature must be 10 K below this temperature.

Due to high air humidity and high temperatures it can lead to moisture condensation. Moisture condensation is dangerous for the inverter, because the inverter can be destroyed through eventual occuring short-circuits.

The user must guarantee that any moisture condensation is avoided!

In order to avoid a moisture condensation the following possibilities can be done. The application of both methods is recommended.

Supply of temper coolant

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

Coolant inlet temperature [°C] is depending on ambient temperature and air humidity

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

Table 13: Supply of temper coolant

Temperature Control

The cooling system can be connected by means of pneumatic or magnetic valves. A relay is frontend. In order to avoid pressure surges, the valves for the temperature control must be inserted before the cooling circuit. All usual valves can be used. Pay attention that the valves are faultless and do not clamp.

C.1.6 Coolant heating depending on power loss and flow rate with water

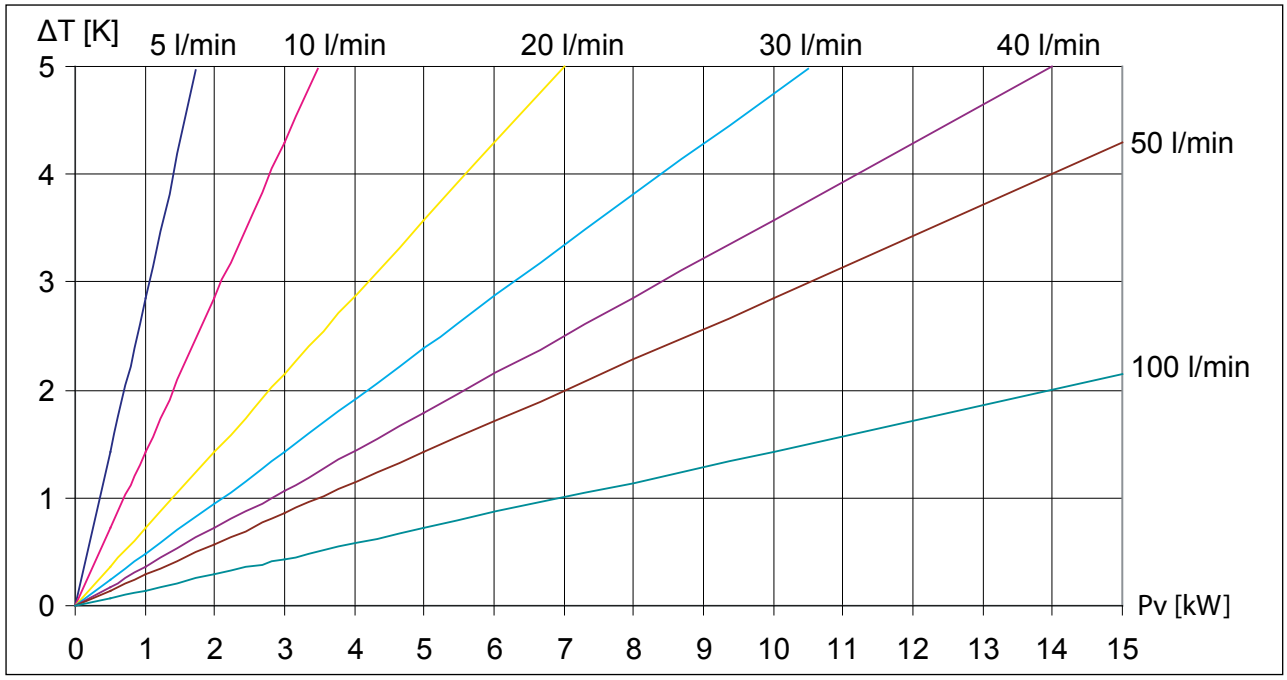


Figure 33: Coolant heating

C.1.7 Typically fall of pressure depending on the rate of flow

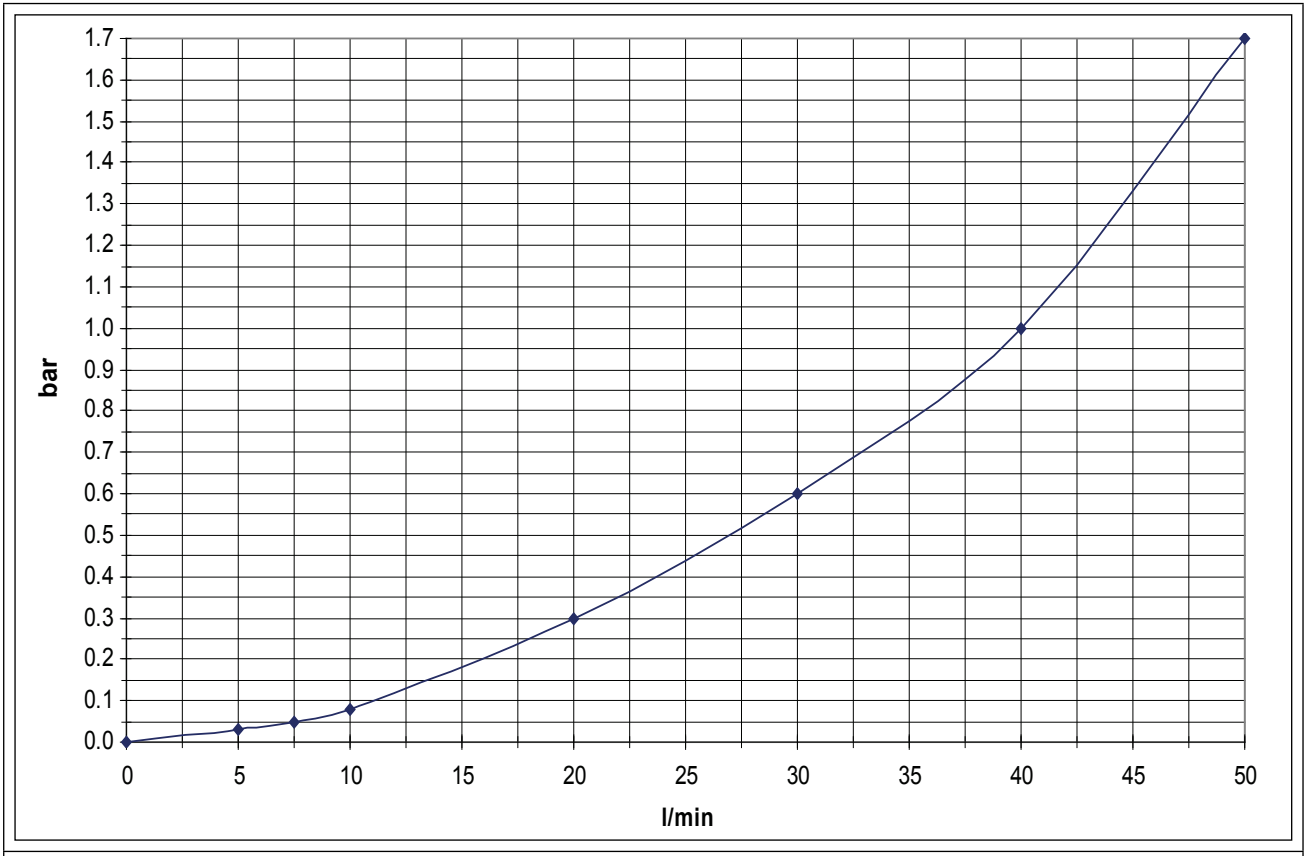


Figure 34: Fall of pressure

D. Annex D

D.1 Changing the response threshold of the braking transistor

To avoid a premature switching of the brake transistor at an input rated voltage of 480 Vac, the response threshold must be controlled or adjusted according to the following graphic.

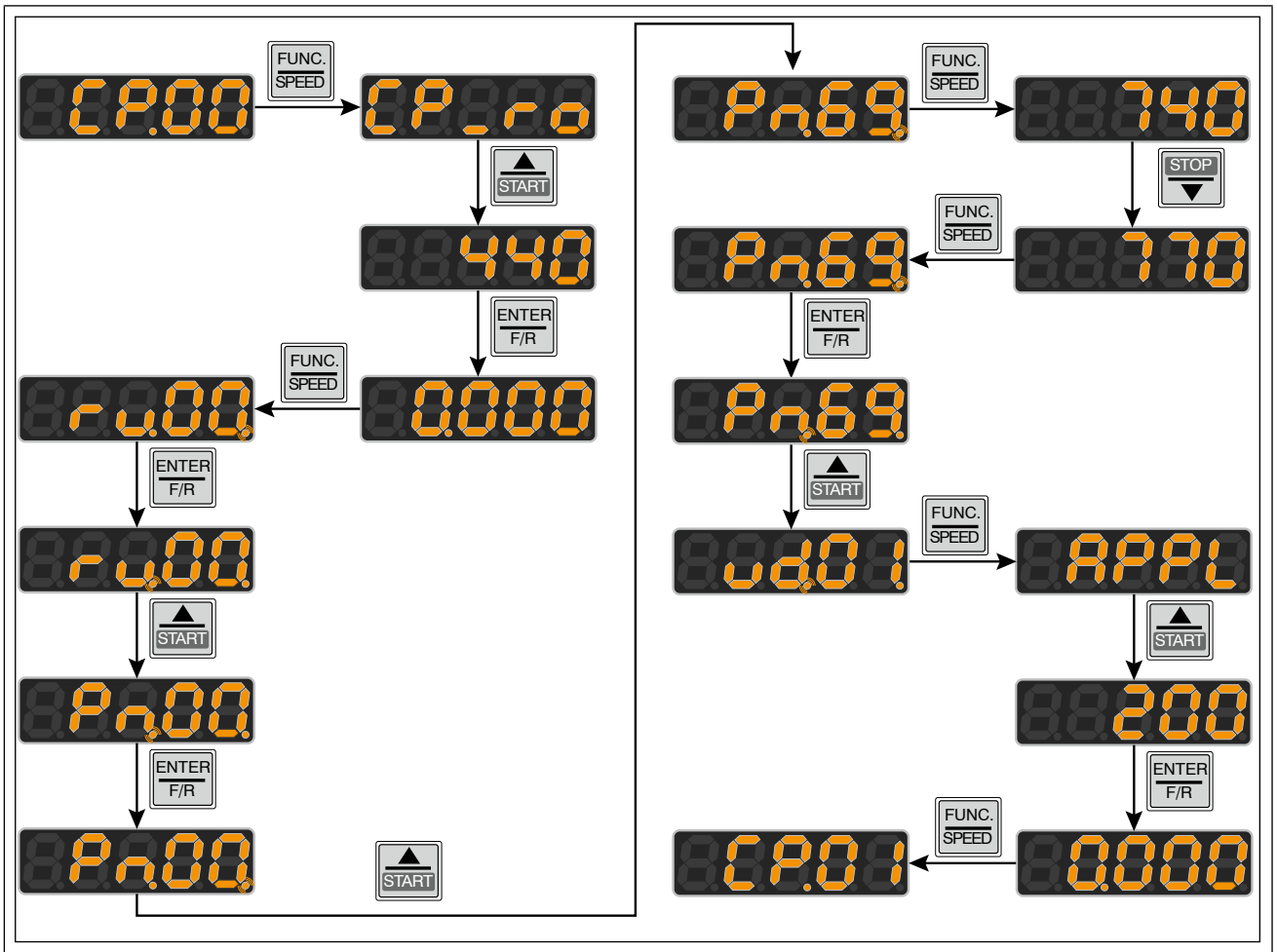


Figure 35: Changing the response threshold of the braking transistor

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