

COMBIVERT



F5/F6

Instruction Manual

Housing G

7.5...11 kW 230 V

7.5...22 kW 400 V

Original manual	
Mat.No.	Rev.
00F50EB-KG00	1E

KEB

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1. Preface

1.1 General


First we would like to welcome you as a customer of the company Karl E. Brinkmann GmbH and congratulation to the purchase of this product. You have decided for a product on highest technical level.

The described hard- and software are developments of the Karl E. Brinkmann GmbH. The enclosed documents correspond to conditions valid at printing. Misprint, mistakes and technical changes reserved.

The instruction manual must be made available to the user. Before working with the unit the user must become familiar with it. This especially applies to the knowledge and observance of the following safety and warning indications. The pictographs used in this instruction manual have following meaning:

	Danger Warning Caution	Is used, if life or health of the user is in danger or if substantial damage to property can occur.
	Attention observe at all costs	Is used, if a measure is necessary for safe and trouble-free operation.
	Information Aid Tip	Is used, if a measure simplifies the handling or operation of the unit.

1.2 Safety instructions

	Observe safety and operating instruc- tions	Precondition for all further steps is the knowledge and observance of the safety -, EMC- and operating instructions (Part 1 „Before Starting“ 0000NEB-0000“). This instruction is provided with the unit or by download of www.keb.de .
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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 outside of our control and therefore lies exclusively in the area of responsibility of the machine manufacturer.

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.

Unauthorised opening and tampering may lead to bodily injury and property damage and may entail the loss of warranty rights. Original spare parts and authorized accessories by the manufacturer serve as security. The use of other parts excludes liability for the consequences arising out of.

The suspension of liability is especially valid also for operation interruption loss, loss of profit, data loss or other damages. 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.

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. All rights reserved.

KEB®, COMBIVERT®, KEB COMBICONTROL® and COMBIVIS® are registered trademarks of Karl E. Brinkmann GmbH.

Other wordmarks or/and logos are trademarks (TM) or registered trademarks (®) of their respective owners and are listed in the footnote on the first occurrence. When creating our documents we pay attention with the utmost care to the rights of third parties. Should we have not marked a trademark or breach a copyright, please inform us in order to have the possibility of remedy.

1.5 Specified application

The KEB COMBIVERT serves exclusively for stepless open loop / closed-loop speed control of three-phase a.c. motors.



The operation of other electric consumers is prohibited and can lead to the destruction of the unit.

The used semiconductors and components of KEB are developed and dimensioned for the use in industrial products. If the KEB COMBIVERT 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 the KEB COMBIVERT 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. The units must be changed after this time.

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:	13... 19 kVA / 230 V class 11... 35 kVA / 400 V class
Housing size:	G
Version:	air and water-cooled

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

18 | F5 | K | 1 | G-3 | 4 | 0 | F

Cooling	
0, 5, A, F	Heat sink (standard)
1, B, G	Flat rear
2, C, H	Water cooling
3, D, I	Convection

Encoder interface	
0: none	

Switching frequency; short time current limit; overcurrent limit							
0	2 kHz; 125%; 150%	5	4 kHz; 150%; 180%	A	8 kHz; 180%; 216%	F	16 kHz; 200%; 240%
1	4 kHz; 125%; 150%	6	8 kHz; 150%; 180%	B	16 kHz; 180%; 216%	G	2 kHz; 400%; 480%
2	8 kHz; 125%; 150%	7	16 kHz; 150%; 180%	C	2 kHz; 200%; 240%	H	4 kHz; 400%; 480%
3	16 kHz; 125%; 150%	8	2 kHz; 180%; 216%	D	4 kHz; 200%; 240%	I	8 kHz; 400%; 480%
4	2 kHz; 150%; 180%	9	4 kHz; 180%; 216%	E	8 kHz; 200%; 240%	K	16 kHz; 400%; 480%

Input identification							
0	1ph 230 VAC/DC	5	400 V class DC	A	6ph 400 VAC		
1	3ph 230 VAC/DC	6	1ph 230 VAC	B	3ph 600 VAC		
2	1/3ph 230 VAC/DC	7	3ph 230 VAC	C	6ph 600 VAC		
3	3ph 400 VAC/DC	8	1/3ph 230 VAC	D	600 VDC		
4	230 V class DC	9	3ph 400 VAC				

Housing type A, B, D, E, G, H, R, U, W, P

Internal options (A...D with STO relay according to EN954-1/1997)	
0, A	none
1, B	Braking transistor
2, C	integrated filter
3, D	Braking transistor and integrated filter
5, -	only with braking transistor (with resistor monitoring)
7, -	with braking transistor (with resistor monitoring) and integrated EMC filter

Control type			
A	APPLICATION	K	like A with safety technology
B	BASIC (controlled frequency inverter)		
C	COMPACT (controlled frequency inverter)		
E	SCL	P	like E with safety technology
G	GENERAL (controlled frequency inverter)		
H	ASCL	L	like H with safety technology
M	MULTI (regulated, field-oriented frequency inverter for three-phase asynchronous motors)		
S	SERVO (regulated frequency inverter for synchronous motors)		

Series F5/F6

Inverter size

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.

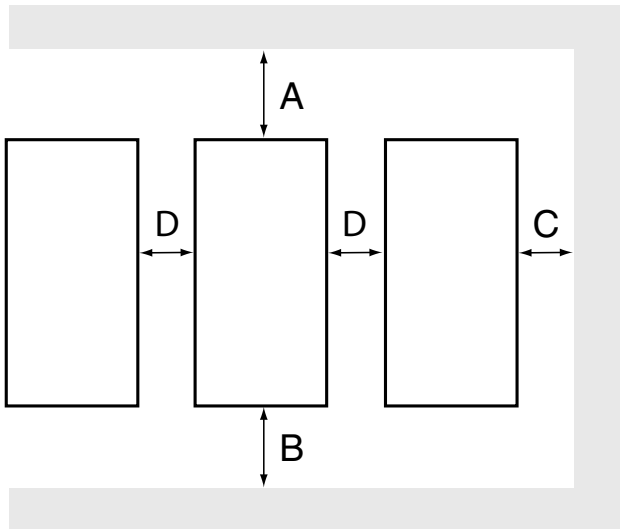
Convection (through-mount version)

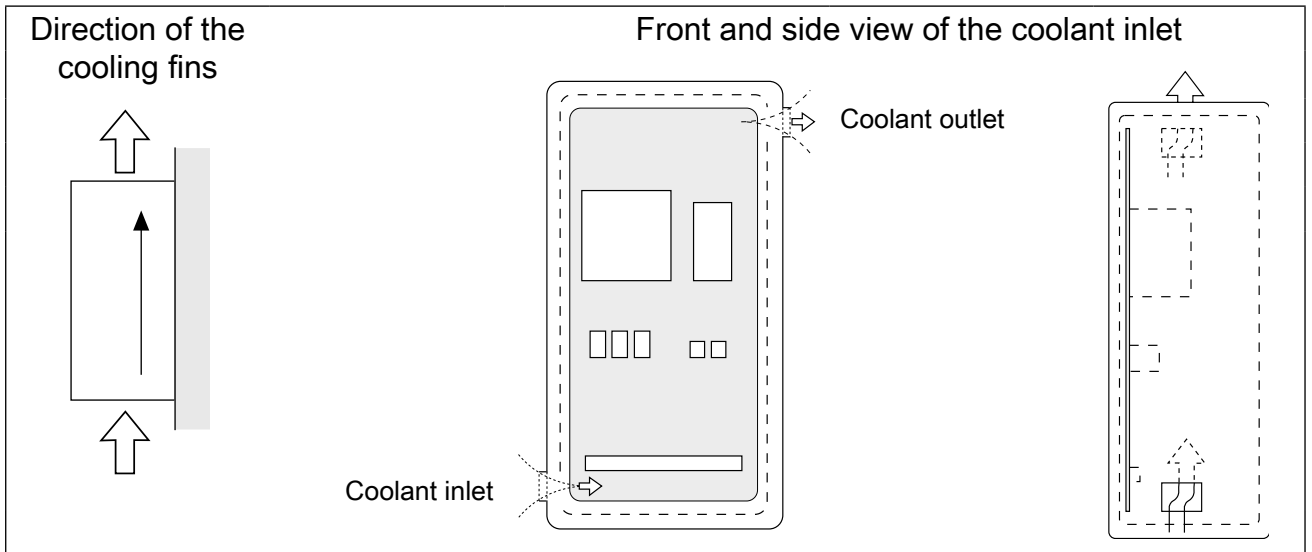
In this version the heat sink is placed externally with a cutout in the control cabinet.



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	Dimension	Distance in mm	Distance in inch
	A	150	6
	B	100	4
	C	30	1.2
	D	0	0
	X ¹⁾	50	2
1) Distance to preceding elements in the cabinet door.			



See annex C for instructions of water-cooled units.

1.9 Safety and operating instructions



Safety and operating instructions 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 Safety Directive - MSD). Account is to be taken of EN 60204.

The drive converter meet the requirements of the Low-Voltage directive 2006/95/EC. They are subject to the harmonized standards of the series EN 61800-5-1.

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 EN 61800-5-1.

4. Installation

The installation and cooling of the devices 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

The manufacturer's documentation shall be followed.


KEEP SAFETY INSTRUCTIONS IN A SAFE PLACE!

Technical Data

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 ⁴⁾ (over 1000 m a derating of 1 % per 100m 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) ³⁾
	Humidity		3K3	
Mechanical	Vibration		3M1	
	Gas		3C2	
Contamination	Solids		3S2	
Ambient conditions during transport				
Climate	Temperature	EN 60721-3-2	2K3	Drain heat sink completely (without condensation)
	Humidity		2K3	
Mechanical	Vibration		2M1	max. 100 m/s ² ; 11 ms
	Surge		2M1	
Contamination	Gas		2C2	
	Solids		2S2	
Ambient conditions for the storage				
Climate	Temperature	EN 60721-3-1	1K4	Drain heat sink completely (without condensation)
	Humidity		1K3	
Mechanical	Vibration		1M1	max. 100 m/s ² ; 11 ms
	Surge		1M1	
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	–	C2 ^{1) 2)}	Earlier limit value A (B optional) according to EN55011
	Radiated interferences	–	C2 ²⁾	Earlier limit value A according to EN55011
Interference immunity				
	Static discharges	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	0.15-80 MHz
	Voltage variation / voltage drop	EN 61000-2-1	3	+10 % -15 % 90 %
	Voltage unsymmetries / Frequency changes	EN 61000-2-4	3	3 % 2 %

1)		This product can cause high frequency disturbances in residential areas (category C1) which require noise suppression measures.
2)		The specified value is only met in connection with a corresponding filter.
3)		Depending on the operating conditions and corresponding power reduction, higher temperatures are permissible after consulting KEB.
4)		Above 2000 m there is no "safe isolation" of the control.

2.2 Technical data of the 230V class

Inverter size		14	15
Housing size		G	G
Input phases		3	3
Output rated power	[kVA]	13	19
Max. rated motor power	[kW]	7.5	11
Output rated current	[A]	33	48
Max. short time current	1) [A]	49.5	86
OC-tripping current	[A]	59	103
Input rated current	[A]	43	63
Max. permissible main fuse gG	5) [A]	50	80
Rated switching frequency	[kHz]	16	4
Max. switching frequency	10) [kHz]	16	16
Power dissipation at nominal operating	[W]	410	460
Power dissipation at DC operating	[W]	355	375
Standstill current at 4 kHz	2) [A]	36	53
Standstill current at 8 kHz	2) [A]	36	53
Standstill current at 16 kHz	2) [A]	33	43
Min. frequency at continuous full load	[Hz]	3	3
Max. heat sink temperature		90 °C (194 °F)	
Motor cable cross-section	3) [mm ²]	10	25
Min. braking resistor	4) [Ω]	8	8
Max. braking current	4) [A]	50	50
Overload characteristic		(see annex A)	
Input rated voltage	[V]	230 (UL: 240)	
Input voltage range U _{in}	[V]	180...260 ±0	
Input voltage at DC operation	[Vdc]	250...370 ±0	
Mains frequency	[Hz]	50 / 60 ±2	
permitted mains forms		TN, TT, IT ⁶⁾ , Δ-mains ⁷⁾	
Output voltage	8) [V]	3 x 0...U _{in}	
Output frequency	9) [Hz]	0 - max. 599	
Max. motor line length shielded	[m]	100	
Cooling mode (L=air; W=water)		L	L

- 1) With regulated systems 5% are to be subtracted as overmodulation capacity
- 2) Max. current before the OL2 function triggers (not at F5 in operating mode v/f)
- 3) Recommended minimum cross section of the motor line for rated power and a cable length of upto 100m (Cu)
- 4) This data is only valid for units with internal braking transistor (see "unit identification")
- 5) Protection in accordance with UL see annex B
- 6) IT system optional
- 7) Phase conductor grounded mains are only permissible without HF filters
- 8) The voltage at the motor is dependent on the series-connected units and on the control method (see A.3)
- 9) 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.
- 10) Max. switching frequency for F6 devices 8 kHz

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.

Technical Data of the 400 V Class

2.3 Technical data of the 400 V class

Inverter size		14	15	16	17	18					
Housing size		G	G	G	G	G					
Input phases		3	3	3	3	3					
Output rated power	[kVA]	11	17	23	29	35					
Max. rated motor power	[kW]	7.5	11	15	18.5	22					
Output rated current	[A]	16.5	24	33	42	50					
Max. short time current	1) [A]	25	36	49.5	63	75					
OC-tripping current	[A]	30	43	59	75	90					
Input rated current	[A]	23	31	43	55	65					
Max. permissible main fuse gG	7) [A]	25	35	50	63	80					
Rated switching frequency	[kHz]	16	8	8	4	2					
Max. switching frequency	12) [kHz]	16	16	16	16	8					
Power dissipation at nominal operating	[W]	380	380	500	500	430					
Power dissipation at DC operating	[W]	350	340	445	430	345					
Standstill current at 4 kHz	2) [A]	16.5	24	33	42	45					
Standstill current at 8 kHz	2) [A]	16.5	21	23	29	30					
Standstill current at 16 kHz	2) [A]	14.5	13	15	21	–					
Min. frequency at continuous full load	[Hz]	3	3	3	3	3					
Max. heat sink temperature		90 °C (194 °F)									
Motor cable cross-section	3) [mm ²]	4	6	10	16	25					
Min. braking resistor	4) [Ω]	39	39	25	25	15					
Max. braking current	4) [A]	21	21	30	30	63					
Overload characteristic		(see annex A)									
Input rated voltage	5) [V]	400 (UL: 480)									
Input voltage range	[V]	305...528 ±0									
Input voltage at DC operation	[Vdc]	420...720 ±0									
Mains frequency	[Hz]	50 / 60 ±2									
permitted mains forms		TN, TT, IT8), Δ-mains9)									
Output voltage	10) [V]	3 x 0...U _{in}									
Output frequency	11) [Hz]	0 - max. 599									
Max. motor line length shielded	[m]	100									
Cooling mode (L=air; W=water)		L	W	L	W	L	W	L	W	L	W
Cooling water content		–	0.3	–	0.3	–	0.3	–	0.3	–	0.3

- 1) With regulated systems 5% are to be subtracted as overmodulation capacity
- 2) Max. current before the OL2 function triggers (not at F5 in operating mode v/f)
- 3) Recommended minimum cross section of the motor line for rated power and a cable length of upto 100 m (Cu)
- 4) This data is only valid for units with internal brake transistor GTR 7 (see "unit identification")
- 5) At rated voltages ≥ 460 V multiply the rated current with factor 0.86
- 6) With BASIC control board only 2 kHz, with COMPACT 8 kHz
- 7) Protection in accordance with UL see annex B
- 8) Restrictions when using HF filters
- 9) Phase conductor grounded mains are only permissible without HF filters
- 10) The voltage at the motor is dependent on the series-connected units and on the control method (see A.3)
- 11) 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.
- 12) Max. switching frequency for F6 devices 8 kHz

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.

	No braking resistor may be connected for control type "Basic" at an input rated voltage of 480 Vac. The response threshold of the braking transistor (Pn.69) for all other controls without safety technology (A, E, G, H, M) must be adjusted at least to 770 Vdc (see annex D).
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2.4 DC supply

2.4.1 Calculation of the DC input current

The **DC input current** of the inverter is basically determined by the used motor. The data can be taken from the motor name plate.

230V class :

$$I_{DC} = \frac{\sqrt{3} \cdot \text{rated motor voltage} \cdot \text{rated motor current} \cdot \text{Motor } \cos \phi}{\text{DC voltage (310 V)}}$$

400V class :

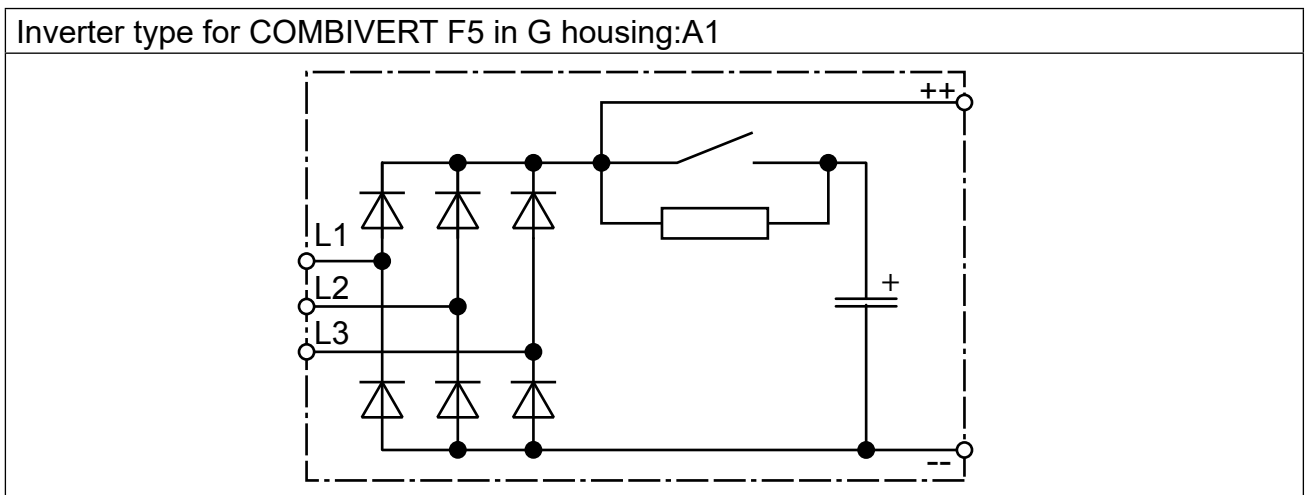
$$I_{DC} = \frac{\sqrt{3} \cdot \text{rated motor voltage} \cdot \text{rated motor current} \cdot \text{Motor } \cos \phi}{\text{DC voltage (540 V)}}$$

The **DC input peak current** is determined by the operating range.

- If you accelerate on the hardware current limit, the short-time current limit of the inverter must be used in the formula above (instead of the rated motor current).
- If the motor in normal operation is never stressed with rated torque, it can be calculated with the real motor current.

2.4.2 Internal input circuit

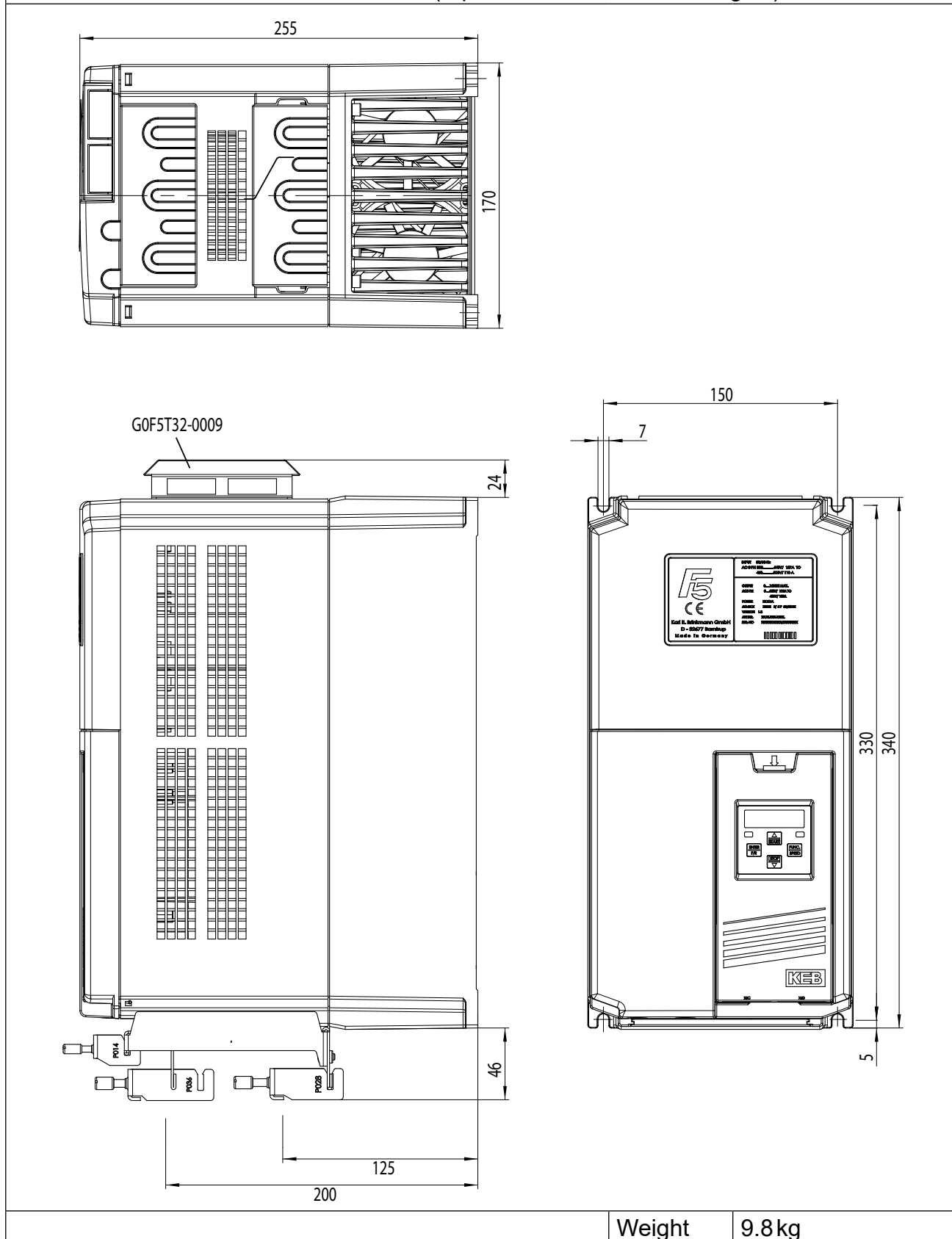
The COMBIVERT F5/F6 in G housing corresponds to the inverter type A1. Pay attention to the inverter type in DC interconnection and in operation at regenerative units.



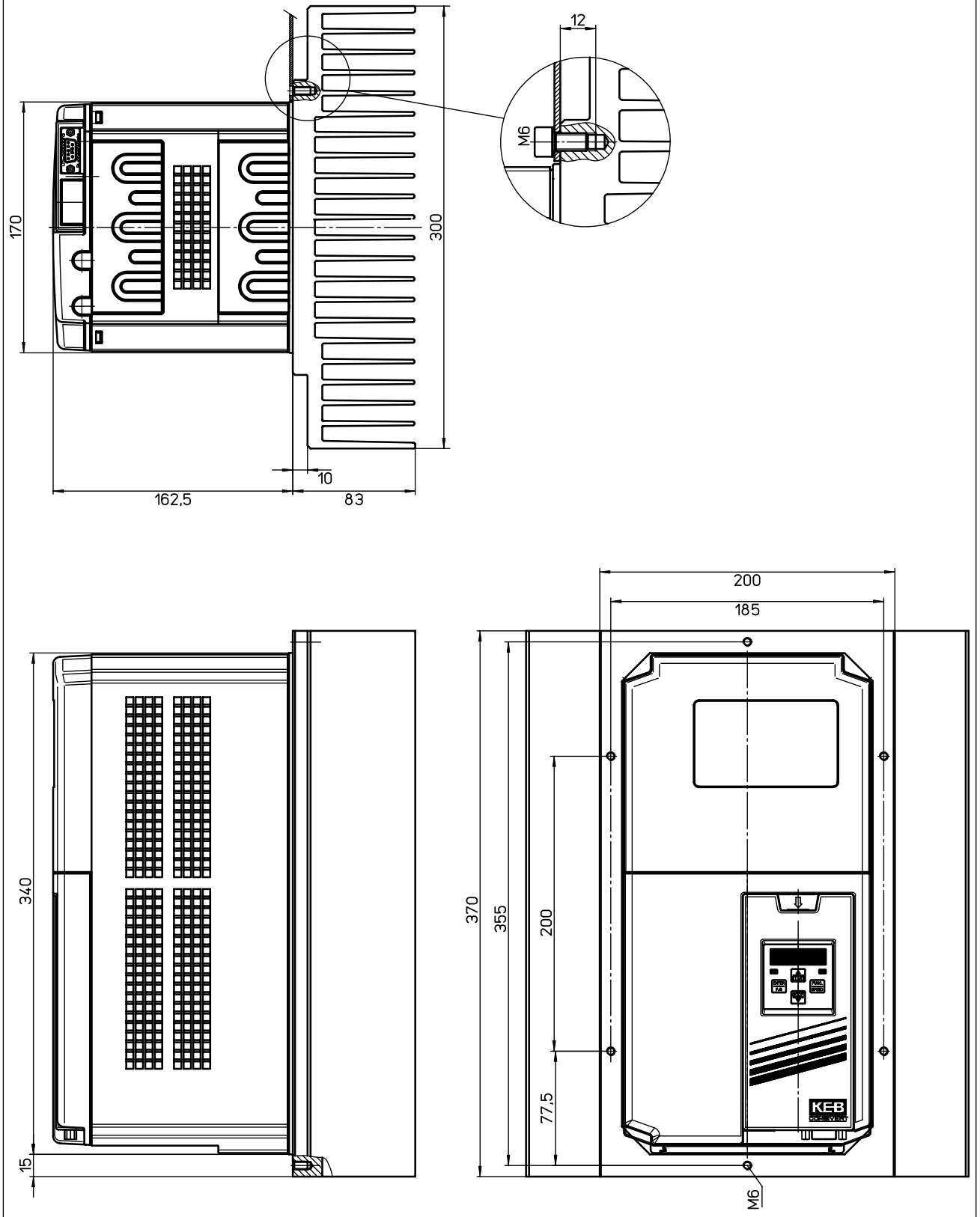
Technical Data - Dimensions and Weights

2.5 Dimensions and weights

Dimensions mounted version air-cooled (representation with mounting kit)



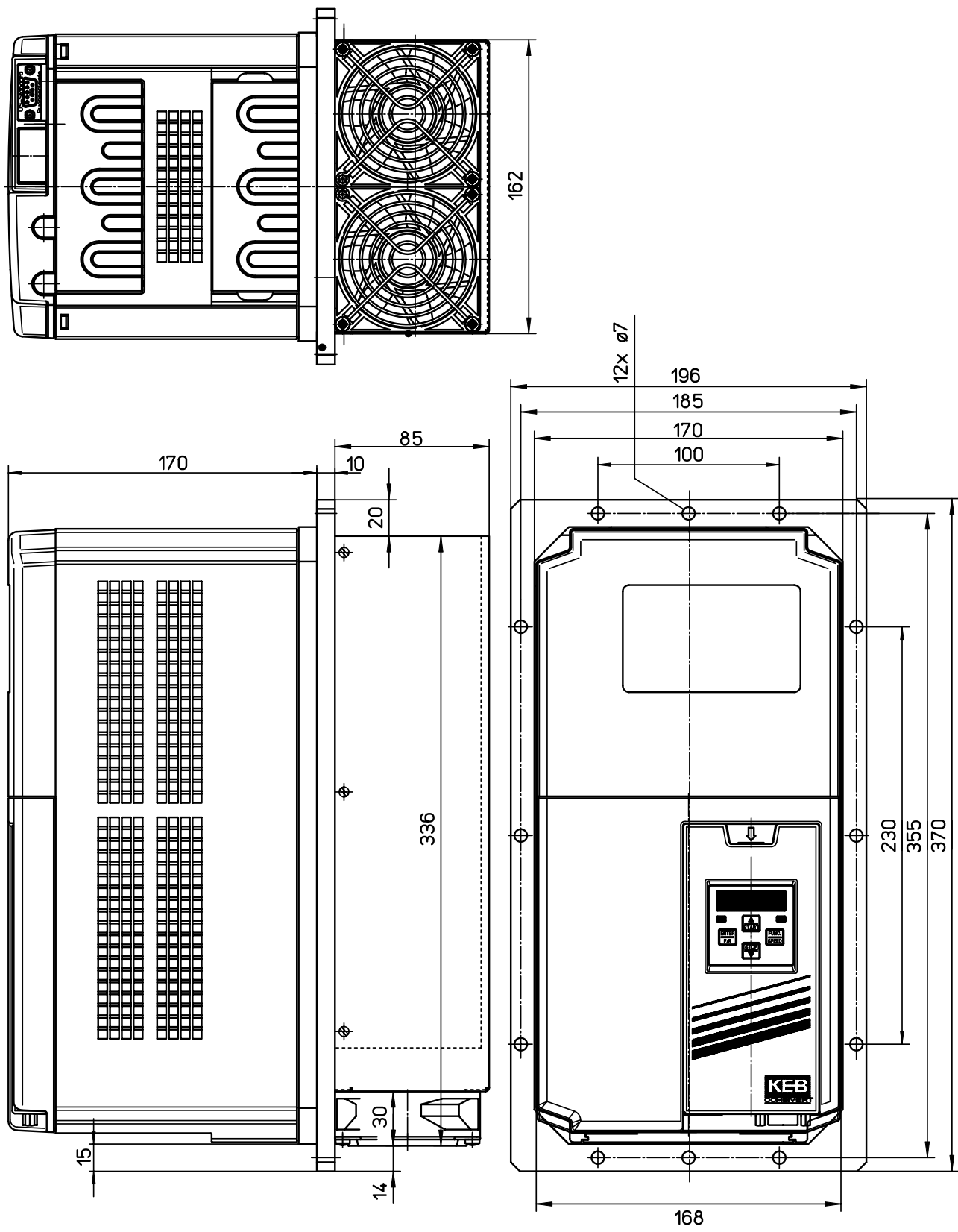
Dimensions through-mount version air-cooled



Weight	12.8 kg
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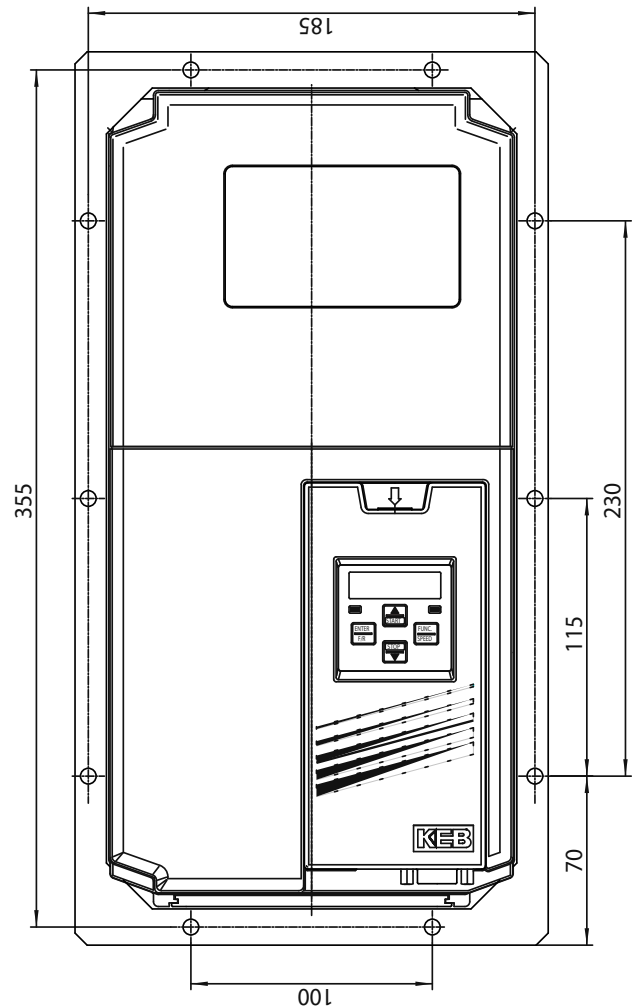
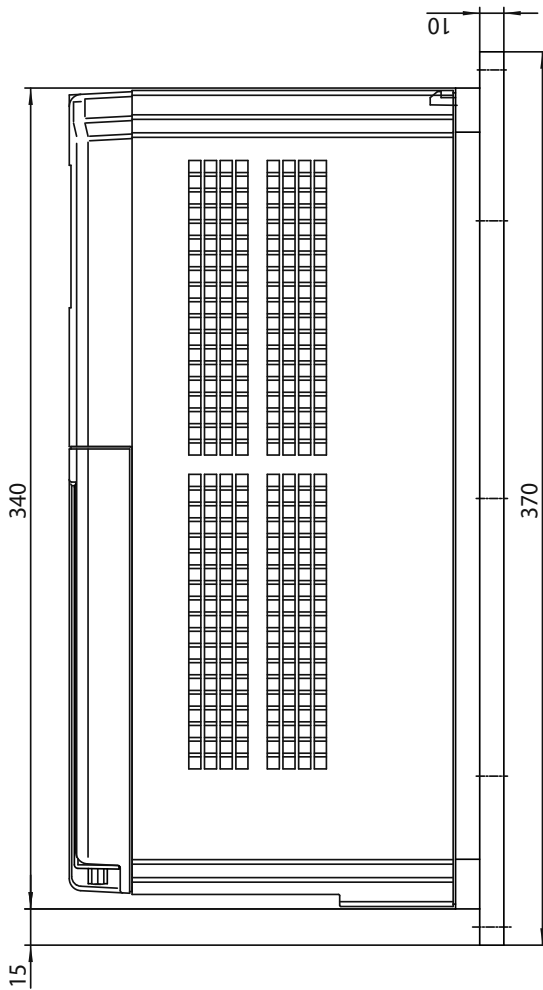
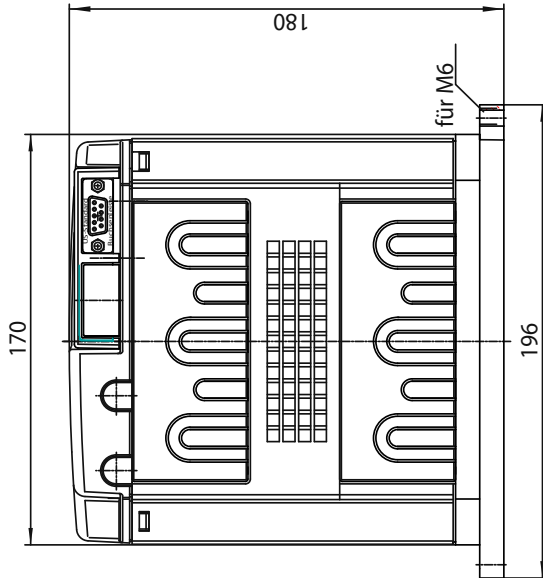
Technical Data - Dimensions and Weights

Dimensions through-mount version air-cooled (with fan)



Weight	13.4 kg
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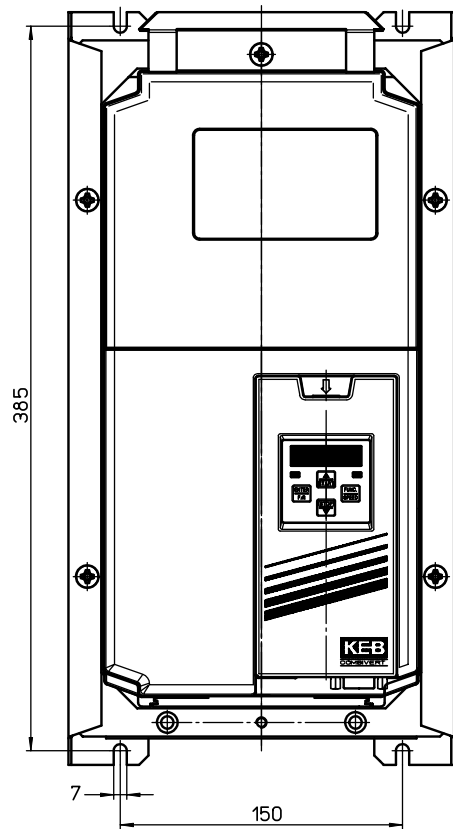
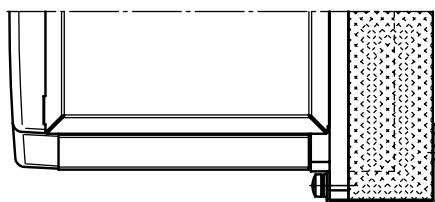
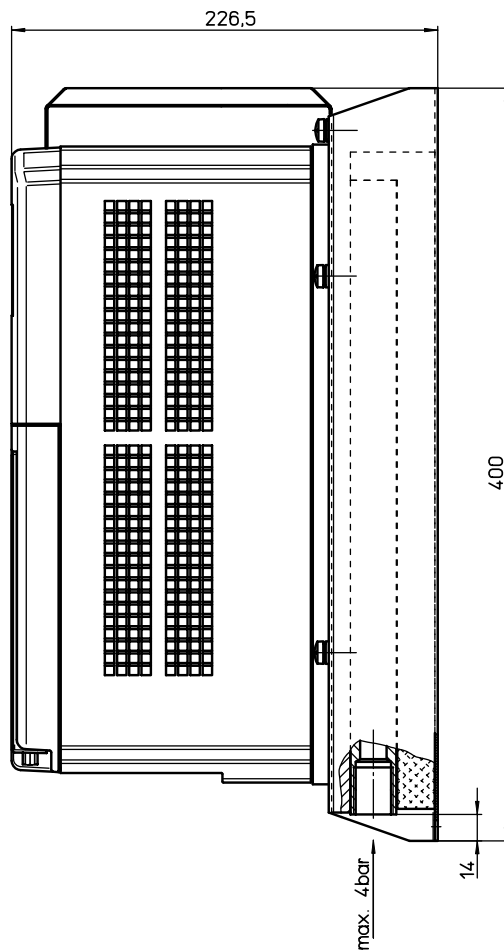
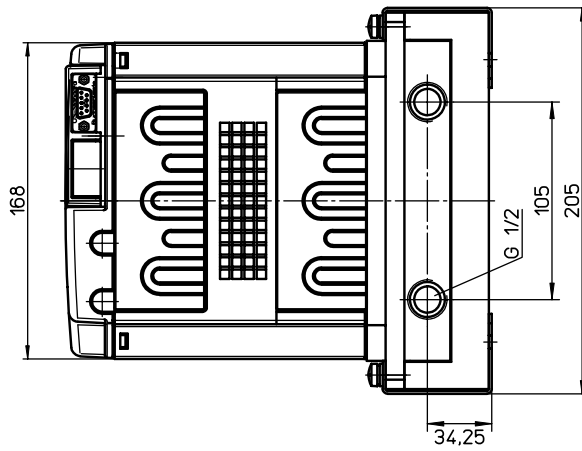
Dimensions Flat Rear



Weight	9.1 kg
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Technical Data - Dimensions and Weights

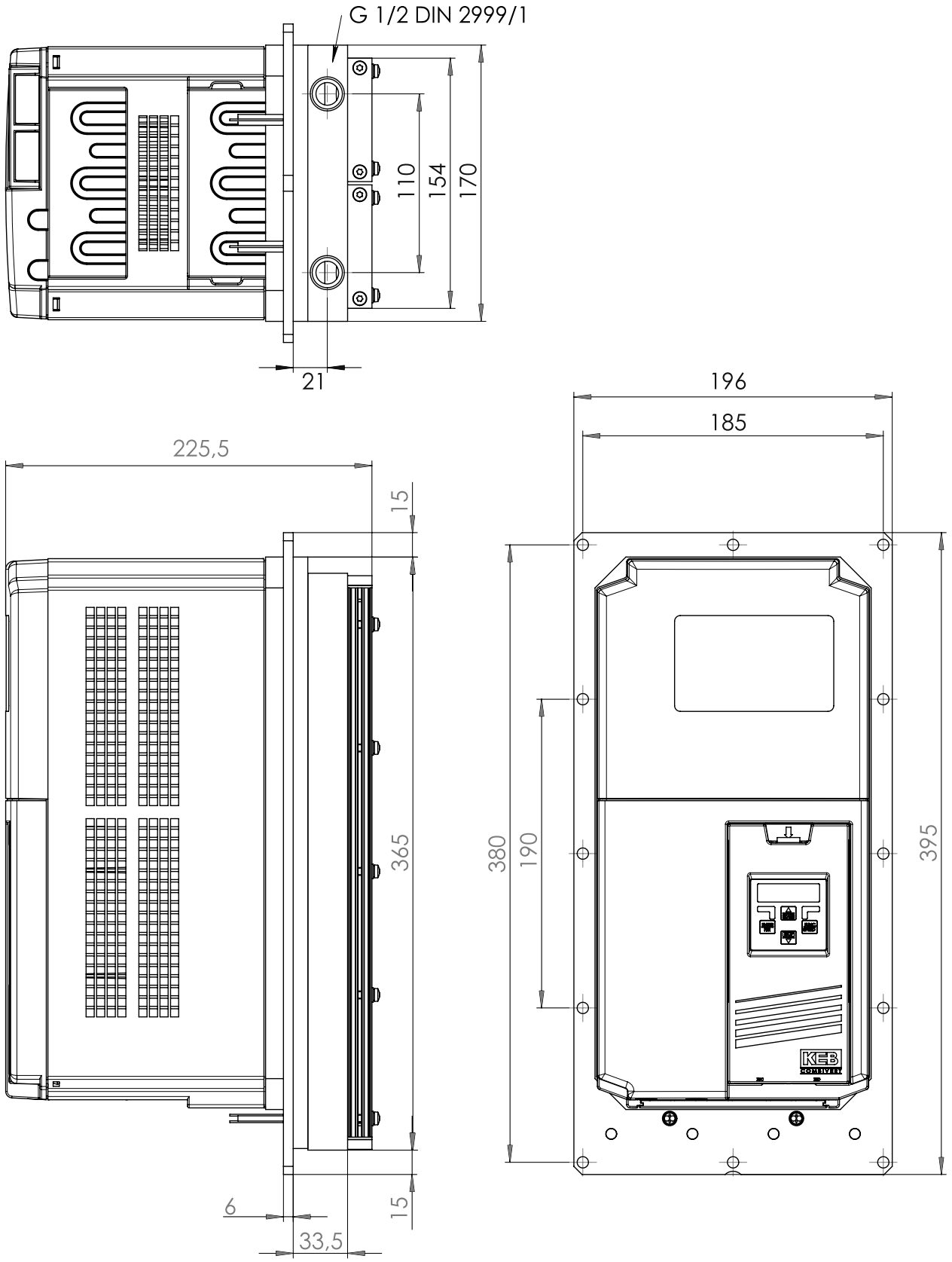
Dimensions water cooling mounted version



Weight



10.6 kg

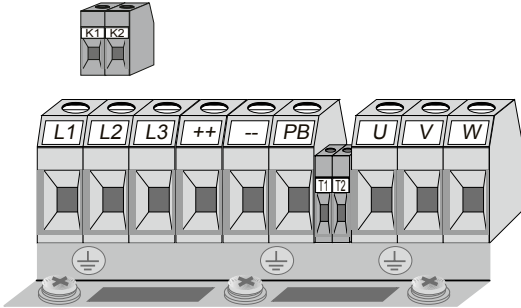

Dimensions water cooling through-mount version

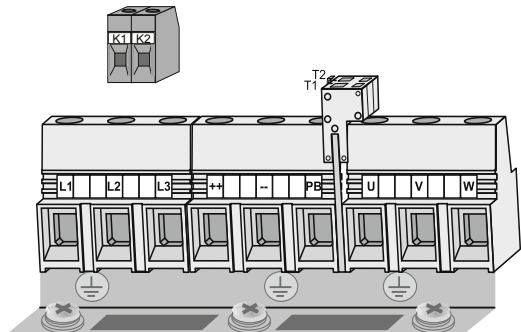



Weight	10.8kg
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2.6 Terminal strips of the power circuit

	Observe input voltage, since 230 V and 400 V class possible
	All terminal strips following the requirements of the EN 60947-7-1 (IEC 60947-7-1)

Housing size G Size 14 200V and size 14...17 400V	Name	Function	Cable cross-sections Terminals No.
	L1, L2, L3	3-phase mains connection	1
	U, V, W	Motor connection	
	++, PB	Connection for braking resistor	
	++, --	Connection for braking module, regenerative and supply unit or as DC voltage input 250...370 VDC (230 V class) 420...720 VDC (400 V class)	
	T1, T2	Connection for temperature sensor	2
	K1, K2	Connection for GTR7 monitoring	2
	PE, 	Connection for shielding /earthing	3

Housing size G Size 15 200V and size 18 400V	Name	Function	Cable cross-sections Terminals No.
	L1, L2, L3	3-phase mains connection	4
	U, V, W	Motor connection	
	++, PB	Connection for braking resistor	
	++, --	Connection for braking module, regenerative and supply unit or as DC voltage input 250...370 VDC (230 V class) 420...720 VDC (400 V class)	
	T1, T2	Connection for temperature sensor	5
	K1, K2	Connection for GTR7 monitoring	2
	PE, 	Connection for shielding /earthing	3

2.6.1 Permissible cable cross-sections and tightening torques of the terminals

No.	permissible cross-section flexible with wire-end ferrule				Tightening torque	
	mm ²		AWG		Nm	lb inch
	min	max	min	max		
1	2.5	10	22	6	1.2...1.5	12
2	0.25	1.0	28	14	0.6	5
3	Screw M4 for ring thimble				1.3	11.5
4	2	4	16	4	2-4	25
5	0.25	1	24	16	–	–

2.7 Accessories

2.7.1 Filter and chokes

Voltage class	Inverter size	Filter	Mains choke 50 Hz (4 % Uk)	Motor choke 100 Hz (4 % Uk)
230 V	14	16E5T60-1001	14Z1B03-1000	16Z1F04-1010
		16E6T60-3000		
	15	18E5T60-1001	15Z1B03-1000	18Z1F04-1010
		18E6T60-3000		
Voltage class	Inverter size	Filter	Mains choke 50 Hz (4 % Uk)	Motor choke 100 Hz (4 % Uk)
400 V	14	14E5T60-1001	14Z1B04-1000	14Z1F04-1010
		14E6T60-3000		
	15	15E5T60-1001	15Z1B04-1000	15Z1F04-1010
		16E6T60-3000		
	16	16E5T60-1001	16Z1B04-1000	16Z1F04-1010
		16E6T60-3000		
	17	18E4T60-1001	17Z1B04-1000	17Z1F04-1010
		18E6T60-3000		
	18	18E5T60-1001	18Z1B04-1000	18Z1F04-1010
		18E6T60-3000		

Connection Power Unit

2.8 Connection Power Unit

2.8.1 Mains and motor connection



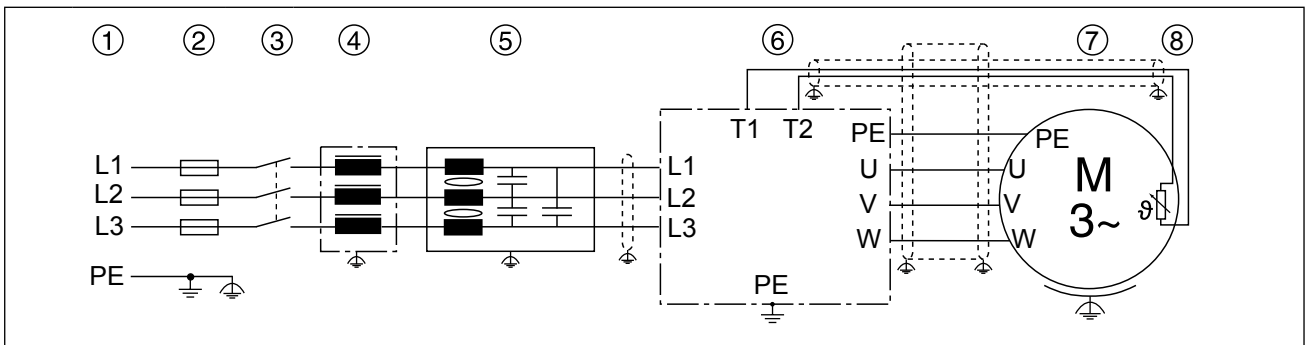
Absolutely pay attention to the supply voltage of the KEB COMBIVERT. A 230 V unit at 400 V mains is destroyed immediately.



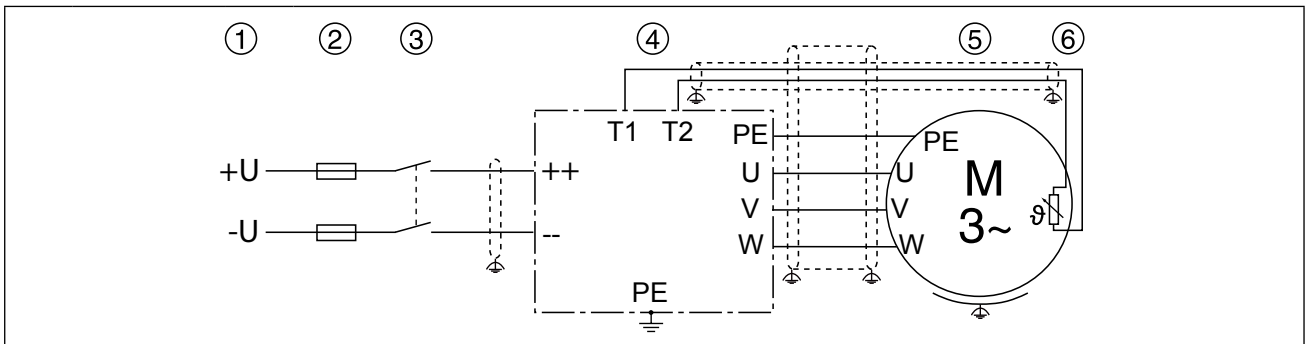
Exchanging mains and motor connection leads to immediate destruction of the unit.



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



Legend	1	Mains supply
	2	Mains fuse
	3	Mains contactor
	4	Mains choke
	5	HF filter
	6	KEB COMBIVERT F5
	7	Motor (see also 2.8.3)
	8	Motor protection temperature sensor (also see 2.8.4)



Legend	1	DC supply
	2	DC fuses
	3	Mains contactor
	4	KEB COMBIVERT F5 with DC input
	5	Motor (see also 2.8.3)
	6	Motor protection temperature sensor (also see 2.8.4)

2.8.2 Selection of the motor cable

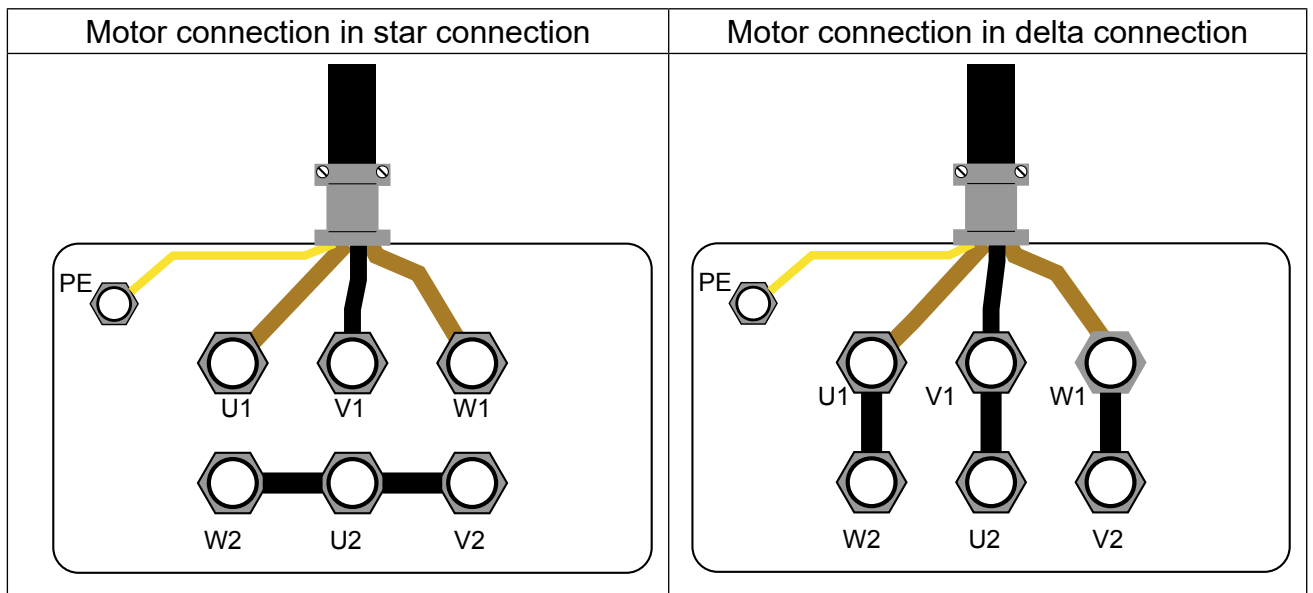
The correct selection and wiring of the motor cable is very important:

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

2.8.3 Connection of the motor

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

Connection of the motor			
230/400 V motor		400/690 V motor	
230V	400V	400V	690 V
Delta	Star	Delta	Star



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

	<p>Protect motor against voltage peaks!</p> <p>Inverter 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 (> 15m). A motor choke, a dv/dt-filter or sine-wave filter can be used for protection of the motor.</p>
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2.8.3.1 Motor cable length for parallel operation of motors

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

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

2.8.4 Temperature detection T1, T2

Parameter In.17 displays in high byte the installed temperature input of the inverter.

If the KEB COMBIVERT F5/F6 is delivered as standard with switchable PTC/KTY evaluation, the required function Pn.72 (dr33 at F6) can be set 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 (in accordance with DIN EN 60947-8)	1	< 750 Ω	T1-T2 closed	–
			0.75...1.65 kΩ (reset resistance)	undefined	–
			1.65...4 kΩ (tripping resistance)	undefined	x
> 4 kΩ			T1-T2 open	x	
6xh	PT100	–	upon request		
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 inverter 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	Mode (F5 => Pn.72; F6 => dr33)
Motor temperature display and monitoring	KTY84
Motor temperature monitoring	PTC
Temperature control for 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.



- 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!

2.8.4.1 Use of the temperature input in KTY mode

<p>Connection of a KTY sensor</p>	
	<p>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.</p>
	<ul style="list-style-type: none"> • KTY sensors may not be combined with other devices. Otherwise wrong measurements would be the consequence. • The control type COMPACT does not support KTY sensors.

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

2.8.4.2 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. This can be:

<p>Wiring example in PTC mode</p>	
<p>Thermal contact (NC contact)</p>	
<p>Temperature sensor (PTC)</p>	
<p>Mixed sensor chain</p>	

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.

2.8.5 Connection of a braking resistor

	Braking resistors dissipate the produced energy of the motor into heat during generative operation. Thus braking resistors can cause very high surface temperatures. During assembly pay attention to appropriate protection against contact and fire.
	The use of a regenerative unit is reasonable for applications which produce a lot of regenerative energy. Regeneration of excess energy into the mains.
	The mains voltage must always be switched off in order to guarantee fire protection in case of a defective braking transistor.
	The frequency inverter remains in operation in spite of switched off power supply in generative operation. An error must be released by external wiring which switches the modulation off in the inverter. This can occur e.g. at terminals T1/T2 or via digital input. The frequency inverter must be programmed accordingly in each case.
	No braking resistor may be connected for control type "Basic" at an input rated voltage of 480 Vac. The response threshold of the braking transistor (Pn.69) for all other controls without safety technology (A, E, G, H, M) must be adjusted at least to 770 Vdc (see annex D).

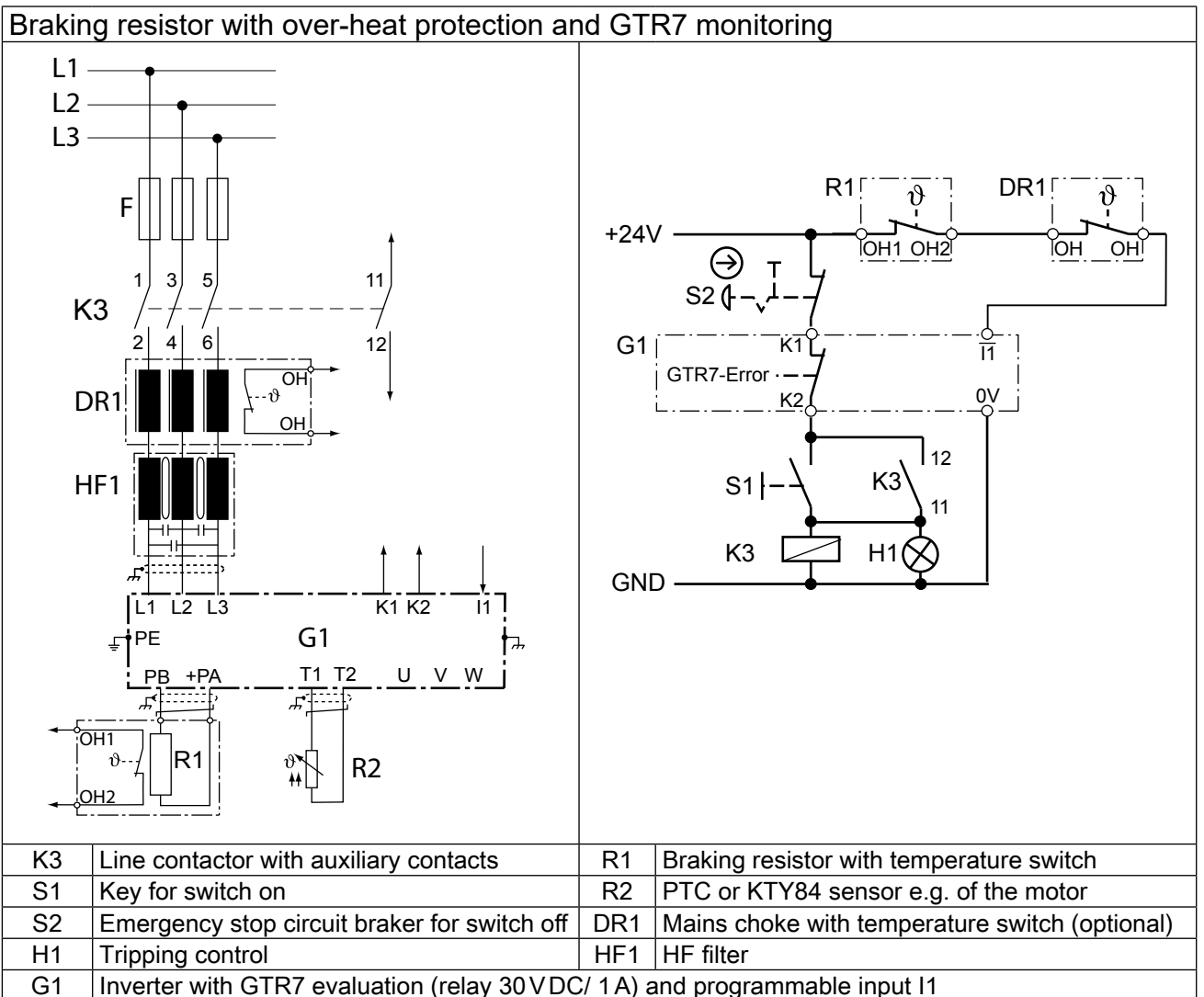
2.8.5.1 Braking resistor without temperature monitoring

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

2.8.5.2 Braking resistor with over-heat protection and GTR7 monitoring

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 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".

	<p>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.</p>
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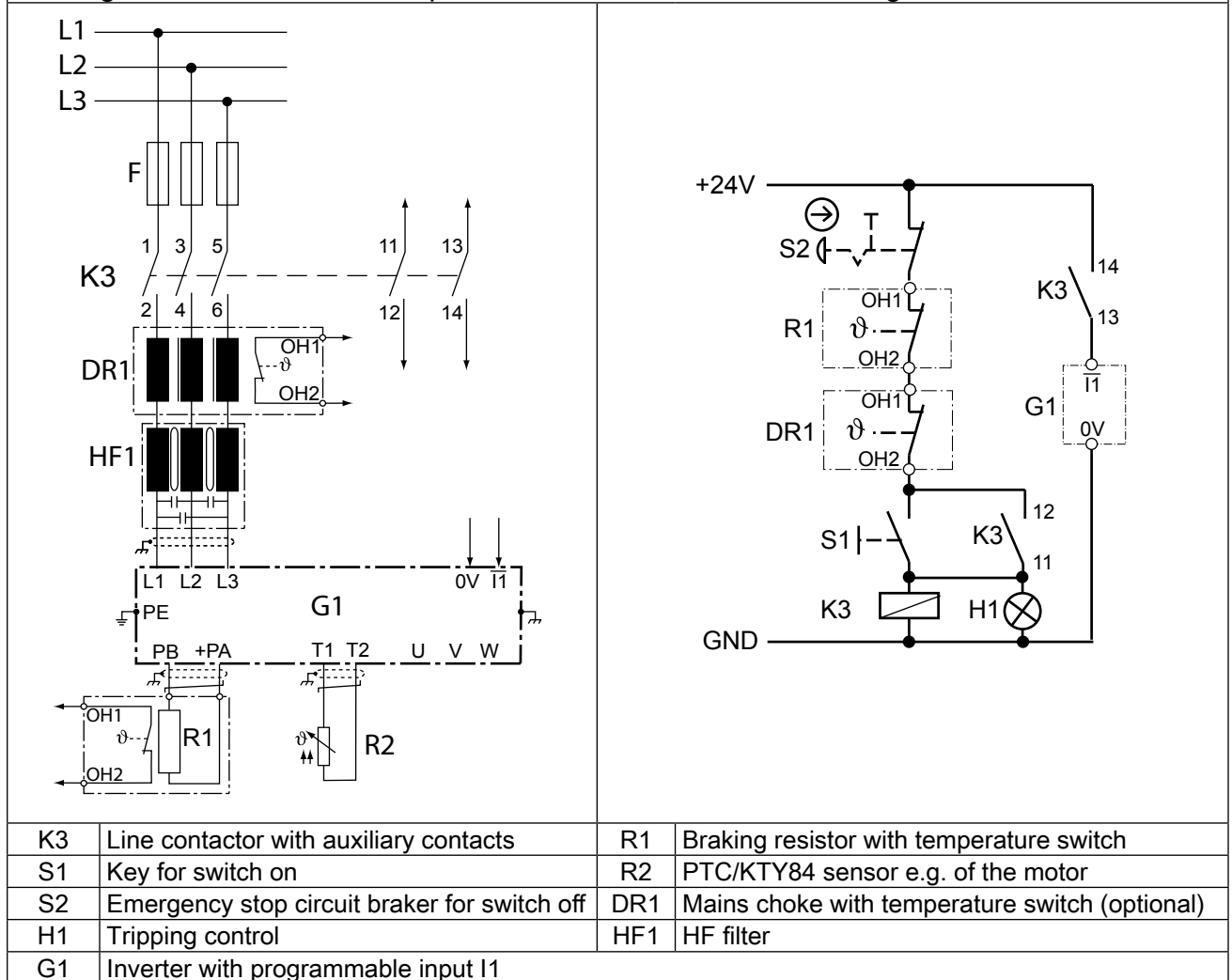
2.8.5.3 Braking resistor with over-heat protection without GTR7 monitoring

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 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.



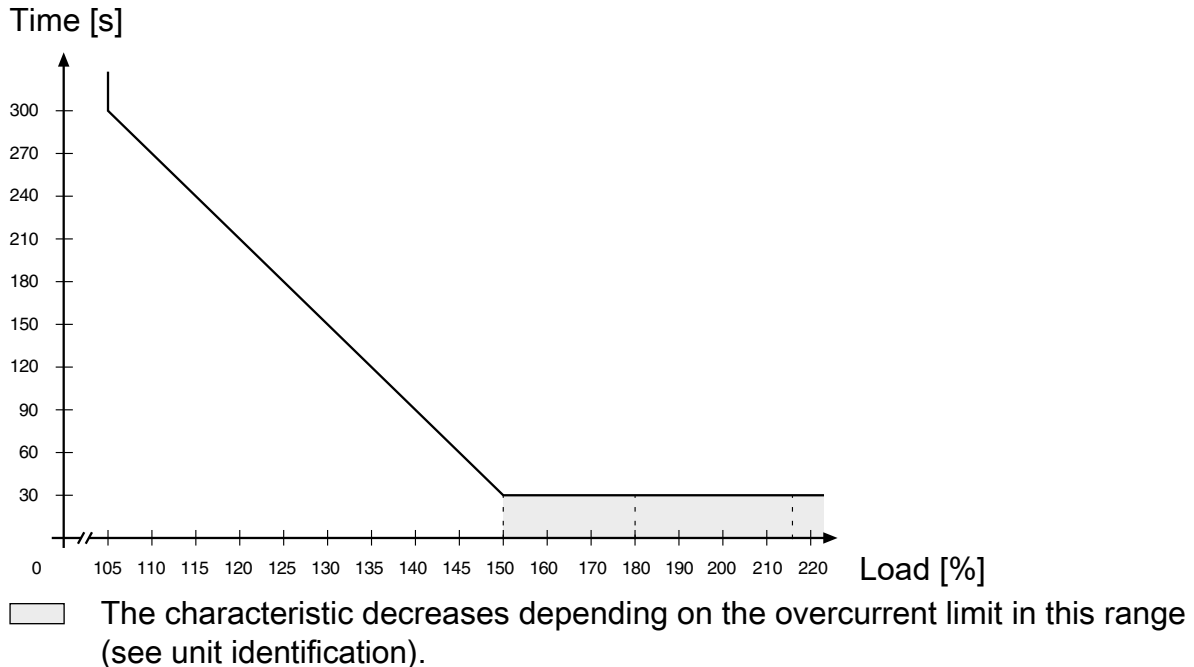
If the PTC/KTY evaluation of the motor at terminals T1/T2 is not used, these terminals can be used instead of the programmable input. The temperature input must be operated in PTC mode.

Braking resistor with over-heat protection without GTR7 monitoring



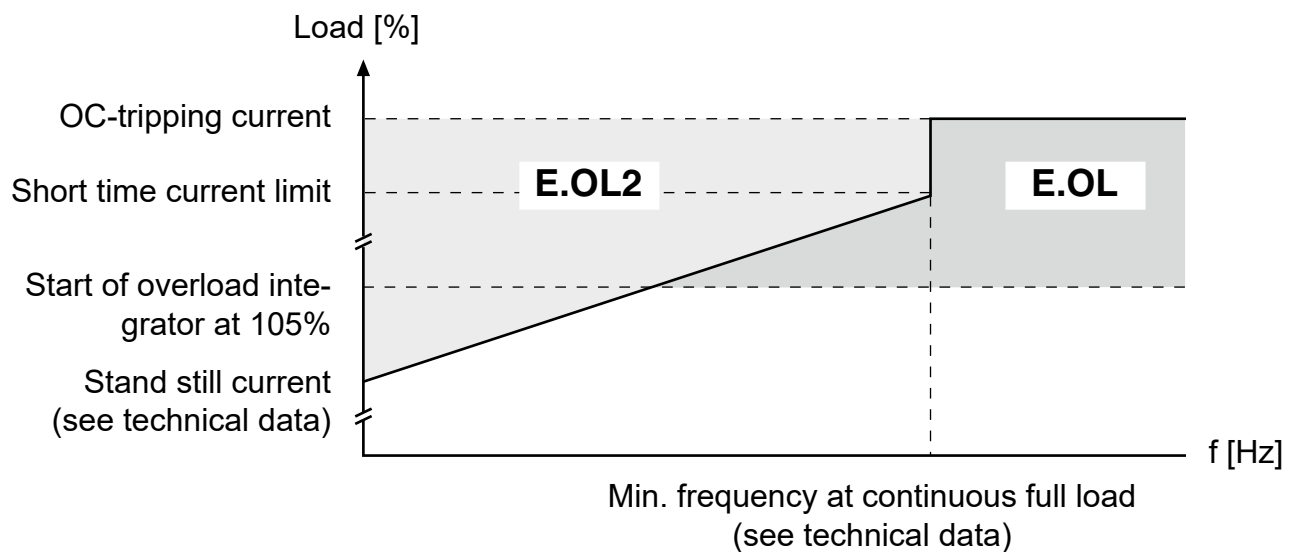
Annex A

A.1 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 (not in v/f operation)



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

A.4 Shut down

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

A.4.1 Maintenance

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.

A.4.2 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
	230 V	0...160V	15 min
		160...220V	15 min
		220...260V	1 h
	400 V	0...280V	15 min
		280...400V	15 min
		400...500V	1 h
Storage period > 3 years			
• Input voltages as before, however double the times per year. Eventually change capacitors.			

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

A.4.3 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.

A.4.4 Fault correction

A defective device should only be repaired by KEB or an authorized partner. Defective components, modules or options may only be replaced by original parts. The device must be returned in original packaging with a detailed bug report.

A.4.5 Disposal

Defective devices which should not be repaired or which are not safe because of their service life are applied as electronic waste and must be disposed as hazardous waste according to the local regulations.

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. They are subject to the harmonized standards of the series EN61800-5-1.

This is a product of limited availability in accordance with IEC61800-3. 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

	Acceptance according to UL is marked at KEB inverters with the adjacent logo on the type plate.
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To be conform according to UL for use on the North American and Canadian Market the following additionally instructions must be observed (original text of the UL-File):

- Information on the Brake Resistor Output ratings shall be provided
- For Drive Models with Brake Resistor Monitoring Board: Electrical ratings for the Brake Resistor Output and max. duty cycle shall be provided.
- For Drive models without Brake Resistor Monitoring Board: Information about the specific Frizlen Resistors and max. duty cycle shall be provided.
- Only for F5 series:
Control Board Rating (max. 30Vdc, 1A)
Encoder Board Rating (max. 30Vdc, 1A)
- F5/F6 series: Only For Drives with Brake Resistor Monitoring Board:
Auxiliary Contact K1-K2:
R300, 250Vac/max. 2A, 24Vdc/max.2A
- Terminal Block for thermal sensor T1-T2 : 10V, 0.01 A
- For 480V Models:
“Only for use in WYE 480V/277V supply sources (or similar wording)”
- „Maximum Surrounding Air Temperature 45°C“

- Internal Overload Protection Operates prior to reaching the 130% of the Motor Full Load Current” or equivalent wording. When the protection level is adjustable, the marking shall be provided with instructions for adjustment, or make reference to the manual for adjustment instructions.
- Short Circuit rating and Branch Circuit details.
- Wiring Terminals marked to indicate proper connections for the power supply, load and control circuit.
- „Use 60/75°C Copper Conductors Only“
- „Use in a Pollution Degree 2 environment“
- ”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“
- Main Input/Output Terminals - Torque Value for Field Wiring Terminals, the value to be according to the R/C or Unlisted Terminal Block used.

14(240V): 20.5 lb-in (2.3Nm)
 14(480V)- 17(480V): 20.5 lb-in (2.3Nm)
 15(240V) and 18(480V): 18.0 lb-in (2.0Nm)

- “For installations according to Canadian National Standard CSA C22.2 No. 274-13, following cULus line Filters manufactured by KEB Automation KG need to be installed:

Inverter size	KEB Filter Part No.
14F5, 14F6 (240V)	18E5 T60-1001
14F5, 14F6 (480V)	16E5 T60-1002
15F5, 15F6 (240V)	18E5 T60-1001
15F5, 15F6 (480V)	16E5 T60-1002
16F5, 16F6 (480V)	18E5 T60-1001
17F5, 17F6 (480V)	18E5 T60-1001
18F5, 18F6 (480V)	18E5 T60-1001

- Short Circuit rating and Branch Circuit Protection F5-G and F6-G housing:

Following markings shall be provided:

Short Circuit rating F5–G and F6-G housing:

For 240 V Models:

„Suitable For Use On A Circuit Capable Of Delivering Not More Than 10000 rms Symmetrical Amperes, 240 Volts Maximum, when Protected by J or RK5 Class.

See instruction manual for maximum fuse sizes“.

For 480 V Models:

„Suitable For Use On A Circuit Capable Of Delivering Not More Than 10000 rms Symmetrical Amperes, 480 Volts Maximum, when Protected by CC, J or RK5.

See instruction manual for maximum fuse sizes“.

Following information shall be present in the instructions:

Table with Branch Circuit protection for inverters F5–G and F6-G housing:

Inverter Size	Input Voltage [V]#	UL 248 Fuse Class RK5 or J [A]	UL 248 Fuse Class CC [A]
14	240 / 3ph	50	---
15	240 / 3ph	70	--
14	480 / 3ph	30	30
15	480 / 3ph	40	--
16	480 / 3ph	50	--
17	480 / 3ph	60	--
18	480 / 3ph	70	--

The Voltage Rating of the external Fuse(s) shall be at least equal to the input voltage of the Drives” (or similar wording)

- Only for F6 series:
“For Connectors X3A/X3B on Control Board 2KF6:
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”



Strain relief at housing G by use of mounting kit G0F4T88-0004

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
2-plate heat sink	Aluminium (-1.67V)	6 bar	0000650-G140

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

	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 1.5.2). 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!

Material	generated Ion	Standard potential	Material	generated Ion	Standard potential
Lithium	Li ⁺	-3.04V	Cobald	Co ²⁺	-0.28V
Potassium	K ⁺	-2.93V	Nickel	Ni ²⁺	-0.25V
Calcium	Ca ²⁺	-2.87V	Tin	Sn ²⁺	-0.14V
Sodium	Na ⁺	-2.71V	Lead	Pb ³⁺	-0.13V
Magnesium	Mg ²⁺	-2.38V	Iron	Fe ³⁺	-0.037V
Titan	Ti ²⁺	-1.75V	Hydrogen	2H ⁺	0.00V
Aluminium	Al ³⁺	-1.67V	Copper	Cu ²⁺	0.34V

Material	generated Ion	Standard potential	Material	generated Ion	Standard potential
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

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. Particularly 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.

Special requirements for open and half-open cooling systems:

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



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 90 °C depending on the power unit and overload capacity (see „Technical data“). To ensure a safe operation the coolant output temperature must be 10K 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 occurring 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:

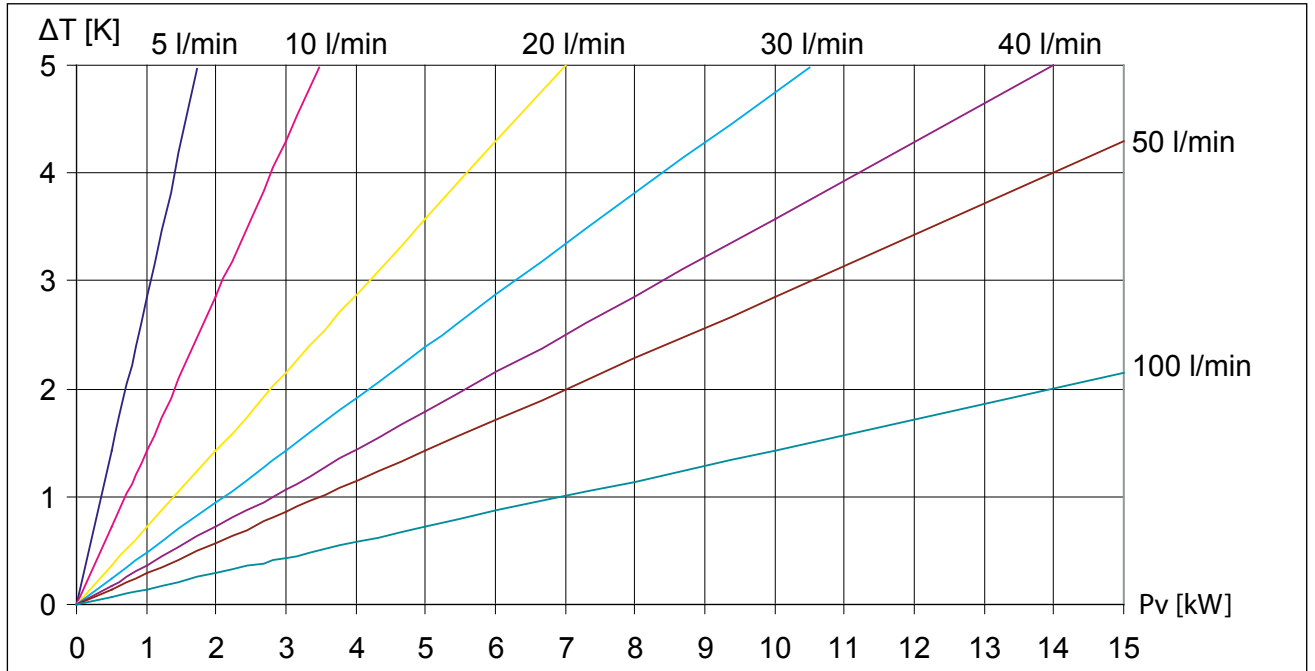
Coolant inlet temperature [°C] is depending on ambient temperature and air humidity

Air humidity [%]	10	20	30	40	50	60	70	80	90	100
Surrounding temperature [°C]										
-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

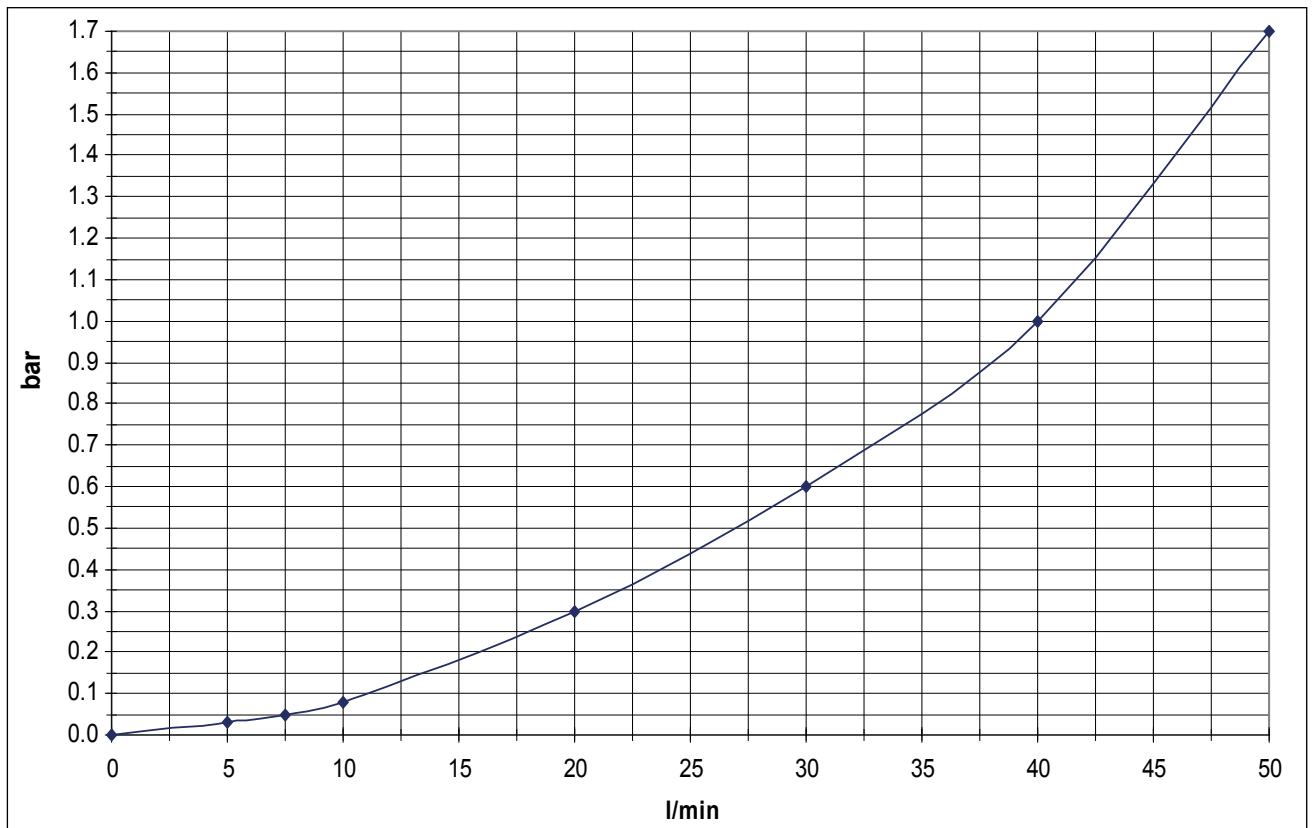
Temperature Control

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



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

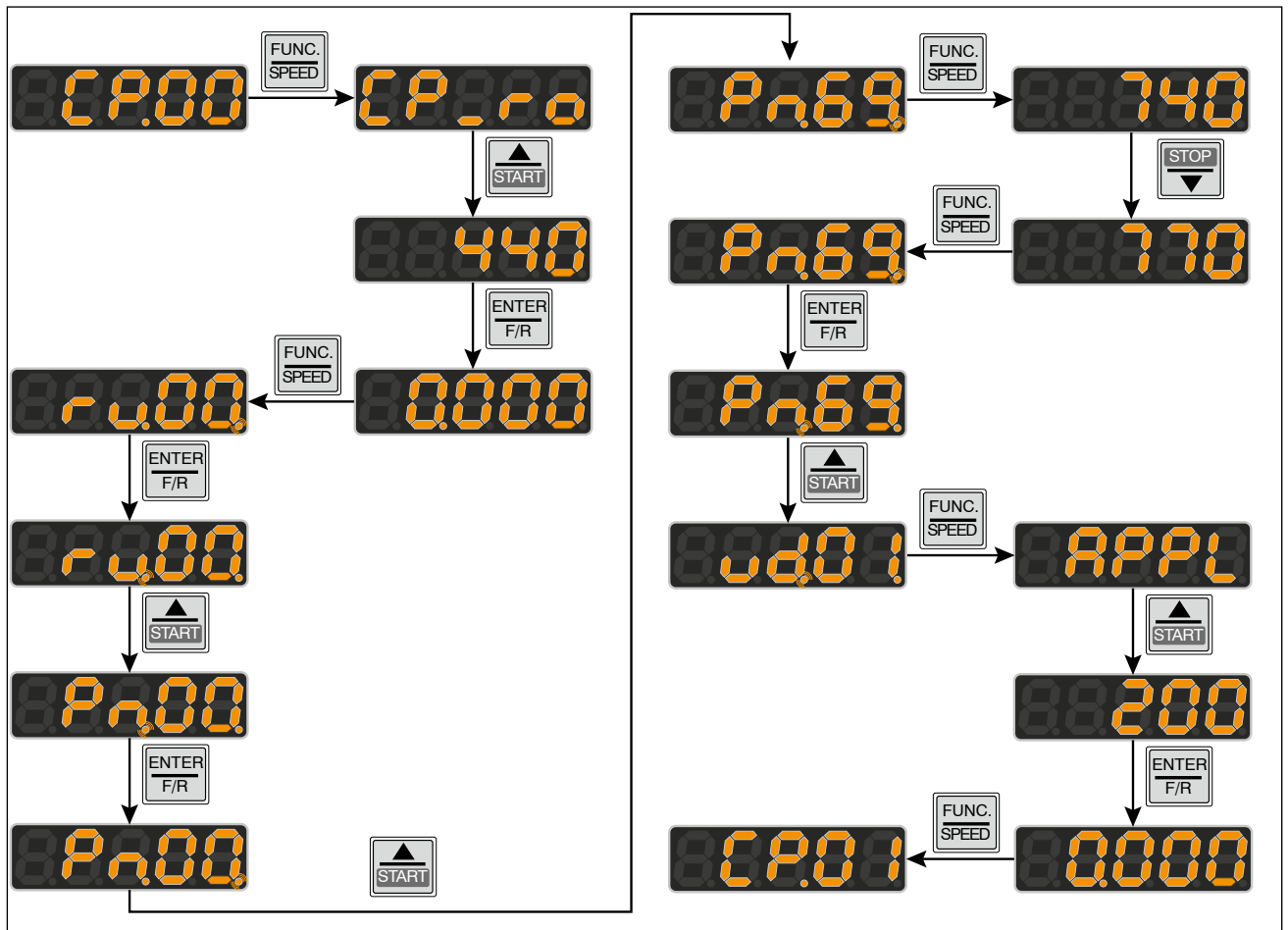


Annex D

D.1 Changing the response threshold of the braking transistor

(not valid for control type „BASIC“)

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





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